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**IGR COMBINED NO_x/SO_x CONTROL
TECHNOLOGY:**

**PHASE 1 TOPICAL REPORT
VOLUME 1**

PREPARED FOR:
DEPARTMENT OF ENERGY, PETC: DE-AC22-92PC91343
OHIO COAL DEVELOPMENT OFFICE: CDO/R-90-21

Dr. Arnold Z. Gordon

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DEPARTMENT OF DEVELOPMENT
OHIO COAL DEV OFFICE

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IGR ENTERPRISES, INC.
11000 Cedar Avenue
Cleveland, OHIO 44106
(216) 721 5511

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IGR NO_x/SO_x Control Technology

TOPICAL REPORT- DOE DE-AC2292PC91343 & OCDO CDO/R-90-21

EXECUTIVE SUMMARY

The objective of this project is to develop and demonstrate the feasibility of a new, simple, modular, all solid-state electrochemical technology for the simultaneous removal of NO_x and SO_x pollutants from utility coal-fired combustors, in a cost effective, reliable and practical manner. This IGR technology contains no moving parts. No solid or liquid inputs of any kind are required, and the only output is non-toxic commodity sulfur. There are no waste products.

In this solid electrolyte process, advantage is taken of the fact that O⁻² ions will transfer through certain ceramic oxides when driven by a small voltage. A metal oxide surface electrocatalyst selectively adsorbs NO_x and SO_x from a gas stream and when a voltage is applied, destroys the NO_x and SO_x.

The Phase I work has demonstrated the basic technical feasibility of IGR's NO_x/SO_x removal technology. We have successfully achieved NO_x and SO_x

removal in the presence of *large concentrations of oxygen* (including the range of oxygen levels in coal-fired combustors). We have demonstrated successful operation of IGR's NO_x/SO_x removal technology at greatly reduced operating temperatures. Significant progress has been made in the reduction of the electrical power requirements of the removal process. In particular, NO_x removal has been accomplished at power consumption levels that are economically feasible. In addition, the ability of this technology to remove SO₂ from a high concentration gas stream (such as that generated from the PETC Copper Oxide absorption process) has been demonstrated.

In summary, the Phase I work has served to resolve the basic feasibility questions associated with this technology. The importance of the Phase I work is that it has greatly reduced the technical risk associated with IGR's NO_x/SO_x removal technology, which makes the development of commercially feasible devices probable.

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SECTION I

INTRODUCTION

A. BACKGROUND

The problem: NO_x and SO_x emissions are principal sources of harmful effects on the biosphere, collectively referred to as "acid rain" after the observed increases in the acidity of rainfall downwind of urban areas. The observed pH drop is believed to largely result from NO_x and SO₂ emissions from fossil fuel combustion in coal-fired power plants and NO_x emissions from internal combustion engines [1,2]. The decreased pH in precipitation may be associated with the acidification of lakes, the loss of fish populations, injuries to forest and agricultural crops, and significant deterioration of stone buildings and similar structures.

NO_x in coal fired combustor exhaust principally arises from the direct high temperature reaction of oxygen and nitrogen contained in the combustion air. It is the goal of this to significantly reduce the release of NO_x into the atmosphere. Emission reduction of 99 % and target emission levels of less than 25 ppm are sought.

NO_x emissions from combustion processes can be controlled by combustion modifications or by post-combustion exhaust gas treatment. For example, one combustion modification approach to reducing NO_x production is to operate under "lean burn" (oxygen poor) conditions. Unfortunately this adjustment to decrease NO_x production may increase CO and

hydrocarbon production. It also reduces power production efficiency.

Rhodium catalytic converter post-combustion technology (honeycomb structure) is presently used for mitigation of NO_x pollutants from *gasoline* engines, but requires oxygen levels below 0.5%. This excludes its use in coal-fired power plants, where the exhaust ranges from 2% to 6% oxygen at the stack.

A different post-combustion technology that functions at higher oxygen levels is ammonia-based selective catalytic reduction (SCR). SCR injects a gaseous reductant into the exhaust gas which is then passed over a catalyst. In the presence of oxygen, the ammonia reacts with NO and NO₂ to form elemental nitrogen and water vapor. Under favorable circumstances, NO_x emissions are reduced by 80-95% [3]. However, this method is difficult to control. It is expensive and suffers from reliability problems that may not be tolerable for coal-fired electric power plants.

The IGR Approach: IGR and others [4] have proposed to use solid state chemistry to electrochemically reduce pollutants such as NO_x and SO₂ to their elemental constituents. IGR's solid state electrolytic technology has several attractive and significant advantages for the removal of combustor exhaust pollutants. No material consumables are required for these devices. Consequently there is no "slip" (unconsumed reagent in the exhaust) involved. This is an important benefit in the reliability of NO_x removal, relative to competing selective catalytic reduction approaches, since the "slip" in

SCR generally consists of materials that decompose photochemically in the atmosphere to produce NO_x. Safety is also enhanced by the lack of a liquid electrolyte.

A second significant benefit of this approach is that these devices contain no moving parts. The overall design is relatively simple, involving no sensors and feedback loops necessary to maintain operation. This technology is also inherently safe in that it has no catastrophic failure modes. Maintenance requirements of the resulting pollutant removal system will be minimal, and reliability is anticipated to be extremely high.

A third important benefit of this method for pollutant mitigation is that it may permit the re-tuning of combustors to which it is applied. That is, they need not be de-rated to minimize NO_x exhaust. IGR's technology can remove the NO_x that results from higher efficiency power production.

At the start of this Phase I project, this pollutant removal technology was in an early laboratory phase of research. It was limited by its oxygen tolerance (i.e., it only worked at low oxygen concentrations) and by its correspondingly low current efficiency (i.e., it took too much power).

The Results: In this Phase I work, significant progress and improvements have been accomplished regarding the limitations of oxygen tolerance and current efficiency. The basic technology has been demonstrated for a solid state *low power flue gas pollutant removal devices* that can easily be attached to coal fired

combustors, along the exhaust system. *This technology has been demonstrated to operate effectively at temperatures as low as 375°C, in 5.7% oxygen in the flue gas containing 500 ppm NO and at a power consumption of about 0.5% of the power generated in a typical coal fired power plant.*

Using the knowledge base and experience gained from the NO_x work, experiments were run determining SO₂ destruction as a function of oxygen level, temperature and power. *At 550°C up to 75% of the SO₂ was removed from gas streams containing 5.7% oxygen and 500 ppm SO₂.* This practical and cost effective exhaust pollutant removal technology can remove both NO_x and SO₂. In Phase I of this project, a dual module system has been proposed for the removal of NO and NO₂, resulting in N₂ and O₂ as products and for removal of SO₂, resulting in O₂ and commodity sulfur as products.

The principal enabling technologies in the development of these devices are the metal oxide electrocatalysts that are applied to the ceramic electrolyte cathodic surface. IGR Enterprises Inc. has achieved a significant innovation in electrocatalytic devices through the development of these materials. The electrocatalyst is a combination of metal oxides prepared via a sol-gel method to insure complete mixing.

The Phase I results can be summarized as follows:

Substantial progress was demonstrated in the expansion of operational temperature range. At the beginning of the Phase I work, operating temperatures

of 550°C or higher were generally required to get satisfactory performance. By the end of Phase I, operation at temperatures as low as 400°C had been extensively evaluated, and promising results were obtained at 375°C.

Operation in the presence of large concentrations of oxygen has been achieved. Substantial removals of both NO_x and SO₂ were obtained in oxygen levels up to 5.7% or greater. At the start of the Phase I effort the oxygen tolerance of technology was generally limited to below about 1%.

Economical removal of NO_x was achieved for high oxygen low temperature environment. Power consumption levels of less than 1% of the power generated by a coal fired power plant is possible while removing 90% of the NO_x. The low power consumption was achieved in the final weeks of the Phase I work (and in a continuation of this effort past the schedule term) through the development of new electrolyte formulations which reduced the power required by more than an order of magnitude.

In work to date, however, a similar power reduction has not been obtained for SO_x removal. A continuation of effort to improve the current efficiency and power efficiency of the technology for NO_x/SO_x removal is planned in the Phase II effort. The importance of the Phase I work is that it has greatly reduced the technical risk associated with IGR's NO_x/SO_x removal technology, making the development of commercially feasible devices highly probable.

This technical approach is also useful under very different pressure and temperature regimes than those encountered in coal fired combustors for power plants. For example, in parallel work (funded by the Air Force via a Phase I and Phase II SBIR), IGR is developing high temperature, high pressure versions of this technology that are suitable for use in jet engines in flight.

B. SCOPE

In Phase I, work was concentrated on three main technical limitations of the the technology. These are:

- Reduction of Device Operating Temperature
- Reduction of Device Power Requirements
- Operation in the Presence of High Levels of Oxygen (2-6% O₂ Levels)

Substantial technical viability has been demonstrated *in all three areas*, in the Phase I work.

The work effort involve assembly of test equipment, electrolyte synthesis, fabrication and characterization, electrocatalyst synthesis, application and testing and final engineering work on the design and operation of 1ACFM test modules for the purpose of NO_x and SO_x removal. In addition waveform studies and high SO₂ concentration work (PETC "Copper Oxide Process of Off Gas") was conducted. In the course of the work, we encountered and successfully overcame several technical difficulties (both anticipated and unforeseen). Information

that was obtained from these problems resulted in design changes to the proposed system. *The basic feasibility of this technology has been established.* The three main technical limitations of this technology were addressed.

In the Phase I work, we initially concentrated on the development of technology for NO_x removal. Then the information gained in this effort was applied to SO₂ removal. This strategy of developing NO_x removal first, and then proceeding to SO₂ removal, was followed for the following reasons:

- In our initial Phase I work we found that systems that worked for NO_x removal also worked for SO₂ removal.
- We concentrated on the development of the technology for NO_x removal first, in part because this did not require extensive time consuming cleaning of the test apparatus after each evaluation trial.
- Switching from SO₂ tests to NO_x tests required an equipment change over which could consume up to one full day. By limiting the switching between gases, IGR's evaluation strategy greatly increased the number of tests that were possible within the available time period.
- During the Phase I work, we then built upon the NO_x removal results, and used them to test the most promising strategies for SO₂ removal.

This strategy of concentrating on NO_x removal first was chosen to increase our total chances for success. This development strategy worked. By the

end of the Phase I work, IGR had achieved:

- Successful operation of the NO_x removal system in oxygen levels between 2% and 5.7%, and promising operation at levels as high as 11.5% oxygen. Power consumption is at levels that are compatible with economical operation in a coal-fired power plant.
- SO₂ removal was achieved from SO₂ gas mixtures, containing up to 5.7% oxygen but at lower power efficiencies than the NO removal.

Coal burning utility power plants typically contain 2-6% oxygen in their flue gas. Thus during the Phase I work, we have been able to extend the "oxygen tolerance" of the process from below the commercially acceptable range to a performance level that fully includes the range of oxygen levels found in coal burning power plants.

SO₂ removal (with downstream solid sulfur collection) was also obtained from high SO₂ concentration gas mixtures, containing up to 40% SO₂ (*PETC Copper Oxide Process*).

The proposed Phase II work will be to:

- Continue the effort to improve the current efficiency of the technology for NO_x/SO_x removal. Specifically, improvements related to electrochemical sciences issues (oxygen tolerance and current efficiency for SO₂ removal from flue gas) will be achieved.
- Optimize the efficiency of the IGR process in removal of SO₂ from a high

concentration gas stream. This gas stream is generated by a copper oxide absorption process that is presently under development at DOE (PETC Copper Oxide Process). This gas stream is about 40% SO₂ with the principal balance being methane and CO₂. *IGR has demonstrated the basic feasibility of the process to directly convert the sulfur dioxide (SO₂) into elemental sulfur.*

- Optimized systems for combined NO_x/SO_x removal will then be subjected to flyash tests.
- A 1 ACFM unit will then be tested using under utility flue gas conditions. This unit will be used to demonstrate cost-effective operation under these conditions.
- Finally, a 100 ACFM unit will be designed, fabricated and tested in Phase II work, to resolve materials science and any remaining electrochemical issues.

SECTION II

TEST DESCRIPTION AND RESULTS

A major objective of the Phase I work was to demonstrate that this technology can, in fact, be used to destroy NO_x and SO_x at temperatures, and in the presence of levels of oxygen that are appropriate for a flue gas pollutant mitigation application. The work involved in carrying out this objective included the development of testing equipment and evaluation of different combinations of FSE,

electrocatalyst and electrodes, at different temperatures and gas mixtures, using different driving waveforms.

A. TEST RIG DEVELOPMENT

One necessary task of the Phase I work involved the design, assembly, and debugging of the computer operated electrocatalytic test bench. The test bench consists of three major components: the furnace assembly with sample holder, the data acquisition system, and the FT-IR gas analyzer.

The furnace assembly consists of a 1.25" clamshell tube furnace that holds the sample tester assembly. The sample tester consists of an outer quartz tube that can be sealed to allow for a controlled atmosphere around the sample. The sample holder, which fits inside the quartz tube, consists of a mullite ceramic tube with a slit cut in it to hold the sample. Appropriate electrical leads to the pellet are achieved by painting metallic leads on the mullite holder.

Gas flow and composition to the sample tester is controlled by a series of computer operated solenoid valves and three MKS gas flow controllers. Where ever possible stainless steel 316 tubing and fittings are used to minimize the possibility of gas circuit leaks. See **Figures 1 and 2** for detailed schematics. **Figure 3** is a photograph of the test apparatus.

The second arm of the test bench, the data acquisition system, is run from a computer that includes a 486DX micro-processor running at 50 MHz with 32 MB Random-Access-Memory (RAM). The hard disk (C:) has a capacity of 300 MB and there

Figure 1. Test Bench.

Figure 2. Details of Test Cell.

Figure 3. Photograph of Test Apparatus.

are 5.25" (A:) and 3.5" (B:) disk drives. An additional 16 MB disk (D:) has been created from the RAM to record data during test runs. This RAM disk allows us to achieve the maximum sampling rate of 1000 Hz (*i.e.* 1 millisecond period) by writing the data to memory chips rather than to the hard drive.

The software data acquisition and analysis package being used is "LabTECH Notebook" supplied by Laboratory Technologies Inc. The software/data acquisition boards are presently configured to supply analog output signals, 5 analog input signals and 3 analog output signals. To accommodate the collection of current and voltage

information when a non-DC voltage waveform is used, the rate of data acquisition can be varied up to the software maximum of 1000 Hz.

The final component of the test bench system is the gas analyzer. IGR chose to use a FT-IR supplied by Nicolet corporation. The advantage of using an FT-IR as opposed to using a more dedicated gas analyzer such as a NDIR is that we were not be limited to sampling only one or two gases (NO and SO₂), but could simultaneously evaluate other potential components of the gas stream such as water, NO₂, SO₃ and NH₃.

The FT-IR is operated by its own computer, with the data time stamped to

allow for easy matching with the direct electrochemical current/voltage data. Resolution of the instrument can be controlled by adjusting the number of scans per reading or by changing the path length of the IR optical cell. *A partial set of plots for the experiments conducted in Phase I is contained in the Appendix to this report.*

The gases used in the calibration work were argon, nitrogen containing various levels of oxygen, sulfur dioxide at 500 ppm in nitrogen, nitrogen oxide at 500 ppm in oxygen and nitrogen dioxide at 100 ppm in nitrogen. Calibration of the FT-IR has involved making two types of (optical) FT-IR measurements. In the first of these we are measuring the infra-red optical spectra of NO₂, NO and SO₂ as supplied directly from the high pressure gas tank to the FT-IR optical gas analysis cell. In transit to the optical cell the gas has to first pass through approximately 5-10 feet of room temperatures stainless steel 304 and 316 valves and tubing ("the bench gas bypass").

In a second type of control/calibration test we pass the gas along the same gas circuit as the first set of tests except it additionally is routed through the hot electrochemical reactor *at open circuit*. No electrochemistry can occur at open circuit and any difference between the two optical tests results solely from spurious catalytic (not electrocatalytic) responses of the open circuit high temperature reactor. No significant difference were found between the two gas circuit paths, suggesting that any alterations in the gas composition in subsequent testing is due to the electrochemistry, not miscellaneous

thermal or catalytic effects.

A 10 cm path length Pyrex FT-IR optical gas cell with calcium fluoride windows was of sufficient size (optical path length) for the SO₂ gas compositions that were studied. This cell has the advantage of being relatively inexpensive, simple, chemically inert and comparatively rugged. The relatively short optical path of only 10 cm was sufficient for sulfur oxide measurements, however the nitric oxide (NO) measurements required the longer optical path length of 1.7 m, in order to be easily visible. This is because the triatomic sulfur dioxide molecule has a much stronger infra-red extinction coefficient (light absorption coefficient) than the diatomic low-dipole nitrogen oxide.

B. IGR DUCTILE COMPOSITE CHARACTERIZATION

The preparation protocol for the ceramic electrolyte is composed from several sequential steps including the formulation, calcining, and sintering procedures. If reasonably optimized an energy efficient,

mechanically robust, foundation composite suitable over a broad range of temperatures and process conditions is the result.

Initial Phase I matrix work involved the optimization of the freeze drying, calcining and sintering of the ceria stabilized electrolyte freeze dried powder to allow for optimum performance of the IGR composite.

Freeze drying involves placing the desired composition into an aqueous solution, quickly freezing the solution, placing the frozen solution under a vacuum, and subliming the solvent (water). If done properly the resulting dry free flowing powder has virtually the same level of intimate mixing as did the precursor true thermodynamic solution. Ceramic materials made from such powders tend to be of a very high quality.

Freeze drying of precursor solutions required several problems to be overcome. Initially the frozen solutions were melting before freeze drying was complete. Various methods of freezing and insulation of the material were tried with limited success. IGR concluded that the dried salts were concentrated on the ice and depressing the melting point. Therefore a second set of tests were conducted with a series of polymeric additives added to the solution before freeze drying. Using this approach the concentration of the solution could be increased to 0.5 M with no evidence during freeze drying. No special freezing procedures were required and any volume of solution could be freeze dried.

Calcining of the freeze dried powder was to remove organics and convert the cations to the oxide phase. Powders were calcined between 900°C to 1125°C. Surface areas of the calcined powders were determined by 3 point BET surface area analysis. (Ideally ceramic powder should have a surface area between 8-12 m²/g to allow for easy and effective processing.) Figure 4 shows the surface area versus calcining temperature results which were lower than anticipated.

As a result of the low surface area the freeze dried powders required milling. Powders, after milling for approximately 7 days and forming into parts, had sintered densities of up to 6.9 g/cc. To reduce processing time the ball milling time was reduced to 24 hours. This resulted in a marked reduction of the sintered density, usually to about 4.7 g/cc.

These results appear to imply that the powder generated by the freeze dry/calcining process is agglomerated and that milling is required to give an active powder that is relatively easy to sinter. The theoretical density for this ceramic solid electrolyte material is given in the literature as approximately 7.1 g/cc. IGR's density of about 6.9 g/cc is approximately 97% of theoretical. This results in optimum electrolytic properties.

The electrochemical testing of the ceramic electrolyte in air is a necessary internal quality control step to verify that the solid electrolyte is exhibiting the desired electrochemical properties such as electrolytic conductivity, energy of activation, acceptable voltage span, and the like.

Electrochemical data on the stabilized solid electrolyte material was determined over the relevant range of temperatures and voltages using a Pine Instruments potentiostat. A disk sintered at 1400°C was used for this work. This sample had a sintered density of 6.1 g/cc. The high density of the sample is associated with improved electrochemical properties, probably due to the elimination of non-equilibrium minority ceramic phases, intragrain electrical defect structures, and stabilization and ordering of the grain boundaries. The sample was tested from 400°C to 800°C.

In the course of the work we changed the ceramic component that was used. There were two reasons for doing so. The first stems from aspects of the manufacturing

of the ceria/gadolinia powder originally proposed. It is made via a freeze drying process that gives a uniform, atomically homogeneous powder. Unfortunately the sintering temperature of the powder turned out to be much higher than anticipated (1450°C) and production of the powder by the freeze drying method proved to be quite slow due to the size of the freeze drier (250 gm/wk). Although it may be possible to speed this production up, we determined that if we used only this material, the work that could be accomplished in Phase I would have been severely limited and might have precluded demonstration of the feasibility of NO_x removal concept. **Therefore for the Phase I work we principally used a fully yttria stabilized ZrO₂ as the ceramic electrolyte.** This material is commercially

Testing: Testing of the samples prepared as described above were conducted in our computer controlled pellet tester described previously. In all cases the gas composition and flow was 20 sccm of either NO (630 ppm NO in nitrogen) or SO₂ (500 ppm SO₂ in nitrogen) with oxygen added as air at between 0.5 and 8.0 sccm. The temperature was varied from 375°C to 900°C with the majority of work being conducted between 400°C and 550°C. Cell voltages between 10 mV and 10 V were applied to the samples with the majority of tests conducted between 10 mV and 5 V. Changes in the gas composition were determined via FT-IR in real time.

Results: Approximately 100 different electrocatalyst compositions were prepared and tested. Further variation in composition and application technique were explored to see if either the morphology or oxidation state of the electrocatalyst had a significant effect on either SO_x/NO_x removal.

The electrocatalyst consists of two major components each made up of several subcomponents. Compositional changes involved varying the ratio's of the two major components or varying the ratio or composition of the subcomponents.

Processing changes involved variations in processing atmosphere, use of a retort or increases in either processing time or temperature. Finally limited changes in the carrier solvent of the electrocatalyst were explored to change the morphology of the electrocatalyst. The goal of this work was to achieve a redox state and surface structure in the electrocatalyst that was favorable to the absorption and destruction of either NO_x or SO_x.

Through a series of iterative tests, IGR was able to identify an electrocatalyst composition which gave the best results at specific levels of oxygen. These comparisons were made in terms of percent removal (at similar conditions). At high oxygen levels, the selectivity of the best electrocatalyst was evident. Table 1a and 2a in the Appendix is a list of all electrocatalysts tested, including temperature, percent oxygen, and current required, with the FT-IR spectra for some of these tests. Data for selected tests is given in Table 1 below. Corresponding FT-IR spectra are in the appendix.

The results in Table 1 highlight what is achievable using optimized electrocatalyst applied to a standard yttria stabilized zirconia electrolyte. The most efficient electrocatalyst was that used in test 6129529.2. For comparison, test results with no electrocatalyst are also presented. Note that for the pellet without electrocatalyst that no pollutant removal was noted when the oxygen present in the flue gas stream exceeded 0.9%. Note that similar electrocatalyst was used to obtain the substantial removal of either NO_x or SO_x as shown in Table 2. It was this similarity of results that allow IGR to

Table 1. Selected Tests Under Similar Condition Showing the Effect of Electrocatalyst.

Test Gas: Nitric Oxide 600 ppm flowing at 20 ccm. Active Area: 2.9 cm ² .				
Test Number	Temperature °C	% Oxygen	% Removal	Current mA
6129514.5	550	5.7	60	870
6129516.5	550	5.7	50	200
6129524.2	550o	5.7	50	361
6129529.2	550	5.7	70	308
5129526.11	550	5.7	25	404
6129533.3	550	5.7	30	254
No Electrocatalyst	550	0.9	75	150
No Electrocatalyst	550	5.7	0	1000

concentrate on NO with only limited excursions with SO₂.

D: CURRENT EFFICIENCY

Current efficiency (the rate of pollutant removal per unit of electric current) depends upon the electrolyte and the electrocatalyst coatings applied to the electrolyte. Low current efficiency results in excessive power consumption and decreased cost effectiveness of the device.

While improved electrocatalyst formulations and application methods resulted in increased oxygen tolerance and increased pollutant removal rates, the

current requirements of these samples were excessive.

Low current efficiency can occur due to the formation of either a non-electrolytic current path or a lack of selectivity of the electrocatalyst for either NO_x/SO_x resulting the reduction of large amounts of molecular oxygen from the flue gas. Non-electrolytic current paths can occur due to the application of thermodynamically large voltages to the solid electrolyte resulting in a partial reduction at the cathode. This may result in n-type electronic doping of the electrolyte.

Table 2. NO/SO_x Removal Using Similar Electrocatalyst

Test Number	Temperature °C	Gas	% Oxygen	% Removal	Current mA
6129518.2	550	SO ₂	1.0	60	440
6129518.4	550	SO ₂	1.8	70	792
6129518.5	550	SO ₂	4.6	80	796
6129518.7	550	SO ₂	5.7	75	630
6129514.1	550	NO	1.0	80	230
6129514.4	550	NO	4.6	65	765
6129514.5	550	NO	5.7	60	870

Results: During the course of the Phase I work IGR found that except for zero oxygen conditions or extremely high current densities across the sample it was very difficult to form a non-electrolytic current path. Based on this result IGR did not investigate the application of topcoats for the sole purpose of preventing a non-electrolytic current path.

Samples that did form this path suffered a rapid loss in performance and in many cases suffered mechanical failure. In many cases a black reduction zone surrounded the crack. It appears that when the zirconia was reduced it experienced a volume change which allowed a crack to propagate.

Therefore based on results noted in the electrocatalyst development work the following model was proposed which would account for the high current requirements. The model concludes that the desired fundamental mechanism for

efficient NO_x and/or SO_x removal is dependent on both the electrocatalyst and the electrolyte.

The proposed fundamental destruction mechanism can be summarized (for the case of NO) as follows:

Proposed Fundamental Cathodic
Electrode Mechanism

The proposed overall electrode (cathodic) reaction is:

The resulting oxide ions are oxidized at

the anode to yield oxygen gas and to complete the electrical circuit.

Site A is thought to occur in the electrocatalyst and is the initial site of adsorption of the NO molecules. The bound molecules, which may be bound as pairs of NO molecules, may then "hop" in the absorbed state from site to site at the gas solid interface until they reach a site B.

At site B two bound nitric oxide molecules disproportionate to yield half a mole of nitrogen gas and a (bound) molecule of nitrogen dioxide. This process does not seem to occur in the absence of an applied voltage so we consider it an electrochemical step. On net this step involves the change in chemical valence of two nitrogen atoms from +2 to 0 and +4. Under certain experimental circumstances we can see in our optical cell some NO₂ which we did not input. We believe that this NO₂ may have become unbound from the surface after this step occurred. As elemental nitrogen does not absorb in the IR it would not be noted in our FT-IR.

Most of the nitrogen dioxide is thought to remain bound to the surface of the solids where it may hop to a site C wherein it is electrochemically reduced in a straightforward way to yield the balance of the elemental nitrogen gas and solute oxide

ions. It is at site C wherein oxygen gas is thought to compete with the nitrogen oxide reduction. IGR believes that site C is a crystal electronic defect site closely associated with the zirconium +4 ion. A similar mechanism can be proposed for SO₂.

Therefore IGR embarked on a program to explore modifications of the electrolyte itself. This was done to develop a specific crystal defect structure that was selective for NO_x and SO_x decomposition and inactive for molecular oxygen.

Approximately 35 different modifications to the powder were prepared and tested. For each composition samples were sintered in various oxidizing or reducing environments to encourage different crystal defect structures.

Only limited improvements were noted for most additions however one class of additions *improved the current efficiency for NO_x removal by approximately a factor of ten when combined with an optimized electrocatalyst.* Results from this series of tests is shown in Table 3. To achieve 25% removal of 600 ppm NO_x at 20 ccm from a simulated flue containing 5.7% oxygen requires 12 mA. These results compare favorably to that noted in Table 1 for the optimized electrocatalyst

Table 3. Optimal Electrolyte/Electrocatalyst Results With NO Gas.

Test Number	Temperature oC	% Oxygen	% Removal	Current mA
6129573.32	400	5.7	9	10
6129573.33	425	5.7	27	10
6129573.15	450	5.7	25	12
6129573.20	550	5.7	0	28

alone. Thin films of this material with the electrocatalyst can achieve this current with an applied voltage of 0.030V. The required current is much higher than expected but the required voltage is much less than predicted.

Unfortunately the improvements seen for NO_x removal due to doping the electrolyte did not transfer to SO_x removal. These results are shown in Table 4. Continuation of this effort, so as to develop materials for SO₂ removal at similarly good efficiencies is a part of the

For both approaches, the goal was to provide additional crystal defect sites for the electrocatalytic destruction of NO_x.

Table 4. Optimal Electrolyte/Electrocatalyst Results With SO₂ Gas.

Test Number	Temperature °C	% Oxygen	% Removal	Current mA
6129576.11	400	1.8	2	9
6129576.12	425	1.8	0	10
6129576.13	450	1.8	0	12
6129576.15	550	1.8	0	23

proposed Phase II work.

In addition to modifying fully stabilized zirconia with other oxides a second line of research was followed. This work involved the fabrication and testing of both higher and lower oxygen ion conducting solid oxide electrolytes in combination with an optimized electrocatalyst. The higher conductivity electrolytes were principally stabilized bismuth oxides which were slipcast into pellets and tested.

while simultaneously reducing the amount of current required to carry out the process. We found that using higher conductivity solid oxide electrolytes, with our best electrocatalyst, had the paradoxical effect of lowering the amount of NO_x removed for a given condition. In addition, the higher the ionic conductivity of the electrolyte the lowered the oxygen tolerance of the system. Lower conductivity electrolytes showed no activity for pollutant removal even with high applied voltage and current.

The second approach involved the compositional modification of our standard fully yttria stabilized solid

electrolyte with different oxides. In most cases, the removal of NO_x was adversely affected by either the oxide additions or by variations in the preparation procedures.

After a great many trials of various combinations of additives and preparation procedures, success was achieved for NO_x removal. An "optimal" formulation and preparation procedure was found, for which the electrical current requirements dropped by approximately an order of magnitude.

This suggested mechanism is consistent with our experimental evidence to date, but should not be considered to be scientifically "proven" as alternative or modified mechanisms are also possible.

IGR was able to successfully destroy NO_x at a power consumption of 0.6% of power plant production, due to a combination of low applied voltage, 0.030V and a current of 4.9E6 amps per gram mole of NO_x destroyed. *To date, IGR has made substantial progress towards the goal of effective efficient SO_x removal.* For high concentration gases, excellent performance was obtained. For example, **Figure 5** is a photograph of sulfur collection during destruction of SO_x from a gas stream of 40% SO_x. Due to the very high concentration of SO₂ quantitative FT-IR spectra were difficult to obtain.

During the Phase I work, removal of SO_x at concentrations corresponding to flue gases has not been achieved at an economically feasible level of power consumption. However, based upon our NO_x experience, we have identified a number of specific steps for improvement

of SO_x removal that should result in significantly improved performance.

E. DRIVING WAVEFORMS

IGR has previously carried out work which suggested that nonlinear discontinuous DC waveforms may be advantageous. In particular it was observed that in a low oxygen environment the activity and selectivity of the first 100 mS of current is very different from the "normal" steady state condition. This is illustrated in **Figure 6** where the current is about 80X greater than the steady state value. It was thought that higher net rates of reaction (lower capital costs) and improved selectivity (lower operating costs) would result. A temporary, but useful, voltage induced catalytically active surface might result from the passage of the electrical power. The active surface degrades only slowly with time relative to the time period necessary to create the surface.

Results: Initial work with waveforms was conducted using three gases with different

Figure 5. Elemental Sulfur Deposit as a Result of SO₂ Destruction.

Figure 6. Non-Linear Wave Form.

oxygen concentrations. The 3 test gases were industrial grade argon (about 50 ppm O₂ as a contaminant), 560 ppm oxygen in nitrogen, and 10,000 ppm (1.0%) oxygen in nitrogen. The oxygen level in the argon stream is termed as "low P_{O₂}". The 560 ppm oxygen containing gas is "medium P_{O₂}". The oxygen level in the 10,000 ppm oxygen stream is comparable to the O₂ gas levels we must deal with in a flue gas stream. We termed this gas as "high P_{O₂}". Voltage "on" times were varied from 10 milliseconds to 100 milliseconds. Voltage off times were varied from 10 milliseconds to 60 milliseconds.

Low P_{O₂} Testing With Non-DC Waveforms:

We experimentally observed that the concentration of oxygen in the flowing gas stream had a significant effect on the steady state diffusion limited current that was measured. An example of this is seen for a test run in flowing industrial grade argon. (This grade of argon is commonly contaminated with roughly 50 ppm O₂, the argon component of the gas stream is electrochemically inactive).

Figure 7 is a current versus time plot immediately after the

periodic voltage was applied to the system. Previous to this test the sample had been at open circuit for a period of tens of minutes allowing for any oxygen gas concentration gradient at the cathode to collapse and the cathodic (reducing) surface to equilibrate with the passing gas stream. The peak current observed in this experiment was about 58 mA which very slightly degrades to about 55 mA during the balance of the power on portion of a given cycle. The latter value is about 95% of the initial value.

The relatively insignificant decay of the current under these circumstances

Figure 7. Current vs Time, in Argon.

suggests that the concentration gradient at the cathode is formed to a negligible degree under these conditions over a term on the order of a few *seconds*. That is slower than we anticipated and allows for considerable electrochemical "elbow room" in our use of the waveform technique to manipulate the concentrations of the differing gaseous components at the electrode surface.

About ten seconds later a second set of readings were made and the current versus time plot is shown in Figure 8. The *only difference* in the two sets of data is the ten or so seconds which have elapsed as the computer drove the system with the listed waveform. In this second set of data the peak current remains at about 58 mA, however the nominal steady state current now decays to about 22 mA, a value which is only 38% of the initial reading. This may be compared to the initial

electrochemical data (Figure 7) wherein the current decayed very slightly (95%). The observed behavior of figure 8 was maintained over the next two hours. It is apparently the true steady state behavior of this system under these conditions of flow, concentration, temperature, and waveform.

This data shows that an oxygen concentration gradient develops over a term of about 10 seconds at the surface of the sample. This gradient then becomes the limiting current factor.

Figure 9 is a very similar test except the voltage was applied for 100 millisecond and off for 30 milliseconds for an on/off ratio of 3.33. In the previous two experiments the power on/off ratio was 0.50. Clearly the experiment of figure 9 was being driven much harder, and begins to approach the limiting case of a simple DC voltage.

Figure 8. Current vs Time, in Argon.

Figure 9. Current vs Time, in Argon.

The current in **Figure 9** drops from an initial peak of 50 mA to about 3 mA over the 100 milliseconds of applied voltage. The initial current peak is slightly lower than in the first two experiments, probably because of concentration gradient does not completely collapse and full adsorption occur during the relatively smaller "off" portion of the duty cycle. The 3mA current is only about 6% of the peak current demonstrating a very considerable concentration gradient under these conditions. The use of a "traditional" DC circuit would have limited the maximum current in this system to less than 3mA in lieu of the much greater currents which we have demonstrated are available by the use of the techniques of Task 4. These higher currents will lower the overall costs of IGR technology.

Medium P_{O₂} Testing With Non-DC Waveforms: To ascertain the quantitative effects of oxygen partial pressure on the electrochemical performance the gas stream was changed from industrial grade argon to 560 ppm oxygen in nitrogen. This amounts to a nominal increase in the oxygen partial pressure of about 10X.

Figures 10 and 11 show the results of tests using this gas stream. The experiments are identical to **Figures 8 and 9** respectively except for the ten fold higher P_{O₂} in **Figures 10 and 11**. Note, in particular, that in comparing **Figures 9 and 11** that the "limiting current" for the higher oxygen case is about 5X greater, this is approximately consistent with the theoretical considerations as subsequently discussed. If a DC waveform had been used and the system had been allowed to

form a stable gradient the theoretical prediction is for the true limiting current to be proportional to the concentration of the oxygen in the bulk gas.

High P_{O₂} Testing With Non-DC Waveform: To further understand the quantitative effects of oxygen partial pressure on the electrochemical performance the gas stream was changed from 560 ppm oxygen in nitrogen to 10,000 ppm (1%) oxygen in nitrogen. This amounts to a nominal increase in the oxygen partial pressure of about 20X over the medium P_{O₂} gas stream and 200X over the low P_{O₂} gas stream.

Figures 12 and 13 give the analogous current versus time plots for conditions identical to those previously described except the gas was changed to 10,000 ppm O₂ (1%) in nitrogen. Note that the limiting currents are reached very quickly and are a full 84% of the peak values, this is because the high level of oxygen gas results in a very shallow gradient. In summary the data seems to indicate that we are electrochemically creating an oxygen concentration gradient at the surface of the sample and that this gradient is dependent on the amount of oxygen present in the bulk gas stream, the duty cycle, and the time elapsed.

This data may be evaluated in light of theoretical considerations for transport in electrode processes. For the case of *linear* diffusion in the gas phase the limiting diffusion current density is given by the Cottrell equation:

$$j = -nFC^{\circ}_{ox}\{D_{ox}/t\}^{1/2}$$

where j is the current density, n is the

Figure 10. Current vs Time, in 560 ppm Oxygen.

Figure 11. Current vs Time in 560 ppm Oxygen.

number of electrons transferred per mole (4 for O₂), F is Faraday's constant, C_{ox}^o is the partial pressure of oxygen in the bulk gas, D_{ox} is the diffusion constant for the reactive species and t is the time elapsed.

For the case of *convective* diffusion in the gas phase the limiting diffusion current density is given by the Ilkovic equation:

$$j = -nFC_{ox}^o \{7D_{ox}/3t\}^{1/2}$$

where the symbols have the same meaning as the above case.

Note that in both types of diffusional controlled transport the current at a given moment in time is proportional to the initial partial pressure of oxygen in the gas stream and that the current density approaches its limiting value asymptotically as the square root of the time elapsed. The data we observed appear to be in agreement with these theoretical considerations.

The above work with just oxygen containing gasses indicated that significant power reduction might be achievable for NO_x and SO_x removal if the anticipated electrochemical reduction could be made specific to those species which are adsorbed to an *active site* on the surface, which is a function of the electrocatalyst. By applying a varying voltage to constantly recycle the active sites on the electrocatalyst and allowing for any concentration gradients to collapse very high current efficiencies are possible as seen with the oxygen work.

A large number (97) of trials were carried out using square waves (i.e., voltages switching off and on), with different

magnitudes of voltage and different on and off times, ranging from 10 milliseconds to 60 seconds. Waveform tests are listed in Table 1a in the appendix along with corresponding spectra. Note that significant NO_x removal rates were achieved but at very high currents.

Despite the occurrence of the transient phenomena described for the oxygen containing gases, we did not observe any significant improvement in current efficiency when these non-constant driving voltage waveforms were used in conjunction with either NO_x or SO_x in the gas stream. *It appears that the choice of electrocatalyst is far more critical than the choice of waveform.*

F. FLYASH EFFECTS

Due to the extended time required in developing an effective electrolyte and electrocatalyst combination, no work was conducted on flyash tests during Phase I. It was felt that conducting flyash tests on systems that were not close to what would eventually be placed in service would not give relevant information.

G. SINGLE CELL DESIGN, FABRICATION, TEST AND DEMONSTRATION

Design of the NO_x/SO_x Mitigation Device: The basic system structure for IGR's NO_x/SO_x removal technology is shown in **Figure 14**. Flue gases will sequentially flow through the NO_x and SO_x modules. The use of our FSE technology allows for the adjustment of the geometry of the flow path of the active surface area to achieve different tradeoffs between back pressure, pollutant removal rate, weight and power

Figure 14. Design of the NO_x/SO_x Mitigation Device.

requirements.

The proposed device utilizes a "bipolar stack" arrangement of unit cells (shown in Figure 15). The individual cells are stacked together such that the anode of one cell is electrically contacting the cathode of the next cell. This places the cells within a module in electrical series. The current is constant across all of the cells, and the voltage through the cells sums linearly with the number of cells. This arrangement comprises a scaleable "modular" form that is relatively easy and inexpensive to adapt to a wide variety of applications. To minimize the pressure drop across the module, the cells are (gas) manifolded in a parallel manner. The inlet gas moves parallel to the planes over the

short dimension of the rectangle. The electrical power moves perpendicular to the planes of the stack. One of the advantages of this gas parallel design is the ability to vary the intercell spacing (the exhaust gas stream plenum width), to maintain the pressure drop at an acceptably low value. By varying the electrical current applied to the module the rate of pollutant removal can be adjusted.

Figure 15. Bipolar Stack Arrangement.

inlet gas passes through the reaction module and contacts the cathodic zone of the unit cells, where electrochemical reduction of NO_x yields elemental nitrogen gas which becomes incorporated into the passing exhaust gas:

The oxygen originating from the pollutant molecules accepts two electrons per oxygen atom and dissolves, as oxide ions, into the cathodic zone of the ceramic electrolyte. Oxide ions are transported across an electrolytic barrier by ion conduction. In the

anodic zone of the cells, oxidation occurs and an equivalent number of oxide ions are converted to oxygen gas with the electrons being returned to the external power circuit. The anodic (oxidation) electrode reaction is:

Thus the overall process for the cells in the NO_x module is:

Removal of NO_x : The typical reactions for NO_x removal are described below. The

Removal of SO_x : A similar process

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occurs for SO_x removal. The typical reactions for SO_x removal are described below. The inlet gas passes through the reaction module and contacts the cathodic zone of the unit cells, where electrochemical reduction of SO_x yields elemental sulfur stays in the vapor phase, and condenses as the flue gas cools below 120°C .

The oxygen originating from the pollutant molecules accepts two electrons per oxygen atom and dissolves, as oxide ions, into the cathodic zone of the ceramic electrolyte. Oxide ions are transported across an electrolytic barrier by ion conduction.

In the anodic zone of the cells, oxidation occurs and an equivalent number of oxide ions are converted to oxygen gas with the electrons being returned to the external power circuit. The anodic (oxidation) electrode reaction is:

Thus the overall process for the cells in the SO_x module is:

For removal of either SO_x or NO_x from the pollutant gas stream, for a compound to be reduced (at the cathode of the chamber), a potential greater than the thermodynamic

potential for that compound must be applied across the cell. To reduce the unstable nitrogen oxides, any cathodic voltage will meet this thermodynamic requirement. In principle, as the applied voltage increases above this thermodynamic minimum value, the rate of decomposition increases in an exponential fashion, up to some as yet undetermined current density. This phenomenon allows for a flexible trade-off between device size (and capital costs) and operating costs.

To reduce more stable compounds such as CO_2 or H_2O , a higher potential must be applied. NO_x may be selectively removed from the inlet gas by maintaining the applied potential below about 1.25 volts. By doing so, N_2 , H_2O and CO_2 will pass unchanged through the device and will not interfere with the cathodic reduction of NO_x . Some amount of O_2 will be reduced in this module, reducing the overall efficiency of this process.

To alleviate this source of inefficiency, IGR has developed proprietary electrocatalysts which, under appropriate temperature and composition conditions, absorb and reduce nitrogen oxides or sulfur oxides at the electrocatalytic surfaces, *in lieu of oxygen*.

The observed current passing through the overall IGR reactor is the sum of two discrete currents:

$$i = i_{\text{ionic}} + i_{\text{electronic}}$$

The ionic current results from transport of oxide ions and in a completely efficient system is proportional to the

electrochemical removal of exhaust pollutants.

For both SO₂ and NO_x removal, current is related to the rate of removal by Faraday's Law:

$$i_{\text{ionic}} = (F)(n_{\text{eq}})(\text{gmols removed/second})$$

where

$$F = \text{Faraday's constant} = 96,489 \text{ coulomb/equiv.}$$

$$n_{\text{eq}} = \text{number of electrons per molecule reacted.}$$

The electronic current is a background noise caused by chemical impurities and defects in the electrolyte. Typically the electronic current is about 1-5 percent of the ionic current.

One completed cell was constructed and tested. The cell included the composite electrolyte, the electrodes, current pickups, flue gas plenum, gas distribution and pickup units at the beginning and end of the gas flow path. The cell was operated between 400°C and 900°C and with various flow rates and applied voltages. Only small amounts of NO_x were removed. Examination of the cell after the test revealed that the gas flow path was around the outside perimeter of the cell and that very little of the gas crossed the active area.

Additional problems were noted in the high resistance of the above test cell (approximately 10x higher than expected). Note that current must transfer from cell to cell via current pick-ups and through the cell via electrodes on the surface of the electrocatalyst. (Figure 15 and 16)

Therefore, besides resistance of the solid oxide electrolyte, there can also be resistance at the each of the contacts of the current pick-up with either the anode or cathode.

In order for IGR's electrocatalytic technology to work efficiently and effectively it is necessary to optimize the electrical circuit used in the system. The two major parts of this circuit are the electrodes applied directly to the electrocatalyst and the current pickups that carry the applied voltage to the electrodes.

For electrodes to work properly they must remain porous and wet the surface of the electrocatalyst at all times. If the electrode sinters, *i.e.* becomes dense, the electrocatalyst under the dense electrode becomes inactive. Also any areas of the electrocatalyst not directly covered by a porous electrode are also inactive due to the relatively high resistivity of the catalyst coating.

IGR has observed over the last two months that the gold electrode that is being used experiences a significant amount of sintering while in test. One consequence of this is that for a specific tests there is a slow drop in performance with time, which made data interpretation difficult. This is especially so as the oxygen level is increased over the course of the test. For example was the failure to remove NO_x at a specific oxygen level due to oxygen intolerance or to limited active electrocatalyst due to sintering of the electrode. Therefore IGR started to explore new electrode materials.

Pure silver inks were not considered due to

their low melting temperatures. Ag/Pd inks were considered because to their low price and refractory behavior (due to the dispersion of the Pd). Two different inks were tried: 83% Ag/17% Pd and 70% Ag/30% Pd. In each case, two coats were applied. In static tests (no current applied), after 72 hrs at 900°C in air, both electrode materials were still porous and completely covered the sample ZrO₂ material. After a similar duration, gold (control trial) electrodes had sintered and had dewetted the surface.

Based on the above results a specimen with an electrode of 83% Ag/17% Pd was placed into an active test (current applied). In these tests, very high voltages and currents were applied, so as to explore the behavior of the materials used. Unfortunately after 3 days this sample failed with the same behavior as the gold. This suggests that even under "normal" operating conditions, the expected lifetime of the Ag/Pd electrode may be unacceptably short. From technical discussions with electrode ink suppliers, it was suggested that a Pt or Pt/Au ink would work better. This is because platinum is highly refractory.

It is relatively easy to make a good ohmic contact between two noble metal layers, such as Au on Au. That is why electrical switch contacts are often Au plated. However coating the current pickup with Au doesn't, by itself, guarantee a good electrical contact between the Au ("Ohmic material") and the underlying metal alloy.

IGR conducted tests to determine how ohmic losses in the current pick-up can be reduced. These tests were conducted over

Figs. 18-21 (Pg 33-34)
remained -

Figure 22. Resistance *Within* Bipolar Inconel 600 Foil at 650 °C in Air.

contact. The other side was coated with the proper ohmic contact material and makes a compression contact to the electrode surface. This arrangement gave a very good electrical contact and distribution with a minimum of gas flow back pressure and a minimum of incremental weight.

H. SULFUR DIOXIDE (SO₂) DESTRUCTION

Using the knowledge and experience gained from the NO_x work experiments were run determining SO₂ destruction as a function of oxygen level, temperature and power. At 550°C up to 75% of the SO₂ was removed from gas streams containing 5.7% oxygen. Coal burning utility power plants typically contain 2-6% oxygen in

their flue gas. During this contract IGR has been able to extend the "oxygen tolerance" of its process from below the commercially acceptable range to fully include the range of oxygen levels found in coal burning power plants. Using the same electrocatalyst system at 450°C SO₂ removal was decreased to 50% and at 425°C SO₂ removal was 40%. By adjusting the active area of the device and therefore the residence time of the flue gas removals up to 99% can be achieved.

I. VOLUME AND POWER PROJECTIONS FOR A 500 MW UTILITY PLANT

The following is based data originally presented in IGR's proposal for this contract and is based on emissions control

for a 500 MW high sulfur coal-fired utility power plant.

The IGR NO_x technology design is based on 90% removal of fluegas NO_x assuming an inlet level of 800 ppm NO_x. The calculation is outlined below.

- High sulfur Eastern coal, 3.0 wt%
- 11,800 BTU/pound of coal
- 35% efficiency
- Exhaust gas: 800 ppm NO + 2000 ppm SO₂
- Flue gas temperature 450°C (before preheaters)

The plant NO_x emissions are approximately:

- 115 pound coal/sec (at 11,800 BTU/pound and 35% efficiency)
- 616 grams of NO_x/sec (at 1 pound NO_x/million BTU
- 19.9 gmoles NO/sec (at 800 vppm)

From our work in the pellet tester the following conditions were achieved:

- 20 sccm of gas with 600 vppm NO flowed through tester
- Active surface area of test pellet is 2.8 cm²
- 12 mA and 30 mV will destroy 30% of the NO_x in the gas stream
- Moles of NO_x in gas stream: 4.874E-7 moles/min
- Moles NO_x destroyed per second: 2.43E-9 moles/second

The volume estimation technique uses Faraday's law, an average current density for NO reduction, an engineering concept of a gas parallel electrical series bipolar stack, and an estimation of the average thickness of a device unit cell. The calculation is as follows:

- Current density: $12 \text{ mA} / 2.8 \text{ mA/cm}^2 = 4.28 \text{ mA/cm}^2$
- Amperage required: $(0.012 \text{ amp} / 2.43\text{E-}9 \text{ gmoles/sec})(19.9 \text{ gmole NO/sec}) = 9.83\text{E}7 \text{ amps}$
- Area required: $9.83\text{E}7 \text{ amps} / 0.00428 \text{ amps/cm}^2 = 2.29\text{E}10 \text{ cm}^2$

For conditions where flyash is present IGR assumes an average cell thickness of 3/16" which gives a total volume of $1.09\text{E}10 \text{ cm}^3$ or $14,267 \text{ yds}^3$. The preferred direction of the gas flow through the IGR modules is generally downward, with a hopper below, to minimize flyash plugging. If necessary the flyash may be removed from the flue gas before contacting the module.

For conditions where no flyash is present the average cell thickness can be reduced to 0.050 inches which gives a total volume of $2.91\text{E}9 \text{ cm}^3$ or 3800 yds^3 .

The power required to operate the IGR NO_x technology for this application is:

$$\begin{aligned} \text{Power} &= \text{cell voltage} * \text{amps required to remove NO}_x \\ &= 0.03 \text{ V} (0.012 \text{ amps} / 2.43\text{E-}9)(19.9 \text{ moles/sec}) \\ &= 2939 \text{ kW} \end{aligned}$$

In the original proposal the power consumption was predicted at 960 kW or 0.19% of the output of the high sulfur coal burning electric power plant. The present calculations are at approximately 0.6% of the output from a similar plant.

SECTION III

DESCRIPTION OF TECHNOLOGY

A. SOLID OXIDE ELECTROLYTES

All electrochemical technologies, no matter how complex the final system, are composed of three basic component types: the anode, the cathode, and the electrolyte. The anode is the interfacial region where chemical species are oxidized; that is, where the electrons are transferred from the molecule/ion and are deposited in the electronic conductor for return to the voltage source. At the cathode the reverse process occurs, and the species in question is reduced as it gains electrons from the electronic circuit. The electrolyte is a material which is capable of transferring charge through ionic motion while exhibiting little or no electronic conductivity (thus preventing an internal short-circuit between the electrodes).

Most commonly used electrolytic materials are liquids or liquid solutions. However it has been known for over 100 years that certain solids also behave as electrolytes. The first important attempt to commercially exploit solid electrolytes was carried out by Nernst, who was competing with Edison to create the

electric light. Nernst invented the "Nernst Glower". This was zirconium oxide, stabilized with yttria, to which a voltage was applied. The voltage drop across the glower, due to the finite conductivity of oxide ion transfer, resulted in heating and a consequential incandescent glow. Solid electrolytes which are commercially important or under commercial development include *beta aluminas* used in sodium/sulfur battery development, *fluoride ion electrolytes* used in sensors, and *stabilized zirconias* used as oxygen gas sensors (in automobiles and certain industrial processes).

More recently, several groups have carried out related work with solid oxide electrolytes. Moghadam [5] has investigated the influence of SO₂ on the electrolytic transference number of partially stabilized zirconia. Gur and Huggins [6], Pancharatram [7], and Mason [4] have performed investigations of NO decomposition with low surface area, non-porous zirconia electrolytes. The work of Sverdrup *et al.* [8] is representative of high temperature solid electrolyte fuel cell (SOFC) development. Oxide ion conducting solid electrolytes are at the heart of the IGR technology for NO_x removal.

Solid oxide electrolytes are typically found in only three crystallographic forms: the *fluorite* structure (also referred to as *face centered cubic (fcc)*), the *rhomboidal* structure and the *perovskite* structure. Figure 23 shows the electrolytic conductivity of a number of important oxide ion electrolytes as a function of the temperature. In general, appreciable ionic conductivities are ob-

Figure 23. Arrhenius Plot of Various Solid Oxide Electrolytes.

served only at relatively high temperatures. Of the electrolytes listed in Figure 23, the compounds containing zirconia, ceria, or bismuth have fcc or rhombohedral structure.

In order for the desired crystallographic structure and electrolytic properties to be maintained over a wide range of temperatures, "stabilizing agents" are added to the base oxide material. Stabilized zirconias and stabilized cerias are in the fluorite (fcc) form, while stabilized bismuth sesquioxides may be either fluorite or rhombohedral, depending on the type and amount of stabilizing agent. For example, zirconia and ceria are commonly stabilized with metal oxides where the adulterating metal ion has a +2 or +3 charge and is added at approximately 10 mole percent of the final solid solution.

B. IGR's SOLID ELECTROLYTES FOR NO_x and SO_x REMOVAL

In pre-contract NO_x removal work conducted by the Principal Investigator (Dr. Arnold Gordon) at IGR, the ability of the Gd-stabilized ceria matrix material to remove NO_x has been evaluated. In these experiments, a chamber composed of open cell ceramic foam was utilized. A high surface area ceramic foam interior was used as the cathode with the low surface area exterior acting as the anode. Data was taken to determine the basic operating characteristics of this electrochemical reactor cell, as a function of pollutant type, concentration, flow rate, applied voltage and temperature.

Direct gas-phase analysis of NO_x by

Fourier Transform Infrared (FT-IR) was performed to independently verify NO_x removal, using pellets of the solid oxide electrolyte. Inlet concentrations were 500 ppm NO in argon carrier gas. FT-IR sample analysis was performed on reactor inlet and outlet streams. A baseline spectrum was established by flowing the feed gas stream at 25°C directly into the FT-IR optical cell.

A control feed gas stream was passed through the reactor under open circuit conditions (no current, no cell potential) to verify that decomposition of NO was not caused by thermal, catalytic or other effects. No change in composition was observed in the absence of electric current, even at high temperatures.

DC voltage was then applied to the IGR reactor with no other change in the experimental apparatus or procedure. FT-IR analysis showed significant removal of NO from gases passed through the reactor (with current). At a cell temperature of 400°C, analysis showed NO reduced to about 100 ppm (80 percent removal efficiency). At 950°C, NO concentrations were sufficiently reduced that they could not be detected by FT-IR (using a 21 meter optical path length gas cell). Figure 24 shows IGR progress with NO_x mitigation technology before the start of this Phase I contract.

C. IGR's FLEXIBLE SOLID ELECTROLYTES

of these electrolytic ceramic composites. **Figure 26** is an example for the same material as in **Figure 25**. The vertical axis is the logarithm of the current and the horizontal axis depicts the voltage between the cathodic electrode and a platinum reference electrode (minus the temperature dependent open circuit potential of 14-15 mV). Solid oxide electrolyte systems typically exhibit "Butler-Volmer" behavior; that is, a linear behavior on a log current vs overpotential plot at high overpotentials, and a steep drop at low overpotentials. The FSE composites exhibit behavior consistent with the Butler-Volmer equation. Note the relatively high current (and current density) at modest overpotentials. Physical and analytical demonstrated that these ceramic composite materials have unusual and useful mechanical properties, including unusually high levels of flexibility, ductility, and energy absorption without failure (toughness).

IGR has carried out two types of electrochemical characterizations of FSE composites. The first of these electrochemical tests, as depicted in **Figure 25** is the measurement of the resistivity of the composite, as a function of temperature. Solid electrolytes, including well behaved solid electrolyte composites, should exhibit a linear relationship between the log of the resistivity and the inverse Kelvin temperature. The *IGR* composites exhibit this behavior.

The second type of electrochemical testing involved the voltage vs. current behavior

Figure 25. YSZ Ionic Conductivity vs Temperature for ZrO_2 FSE.

Figure 26. FSE Butler-Volmer Behavior.

Figure 28. Strength of Composite.

IV. CONCLUSIONS

The work accomplished in this Phase I project involved the formulation and testing of proprietary materials for NO_x and SO_x removal under conditions appropriate to coal-fired combustors for electric power production. The Phase I work also explored methods for reduction of the operating temperatures of the process, reduction of its power requirements, and increasing the levels of NO_x and SO_x removal at higher levels of oxygen.

The Phase I work has demonstrated the basic technical feasibility of IGR's NO_x/SO_x removal technology. We have

successfully achieved NO_x and SO_x removal in the presence of large concentrations of oxygen (including the range of oxygen levels in coal-fired combustors). We have demonstrated successful operation of IGR's NO_x/SO_x removal technology at greatly reduced operating temperatures. Significant progress has been made in the reduction of the electrical power requirements of the removal process. In particular, NO_x removal has been accomplished at power consumption levels that are economically feasible. In addition, the ability of this technology to remove SO₂ from a high concentration gas stream (such as that generated from the copper oxide absorption process) has been

demonstrated. *In summary, the Phase I work has served to resolve the basic feasibility questions associated with this technology.* The importance of the Phase I work is that it has greatly reduced the technical risk associated with IGR's NO_x/SO_x removal technology, which makes the development of commercially feasible devices highly probable.

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SECTION V

References

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VI. APPENDIX

Tables 1A and 2A are a list of tests conducted under this contract in both tabular form and as FT-IR spectra for each condition. The table listings can be directly referenced to the FT-IR spectra with the test number. In some cases the FT-IR spectra was not available. Results from these tests are listed in Table 2A.. For all the cases listed, either NO or SO₂ were at 600 ppm with the balance being nitrogen. The flow rate was 20 sccm. The oxygen source was generally compressed air blended in at the desired level.

NO peaks on the FT-IR spectra are centered around 1900 cm⁻¹. The SO₂ peak on the FT-IR spectra is at approximately 1375 cm⁻¹. Other peaks seen in the spectra are due to water and partially combusted organic material leftover from the test cell assembly.

DOE Tables for NO_x and SO_x Work

 Table 1A. NO and SO₂ Spectra for Which Spectra are Available

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
612951.1	NO	500	05	yes	0	Intermittent
612951.2	NO	500	05	yes	0	Intermittent
612951.3	NO	500	05	yes	0	Intermittent
612951.4	NO	500	05	yes	0	Intermittent
612951.5	NO	500	05	yes	0	Intermittent
612951.6	NO	500	05	yes	0	Intermittent
612951.7	NO	500	05	yes	0	Intermittent
612951.8	NO	500	05	yes	0	Intermittent
612952.1	NO	900	05	yes	05	Intermittent
612952.2	NO	900	05	yes	05	Intermittent
612952.3	NO	900	05	yes	05	Intermittent
612952.4	NO	900	05	yes	0	Intermittent
612952.5	NO	900	05	yes	0	Intermittent
612952.6	NO	900	05	yes	0	Intermittent
612952.7	NO	900	05	yes	0	Intermittent
612952.8	NO	900	05	yes	0	Intermittent
612952.9	NO	900	05	yes	0	Intermittent
612952.10	NO	900	05	yes	60-70	Intermittent
612952.11	NO	900	05	yes	0	Intermittent
612952.12	NO	900	05	yes	0	Intermittent
612952.13	NO	900	05	yes	50	Intermittent
612952.14	NO	900	05	yes	30-40	Intermittent
612952.15	NO	900	05	yes	0-15	Intermittent
612952.16	NO	900	05	yes	0-5	Intermittent
612952.17	NO	900	05	yes	0-5	Intermittent
612952.18	NO	900	05	yes	0-5	Intermittent
612952.19	NO	900	05	yes	30-40	Intermittent
612952.20	NO	900	05	yes	80-100	Intermittent
612952.21	NO	900	05	yes	50-75	Intermittent
612952.22	NO	500	0.4	yes	0	Intermittent
612952.23	NO	500	0.4	yes	0	Intermittent
612954.1	NO	500	0.4	yes	0-5	Intermittent
612954.2	NO	900	0.4	yes	>80	Intermittent
612954.3	NO	900	0.4	yes	80	Intermittent
612954.4	NO	900	0.4	yes	80	Intermittent
612954.5	NO	900	0.8	yes	10	Intermittent
612954.6	NO	900	0.8	yes	40	Intermittent
612954.7	NO	900	0.8	yes	40	Intermittent
612954.8	NO	900	4.25	yes	0	Intermittent
612954.9	NO	900	4.25	yes	0	Intermittent
612954.10	NO	900	4.25	yes	0	Intermittent
612955.1	NO	900	0.4	yes	0	Intermittent
612955.2	NO	500	0.4	yes	0	Intermittent
612955.3	NO	500	0.4	yes	0	Intermittent

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
612955.4	NO	500	0.8	yes	0	Intermittent
612955.5	NO	900	2cc	yes	0	Intermittent
612955.6	NO	900	2cc	yes	0	Intermittent
612955.7	NO	900	2cc	yes	0	Intermittent
612955.8	NO	900	2cc	yes	35	Intermittent
612955.9	NO	900	4cc	yes	0	Intermittent
612956.1	NO	500	0.4	yes	0	Intermittent
612956.2	NO	500	0.4	yes	0	Intermittent
612956.3	NO	500	0.4	yes	0	Intermittent
612956.4	NO	500	0.4	yes	0	Intermittent
612956.5	NO	500	0.4	yes	0	Intermittent
612956.6	NO	500	0.8	yes	15	Intermittent
612956.7	NO	500	0.8	yes	0	Intermittent
612956.8	NO	900	0.5	yes	80	Intermittent
612956.9	NO	850	0.8	yes	26	Intermittent
612956.11	NO	900	0.8	yes	52	Intermittent
612956.12	NO	900	0.8	yes	52	Intermittent
612956.13	NO	900	0.8	yes	61	Intermittent
612956.14	NO	900	0.8	yes	5-10	Intermittent
612956.15	NO	900	0.8	yes	46	Intermittent
612956.16	NO	900	0.8	yes	5-10	Intermittent
612956.17	NO	900	0.8	yes	46	Intermittent
612956.18	NO	900	2.7	yes	10	Intermittent
612956.19	NO	900	2.7	yes	0	Intermittent
612956.20	NO	900	2.7	yes	0	Intermittent
612957.1	NO	900	3.1	yes	5	Intermittent
612957.2	NO	900	3.1	yes	17	Intermittent
612957.3	NO	900	3.1	yes	0	Intermittent
612957.4	NO	900	3.1	yes	0	Intermittent
612957.5	NO	900	3.1	yes	0	Intermittent
612957.6	NO	900	3.1	yes	0	Intermittent
612957.7	NO	900	3.1	yes	0	Intermittent
612958.1	NO	900	0.95	yes	0	Intermittent
612958.2	NO	900	0.95	yes	0	Intermittent
612959.1	NO	900	1.8	yes	50	Intermittent
612959.2	NO	900	1.8	yes	50	Intermittent
612959.3	NO	900	1.8	yes	78	Intermittent
612959.4	NO	900	1.8	yes	37	Intermittent
612959.5	NO	900	1.8	yes	75.5	Intermittent
612959.6	NO	900	0.4	yes	6.3	Intermittent
612959.7	NO	900	0.4	yes	24	Intermittent
612959.8	NO	900	0.4	yes	80	Intermittent
612959.9	NO	900	0.4	yes	35	Intermittent
612959.10	NO	900	0.4	yes	84	Intermittent
6129510.1B	NO	550	1.8	yes	0	Intermittent
6129510.1	NO	900	1.8	yes	21	Intermittent

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
6129510.2	NO	900	1.8	yes	55	Intermittent
6129510.3	NO	900	1.8	yes	43	Intermittent
6129510.4	NO	900	1.8	yes	66	Intermittent
6129510.5	NO	900	4	yes	0	Intermittent
6129510.6	NO	900	4	yes	0	Intermittent
6129510.7	NO	900	4	yes	26	Intermittent
6129510.8	NO	900	4	yes	31	Intermittent
6129510.9	NO	900	4	yes	0	Intermittent
6129511.1	NO	900	0.95	yes	35	Intermittent
6129511.2	NO	550	0.95	yes	0	Intermittent
6129511.3	NO	550	0.95	yes	0	Intermittent
6129511.4	NO	550	0.9	yes	0	Intermittent
6129511.5	NO	550	0.9	yes	0	Intermittent
6129511.6	NO	550	0.9	yes	0-5	Intermittent
6129511.7	NO	550	2	no	70	220 mA
6129512.1B	NO	550	1	no	0	NA
6129512.1	NO	550	0.9	no	78	400 mA
6129512.2	NO	550	0.9	no	78	400 mA
6129512.3	NO	550	1.8	no	45	400 mA
6129512.4	NO	550	1.8	no	75	400 mA
6129512.5	NO	550	3.3	no	75	400 mA
6129513.1	NO	550	1	no	75	270 mA
6129513.2	NO	500	1	no	65	230 mA
6129514.1	NO	550	1	no	80	230 mA
6129514.2	NO	550	1	no	5	125 mA
6129514.3	NO	550	1	no	80	595 mA
6129514.4	NO	550	4.6	no	65	765 mA
6129514.5	NO	550	5.7	no	60	870 mA
6129515.1	NO	550	0.9	no	80	284 mA
6129515.2	NO	550	1.8	no	80	400 mA
6129515.3	NO	550	4.6	no	75	850 mA
6129515.4	NO	550	5.6	no	75	1000 mA
6129515.5	NO	500	5.6	no	70	1000 mA
6129515.6	NO	500	5.6	no	65	970 mA
6129515.7	NO	450	4.6	no	80	979 mA
6129515.8	NO	450	4.6	no	70	916 mA
6129515.9	NO	450	4.6	no	65	780 mA
6129515.10	NO	450	4.6	no	75	770 mA
6129516.1	NO	550	0.9	no	75	86 mA
6129516.2	NO	550	1.8	no	75	122 mA
6129516.3	NO	550	3.3	no	75	134 mA
6129516.4	NO	550	4.6	no	65	191 mA
6129516.5	NO	550	5.7	no	50	250 mA
6129516.7	NO	500	5.7	no	75	250 mA
6129517.1	NO	450	0.9	no	90	128 mA
6129517.2	NO	450	1.8	no	87	129 mA

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
6129517.3	NO	450	3.3	no	83	129 mA
6129517.4	NO	450	4.6	no	80	130 mA
6129517.6	NO	450	5.7	no	77	118 mA
6129517.7	NO	450	5.7	no	80	129 mA
6129517.8	NO	425	5.7	no	77	134 mA
6129517.9	NO	425	5.7	no	77	121 mA
6129517.10	NO	425	5.7	no	77	107 mA
6129517.11	NO	425	5.7	no	77	92 mA
6129517.12	NO	425	5.7	no	77	79 mA
6129517.14	NO	425	5.7	no	77	66 mA
6129518.1	SO ₂	550	1	no	40	390 mA
6129518.2	SO ₂	550	1	no	60	440 mA
6129518.3	SO ₂	550	1	no	66	610 mA
6129518.4	SO ₂	550	1.8	no	70	792 mA
6129518.5	SO ₂	550	4.6	no	80	796 mA
6129518.7	SO ₂	550	5.7	no	75	630 mA
6129518.8	SO ₂	500	5.7	no	60	530 mA
6129518.9	SO ₂	500	5.7	no	75	830 mA
6129518.10	SO ₂	475	5.7	no	72	820 mA
6129518.11	SO ₂	450	5.7	no	63	867 mA
6129519.1	NO	550	8.3	no	45	586 mA
6129520.1	NO	550	1.8	no	30	350 mA
6129521.2	NO	550	11.5	no	60	640 mA
6129522.1	NO	550	5.7	no	55	352 mA
6129522.2	NO	550	11.5	no	40	352 mA
6129522.3	NO	450	11.5	no	40	611 mA
6129522.4	NO	425	11.5	no	50	641 mA
6129523.1	NO	450	5.7	no	65	330 mA
6129523.2	NO	450	11.5	no	65	505 mA
6129523.3	NO	550	11.5	no	60	470 mA
6129524.1	NO	550	4.6	no	63	365 mA
6129524.2	NO	550	5.7	no	50	361 mA
6129524.3	NO	550	5.7	no	60	500 mA
6129524.4	NO	450	5.7	no	70	533 mA
6129524.5	NO	450	5.7	no	63	379 mA
6129524.6	NO	450	11.5	no	50	379 mA
6129524.7	NO	450	11.5	no	55-60	490 mA
6129524.8	NO	450	11.5	no	60	640 mA
6129525.1	NO	550	4.6	no	60	458 mA
6129525.2	NO	450	5.7	no	50	640 mA
6129525.3	NO	450	0	no	70	315 mA
6129526.1	NO	550	5.7	no	45	483 mA
6129526.2	NO	450	5.7	no	45	335 mA
6129526.1B	NO	550	0	no	---	NA
6129526.1B	NO	550	1.8	no	---	NA
6129526.3	NO	550	1.8	no	0	120 mA

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
6129526.4	NO	550	1.8	no	0	241 mA
6129526.5	NO	550	1.8	no	0	364 mA
6129526.6	NO	550	1.8	no	0	472 mA
6129526.7	NO	550	1.8	no	0	581 mA
6129526.8	NO	550	1.8	no	95	116 mA
6129526.8B	NO	550	20	no	---	NA
6129528.1	NO	550	1.8	no	55	129 mA
6129529.1	NO	550	5.7	no	65	308 mA
6129529.2	NO	550	5.7	no	70	308 mA
6129529.3	NO	550	11.5	no	30	332 mA
6129529.4B	NO	550	7.54	no	---	NA
6129529.4	NO	550	7.54	no	15	102 mA
6129529.5	NO	550	7.54	no	20	206 mA
6129529.6	NO	550	22	no	80-100	306 mA
6129529.7	NO	550	7.54	no	22	306 mA
6129529.8B	NO	550	7.54	no	20	206 mA
6129529.8	NO	550	11.05	no	10	306 mA
6129529.10	NO	550	11.05	no	25	507mA
6129529.11B	NO	550	50	no	---	NA
6129529.11	NO	550	5.7	no	15	199 mA
6129529.12	NO	550	5.7	no	30	303 mA
6129529.13	NO	550	5.7	no	45	400 mA
6129529.14	NO	550	5.7	no	50	433 mA
6129529.15	NO	450	5.7	no	20	440 mA
6129530.1B	NO	550	50	no	---	NA
6129530.1	NO	550	75	no	75	220 mA
6129530.2	NO	550	75	no	75	220 mA
6129531.1	NO	550	1.8	no	20-30	64 mA
6129531.2	NO	550	3.3	no	60	238 mA
6129531.3	NO	550	1.8	no	75	238 mA
6129531.5	NO	550	3.3	no	15-20	67 mA
6129531.6	NO	550	3.3	no	40	154 mA
6129532.1B	NO	450	5.7	no	---	NA
6129532.1	NO	450	5.7	no	30	258 mA
6129532.2	NO	500	5.7	no	35	260 mA
6129532.3	NO	550	5.7	no	40	188 mA
6129533.1	NO	550	1.8	no	40	125 mA
6129533.2	NO	550	4.6	no	35	253 mA
6129533.3	NO	550	5.7	no	30	254 mA
6129533.4B	NO	550	5.7	no	---	NA
6129533.5	NO	550	5.7	no	40	376 mA
6129533.6	NO	500	5.7	no	40	379 mA
6129533.7	NO	450	5.7	no	30	150 mA
6129534.1	NO	550	1.8	no	10	24 mA
6129534.2	NO	550	1.8	no	20	48 mA

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
6129534.3	NO	550	1.8	no	50	104 mA
6129535.1	NO	400	5.7	no	50	183 mA
6129535.2	NO	400	5.7	no	55	302 mA
6129535.3	NO	425	5.7	no	60	270 mA
6129535.4B	NO	425	5.7	no	---	NA
6129535.5	NO	425	5.7	no	60	383 mA
6129535.6	NO	450	5.7	no	10	191 mA
6129535.7	NO	450	5.7	no	70	383 mA
6129535.8	NO	550	5.7	no	45	443 mA
6129535.10	NO	375	5.7	no	0	193 mA
6129536.1B	NO	375	5.7	no	---	NA
6129536.1B2	NO	400	1.8	no	---	NA
6129536.1	NO	400	1.8	no	25	49 mA
6129536.2	NO	425	1.8	no	25	98 mA
6129536.3	NO	450	1.8	no	25	139 mA
6129536.4	NO	450	1.8	no	23	144 mA
6129536.5	NO	450	5.7	no	24	72 mA
6129536.6	NO	450	5.7	no	24	36 mA
6129536.7	NO	425	5.7	no	20	37 mA
6129536.8	NO	425	5.7	no	31	74 mA
6129536.9	NO	400	5.7	no	4	38 mA
6129537.1B	NO	400	1.8	no	---	NA
6129537.1	NO	400	1.8	no	6.5	29 mA
6129538.1	NO	400	1.8	no	14	46 mA
6129538.2	NO	425	1.8	no	15	44 mA
6129538.3	NO	425	1.8	no	20	76 mA
6129538.4	NO	450	1.8	no	12	72 mA
6129538.5	NO	450	1.8	no	12	30 mA
6129538.6B	NO	450	1.8	no	---	NA
6129538.6B2	NO	450	5.7	no	---	NA
6129538.6	NO	450	5.7	no	6	26 mA
6129538.7	NO	450	5.7	no	14	87 mA
6129538.8	NO	425	5.7	no	12	83 mA
6129538.9	NO	400	5.7	no	10	84 mA
6129539.1B	NO	400	1.8	no	---	NA
6129539.1	NO	400	1.8	no	47	68 mA
6129539.2	NO	425	1.8	no	51	68 mA
6129539.4	NO	550	1.8	no	35	70 mA
6129539.5	NO	450	5.7	no	27	70 mA
6129539.6	NO	450	5.7	no	13	35 mA
6129539.7	NO	450	5.7	no	10.5	17 mA
6129539.8	NO	425	5.7	no	7.5	17 mA
6129539.10	NO	425	5.7	no	27	70 mA
6129540.1B	NO	400	1.8	no	---	NA
6129540.1	NO	400	1.8	no	21	39 mA
6129540.2	NO	425	1.8	no	19	38 mA

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
6129540.3	NO	450	1.8	no	17	37 mA
6129540.4	NO	450	5.7	no	18.5	37 mA
6129540.5	NO	450	5.7	no	25	74 mA
6129540.6	NO	425	5.7	no	31	76 mA
6129540.7	NO	425	5.7	no	19.5	38 mA
6129540.8	NO	400	5.7	no	16	38 mA
6129540.9	NO	400	5.7	no	29	75 mA
6129541.1B	NO	400	1.8	no	---	NA
6129541.1	NO	400	1.8	no	21	32 mA
6129541.2	NO	425	1.8	no	22	33 mA
6129541.3	NO	450	1.8	no	22	35 mA
6129541.4	NO	550	1.8	no	23	33 mA
6129541.5	NO	450	5.7	no	19.5	35 mA
6129541.6	NO	450	5.7	no	33	67 mA
6129541.7	NO	425	5.7	no	3	65 mA
6129542.1B	NO	400	1.8	no	--	NA
6129542.1	NO	425	5.7	no	20	52 mA
6129543.1B	NO	400	1.8	no	---	NA
6129543.1	NO	425	5.7	no	3.2	38 mA
6129543.2B	NO	550	1.8	no	---	NA
6129543.2	NO	550	1.8	no	43	1.6 mA
6129543.3	NO	450	1.8	no	25	126 mA
6129543.4	NO	425	1.8	no	12	130 mA
6129543.5	NO	400	1.8	no	25	134 mA
6129543.6	NO	400	5.7	no	0	134 mA
6129543.7	NO	425	5.7	no	0	129 mA
6129543.8B	NO	425	5.7	no	---	NA
6129543.8	NO	450	5.7	no	0	125 mA
6129544.1B	NO	400	1.8	no	---	NA
6129544.1	NO	400	1.8	no	24	70 mA
6129544.2	NO	425	1.8	no	28.7	70 mA
6129544.3	NO	450	1.8	no	13	68 mA
6129544.4	NO	550	1.8	no	9	83 mA
6129544.5	NO	450	5.7	no	0	64 mA
6129544.6	NO	900	0	no	+80	400 mA
6129544.7	NO	550	0	no	40	102 mA
6129544.8	NO	450	0	no	40	102 mA
6129544.9	NO	450	0	no	0	250 mA
6129545.1B	NO	400	1.8	no	---	NA
6129545.1	NO	400	1.8	no	33	95 mA
6129545.2	NO	425	1.8	no	5	63 mA
6129545.3	NO	450	1.8	no	3	62 mA
6129545.4	NO	375	1.8	no	23	146 mA
6129546.1B	NO	400	1.8	no	---	NA
6129546.1	NO	400	1.8	no	29	75 mA
6129546.2	NO	450	1.8	no	37.5	90 mA

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
6129546.3B	NO	425	1.8	no	---	NA
6129546.3	NO	425	1.8	no	23	56 mA
6129546.4	NO	450	1.8	no	23	62 mA
6129546.5	NO	550	1.8	no	55	242 mA
6129546.6	NO	550	5.7	no	43	379 mA
6129546.7	NO	450	5.7	no	30	110 mA
6129546.8	NO	450	5.7	no	13	54 mA
6129546.9	NO	450	5.7	no	4	32 mA
6129546.10	NO	425	5.7	no	6.5	58 mA
6129546.11	NO	425	5.7	no	6.5	58 mA
6129547.1B	NO	375	1.8	no	---	NA
6129547.1	NO	375	1.8	no	0	38 mA
6129547.2	NO	375	1.8	no	10	94 mA
6129547.3	NO	400	1.8	no	10	93 mA
6129547.4	NO	450	1.8	no	0	87 mA
6129547.5	NO	450	1.8	no	0	457 mA
6129547.6	NO	450	1.8	no	0	646 mA
6129548.1B	NO	400	1.8	no	---	NA
6129548.1	NO	400	1.8	no	26	62 mA
6129548.2	NO	425	1.8	no	25	60 mA
6129548.3	NO	450	1.8	no	19	60mA
6129548.4	NO	550	1.8	no	11	57 mA
6129548.5	NO	450	5.7	no	0	61 mA
6129548.6	NO	375	5.7	no	20	71 mA
6129548.7	NO	350	5.7	no	5.5	18 mA
6129548.8	NO	375	5.7	no	5.5	18 mA
6129548.9	NO	350	5.7	no	0	35 mA
6129549.1B	NO	400	1.8	no	---	NA
6129549.1	NO	400	1.8	no	0	39 mA
6129549.2	NO	450	1.8	no	19	67 mA
6129549.3	NO	450	1.8	no	19	67 mA
6129549.4	NO	450	5.7	no	19	61 mA
6129549.5	NO	450	5.7	no	0	67 mA
6129549.6	NO	450	5.7	no	23	112 mA
6129549.7	NO	425	5.7	no	8.5	111 mA
6129550.1B	NO	400	1.8	no	---	NA
6129550.1	NO	400	1.8	no	50	133 mA
6129550.2	NO	425	1.8	no	45	117 mA
6129550.3	NO	450	1.8	no	39	113 mA
6129550.4B	NO	550	1.8	no	---	NA
6129550.4	NO	550	1.8	no	31	113 mA
6129550.5	NO	450	5.7	no	26	126 mA
6129550.6	NO	450	5.7	no	26	63 mA
6129550.7	NO	450	5.7	no	9	21 mA
6129550.8	NO	425	5.7	no	4.5	22 mA
6129550.9	NO	400	1.8	no	23	31 mA

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
6129550.10	NO	425	5.7	no	23	64 mA
6129550.11	NO	425	5.7	no	40	124 mA
6129551.1B	NO	400	5.7	no	36.5	124 mA
6129551.1	NO	400	1.8	no	---	NA
6129551.2B	NO	425	1.8	no	---	NA
6129551.3	NO	450	1.8	no	25.1	61 mA
6129551.4	NO	550	1.8	no	18.9	56 mA
6129551.6	NO	450	5.7	no	7	29 mA
6129551.7	NO	450	5.7	no	0	14 mA
6129551.8B	NO	450	5.7	no	---	NA
6129551.8B2	NO	425	5.7	no	---	NA
6129551.8	NO	425	5.7	no	0	14 mA
6129551.9	NO	425	5.7	no	6	30 mA
6129551.10	NO	425	5.7	no	7.6	60 mA
6129551.12	NO	425	1.8	no	27.5	60 mA
6129552.1B	NO	400	1.8	no	---	NA
6129552.1	NO	400	1.8	no	34	142 mA
6129552.2	NO	425	1.8	no	34	146 mA
6129552.3	NO	450	1.8	no	27	143 mA
6129552.4	NO	550	1.8	no	0	132 mA
6129552.5B	NO	450	5.7	no	---	NA
6129552.5	NO	450	5.7	no	26	141 mA
6129552.6	NO	450	5.7	no	0	71 mA
6129552.7	NO	425	5.7	no	0	71mA
6129553.1B	NO	400	1.8	no	---	NA
6129553.1	NO	400	1.8	no	0	42 mA
6129553.2	NO	425	1.8	no	0	41 mA
6129553.4	NO	450	1.8	no	0	81 mA
6129553.5	NO	550	1.8	no	0	72 mA
6129553.6	NO	650	1.8	no	0	70 mA
6129554.1B	NO	400	1.8	no	---	NA
6129554.1	NO	400	1.8	no	10.4	31 mA
6129554.2	NO	425	1.8	no	0	30 mA
6129554.3	NO	450	1.8	no	0	27 mA
6129554.4	NO	550	1.8	no	0	27 mA
6129554.5	NO	650	1.8	no	0	25 mA
6129554.6	NO	650	1.8	no	0	99 mA
6129554.7B	NO	400	1.8	no	---	NA
6129554.8	NO	425	1.8	no	0	39 mA
6129554.9	NO	450	1.8	no	0	38 mA
6129554.10	NO	450	1.8	no	12.9	86 mA
6129554.11	NO	550	1.8	no	0	86 mA
6129555.1B	NO	400	1.8	no	---	NA
6129555.1	NO	400	1.8	no	32	90 mA
6129555.2	NO	425	1.8	no	33	87 mA
6129555.3	NO	425	1.8	no	33	87 mA

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
6129555.4	NO	550	1.8	no	24	80 mA
6129556.1B	NO	400	1.8	no	---	NA
6129556.1	NO	400	1.8	no	20	29 mA
6129556.2	NO	425	1.8	no	7.5	27 mA
6129556.3	NO	450	1.8	no	5.5	27 mA
6129556.4	NO	375	1.8	no	3.5	55 mA
6129557.1B	NO	400	1.8	no	---	NA
6129557.1	NO	400	1.8	no	21	27 mA
6129557.2B	NO	425	1.8	no	---	NA
6129557.2	NO	425	1.8	no	18.7	28 mA
6129557.3	NO	450	1.8	no	7	28 mA
6129557.4	NO	550	1.8	no	2	25 mA
6129557.5	NO	450	5.7	no	6	26 mA
6129557.6	NO	450	5.7	no	14.7	51 mA
6129557.7	NO	450	5.7	no	17.5	90 mA
6129557.8	NO	425	5.7	no	12.5	86 mA
6129557.9	NO	425	5.7	no	3.5	48 mA
6129557.11	NO	400	5.7	no	7.3	90 mA
6129558.1B	NO	400	1.8	no	---	NA
6129558.1	NO	400	1.8	no	20	.5 mA
6129558.2	NO	425	1.8	no	0	28 mA
6129558.3	NO	375	1.8	no	3	15 mA
6129558.4B	NO	375	1.8	no	---	NA
6129558.4B2	NO	400	1.8	no	---	NA
6129558.5	NO	400	1.8	no	0	15 mA
6129558.6	NO	400	5.7	no	0	48 mA
6129558.7B	NO	450	5.7	no	5.1	44 mA
6129558.7	NO	450	5.7	no	5.1	44 mA
6129558.8	NO	450	5.7	no	19.5	68 mA
6129559.1B	NO	425	5.7	no	---	NA
6129559.1B2	NO	400	1.8	no	---	NA
6129559.1	NO	400	1.8	no	0	38 mA
6129559.2	NO	425	1.8	no	0	37 mA
6129559.3	NO	450	1.8	no	0	30 mA
6129559.4	NO	550	1.8	no	0	34 mA
6129559.5	NO	550	1.8	no	45	130 mA
6129559.6	NO	550	5.7	no	0	135 mA
6129560.1	NO	400	1.8	no	0	20 mA
6129560.2	NO	425	1.8	no	0	32 mA
6129560.3	NO	450	1.8	no	0	61 mA
6129560.4	NO	550	1.8	no	0	54 mA
6129561.1B	NO	400	1.8	no	---	NA
6129561.1	NO	400	1.8	no	178	51 mA
6129561.2	NO	425	1.8	no	20.2	52 mA
6129561.3	NO	450	1.8	no	22	52 mA
6129561.4	NO	550	1.8	no	25	38 mA

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
6129562.1B	NO	550	1.8	no	---	NA
6129562.1B2	NO	400	1.8	no	---	NA
6129562.1	NO	400	1.8	no	0	24 mA
6129562.2	NO	425	1.8	no	0	30 mA
6129563.1B	NO	400	1.8	no	---	NA
6129563.2	NO	400	1.8	no	11	27 mA
6129563.3	NO	425	1.8	no	0	27 mA
6129563.4	NO	450	1.8	no	0	27 mA
6129564.1B	NO	400	1.8	no	---	NA
6129564.1	NO	400	1.8	no	0	26 mA
6129564.2	NO	400	1.8	no	27.2	66 mA
6129564.3	NO	425	1.8	no	24	64 mA
6129564.4	NO	450	1.8	no	13.8	63 mA
6129564.5	NO	550	1.8	no	0	60 mA
6129564.6	NO	450	5.7	no	8.5	60 mA
6129564.7	NO	450	5.7	no	0	102 mA
6129564.8	NO	425	5.7	no	0	105 mA
6129565.1B	NO	400	1.8	no	---	NA
6129565.2	NO	425	1.8	no	0	58 mA
6129565.3	NO	450	1.8	no	0	57 mA
6129565.4B	SO ₂	400	1.8	no	---	NA
6129565.4	SO ₂	400	1.8	no	7.6	58 mA
6129565.5	SO ₂	425	1.8	no	12.9	53 mA
6129565.6	SO ₂	450	1.8	no	20	54 mA
6129565.7B	SO ₂	450	1.8	no	---	NA
6129565.7	SO ₂	550	1.8	no	30	81 mA
6129565.8B	SO ₂	450	1.8	no	---	NA
6129565.8	SO ₂	450	5.7	no	0	56 mA
6129565.9	SO ₂	425	5.7	no	0	44 mA
6129565.10	SO ₂	400	5.7	no	0	37 mA
6129566.1B	SO ₂	450	1.8	no	---	NA
6129566.1	SO ₂	450	1.8	no	20	34 mA
6129567.1B	SO ₂	400	5.7	no	---	NA
6129567.1	SO ₂	400	5.7	no	0	9 mA
6129567.2	SO ₂	425	5.7	no	11	25 mA
6129567.3	SO ₂	450	5.7	no	26	23 mA
6129567.4	SO ₂	550	5.7	no	0	45 mA
6129567.5B	SO ₂	550	5.7	no	---	NA
6129567.5	SO ₂	550	5.7	no	0	90 mA
6129567.6	SO ₂	450	5.7	no	0	45 mA
6129568.1B	NO	550	1.8	no	---	NA
6129568.1	NO	550	1.8	no	20	46 mA
6129568.2	NO	450	1.8	no	20	5 mA
6129568.3B	NO	450	1.8	no	---	NA
6129568.3	NO	450	1.8	no	0	6 mA
6129568.4	NO	600	1.8	no	0	50 mA

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
6129568.5	NO	600	1.8	no	0	83 mA
6129569.1B	NO	550	1.8	no	---	NA
6129569.1	SO ₂	550	1.8	no	52	71 mA
6129569.2	SO ₂	500	1.8	no	48	71 mA
6129569.3B	SO ₂	450	1.8	no	---	NA
6129569.3	SO ₂	450	1.8	no	50	42 mA
6129569.4B	NO	450	1.8	no	---	NA
6129569.5	NO	425	1.8	no	7	17 mA
6129569.6	NO	400	1.8	no	10	9 mA
6129569.7B	NO	400	1.8	no	---	NA
6129569.7B2	NO	400	5.7	no	---	NA
6129569.7	NO	400	5.7	no	0	9 mA
6129569.8	NO	425	5.7	no	0	18 mA
6129569.9	NO	450	5.7	no	0	34 mA
6129569.10	NO	550	5.7	no	0	294 mA
6129569.11B	NO	900	1.8	no	---	NA
6129569.11	NO	900	1.8	no	0	107 mA
6129570.1B	NO	550	1.8	no	---	NA
6129570.1	NO	550	1.8	no	0	4 mA
6129570.2B	NO	900	1.8	no	---	NA
6129570.2	NO	900	1.8	no	6	1.8 mA
6129570.3	NO	900	1.8	no	80	231 mA
6129570.4	NO	900	1.8	no	6.5	124 mA
6129570.5	NO	900	1.8	no	55	183 mA
6129571.1B	NO	550	5.7	no	---	NA
6129571.1B2	SO ₂	550	1.8	no	---	NA
6129571.1	SO ₂	550	1.8	no	6.5	160 mA
6129571.2	SO ₂	550	1.8	no	19	210 mA
6129572.1B	NO	400	1.8	no	---	NA
6129572.1	NO	400	1.8	no	0	45 mA
6129573.1B	NO	425	1.8	no	---	NA
6129573.1	NO	425	1.8	no	22	45 mA
6129573.2	NO	450	1.8	no	73	108 mA
6129572.2	NO	550	1.8	no	0	86 mA
6129572.3	NO	550	1.8	no	70	130 mA
6129572.4	NO	550	1.8	no	70	130 mA
6129572.5B	NO	550	5.7	no	---	NA
6129572.5B2	NO	550	1.8	no	---	NA
6129572.5	NO	450	5.7	no	4	150 mA
6129572.6B	NO	485	5.7	no	---	NA
6129572.6	NO	425	5.7	no	0	90 mA
6129573.3B	NO	400	1.8	no	---	NA
6129573.3	NO	400	1.8	no	21	14 mA
6129573.4	NO	425	1.8	no	18	14 mA
6129573.5B	NO	425	1.8	no	---	NA
6129573.5	NO	450	1.8	no	15	13 mA

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
6129573.6	NO	550	1.8	no	0	13 mA
6129573.7	NO	550	1.8	no	13	50 mA
6129573.8	NO	550	1.8	no	21	18 mA
6129573.9B	NO	375	1.8	no	---	NA
6129573.10	NO	375	1.8	no	21	50 mA
6129573.11	NO	375	1.8	no	5	6 mA
6129573.12	NO	425	5.7	no	25	21 mA
6129573.13	NO	425	5.7	no	25	11 mA
6129573.14B	NO	425	5.7	no	---	NA
6129573.14B2	NO	450	5.7	no	---	NA
6129573.14	NO	450	5.7	no	21	17 mA
6129573.15	NO	450	5.7	no	25	12 mA
6129573.16	NO	450	5.7	no	25	12A
6129573.17	NO	450	5.7	no	8.7	4 mA
6129573.18B	NO	550	1.8	no	---	NA
6129573.18	NO	550	5.7	no	0	4 mA
6129573.19	NO	550	5.7	no	0	12 mA
6129573.20	NO	550	5.7	no	0	28 mA
6129573.21	NO	450	5.7	no	0	12 mA
6129573.22	NO	450	1.8	no	33	17 mA
6129573.23B	NO	400	1.8	no	---	NA
6129573.23	NO	400	1.8	no	15	10 mA
6129573.24	NO	425	1.8	no	0	10 mA
6129573.25	NO	425	1.8	no	25.2	20 mA
6129573.26	NO	450	1.8	no	27	12 mA
6129573.27	NO	450	1.8	no	35	25 mA
6129573.28	NO	450	1.8	no	16.6	6 mA
6129573.29	NO	550	1.8	no	0	6 mA
6129573.30	NO	550	1.8	no	9.5	11 mA
6129573.31	NO	550	1.8	no	20.9	23mA
6129573.32B	NO	400	5.7	no	---	NA
6129573.32	NO	400	5.7	no	9	10 mA
6129573.33	NO	425	5.7	no	27	10 mA
6129573.34	NO	425	5.7	no	27	20 mA
6129573.35	NO	450	5.7	no	30	9 mA
6129573.36	NO	450	5.7	no	36	23 mA
6129574.1B	NO	450	5.7	no	---	NA
6129574.1B2	NO	425	1.8	no	---	NA
6129574.1	NO	425	1.8	no	20	40 mA
6129574.2B	NO	450	1.8	no	---	NA
6129574.2	NO	450	1.8	no	21	80 mA
6129572.3B	NO	400	1.8	no	---	NA
6129572.3	NO	400	1.8	no	43	10 mA
6129572.4B	NO	375	1.8	no	---	NA
6129572.4	NO	375	1.8	no	33	9 mA
6129572.5B	NO	425	1.8	no	---	NA

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
6129572.5	NO	425	1.8	no	25.3	9 mA
6129572.6	NO	425	1.8	no	25.3	9 mA
6129572.7B	NO	450	5.7	no	---	NA
6129572.7B2	NO	400	5.7	no	---	NA
6129572.7	NO	400	5.7	no	34	9 mA
6129572.8B	NO	425	5.7	no	---	NA
6129572.8	NO	400	5.7	no	9.2	9 mA
6129572.9B	NO	450	5.7	no	---	NA
6129572.9	NO	450	5.7	no	9.2	9 mA
6129572.10	NO	450	5.7	no	18.5	20 mA
6129575.1B	NO	400	1.8	no	---	NA
6129575.1	NO	400	1.8	no	25.5	9 mA
6129575.2B	NO	425	1.8	no	---	NA
6129575.2	NO	425	1.8	no	22	9 mA
6129575.3	NO	450	1.8	no	11	9 mA
6129575.4B	NO	450	1.8	no	---	NA
6129575.4B2	NO	400	5.7	no	---	NA
6129575.4	NO	400	5.7	no	9	9 mA
6129575.5	NO	425	5.7	no	9	9 mA
6129576.1B	NO	400	1.8	no	---	NA
6129576.1	NO	400	1.8	no	32	11 mA
6129576.2B	NO	400	1.8	no	---	NA
6129576.2	NO	400	1.8	no	28.6	11 mA
6129576.3	NO	425	1.8	no	11	16 mA
6129576.4	NO	425	1.8	no	11	9 mA
6129576.5	NO	450	1.8	no	18.5	13 mA
6129576.6B	NO	400	5.7	no	---	NA
6129576.6	NO	450	5.7	no	16	11 mA
6129576.7B	NO	425	5.7	no	---	NA
6129576.7	NO	425	5.7	no	21	10 mA
6129576.8B	NO	450	5.7	no	---	NA
6129576.8	NO	450	5.7	no	14.7	11 mA
6129576.9	NO	450	5.7	no	16.5	5 mA
6129576.10	NO	450	5.7	no	10	3 mA
6129577.1B	NO	400	1.8	no	---	NA
6129577.1	NO	400	1.8	no	23.3	10 mA
6129577.2	NO	425	1.8	no	18.07	9 mA
6129577.3B	NO	425	1.8	no	---	NA
6129577.3B2	NO	450	1.8	no	---	NA
6129577.3	NO	450	1.8	no	12.1	9 mA
6129577.4	NO	550	1.8	no	5	8 mA
6129577.5B	NO	550	1.8	no	---	NA
6129577.5B2	NO	400	5.7	no	---	NA
6129577.5	NO	400	5.7	no	17	11 mA
6129577.6	NO	425	5.7	no	7.2	13 mA
6129577.7B	NO	425	5.7	no	---	NA

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
6129577.7B2	NO	450	5.7	no	---	NA
6129577.7	NO	450	5.7	no	0	9 mA
6129578.1B	NO	400	1.8	no	---	NA
6129578.1	NO	400	1.8	no	26	11 mA
6129578.2B	NO	425	1.8	no	---	NA
6129578.2	NO	425	1.8	no	0	12 mA
6129578.3	NO	425	1.8	no	18.6	10 mA
6129578.4	NO	450	1.8	no	9.72	7 mA
6129578.5	NO	450	1.8	no	10.87	10 mA
6129578.6B	NO	550	1.8	no	---	NA
6129578.6	NO	550	1.8	no	0	9 mA
6129579.1B	NO	400	1.8	no	---	NA
6129579.1	NO	400	1.8	no	23	10 mA
6129579.2	NO	425	1.8	no	30.8	11 mA
6129580.1B	NO	400	1.8	no	---	NA
6129580.1	NO	400	2.2	no	0	9 mA
6129580.2	NO	400	2.2	no	0	8 mA
6129580.3	NO	425	2.2	no	0	18 mA
6129580.4	NO	425	2.2	no	0	53 mA
6129580.5	NO	425	2.2	no	0	108 mA
6129576.11B	SO ₂	400	1.8	no	---	NA
6129576.11	SO ₂	400	1.8	no	2	9 mA
6129576.12	SO ₂	425	1.8	no	0	10 mA
6129576.13	SO ₂	450	1.8	no	0	12 mA
6129576.14	SO ₂	550	1.8	no	13	14 mA
6129576.15	SO ₂	550	1.8	no	0	23 mA
6129573.37	SO ₂	650	1.8	no	0	18 mA
6129573.38B	SO ₂	650	1.8	no	---	NA
6129573.38	SO ₂	650	1.8	no	0	158 mA
6129581.1B	SO ₂	375	1.8	no	---	NA
6129581.1	SO ₂	375	1.8	no	0	3mA
6129581.3	SO ₂	375	1.8	no	0	10 mA
6129581.4	SO ₂	375	1.8	no	0	91 mA
6129581.5	SO ₂	375	1.8	no	3	138 mA
6129581.6	SO ₂	375	1.8	no	3	204 mA
6129581.7	SO ₂	375	1.8	no	3	278 mA
6129581.8	SO ₂	375	1.8	no	0	406 mA
6129581.9	SO ₂	375	1.8	no	0	521 mA
6129581.1	SO ₂	375	1.8	no	0	646 mA
6129582.1B	SO ₂	400	1.8	no	---	NA
6129582.1	SO ₂	400	1.8	no	12	4 mA
6129582.2	SO ₂	400	1.8	no	12	16 mA
6129582.3	SO ₂	400	1.8	no	12	68 mA
6129582.4	SO ₂	400	1.8	no	17	167 mA
6129582.5	SO ₂	400	1.8	no	19	262 mA
6129582.6	SO ₂	400	1.8	no	21	392 mA

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
6129582.7	SO ₂	400	1.8	no	22	516 mA
6129582.8	SO ₂	400	1.8	no	22	743 mA
6129582.9	SO ₂	400	1.8	no	23	957 mA
6129582.1	SO ₂	425	1.8	no	23	1186 mA
6129583.1B	SO ₂	425	1.8	no	---	NA
6129583.1	SO ₂	425	1.8	no	5	7 mA
6129583.2	SO ₂	425	1.8	no	5	27 mA
6129583.3	SO ₂	425	1.8	no	5	134 mA
6129583.4	SO ₂	425	1.8	no	5	318 mA
6129583.5	SO ₂	425	1.8	no	9	493 mA
6129583.6	SO ₂	425	1.8	no	17	710 mA
6129583.7	SO ₂	425	1.8	no	17	958 mA
6129583.8	SO ₂	425	1.8	no	21	1230 mA
6129584.1B	SO ₂	450	1.8	no	---	NA
6129584.1	SO ₂	450	1.8	no	2	17 mA
6129584.2	SO ₂	450	1.8	no	4.5	52 mA
6129584.3	SO ₂	450	1.8	no	5.5	301 mA
6129584.4	SO ₂	450	1.8	no	7.3	611 mA
6129584.5	SO ₂	450	1.8	no	11.5	922 mA
6129584.6	SO ₂	450	1.8	no	17	1232 mA
6129585.1B	SO ₂	475	1.8	no	---	NA
6129585.1	SO ₂	475	1.8	no	0	44 mA
6129585.2	SO ₂	475	1.8	no	3.6	116 mA
6129585.3	SO ₂	475	1.8	no	2	590 mA
6129585.4	SO ₂	475	1.8	no	10	1036 mA
6129586.1B	SO ₂	500	1.8	no	---	NA
6129586.1	SO ₂	500	1.8	no	0	22 mA
6129586.2	SO ₂	500	1.8	no	0	41 mA
6129586.3	SO ₂	500	1.8	no	0	60 mA
6129586.4	SO ₂	500	1.8	no	2	82 mA
6129586.5	SO ₂	500	1.8	no	7	108 mA
6129586.6	SO ₂	500	1.8	no	7	138 mA
6129586.7	SO ₂	500	1.8	no	9	173 mA
6129586.8	SO ₂	500	1.8	no	11	209 mA
6129586.9	SO ₂	500	1.8	no	13.5	237 mA
6129586.10	SO ₂	500	1.8	no	14	265 mA
6129586.11	SO ₂	500	1.8	no	16	309 mA
6129586.12	SO ₂	500	1.8	no	16	342 mA
6129586.13	SO ₂	500	1.8	no	13	398 mA
6129586.14	SO ₂	500	1.8	no	7	473 mA
6129586.15	SO ₂	500	1.8	no	7	560 mA
6129586.16	SO ₂	500	1.8	no	7	653 mA
6129586.17	SO ₂	500	1.8	no	8	746 mA
6129586.18	SO ₂	500	1.8	no	8	837 mA
6129586.19	SO ₂	500	1.8	no	9	924 mA
6129586.20	SO ₂	500	1.8	no	14	1064 mA

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
6129587.1B	SO ₂	525	1.8	no	---	NA
6129587.1	SO ₂	525	1.8	no	8	58 mA
6129587.2	SO ₂	525	1.8	no	12.8	89 mA
6129587.3	SO ₂	525	1.8	no	14	118 mA
6129587.4	SO ₂	525	1.8	no	17.3	142 mA
6129587.5	SO ₂	525	1.8	no	20.7	163 mA
6129587.6	SO ₂	525	1.8	no	23.6	202 mA
6129587.7	SO ₂	525	1.8	no	27.2	236 mA
6129587.8	SO ₂	525	1.8	no	29.6	226 mA
6129587.9	SO ₂	525	1.8	no	32.3	235 mA
6129587.10	SO ₂	525	1.8	no	32.5	259 mA
6129587.11	SO ₂	525	1.8	no	32.6	286 mA
6129587.12	SO ₂	525	1.8	no	32.1	331 mA
6129587.13	SO ₂	525	1.8	no	32.5	407 mA
6129587.14	SO ₂	525	1.8	no	32	504 mA
6129587.15	SO ₂	525	1.8	no	32	615 mA
6129587.16	SO ₂	525	1.8	no	31.3	730 mA
6129587.17	SO ₂	525	1.8	no	31.3	837 mA
6129587.18	SO ₂	525	1.8	no	31.3	934 mA
6129587.19	SO ₂	525	1.8	no	32.5	953 mA
6129587.20	SO ₂	525	1.8	no	32.5	1067 mA
6129588.1B	SO ₂	550	1.8	no	---	NA
6129588.1	SO ₂	550	1.8	no	1.3	79 mA
6129588.2	SO ₂	550	1.8	no	3.5	79 mA
6129588.3	SO ₂	550	1.8	no	6	157 mA
6129588.4	SO ₂	550	1.8	no	8.9	173 mA
6129588.5	SO ₂	550	1.8	no	11	182 mA
6129588.6	SO ₂	550	1.8	no	13.9	209 mA
6129588.7	SO ₂	550	1.8	no	13.9	243 mA
6129588.8	SO ₂	550	1.8	no	14.2	279 mA
6129588.9	SO ₂	550	1.8	no	15.3	281 mA
6129588.10	SO ₂	550	1.8	no	15.4	296 mA
6129588.11	SO ₂	550	1.8	no	15.4	321 mA
6129588.12	SO ₂	550	1.8	no	14.9	395 mA
6129588.13	SO ₂	550	1.8	no	14.6	491 mA
6129588.14	SO ₂	550	1.8	no	14	610 mA
6129588.15	SO ₂	550	1.8	no	14	738 mA
6129588.16	SO ₂	550	1.8	no	14.4	868 mA
6129588.17	SO ₂	550	1.8	no	14.4	970 mA
6129588.18	SO ₂	550	1.8	no	14.4	1050 mA
6129589.1b	SO ₂	375	5.7	no	---	NA
6129589.1	SO ₂	375	5.7	no	0	0 mA
6129589.2	SO ₂	375	5.7	no	0	0 mA
6129589.3	SO ₂	375	5.7	no	0	0 mA
6129589.1b2	SO ₂	375	5.7	no	---	NA
6129589.4	SO ₂	375	5.7	no	0	0 mA

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
6129589.5	SO ₂	375	5.7	no	0	0 mA
6129589.6	SO ₂	375	5.7	no	0	0 mA
6129589.7	SO ₂	375	5.7	no	0	0 mA
6129589.8	SO ₂	375	5.7	no	0	0 mA
6129589.9	SO ₂	375	5.7	no	0	0 mA
6129589.10	SO ₂	375	5.7	no	0	0 mA
6129590.1b	SO ₂	400	5.7	no	---	NA
6129590.1	SO ₂	400	5.7	no	0	12 mA
6129590.2	SO ₂	400	5.7	no	2.2	45 mA
6129590.3	SO ₂	400	5.7	no	12.5	151 mA
6129590.4	SO ₂	400	5.7	no	22.4	327 mA
6129590.5	SO ₂	400	5.7	no	25.5	495 mA
6129590.6	SO ₂	400	5.7	no	26.9	820 mA
6129590.7	SO ₂	400	5.7	no	25.7	1167 mA
6129591.1b	SO ₂	425	5.7	no	---	NA
6129591.1	SO ₂	425	5.7	no	0	0 mA
6129591.2	SO ₂	425	5.7	no	0	3 mA
6129591.3	SO ₂	425	5.7	no	0.7	7 mA
6129591.4	SO ₂	425	5.7	no	0.7	10 mA
6129591.5	SO ₂	425	5.7	no	2	50 mA
6129591.6	SO ₂	425	5.7	no	5.1	110 mA
6129591.7	SO ₂	425	5.7	no	17.8	205 mA
6129591.8	SO ₂	425	5.7	no	24.6	341 mA
6129591.9	SO ₂	425	5.7	no	27.4	512 mA
6129591.10	SO ₂	425	5.7	no	29.2	672 mA
6129591.11	SO ₂	425	5.7	no	31.6	849 mA
6129591.12	SO ₂	425	5.7	no	31.6	1061 mA
6129592.1b	SO ₂	450	5.7	no	---	NA
6129592.1	SO ₂	450	5.7	no	0	1 mA
6129592.2	SO ₂	450	5.7	no	0	4 mA
6129592.3	SO ₂	450	5.7	no	0	8 mA
6129592.4	SO ₂	450	5.7	no	0	14 mA
6129592.5	SO ₂	450	5.7	no	1	23 mA
6129592.6	SO ₂	450	5.7	no	0	34 mA
6129592.7	SO ₂	450	5.7	no	0	55 mA
6129592.8	SO ₂	450	5.7	no	0	91 mA
6129592.9	SO ₂	450	5.7	no	0	133 mA
6129592.10	SO ₂	450	5.7	no	0	187 mA
6129592.11	SO ₂	450	5.7	no	0	238 mA
6129592.12	SO ₂	450	5.7	no	1	288 mA
6129592.13	SO ₂	450	5.7	no	4.5	325 mA
6129592.14	SO ₂	450	5.7	no	11.8	335 mA
6129592.15	SO ₂	450	5.7	no	20.2	345 mA
6129592.16	SO ₂	450	5.7	no	24	368 mA
6129592.17	SO ₂	450	5.7	no	26.9	403 mA
6129592.18	SO ₂	450	5.7	no	29.9	447 mA

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
6129592.19	SO ₂	450	5.7	no	29.6	493 mA
6129592.20	SO ₂	450	5.7	no	31	540 mA
6129592.21	SO ₂	450	5.7	no	31.8	588 mA
6129592.22	SO ₂	450	5.7	no	34	639 mA
6129592.23	SO ₂	450	5.7	no	32.5	689 mA
6129592.24	SO ₂	450	5.7	no	34.8	739 mA
6129592.25	SO ₂	450	5.7	no	34.8	790 mA
6129592.26	SO ₂	450	5.7	no	34.3	841 mA
6129592.27	SO ₂	450	5.7	no	36.1	895 mA
6129592.28	SO ₂	450	5.7	no	35.2	946 mA
6129592.29	SO ₂	450	5.7	no	35	997 mA
6129593.1b	SO ₂	475	5.7	no	---	NA
6129593.1	SO ₂	475	5.7	no	1.8	4 mA
6129593.2	SO ₂	475	5.7	no	2.3	10 mA
6129593.3	SO ₂	475	5.7	no	2.9	18 mA
6129593.4	SO ₂	475	5.7	no	2.9	34 mA
6129593.5	SO ₂	475	5.7	no	2.8	55 mA
6129593.6	SO ₂	475	5.7	no	2.5	85 mA
6129593.7	SO ₂	475	5.7	no	2.5	146 mA
6129593.8	SO ₂	475	5.7	no	2.8	216 mA
6129593.9	SO ₂	475	5.7	no	2.5	294 mA
6129593.10	SO ₂	475	5.7	no	3.8	387 mA
6129593.11	SO ₂	475	5.7	no	3.5	464 mA
6129593.12	SO ₂	475	5.7	no	4.3	546 mA
6129593.13	SO ₂	475	5.7	no	5.5	624 mA
6129593.14	SO ₂	475	5.7	no	6	698 mA
6129593.15	SO ₂	475	5.7	no	8.4	767 mA
6129593.16	SO ₂	475	5.7	no	10	828 mA
6129593.17	SO ₂	475	5.7	no	10.5	872 mA
6129593.18	SO ₂	475	5.7	no	14.2	914 mA
6129593.19	SO ₂	475	5.7	no	16.4	973 mA
6129593.20	SO ₂	475	5.7	no	18.2	1043 mA
6129594.1b	SO ₂	500	5.7	no	---	NA
6129594.1	SO ₂	500	5.7	no	1.2	8 mA
6129594.2	SO ₂	500	5.7	no	1.3	18 mA
6129594.3	SO ₂	500	5.7	no	2.5	36 mA
6129594.4	SO ₂	500	5.7	no	3.2	72 mA
6129594.5	SO ₂	500	5.7	no	3.2	129 mA
6129594.6	SO ₂	500	5.7	no	3.2	207 mA
6129594.7	SO ₂	500	5.7	no	4.6	309 mA
6129594.8	SO ₂	500	5.7	no	5	419 mA
6129594.9	SO ₂	500	5.7	no	5.9	530 mA
6129594.10	SO ₂	500	5.7	no	7.5	640 mA
6129594.11	SO ₂	500	5.7	no	9.9	732 mA
6129594.12	SO ₂	500	5.7	no	12.4	785 mA
6129594.13	SO ₂	500	5.7	no	14	824 mA

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
6129594.14	SO ₂	500	5.7	no	14	845 mA
6129594.15	SO ₂	500	5.7	no	14.3	884 mA
6129594.16	SO ₂	500	5.7	no	12.9	971 mA
6129594.17	SO ₂	500	5.7	no	12.1	1083 mA
6129595.1b	SO ₂	525	5.7	no	---	NA
6129595.1	SO ₂	525	5.7	no	0	15 mA
6129595.2	SO ₂	525	5.7	no	0	29 mA
6129595.3	SO ₂	525	5.7	no	2.5	57 mA
6129595.4	SO ₂	525	5.7	no	0	120 mA
6129595.5	SO ₂	525	5.7	no	0	223 mA
6129595.6	SO ₂	525	5.7	no	1	371 mA
6129595.7	SO ₂	525	5.7	no	0.4	540 mA
6129595.8	SO ₂	525	5.7	no	1.8	716 mA
6129595.9	SO ₂	525	5.7	no	3.4	880 mA
6129595.10	SO ₂	525	5.7	no	4.5	1032 mA
6129596.1b	SO ₂	550	5.7	no	---	NA
6129596.1	SO ₂	550	5.7	no	1	28 mA
6129596.2	SO ₂	550	5.7	no	2.6	51 mA
6129596.3	SO ₂	550	5.7	no	2.9	96 mA
6129596.5	SO ₂	550	5.7	no	4.3	388 mA
6129596.6	SO ₂	550	5.7	no	5.7	610 mA
6129596.7	SO ₂	550	5.7	no	6.9	853 mA
6129596.8	SO ₂	550	5.7	no	7.4	1098 mA

Table 2A. Tests for which no Spectra are Available.

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
0512951.1	SO ₂	600	0	no	20	40
0512951.2	SO ₂	600	0	yes	20	50
0512951.3	SO ₂	600	0	yes	25	17
0512952.1	NO	600	0	yes	70	70
0512952.2	NO	700	0	yes	50	5
0512953.1	NO	500	0	no	60	3
0512953.2	NO	500	0	yes	50	3
0512953.3	NO	500	0.4	no	20	5
0512953.4	NO	600	0.4	no	20	10
0512953.5	NO	500	0	no	25	4.5
0512953.6	NO	500	0	no	70	7.6
0512954.1	NO	900	0	no	100	200
0512954.2	NO	900	0.4	yes	30	200
0512955.1	NO	500	0.4	yes	30	200
0512956.1	NO	900	0.4	yes	70	250
0512956.2	NO	900	0.4	yes	80	250
0512957.1	NO	900	0	no	0	250
0512957.2	NO	900	0	yes	0	250
0512958.1	NO	500	0.4	no	0	200
0512958.2	NO	500	0.4	yes	0	200
0512958.3	NO	500	0.8	no	0	225
0512958.4	NO	500	0.8	yes	0	225
0512959.1	NO	500	0.4	yes	0	25
0512959.2	NO	500	0.8	yes	0	25
05129510.1	NO	500	0	yes	10	200
05129511.1	NO	600	0	yes	20	150
05129511.2	NO	600	3.2	yes	10	230
05129511.3	SO ₂	600	0	yes	0	25
05129511.4	SO ₂	600	1.8	yes	0	30
05129511.5	SO ₂	600	3.2	yes	0	30
05129512.1	NO	550	0.9	no	0	12
05129512.2	NO	550	0.9	no	0	44
05129512.3	NO	550	0.9	no	0	88
05129512.4	NO	550	0.9	no	38	150
05129512.5	NO	500	0.9	no	0	100
05129512.6	NO	550	1.8	no	0	150
05129513.1	NO	550	1.8	no	0	28
05129513.2	NO	550	1.8	no	0	70
05129513.3	NO	550	1.8	no	0	117
05129513.4	NO	550	1.8	no	0	185
05129514.1	NO	550	1.8	no	0	26
05129514.2	NO	550	1.8	no	0	73
05129514.3	NO	550	1.8	no	0	125
05129514.4	NO	550	1.8	no	0	172
05129515.1	NO	550	0.9	no	5	115
05129515.2	NO	550	0.9	no	70	222

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
05129515.3	NO	550	0.9	no	50	162
05129516.1	NO	550	0.9	no	0	16
05129516.2	NO	550	0.9	no	0	35
05129516.3	NO	550	0.9	no	0	61
05129516.4	NO	550	0.9	no	0	90
05129516.5	NO	550	0.9	no	2	129
05129516.6	NO	550	0.9	no	45	178
05129516.7	NO	550	0.9	no	80	264
05129516.8	NO	550	0.9	no	33	140
05129517.1	NO	550	0.9	no	0	18
05129517.2	NO	550	0.9	no	0	39
05129517.3	NO	550	0.9	no	0	58
05129517.4	NO	550	0.9	no	0	88
05129517.5	NO	550	0.9	no	0	124
05129517.6	NO	550	0.9	no	0	161
05129517.7	NO	550	0.9	no	75	226
05129518.1	NO	400	0.9	no	0	1.6
05129518.2	NO	400	0.9	no	0	3.8
05129518.3	NO	400	0.9	no	0	6.7
05129518.4	NO	450	0.9	no	0	4.3
05129518.5	NO	450	0.9	no	0	9.6
05129518.6	NO	500	0.9	no	0	9.6
05129518.7	NO	500	0.9	no	0	40
05129518.8	NO	500	0.9	no	0	32
05129518.9	NO	500	0.9	no	0	46
05129518.10	NO	500	0.9	no	0	78
05129518.11	NO	550	0.9	no	0	45
05129518.12	NO	550	0.9	no	0	68.5
05129518.13	NO	550	0.9	no	0	97
05129518.14	NO	550	0.9	no	0	180
05129518.15	NO	550	0.9	no	0	330
05129518.16	NO	550	0.9	no	0	475
05129518.17	NO	550	0.9	no	0	600
05129518.18	NO	550	0.9	no	0	820
05129519.1	NO	550	0.9	no	0	28
05129519.2	NO	550	0.9	no	0	63
05129519.3	NO	550	0.9	no	0	102
05129519.4	NO	550	0.9	no	0	160
05129519.5	NO	550	0.9	no	80	212
05129520.1	NO	550	0.9	no	0	2.7
05129520.2	NO	550	0.9	no	0	11.3
05129520.3	NO	550	0.9	no	0	25
05129520.4	NO	550	0.9	no	0	46
05129520.5	NO	550	0.9	no	0	77
05129520.6	NO	550	0.9	no	3	128
05129520.7	NO	550	0.9	no	70	250
05129521.1	NO	550	0.9	no	0	4.2

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
05129521.2	NO	550	0.9	no	0	15
05129521.3	NO	550	0.9	no	0	28
05129521.4	NO	550	0.9	no	0	51
05129521.5	NO	550	0.9	no	3	80
05129521.6	NO	550	0.9	no	45	150
05129522.1	NO	400	0.9	no	0	8.5
05129522.2	NO	400	0.9	no	0	160
05129522.3	NO	450	0.9	no	0	23
05129522.4	NO	450	0.9	no	0	600
05129522.5	NO	550	0.9	no	0	27
05129522.6	NO	550	0.9	no	0	1000
05129523.1	NO	450	0.9	no	0	8.7
05129523.2	NO	450	0.9	no	0	23
05129523.3	NO	450	0.9	no	0	43
05129523.4	NO	550	0.9	no	0	47
05129523.5	NO	550	0.9	no	0	106
05129523.6	NO	550	0.9	no	0	200
05129523.7	NO	550	0.9	no	0	900
05129523.8	NO	650	0.9	no	0	164
05129523.9	NO	650	0.9	no	0	477
05129524.1	NO	500	0.9	no	0	0.5
05129524.2	NO	500	0.9	no	0	10
05129524.3	NO	550	0.9	no	0	80
05129524.4	NO	550	0.9	no	80	880
05129524.5	NO	550	0.9	no	80	200
05129524.6	NO	550	0.9	no	0	160
05129524.7	NO	550	1.8	no	70	400
05129524.8	NO	550	1.8	no	70	290
05129524.9	NO	550	3.3	no	55	360
05129525.1	NO	550	0.9	no	0	1.3
05129525.2	NO	550	0.9	no	0	2.7
05129525.3	NO	550	0.9	no	0	6
05129525.4	NO	550	0.9	no	0	10
05129525.5	NO	550	0.9	no	0	13.5
05129525.6	NO	550	0.9	no	0	40
05129525.7	NO	550	0.9	no	0	48
05129525.8	NO	550	0.9	no	0	61
05129525.9	NO	550	0.9	no	0	93
05129525.10	NO	550	0.9	no	0	129
05129525.11	NO	550	0.9	no	0	170
05129525.12	NO	550	0.9	no	0	210
05129525.13	NO	550	0.9	no	75	280
05129525.13	NO	500	0.9	no	65	230

Test #	Test Gas	Temperature (°C)	% Oxygen	Waveform	% Removal	Average Current (mA)
05129526.1	NO	550	1.8	no	30	64
05129526.2	NO	550	1.8	no	75	233
05129526.3	NO	550	3.3	no	15	67
05129526.4	NO	550	3.3	no	60	238
05129526.5	NO	550	3.3	no	75	406
05129526.6	NO	550	4.6	no	0	69
05129526.7	NO	550	4.6	no	20	153
05129526.8	NO	550	4.6	no	30	410
05129526.9	NO	550	5.7	no	0	61
05129526.10	NO	550	5.7	no	5	235
05129526.11	NO	550	5.7	no	25	404

IGR Enterprises
Title: 612951.1
Mon Sep 20 17:18:52 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 500 C
Percent oxygen: 5%
Percent NO removal: 0%

A
b
s
o
r
b
a
n
c
e

Absorbance

0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14

IGR Enterprises
Title: 612951.1
Mon Sep 20 19:19:01 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS/KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 500 C
Percent oxygen: 5%
Percent NO removal: 0%

Wavenumbers (cm-1)

1950 1900 1850 1800 1750 1700 1650 1600 1550

Absorbance

0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14

IQR Enterprises
Title: 612951.2
Mon Sep 20 19:38:55 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS/KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 500 C
Percent oxygen: 5%
Percent NO removal: 0%

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14

IGR Enterprises
Title: 612951.3
Mon Sep 20 23:19:05 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 500 C
Percent oxygen: 5%
Percent NO removal: 0%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

Abundance

0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15

IGR Enterprises
Title: 612951.4
Mon Sep 20 23:39:03 1993
Number of sample/scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: BTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 500 C
Percent oxygen: 5 %
Percent NO removal: 0 %

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

Absorbance

0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14

IGR Enterprises
Title: 612951.4
Tue Sep 21 01:18:58 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 500 C
Percent oxygen: 5%
Percent NO removal: 0%

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

Absorbance

A
b
s
o
r
b
a
n
c
e

0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16

IGR Enterprises
Title: 612951.5
Tue Sep 21 03:19:03 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 500 C
Percent oxygen: 5%
Percent NO removal: 0%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

Absorbance

0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15

IGR Enterprises
Title: 612951.6
Tue Sep 21 03:39:05 1993
Number of sample/scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 500 C
Percent oxygen: 5%
Percent NO removal: 0%

A
b
s
o
r
b
a
n
c
e

0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15

IGR Enterprises
Title: 612951.6
Tue Sep 21 05:18:53 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 500 C
Percent oxygen: 5%
Percent NO removal: 0%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

Ab sorbance

A
b
s
o
r
b
a
n
c
e

0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
-0.18
-0.20
-0.22
-0.24

IGR Enterprises
Title: 612951.7
Tue Sep 21 11:14:08 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 500 C
Percent oxygen: 5%
Percent NO removal: 0%

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
-0.18
-0.20
-0.22
-0.24
-0.26

IGR Enterprises
Title: 612951.8
Tue Sep 21 12:14:10 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 500 C
Percent oxygen: 5%
Percent NO removal: 0%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

Abso r b a n c e

Absorbance

0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
-0.18
-0.20
-0.22
-0.24
-0.26
-0.28

IGR Enterprises
Title: 612952.1
Tue Sep 21 13:14:13 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 5%
Percent NO removal: 5%

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
-0.18
-0.20
-0.22
-0.24
-0.26
-0.28

IGR Enterprises
Title: 612952.2
Tue Sep 21 13:34:03 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 5%
Percent NO removal: 5%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
-0.18
-0.20
-0.22
-0.24
-0.26
-0.28

IGR Enterprises
Title: 612952.3
Tue Sep 21 14:34:03 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 5%
Percent NO removal: 5%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

rB

A
b
s
o
r
b
a
n
c
e

0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
-0.18
-0.20
-0.22
-0.24
-0.26
-0.28

IGR Enterprises
Title: 612952.3
Tue Sep 21 14:53:52 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 5%
Percent NO removal: 5%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

Abundance

IGR Enterprises
Title: 612952.4
Tue-Sep-21 15:53:54 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 5%
Percent NO removal: 0%

IGR Enterprises
Title: 612952.5
Thu Sep 23 16:34:05 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 5%
Percent NO removal: 0%

Absorbance

0.27
0.26
0.25
0.24
0.23
0.22
0.21
0.20
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05

Absorbance

IGR Enterprises
Title: 612952.5
Thu Sep 23 18:34:13 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 5%
Percent NO removal: 0%

Absorbance

Ab
s
o
l
u
t
e

0.100
0.095
0.090
0.085
0.080
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035

IGR Enterprises
Title: 612952.6
Thu Sep 23 20:34:05 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 5%
Percent NO removal: 0%

1950
1900
1850
1800
1750
1700
1650
1600
1550
Wavenumbers (cm⁻¹)

absorbance

A
b
s
o
r
b
a
n
c
e

0.135
0.130
0.125
0.120
0.115
0.110
0.105
0.100
0.095
0.090
0.085
0.080
0.075
0.070
0.065
0.060
0.055
0.050

IGR Enterprises
Title: 612952.8
Fri Sep 24 00:14:00 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent NO removal: 0%

2000

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

absorbance

Ab sorbance

0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03

IGR Enterprises
Title: 612952.9
Fri Sep 24 08:53:53 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS/KBr
Beam splitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent NO removal: 0%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

Absorbance

0.095
0.090
0.085
0.080
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030

IGR Enterprises
Title: 612952.10
Fri Sep 24 09:13:46 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent NO removal: 60-70%

Aborbance

IGR Enterprises
Title: 612952.10
Fri Sep 24 10:54:06 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample pair: B10
Mirror velocity: 0.3185
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent NO removal: 60-70%

A
b
s
o
r
b
a
n
c
e

0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05

IGR Enterprises
Title: 612952.11
Fri Sep 24 11:13:59 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent NO removal: 0%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05

IGR Enterprises
Title: 612952.11
Fri Sep 24 11:33:53 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent NO removal: 0%

2000

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

IGR Enterprises
Title: 612952.12
Fri Sep 24 12:18:59 1993
Number of sample scans: 134
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 17 meters
Test cuvette: intermittent
Test temperature: 900 C
Percent NO removal: 0%

Absorbance

0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

Absorbance

0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
-0.01
-0.02
-0.03

IGR Enterprises
Title: 612952.12
Fri Sep 24 14:19:07 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: Intermittent
Test temperature: 900 C
Percent NO removal: 0%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05

IGR Enterprises
Title: 612952.13
Fri Sep 24 14:38:59 1999
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent NO removal: 50%

2000

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

Absorbance

Absorbance

A
b
s
o
r
b
a
n
c
e

0.07
0.06
0.05
0.04
0.03
0.02
0.01
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07

IGR Enterprises
Title: 612952.14
Fri Sep 24 17:50:10 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent NO removal: 30-40%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

Absorbance

A
b
s
o
r
b
a
n
c
e

0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17

IGR Enterprises
Fri Sep 24 19:49:14 1993
Fri Sep 24 19:49:57 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent NO removal: 0-15%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14

IGR Enterprises
Title: 612952.16
Fri Sep 24 20:09:52 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature:
Percent NO removal: 0-5%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

Absorbance

IGR Enterprises
Title: 61252.17
Fri Sep 24 23:50:04 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent NO removal: 0-5%

A
b
s
o
r
b
a
n
c
e

-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14

IGR Enterprises
Title: 612952.18
Sat Sep 25 00:10:02 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent NO removal: 0-5%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

absorbance

A
b
s
o
r
b
a
n
c
e

-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14

IGR Enterprises
Title: 612952.19
Sat Sep 25 02:09:56 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.8165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent NO removal: 30-40%

2000

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

Abso r b a n c e

-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17

IGR Enterprises
Title: 612952.20
Sat Sep 25 12:08:50 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent NO removal: 80-100%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

148- IGR ENTERPRISES
146- 612952.20
Sat Sep 25 12:08:50 1993
144- Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
142- Sample gain: 8.0
Mirror velocity: 0.3165
140- Aperture: 1.00
Detector: DTGS KBr
138- Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
136- Test current: intermittent
Test temperature: 900 C
Percent NO removal: 80-100%

% T r a n s m i t t a n c e

Abundance

-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
-0.19

IQR Enterprises
Title: 612952.21
Sat Sep 25 15:49:02 1993
Number of sample scans: 30
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror Velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent NO removal: 50-75%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

IGR ENTERPRISES
612952.21
Sat Sep 25 14:09:17 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.00
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 c
Percent NO removal: 50-75%

Absorbance

-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16

2000

1900

1800

1700

1600

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
-0.19

IGR Enterprises
Title: 612952.22
Fri Oct 01 20:36:07 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 500 C
Percent oxygen: .4%
Percent NO removal: 0%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

Absorbance

0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
-0.19

IGR Enterprises
Title: 612952.22
Fri Oct 01 22:15:50 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: Intermittent
Test temperature: 500 C
Percent oxygen: .4%
Percent NO removal: 0%

A
b
s
o
r
b
a
n
c
e

0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18

IGR Enterprises
Title: 612952.23
Sat Oct 02 00:36:15 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 500 C
Percent oxygen: .4%
Percent NO removal: 0%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18

IGR Enterprises
Title: 612952.23
Sat Oct 02 02:15:54 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 500 C
Percent oxygen: .4%
Percent NO removal: 0%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
-0.19
-0.20
-0.21

IGR Enterprises
Title: 612954.1
Tue Oct 05 10:55:20 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 500 C
Percent oxygen: .4%
Percent NO removal: 0-5%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
-0.19
-0.20
-0.21

IGR Enterprises
Title: 612954.2
Tue Oct 05 15:19:05 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .4%
Percent NO removal: 78%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
-0.19
-0.20
-0.21
-0.22

IGR Enterprises
Title: 612954.2
Tue Oct 05 16:58:52 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .4%
Percent NO removal: >80%

2000

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

Absorbance

Absorbance

IR Enterprises
Title: 612954J3
Tue Oct 05 21:18:56 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .4%
Percent NO removal: 80%

Absorbance

-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
-0.19
-0.20
-0.21
-0.22
-0.23
-0.24

IGR Enterprises
Title: 612954.4
Tue Oct 05 23:58:57 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .4%
Percent NO removal: 80%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
-0.19
-0.20
-0.21
-0.22
-0.23
-0.24

IGR Enterprises
Title: 612954.5
Wed Oct 06 03:59:15 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .8%
Percent NO removal: 10%

2000

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

Absorbance

IGR Enterprises
Time: 1612954.5
Wed Oct 06 05:59:00 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: Intermittent
Test temperature: 900 C
Percent oxygen: .8%
Percent NO removal: 10%

Wavenumbers (cm-1)

-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
-0.19
-0.20
-0.21
-0.22
-0.23
-0.24

Abundance

IGR Enterprises
Title: 612954.6
Wed Oct 06 08:19:15 1999
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .8%
Percent NO removal: 40%

Abso r b a n c e

-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
-0.19
-0.20
-0.21
-0.22
-0.23
-0.24

IGR Enterprises
Title: 612954.6
Wed Oct 06 09:19:18 1998
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .8%
Percent NO removal: 40%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
-0.19
-0.20
-0.21
-0.22
-0.23
-0.24

IGR Enterprises
Title: 612954.7
Wed Oct 06 11:59:19 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .8%
Percent NO removal: 40%

2000

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

Absoorbance

A
b
s
o
r
b
a
n
c
e

0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
-0.18
-0.20
-0.22

IGR Enterprises
Title: 612954.9
Wed Oct 06 21:43:54 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 4.25%
Percent NO removal: 0%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

IGR Enterprises
Title: 612954.9
Wed Oct 06 23:24:10 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 4.25%
Percent NO removal: 0%

Absorbance

0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
-0.18
-0.20

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

Absorbance

Wavenumbers (cm-1)

IGR Enterprises
Title: 612955.1
Thu Oct 07 16:46:44 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .4%
Percent NO removal: 0%

Absorbance

-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17

IGR Enterprises
Title: 612955.2
Thu Oct 07 20:47:04 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 500 C
Percent oxygen: .4%
Percent NO removal: 0%

Absorbance

Absorbance

0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15

IQR Enterprises
Title: 612955.4
Fri Oct 08 04:47:07 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 500 C
Percent oxygen: .8%
Percent NO removal: 0%

A
b
s
o
r
b
a
n
c
e

0.01

IGR Enterprises

Title: 612955.4

Fri Oct 08 06:47:19 1993

Number of sample scans: 32

Number of background scans: 32

Resolution: 4.000

Sample gain: 8.0

Mirror velocity: 0.3165

Aperture: 1.00

Detector: DTGS KBr

Beamsplitter: KBr

Source: IR

Cell length: 17 meters

Test current: intermittent

Test temperature: 500 C

Percent oxygen: .8%

Percent NO removal: 0%

-0.05

-0.06

-0.07

-0.08

-0.09

-0.10

-0.11

-0.12

-0.13

-0.14

-0.15

2000

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16

IGR Enterprises
Title: 612955.5
Fri Oct 08 12:38:05 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: JBr
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 2cc
Percent NO removal: 0%

2000

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13

IGR Enterprises
Title: 612955.6
Fri Oct 08 15:17:47 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 2cc
Percent NO removal: 0%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

IGR Enterprises
Title: 612955.6
Fri Oct 08 17:57:54 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 2cc
Percent NO removal: 0%

Abstract

IGR Enterprises
Title: 612955.7
Fri Oct 08 19:57:51 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 2cc
Percent NO removal: 0%

A
b
s
o
r
b
a
n
c
e

0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15

IGR Enterprises
Title: 612955.7
Fri Oct 08 21:17:58 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 2cc
Percent NO removal: 0%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14

IGR Enterprises
Title: 612955.8
Fri Oct 08 23:37:56 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 2cc
Percent NO removal: 35%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

Abundance

IGR Enterprises
Title: 612955.9
Sat Oct 09 03:58:12 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Squid IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 4cc
Percent NO removal: 0%

0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15

IGR Enterprises
Title: 612955.9
Sat Oct 09 05:38:10 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 4cc
Percent NO removal: 0%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

absorbance

0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030
-0.035
-0.040
-0.045
-0.050
-0.055
-0.060
-0.065
-0.070
-0.075

IGR Enterprises
Title: 612956.1
Tue Oct 12 16:17:56 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 500 C
Percent oxygen: 14%
Percent NO removal: 0%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

Absorbance

0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07

IGR Enterprises
Title: 612956.1
Tue Oct 12 17:37:51 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 500 C
Percent oxygen: .4%
Percent NO removal: 0%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.01

0.00

-0.01

-0.02

-0.03

-0.04

-0.05

-0.06

-0.07

-0.08

-0.09

-0.10

-0.11

-0.12

-0.13

IGR Enterprises

Title: 612956.4

Wed Oct 13 01:58:11 1993

Number of sample scans: 32

Number of background scans: 32

Resolution: 4.000

Sample gain: 8.0

Mirror velocity: 0.3165

Aperture: 1.00

Detector: DTGS KBr

Beamsplitter: KBr

Source: IR

Cell length: 1.7 meters

Test current: intermittent

Test temperature: 500 C

Percent oxygen: .4%

Percent NO removal: 0%

2000

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

Absorbance

A
b
s
o
r
b
a
n
c
e

-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
-0.19

IGR Enterprises
Title: 612956.8
Wed Oct 13 16:19:56 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 5%
Percent NO removal: 80%

2000

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

Absorbance

Absorbance

Abundance

-0.024
-0.026
-0.028
-0.030
-0.032
-0.034
-0.036
-0.038
-0.040
-0.042
-0.044
-0.046
-0.048
-0.050
-0.052
-0.054
-0.056
-0.058
-0.060
-0.062
-0.064
-0.066
-0.068
-0.070
-0.072
-0.074
-0.076

IGR Enterprises
Title: 612956.12
Mon Oct 18 18:02:44 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .8%
Percent NO removal: 52%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

Absorbance

Aborbance

IGR Enterprises
Title: 612956.13
Mon Oct 18 20:03:07 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS/KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .8%
Percent NO removal: 61%

A
b
s
o
r
b
a
n
c
e

-0.018
-0.020
-0.022
-0.024
-0.026
-0.028
-0.030
-0.032
-0.034
-0.036
-0.038
-0.040
-0.042
-0.044
-0.046
-0.048
-0.050
-0.052
-0.054
-0.056
-0.058
-0.060
-0.062
-0.064
-0.066
-0.068
-0.070
-0.072
-0.074

IGR Enterprises
Title: 612956.13
Mon Oct 18 21:43:14 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .8%
Percent NO removal: 61%

2000

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

Absorbance

Aborbance

IGR Enterprises
Title: 612956.15
Tue Oct 19 02:02:55 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS/KBr
Beamsplitter: KBr
Source: JF
Cell length: 1.7 meters
Test current: Intermittent
Test temperature: 900 C
Percent oxygen: .8%
Percent NO removal: 46%

A
b
s
o
r
b
a
n
c
e

0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030
-0.035
-0.040
-0.045
-0.050
-0.055
-0.060
-0.065

IGR Enterprises
Title: 612956.16
Tue Oct 19 02:42:57 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .8%
Percent NO removal: 5-10%

2000

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

Absorbance

0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030
-0.035
-0.040
-0.045
-0.050
-0.055
-0.060
-0.065

IQR Enterprises
Title: 612956.16
Tue Oct 19 02:42:57 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .8%
Percent NO removal: 5-10%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030
-0.035
-0.040
-0.045

IGR Enterprises
Title: 612956.16
Tue Oct 19 04:03:06 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .8%
Percent NO removal: 5-10%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

IGR Enterprises
Title: 612956.17
Tue Oct 19 04:23:09 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .8%
Percent NO removal: 46%

A
b
s
o
r
b
a
n
c
e

-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
-0.19
-0.20
-0.21
-0.22

IGR Enterprises
Title: 612956.19
Wed Nov 10 16:49:02 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 2.7%
Percent NO removal: 0%

2000

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

Ab sorbance

IGR Enterprises
Title: 612956.19
Wed Nov 10 18:29:01 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3185
Aperture: 1.00
Detector: DTGS KB
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 2.7%
Percent NO removal: 0%

A
b
s
o
r
b
a
n
c
e

-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
-0.19
-0.20
-0.21
-0.22
-0.23
-0.24

IGR Enterprises
Title: 612956.20
Wed Nov 10 21:09:00 1998
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 2.7%
Percent NO removal: 0%

2000

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04

IGR Enterprises
Title: 612957.1
Fri Nov 12 15:13:50 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 3.1%
Percent NO removal: 5%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04

IGR Enterprises
Title: 612957.1
Fri Nov 12 17:13:54 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 3.1%
Percent NO removal: 5%

2000

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04

IGR Enterprises
Title: 612957.2
Fri Nov 12 17:33:47 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 3.1%
Percent NO removal: 17%

2000 1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05

IGR Enterprises
Title: 612957.2
Fri Nov 12 19:13:46 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 3.1%
Percent NO removal: 17%

2000

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05

IGR Enterprises
Title: 612957.3
Fri Nov 12 19:34:11 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 3.1%
Percent NO removal: 0%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

IQR Enterprises
Title: 612957.3
Fri Nov 12 21:13:52 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 3.1%
Percent NO removal: 0%

Absorbance

A
b
s
o
r
b
a
n
c
e

IGR Enterprises
Title: 612957.4
Sat Nov 13 18:18:10 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 3.1%
Percent NO removal: 0%

A
b
s
o
r
b
a
n
c
e

0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02

IGR Enterprises
Title: 612957.5
Sat Nov 13 18:38:03 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 3.1%
Percent NO removal: 0%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

IGR Enterprises
Title: 612957.5
Sat Nov 13 20:18:03 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 3.1 %
Percent NO removal: 0 %

Absorbance

A
b
s
o
r
b
a
n
c
e

0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05

IGR Enterprises
Title: 612957.6
Sat Nov 13 20:37:59 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 3.1%
Percent NO removal: 0%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06

IGR Enterprises
Title: 612957.6
Sat Nov 13 23:18:04 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 3.1%
Percent NO removal: 0%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

IGR Enterprises
Title: 612957.7
Sat Nov 13 22:38:09 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 3.1%
Percent NO removal: 0%

Absorbance

0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

IGR Enterprises
Title: 612958.1
Thu Nov 18 13:37:48 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .95%
Percent NO removal: 0%

Absorbance

0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03

IGR Enterprises
Title: 612958.1
Thu Nov 18 15:18:01 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .95%
Percent NO removal: 0%

Absorbance

A
b
s
o
r
b
a
n
c
e

0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01

IGR Enterprises
Title: 612958.2
Thu Nov 18 15:37:51 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .95%
Percent NO removal: 0%

0.17 -
0.16 - IGR Enterprises
Title: 612958.2
Thu Nov 18 15:57:43 1993
0.15 - Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
0.14 - Mirror velocity: 0.3165
Aperture: 1.00
0.13 - Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
0.12 - Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .95%
0.11 - Percent NO removal: 0%

A b s o r b a n c e

A
b
s
o
r
b
a
n
c
e

0.080
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025

IGR Enterprises
Title: 612959.1
Wed Nov 24 12:02:53 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 1.8%
Percent NO removal: 50%

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

absorbance

0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030
-0.035

IGR Enterprises
Title: 612959.1
Wed Nov 24 14:03:02 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 1.8%
Percent NO removal: 50%

A
b
s
o
r
b
a
n
c
e

0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030

IGR Enterprises
Title: 612959.2
Wed Nov 24 14:22:55 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 1.8%
Percent NO removal: 50%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

IGR Enterprises
Title: 612959.2
Wed Nov 24 15:22:59 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 1.8%
Percent NO removal: 50%

Absorbance

0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

Absoorbance

0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030

IGR Enterprises
612959.3
Wed Nov 24 16:21:56 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 1.8%
Percent NO removal: 78%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

Absorbance

IGR Enterprises
Title: 612959.3
Wed Nov 24 18:01:46 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 1.8%
Percent NO removal: 78%

0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030
-0.035

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

Abundance

IGR Enterprises
Title: 612959.4
Wed Nov 24 20:02:09 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 1.8%
Percent NO removal: 37%

Wavenumbers (cm-1)

Absorbance

0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030
-0.035
-0.040
-0.045
-0.050

IGR Enterprises
Title: 612959.5
Wed Nov 24 22:02:14 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 1.8%
Percent NO removal: 75.5%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm⁻¹)

A
b
s
o
r
b
a
n
c
e

0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05

IGR Enterprises
Title: 612959.6
Thu Nov 25 00:22:05 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 6.3%
Percent oxygen: 4%
Percent NO removal: 6.3%

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05

IGR Enterprises
Title: 612959.7
Thu Nov 25 02:42:13 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 4%
Percent NO removal: 24%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04

IGR Enterprises
Title: 612959.7
Thu Nov 25 04:21:59 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 4%
Percent NO removal: 24%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

absorbance

Absoorbance

-0.030
-0.032
-0.034
-0.036
-0.038
-0.040
-0.042
-0.044
-0.046
-0.048
-0.050
-0.052
-0.054
-0.056
-0.058
-0.060
-0.062

IGR Enterprises
Title: 612959.8
Thu Nov 25 06:22:04 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.90
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 Meters
Test current: Intermittent
Test temperature: 900 C
Percent oxygen: 4 %
Percent NO removal: 80 %

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

Abso
rban
cane

-0.024
-0.026
-0.028
-0.030
-0.032
-0.034
-0.036
-0.038
-0.040
-0.042
-0.044
-0.046
-0.048
-0.050
-0.052
-0.054

IGR Enterprises
Title: 612959.10
Thu Nov 25 08:42:00 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 18.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 4%
Percent NO removal: 84%

A
b
s
o
r
b
a
n
c
e

0.008
0.006
0.004
0.002
0.000
-0.002
-0.004
-0.006
-0.008
-0.010
-0.012
-0.014
-0.016
-0.018
-0.020
-0.022
-0.024
-0.026
-0.028
-0.030
-0.032
-0.034
-0.036

IGR Enterprises
Title: 612959.10
Thu Nov 25 10:22:21 1998
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 4%
Percent NO removal: 84%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.20
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01

IGR Enterprises
Title: 6129510.1B
Tue Dec 07 08:08:08 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test temperature: 550 C
Percent oxygen: 1.8%

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.17
0.16 IGR Enterprises
0.15 Title: 6129510.1
0.14 Tue Dec 07 12:11:56 1993
0.13 Number of sample scans: 32
0.12 Number of background scans: 32
0.11 Resolution: 4.000
0.10 Sample gain: 8.0
0.09 Mirror velocity: 0.3165
0.08 Aperture: 1.00
0.07 Detector: DTGS KBr
0.06 Beamsplitter: KBr
0.05 Source: IR
0.04 Cell length: 1.7 meters
0.03 Test current: intermittent
0.02 Test temperature: 900 C
0.01 Percent oxygen: 1.8%
-0.01 Percent NO removal: 21%

Abso
rban
cane

0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
-0.002
-0.004
-0.006
-0.008
-0.010
-0.012
-0.014
-0.016

IGR Enterprises
Title: 6129510.2
Tue Dec 07 14:31:56 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 800 C
Percent oxygen: 18%
Percent NO removal: 55%

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

Absoorbance

0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
-0.002
-0.004
-0.006
-0.008
-0.010
-0.012
-0.014
-0.016
-0.018
-0.020

IGR Enterprises
Title: 6129510.2
Tue Dec 07 16:11:56 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 1.8%
Percent NO removal: 55%

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

Abso r b a n c e

0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
-0.002
-0.004
-0.006
-0.008
-0.010
-0.012
-0.014
-0.016
-0.018
-0.020

IGR Enterprises
Title: 6129510.4
Tue Dec 07 18:31:59 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 1.8%
Percent NO removal: 66%

absorbance

A
b
s
o
r
b
a
n
c
e

0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030
-0.035
-0.040

IGR Enterprises
Title: 6129510.5
Tue Dec 07 22:32:01 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 4%
Percent NO removal: 0%

A
b
s
o
r
b
a
n
c
e

0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030
-0.035
-0.040
-0.045
-0.050
-0.055
-0.060

IGR Enterprises
Title: 6129510.5
Wed Dec 08 00:12:18 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 11.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 4%
Percent NO removal: 0%

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

*p21521

A
b
s
o
r
b
a
n
c
e

0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05

IGR Enterprises
Title: 6129510.6
Wed Dec 08 00:31:53 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 4%
Percent NO removal: 0%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04

IGR Enterprises
Title: 6129510.6
Wed Dec 08 02:11:51 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 4%
Percent NO removal: 0%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04

IGR Enterprises
Title: 6129510.7
Wed Dec 08 02:31:58 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: 4%
Percent NO removal: 26%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

IGR Enterprises
Title: 6129511.1
Fri Dec 10 16:13:06 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .95%
Percent NO removal: 35%

Absorbance

A
b
s
o
r
b
a
n
c
e

W P

IGR Enterprises
Title: 6129511.1
Fri Dec 10 20:33:14 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 900 C
Percent oxygen: .95%
Percent NO removal: 35%

0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.21
0.20
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00

IGR Enterprises
Title: 6129511.1
Fri Dec 17 14:47:45 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 550 C
Percent oxygen: .95%
Percent NO removal: 0%

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

absorbance

A
b
s
o
r
b
a
n
c
e

0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07

IGR Enterprises
Title: 6129511.3
Fri Dec 17 15:27:54 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 550 C
Percent oxygen: .95%
Percent NO removal: 0%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

IGR Enterprises
Title: 6129511.3
Fri Dec 17 16:08:06 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test currently intermittent
Test temperature: 550 C
Percent oxygen: .9%
Percent NO removal: 0%

Absorbance

0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

Absorbance

A
b
s
o
r
b
a
n
c
e

0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14

IGR Enterprises
Title: 6129511.4
Fri Dec 17 18:07:52 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 550 C
Percent oxygen: .9%
Percent NO removal: 0%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16

IGR Enterprises
Title: 6129511.5
Fri Dec 17 18:27:46 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 550 C
Percent oxygen: .9%
Percent NO removal: 0%

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12

IGR Enterprises
Title: 6129511.5
Fri Dec 17 20:07:54 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS/KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 550 C
Percent oxygen: .9%
Percent NO removal: 0%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

absorbance

Absorbance

0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14

IGR Enterprises
Title: 6129511.6
Fri Dec 17 22:08:11 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS/KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: intermittent
Test temperature: 550 C
Percent oxygen: .9%
Percent NO removal: 0-5%

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06

IGR Enterprises
Title: 6129511.7
Tue Dec 21 11:59:33 1993
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 220 mA
Test temperature: 550 C
Percent oxygen: 2%
Percent NO removal: 70%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

Absorbance

0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08

IQR Enterprises
Title: 6129512.1B
Tue Jan 18 10:03:01 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 feet
Test temperature: 550 C
Percent oxygen: 1%

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

Abso
rban
cance

IGR Enterprises
Title: 6129512.1
Mon Jan 24 11:00:52 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 400 mA
Test temperature: 550 C
Percent oxygen: .9%
Percent NO removal: 78%

A
b
s
o
r
b
a
n
c
e

0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02

IGR Enterprises
Title: 6129512.3
Mon Jan 24 12:05:35 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 400 mA
Test temperature: 550 C
Percent oxygen: 1.8%
Percent NO removal: 45%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

IGR Enterprises
Title: 6129512.4
Mon Jan 24 13:17:14 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 400 mA
Test temperature: 550 C
Percent oxygen: 1.8%
Percent NO removal: 75%

Absorbance

0.26
0.25
0.24
0.23
0.22
0.21
0.20
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

Absorbance

0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02

IGR Enterprises
Title: 6129512.5
Mon Jan 24 15:00:07 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: MTEC
Cell length: 1.7 meters
Test current: 400 mA
Test temperature: 550 C
Percent oxygen: 3.3%
Percent NO removal: 75%

A
b
s
o
r
b
a
n
c
e

0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06

IGR Enterprises
Title: 6129513.1
Wed Jan 26 14:58:43 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 270 mA
Test temperature: 550 C
Percent oxygen: 1%
Percent NO removal: 75%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

IGR Enterprises
Title: 6129513.2
Thu Jan 27 08:20:52 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 230 mA
Test temperature: 500 C
Percent oxygen: 1%
Percent NO removal: 65%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

absorbance

Abso
rban
cenc
e

0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
-0.18

IGR Enterprises
Title: 612951413
Tue Feb 01 12:54:35 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 595 mA
Test temperature: 550 C
Percent oxygen: 1%
Percent NO removal: 80%

A
b
s
o
r
b
a
n
c
e

0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
-0.18
-0.20

IGR Enterprises
Title: 6129514.4
Tue Feb 01 14:03:30 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 765 mA
Test temperature: 550 C
Percent oxygen: 4.6%
Percent NO removal: 65%

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
-0.18

IGR Enterprises
Title: 6129514.5
Tue Feb 01 16:19:03 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 870 mA
Test temperature: 550 C
Percent oxygen: 5.7%
Percent NO removal: 60%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

absorbance

0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14

IGR Enterprises
Title: 61295151
Wed Feb 02 14:00:32 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 284 mA
Test temperature: 550 C
Percent oxygen: .9%
Percent NO removal: 80%

IGR Enterprises
Title: 6129515.2
Wed Feb 02 14:59:48 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 400 mA
Test temperature: 550 C
Percent oxygen: 1.8%
Percent NO removal: 80%

Absoorbance

0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

absorbance

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08

IGR Enterprises
Title: 6129515.5
Thu Feb 03 13:25:33 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 1000 mA
Test temperature: 500 C
Percent oxygen: 5.6%
Percent NO removal: 70%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

Abso
rban
ce

A
b
s
o
r
b
a
n
c
e

0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10

IGR Enterprises
Title: 6129515.8
Thu Feb 03 15:35:00 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 916 mA
Test temperature: 450 C
Percent oxygen: 4.6%
Percent NO removal: 70%

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

IGR Enterprises
Title: 6129515.10
Fri Feb 04 08:29:13 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 810
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 770 mA
Test temperature: 450 C
Percent oxygen: 4.6%
Percent NO removal: 75%

Absorbance

0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

IGR Enterprises
Title: 6129516.1
Fri Feb 18 10:20:07 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 86 mA
Test temperature: 550 C
Percent oxygen: .9%
Percent NO removal: 75%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

Absoorbance

IGR Enterprises
Title: 6129516.2
Fri Feb 18 10:56:20 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 122 mA
Test temperature: 550 C
Percent oxygen: 1.8%
Percent NO removal: 75%

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08

IGR Enterprises
Title: 6129516.3
Fri Feb 18 11:52:23 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 134 mA
Test temperature: 550 C
Percent oxygen: 3.3%
Percent NO removal: 75%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

IGR Enterprises
Title: 6129516.4
Fri Feb 18 13:46:28/1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 191 mA
Test temperature: 550 C
Percent oxygen: 4.6%
Percent NO removal: 65%

Absorbance

0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02

IGR Enterprises
Title: 6129516.5
Fri Feb 18 14:07:56/1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 200 mA
Test temperature: 550 C
Percent oxygen: 5.7%
Percent NO removal: 50%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.37
0.36
0.35
0.34
0.33
0.32
0.31
0.30
0.29
0.28
0.27
0.26
0.25
0.24
0.23
0.22
0.21
0.20
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12

IGR Enterprises
Title: 6129517.1
Tue Feb 22 10:42:42 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 128 mA
Test temperature: 450 C
Percent oxygen: .9%
Percent NO removal: 90%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

IGR Enterprises
Title: 6V29517.2
Tue Feb 22 11:46:38 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 129 mA
Test temperature: 450 C
Percent oxygen: 1.8%
Percent NO removal: 87%

Absorbance

0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

IGR Enterprises
Title: 6129517.3
Tue Feb 22 12:28:28 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 129 mA
Test temperature: 450 C
Percent oxygen: 3.3%
Percent NO removal: 83%

0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04

IGR Enterprises
Title: 6129517.4
Tue Feb 22 13:16:07 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 130 mA
Test temperature: 450 C
Percent oxygen: 4.6%
Percent NO removal: 80%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.46
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04

IGR Enterprises
Title: 6129517.6
Tue Feb 22 15:07:01 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 118 mA
Test temperature: 450 C
Percent oxygen: 5.7%
Percent NO removal: 77%

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.52
0.50
0.48
0.46
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08

IGR Enterprises
Title: 6129517.7
Wed Feb 23 08:26:08 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 129 mA
Test temperature: 450 C
Percent oxygen: 5.7%
Percent NO removal: 80%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.46
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02

IGR Enterprises
Title: 6129517.8
Wed Feb 23 09:49:00 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 134 mA
Test temperature: 425 C
Percent oxygen: 5.7%
Percent NO removal: 77%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.54
0.52
0.50
0.48
0.46
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08

IGR Enterprises
Title: 6129517.10
Wed Feb 23 11:11:36 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 107 mA
Test temperature: 425 C
Percent oxygen: 5.7%
Percent NO removal: 77%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.58
0.56
0.54
0.52
0.50
0.48
0.46
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12

IGR Enterprises
Title: 6129517.11
Wed Feb 23 11:47:41 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS/KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 92 mA
Test temperature: 425 C
Percent oxygen: 5.7%
Percent NO removal: 77%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.58
0.56
0.54
0.52
0.50
0.48
0.46
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10

IGR Enterprises
Title: 6129517.12
Wed Feb 23 12:20:31 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 79 mA
Test temperature: 425 C
Percent oxygen: 5.7%
Percent NO removal: 77%

1950

1900

1850

1800

1750

1700

1650

1600

1550

Wavenumbers (cm-1)

IGR Enterprises
Title: 6129517.14
Thu Feb 24 11:52:16 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 810
Mirror velocity: 0.3165
Aperture: 1.00
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 66 mA
Test temperature: 425 C
Percent oxygen: 5.7%
Percent NO removal: 77%

Absorbance

0.66
0.64
0.62
0.60
0.58
0.56
0.54
0.52
0.50
0.48
0.46
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22

Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
-0.18
-0.20
-0.22
-0.24
-0.26
-0.28
-0.30
-0.32
-0.34
-0.36
-0.38
-0.40

IGR Enterprises
Title: 6129519.1
Tue Apr 19 10:20:05 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 92.11
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 586 mA
Test temperature: 550 C
Percent oxygen: 8.3%
Percent NO removal: 45%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

Absorbance

0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
-0.18
-0.20
-0.22
-0.24
-0.26
-0.28
-0.30
-0.32
-0.34
-0.36
-0.38
-0.40
-0.42
-0.44

IGR Enterprises
Title: 6129520.1
Thu Apr 21 10:40:37 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 9211
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 350 mA
Test temperature: 550 C
Percent oxygen: 1.8%
Percent NO removal: 30%

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40

IGR Enterprises
Title: 6129521.2
Fri Apr 22 16:31:56 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 92.11
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 640 mA
Test temperature: 550 C
Percent oxygen: 11.5%
Percent NO removal: 60%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

Absorbance

0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16

IGR Enterprises
Title: 6129522.1
Thu Apr 28 09:24:25 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 810
Mirror velocity: 0.3165
Aperture: 92.11
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 352 mA
Test temperature: 550 C
Percent oxygen: 5.7%
Percent NO removal: 55%

IGR Enterprises
Title: 6129522.3
Thu Apr 28 12:20:54 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 92.11
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 611 mA
Test temperature: 450 C
Percent oxygen: 11.5%
Percent NO removal: 50%

Absorbance

0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
-0.18
-0.20
-0.22

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

IGR Enterprises
Title: 6129522.4
Thu Apr 28 12:44:00 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 92.11
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 64.1 mA
Test temperature: 425 C
Percent oxygen: 11.5%
Percent NO removal: 50%

Absorbance

0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
-0.18
-0.20
-0.22
-0.24

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

A
b
s
o
r
b
a
n
c
e

0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10

IGR Enterprises
Title: 612524.4
Fri May 06 13:15:09 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 92.11
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 533 mA
Test temperature: 450 C
Percent oxygen: 5.7%
Percent NO removal: 70%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

IGR Enterprises
Title: 6129524.6
Fri May 06 14:09:49 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 92.11
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 379 mA
Test temperature: 450 C
Percent oxygen: 11.5%
Percent NO removal: 50%

Absorbance

A
b
s
o
r
b
a
n
c
e

0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12

IGR Enterprises
Title: 6129524.7
Fri May 06 14:51:40 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 92.11
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 490 mA
Test temperature: 450 C
Percent oxygen: 11.5%
Percent NO removal: 55-60%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

Abso
rban
ance

IGR Enterprises
Title: 6129525.1
Thu May 12 13:11:35 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 92.11
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 458 mA
Test temperature: 550 C
Percent oxygen: 4.6%
Percent NO removal: 60%

A
b
s
o
r
b
a
n
c
e

0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02

IGR Enterprises
Title: 6129525.3
Fri May 13 11:07:59 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 92.11
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 315 mA
Test temperature: 450 C
Percent oxygen: 0%
Percent ethylene removal: 70%

2450

2400

2350

2300

2250

2200

2150

2100

2050

Wavenumbers (cm-1)

Absorbance

-0.052
-0.054
-0.056
-0.058
-0.060
-0.062
-0.064
-0.066
-0.068
-0.070
-0.072
-0.074
-0.076
-0.078
-0.080

IQR Enterprises
Title: 6129526.3
Tue May 17 14:31:39 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 92.11
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 120 mA
Test temperature: 550 C
Percent oxygen: 1.8%
Percent NO removal: 0%

1950 1900 1850 1800 1750 1700 1650 1600 1550
Wavenumbers (cm-1)

Absorbance

-0.054
-0.056
-0.058
-0.060
-0.062
-0.064
-0.066
-0.068
-0.070
-0.072
-0.074
-0.076
-0.078
-0.080
-0.082
-0.084

IGR Enterprises
Title: 6129526.4
Tue May 17 14:49:21 1994
Number of sample scans: 32
Number of background scans: 32
Resolution: 4.000
Sample gain: 8.0
Mirror velocity: 0.3165
Aperture: 92.11
Detector: DTGS KBr
Beamsplitter: KBr
Source: IR
Cell length: 1.7 meters
Test current: 24.1 mA
Test temperature: 550 C
Percent oxygen: 1.8%
Percent NO removal: 0%

1950 1900 1850 1800 1750 1700 1650 1600 1550

Wavenumbers (cm-1)

Additional IR spectra
in Vols 2+3