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Tritium Effluent Control Project
Progress Report: April-June 1975

C. J. Kershner and J. C. Bixel

November 17, 1975

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**UNITED STATES ENERGY RESEARCH
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Summary

Tritiated Liquid Waste Decontamination (Molecular Excitation) The major effort this quarter has been directed toward procurement of the equipment needed to perform feasibility experiments on water detritiation. A Q-switched Nd:YAG laser had been ordered from General Photonics Corporation and is presently under construction. A LiNbO₃ crystal for the parametric oscillator and associated optical components have been procured. A UV flashlamp system is being ordered from Xenon Corporation. An H₂O/H₂ reaction chamber was designed in cooperation with Dr. Anthony Gilby of Wilks Scientific Corporation. We are in the process of procuring the reaction chamber.

An FTS-14 Digilab Spectrophotometer was used to obtain several infrared spectra of HDO. The HDO molecule is being used as a surrogate in developing a method to determine the exact frequency and absorption intensity of the ν_1 band for HTO. All of the spectra obtained on the FTS-14 were superior to previous efforts using a Beckman IR-12. The wave length resolution (0.5 cm^{-1}) is more than adequate. Measurement of the relative peak intensities in the range $2650\text{--}2800 \text{ cm}^{-1}$ is possible with HDO concentrations corresponding to a total cell content of 50 millicuries of tritium. If the HTO ν_1 absorption intensities are equally strong it would appear to be no problem to measure the infrared spectrum for this molecule. A new cell has been procured and is being modified for this purpose.

A detailed design and layout has been developed for an experimental system to test the selective excitation method for water decontamination. This system will also be capable of experiments to refine the basic parameters for the method. All components are either on hand or on order. (Page 5)

Catalytic Exchange Detritiation Studies Fabrication of the experimental catalytic water detritiation system was completed by Engelhard Minerals and Chemicals Corporation at their shop in Newark, New Jersey. Helium leak tests and inspection of the equipment showed the system acceptable for shipment to Mound Laboratory. The system was received at Mound and will be installed in the Tritium Effluent Control Development Laboratory.

The newly formed Division of Nuclear Fuel Cycle and Production of the ERDA has prepared a draft of an agreement for a cooperative effort between Mound Laboratory and Chalk River Nuclear Laboratory in the area of catalytic exchange technology. (Page 10)

TRITIUM WASTE CONTROL DEVELOPMENT PROJECT

*C. J. Kershner, Science Fellow
J. C. Bixel, Project Leader*

A December 1970 Commission communique asked that contractors seek to limit their tritium and other radioactive effluents to levels that are "as low as practicable." Subsequent communiques suggest control of radiological release to less than 10% of the Radioactivity Concentration Guide (RCG) for uncontrolled areas and also suggest moving the point of concentration measurement from plant boundary limits to within the effluent stacks.

Beginning in 1970, an intensive tritium emission control effort was put into effect at Mound Laboratory. This effort has as its goal an ultimate objective of approaching zero emissions and an engineering goal quantified in terms of maintaining stack emission levels at or below 10% of the present RCG values ($40 \mu\text{Ci}/\text{m}^3$ for HT and $0.2 \mu\text{Ci}/\text{m}^3$ for HTO). To accomplish these goals facility design and operating philosophies were revised to those of containment and recycle as opposed to the past practice of high dilution and release. Over the past five years, implementation of this philosophy through facility modifications and additions and changes in operating procedures has resulted in a 30-fold reduction in the gaseous tritium effluents released from the laboratory. However, reduction of tritium effluent levels to 10% of RCG values at the point of emission and nearly complete recycle pose problems that are beyond ready solution with state-of-the-art tritium control technology.

To meet this advanced technology need, the Tritium Effluent Control Project was initiated in January 1972. The experimental direction of this project was predicated on the results of an initial source and facility evaluation which revealed that as much as 80% of the total annual release to the atmosphere could be attributed to "background" diffusion from gloveboxes and other containments to the room ventilation systems which are directly stacked. Treatment of the voluminous quantity of high humidity room air was deemed to be both economically and technically impractical. Therefore, emphasis has been placed on (1) confining the tritium at the source through the use of glovebox atmosphere detritiation and recovery systems and (2) applying room air treatment only for emergency conditions in the event of accidental releases. Initial bench scale research was directed mainly toward gaseous effluent detritiation and recovery. The major portion of the gaseous effluent treatment work is now in the pilot scale development stage. A test laboratory, embodying many of the results of the past research phase of the work, has been designed, and its construction is nearly completed.¹

As the program has matured, the scope of the development effort has expanded to include liquid tritium wastes as well as gaseous. Over the past several years it has become increasingly evident that the currently acceptable practices for disposing of tritiated liquid waste will not be adequate for the future, due to the expected increases in the quantities to be handled and the growing public concern with radioisotopic releases to the environment.

At present, the primary sources of tritiated liquid wastes are the ERDA contractors. Because of the increased emphasis on effluent control, glovebox detritiation (GADS) and other effluent removal systems (ERS) have been and are being installed, resulting in increased production of tritiated liquid waste (primarily high level; $>1000 \text{ Ci}/\text{l}$). Although modest increases are expected in high level wastes when Los Alamos and Sandia Livermore go on-stream with their new ERS and GADS, the intermediate level liquid wastes (between 1000 - $0.01 \text{ Ci}/\text{l}$) from fuel reprocessing plant operations are expected to dominate by 1985. Moreover, in the period from 1985 to the year 2000 the quantities of tritium being produced from the reprocessing of fission reactor fuels are expected to more than triple. Added to this will be a yet unknown quantity of tritiated liquid wastes generated by fusion experiments and reactors which could significantly contribute to the quantities to be disposed of in the latter part of this century.

The Tritium Waste Control Development Project at Mound Laboratory has been directed toward the development of detritiation and recovery processes that can be directly applied to the tritiated liquid waste recovery problem. We contend that of all the possible approaches to the disposal of tritiated liquid wastes, recovery offers the greatest advantages for the high level and intermediate level tritiated water categories.

In summary, although the initial thrust of the work under this program was oriented toward development of gaseous effluent treatment systems, its natural evolution has been toward the liquid waste recovery problem. At the present time, the major development effort is in this area.

BACKGROUND

Operations involving tritium produce significant quantities of aqueous waste, which must be disposed of in a safe manner. Much of the waste contains a low concentration of tritium. At present, these low-level wastes are processed and buried at relatively high expense. An alternative procedure might entail dilution of the wastes to "safe" levels and discharge to the surroundings. Both methods eventually allow some or all the tritium to enter the environment. A preferable procedure would be to decontaminate the wastes by extracting the small amounts of tritium. The economic feasibility of detritiating large volumes of low-level (10^{-3} to 10 $\mu\text{Ci/ml}$) water is highly dependent on the separation factor of the elementary isotopic separation process employed. The separation factor for most H/T isotopic systems is quite small - ranging from slightly greater than 1 to approximately 10 for the case of water electrolysis. However, one process, selective photoexcitation, has the potential for higher orders of magnitude separation factors and, in principle, requires much less separative work because the separation energy is applied to the minor constituent rather than to the entire feed mixture. In conventional multistaged separation processes, sufficient energy input is needed for processing the total feed quantity many times to maintain the total cascade flow required for the desired separation. Thus, selective photoexcitation is a very attractive process for an application where one is concerned with the isotopic separation of trace quantities from a voluminous quantity of feed such as in the case of detritiation of water or heavy water enrichment.

The goal of this study is to determine the feasibility of decontamination of selective molecular excitation. If the process proves successful, further applications will be considered, such as: (1) extension to the treatment of high-level aqueous wastes, (2) control of the tritium level in

the primary coolant of light water reactors, and (3) removal of deuterium from water.

PRIOR WORK

In the previous six months, we have formulated a scheme to detritiate aqueous wastes by molecular photoexcitation. The process consists of selective photodissociation of the HTO vapor phase fraction followed by scavenging of the photoproducts with H_2 . The selective photodissociation is achieved by a two-step process employing an infrared (IR) laser and an ultraviolet (UV) continuum source. The IR laser excites the OT stretching vibration in HTO at 4.35 μm , while the UV lamp supplies enough energy to photodissociate only the vibrationally excited HTO molecules. The photoproducts, T and OH, both react rapidly with H_2 to produce HT and H_2O , respectively. By recycling the hydrogen stream the tritium may be greatly enriched relative to the water stream. An analysis of the kinetics indicates that for low-level wastes the effect of the tritium β decay in regenerating HTO places a more stringent limitation on the allowable tritium level in the hydrogen stream than does the reaction, $\text{OH} + \text{HT} \rightarrow \text{HTO} + \text{H}$. However, enrichment of the hydrogen stream in tritium by a factor 10^4 or more relative to the water stream still appears to be possible.

A search of the available IR lasers indicated that the tunable IR laser developed by Prof. R. L. Byer and co-workers at Stanford University was the most appropriate for the initial excitation of HTO. The laser consists of an LiNbO_3 parametric oscillator pumped by a Q-switched Nd:YAG laser. The laser is tunable from 1.4 to 4.45 μ with relatively high powers (approx. 1 mJ/pulse). Prof. Byer was hired as a consultant to advise on the construction of the laser system.

An analysis of the IR absorption cross sections and concentrations of HTO to be used demonstrated the need for a long path

H₂O/H₂ reaction chamber. Based on preliminary designs for the reaction chamber and a knowledge of the UV power requirements, the specifications for a UV flashlamp system were defined.

Estimates of the quantities of tritium required to obtain adequate wavelength resolution and relative line intensities of HTO using a 7.5 cc/5 cm path length cell in a Beckman IR-12 infrared spectrometer were made using HDO as a surrogate for HTO. Barely adequate spectra were obtained for quantities of HDO comparable to approximately 3 Ci of HTO. Since this is a relatively large quantity of tritium to handle in the uncontrolled spectrometer facility, alternate approaches were pursued.

ACCOMPLISHMENTS

Laser System The major effort this quarter has been directed toward procurement of the equipment needed to perform feasibility experiments on water detritiation by molecular photoexcitation. A Q-switched Nd:YAG laser has been ordered from General Photonics Corporation and is presently under construction. A LiNbO₃ crystal for the parametric oscillator and associated optical components have been procured. A UV flashlamp system is being ordered from Xenon Corporation. An H₂O/H₂ reaction chamber was designed in cooperation with Dr. Anthony Gilby of Wilks Scientific Corporation. We are in the process of procuring the reaction chamber.

HTO Spectrum Determination Using HDO as a surrogate for HTO several experimental infrared spectra were obtained in the ν_1 region. An FTS-14 Digilab Spectrophotometer was used in this work and the spectra were of much higher resolution than those obtained previously using a Beckman IR-12. Wavelength resolution and relative line intensity were judged very adequate for assignment of the laser frequency for selective excitation of HTO. Furthermore, the increased sensitivity should make the HTO spectrum determination possible with samples containing as low as 50 millicuries of tritium. A new sample cell and set of replacement windows have been procured for the HTO spectrum determination.

Reaction Cell and Product Separation System Design and detailed layout drawings have been completed for the reaction and separation gas flow system. Many of the system components are presently on hand and the remainder have been ordered.

DISCUSSION

Laser System The tunable IR laser developed by Byer, et. al., requires a Q-switched Nd:YAG laser to pump the LiNbO₃ parametric oscillator. The specifications for the pump laser were drawn up in conjunction with Prof. Byer, who has been hired as a consultant. A request for quote was sent out and as a result the General Photonics Corporation was contracted to build the Nd:YAG laser. When completed, (delivery is scheduled for September 1975), the laser will supply at least 15 mj/pulse of TEM₀₀ radiation at 1.06 μ m with a pulse width of 20 nsec or greater and a repetition rate of 1 to 50 pps. The housing will be compatible with expansion to a system of one Nd:YAG oscillator, three YAG amplifiers and two Faraday rotator isolators. The expanded system will produce on the order of 500 mj/pulse at a rate of 10 pps.

A LiNbO₃ crystal grown perpendicular to the (01.4) plane was purchased from Crystal Technology, Inc. for use in the parametric oscillator. The polished ends of the crystal were anti-reflection (AR) coated at 1.6 μ m by Coherent Radiation. The mirrors for the parametric oscillator cavity consist of a fused silica input mirror (Laser Optics, Inc.) and a sapphire output mirror (Crystal Optics Research, Inc.). Both mirrors were coated (Coherent Radiation) to reflect greater than 95% of the light between 1.34-1.63 μ and to transmit approximately 80% of the light at 1.06 μ m and 4.35 μ m. Stainless steel mirror mounts have been purchased from Burleigh Instruments, Inc.

A low profile 3 m aluminum optical bench has been ordered from Gaertner Scientific Corporation along with various flat-bed carriages to mount and align the Nd:YAG laser, parametric oscillator and reaction cell. To manipulate the laser beam, various lenses, filters and beam splitters have been procured. A 1.7 m W He-Ne cw laser has been purchased from Metrologic for alignment purposes. An "Eppley" thermopile was purchased to measure the output energy of the Nd:YAG laser at 1.06 μ m. Finally, indium antimonide (Optoelectronics) and silicon photodiode (Hewlett-Packard) detectors have been procured to measure the absorption at 4.35 μ m and check the Gaussian beam distribution of the laser, respectively.

Reaction Cell The low concentration of HTO (10^8 - 10^{11} molecules/cc) that usually will be employed in the H₂O/H₂ detritiation experiments engenders a need for long optical path lengths to increase the absorption of the IR laser and UV flashlamp.

The reaction cell should be designed to maximize the optical path length without significantly enlarging the volume of the cell, and hence, the amount of tritium to be handled. Towards this end, Dr. A. C. Gilby of Wilks Scientific Corp., a leading manufacturer of long-path IR cells, was contacted concerning the design of the reaction cell.

Because of the small beam divergence of the IR laser, it is possible to achieve long path lengths within a relatively small volume. In fact, Dr. Gilby has designed a cell with inside dimensions of 0.95 x 2.54 x 100 cm or 242 cm³, which will provide a 45 m path length (beam reduced to 50% original intensity) using gold mirrors (98.5% reflectivity) or a 246 m path length using mirrors coated to reflect 4.35 μ m at 99.8% efficiency. The cell body will be made from drawn aluminum 6061-T6 tubing. Since the internal surface will be smooth and polished in the drawing process, it will behave as a light pipe for the UV beam giving a nominal path length of 1 m. Since we will be dealing with low pressures of water and hydrogen at room temperature the aluminum surface is not expected to promote any undesirable reactions. If necessary, a more inert cell body could be made from suprasil quartz with an external aluminized coating. An aluminum reaction cell as described above with gold coated mirrors is being procured from Wilks Scientific Corporation.

To gauge the effectiveness of the Wilks cell, let us consider a typical sample of low-level tritiated water containing 10 μ Ci/cc of HTO. Operating at 20 torr of H₂O, the HTO concentration, c , is 4×10^9 molecules/cc. The absorption cross section, α , for the OT stretch at 4.35 μ m is expected to be approximately 10^{-18} cm²/molecule.

Finally, if the path length, l , is 46 m = 4.6×10^3 cm, then the Beer-Lambert Law gives the following result for absorption of the IR laser beam.

$$\begin{aligned} A &= \frac{I_0 - I}{I_0} = 1 - e^{-\alpha cl} = \\ &= 1 - e^{-(10^{-18})(4 \times 10^9)(4.6 \times 10^3)} \\ &= 1 - e^{-2 \times 10^{-5}} \\ A &= 2 \times 10^{-5} \end{aligned}$$

The amount of absorption is very small and undetectable. The tunable IR laser puts out about 1.2×10^{16} photons/pulse at 4.35 μ m (assuming the parametric

oscillator operates on the 15 mj/pulse of 1.06 μ m radiation from the Nd:YAG laser with 15% photon conversion efficiency). Then the number of excited HTO molecules is $(1.2 \times 10^{16})(2 \times 10^{-5}) = 2.4 \times 10^{11}$ or approximately 25% of the HTO molecules ($246 \times 4 \times 10^9 = \sim 10^{12}$ molecules/cc) in the cell are excited. Therefore, although the absorption of the IR laser beam is negligible, a significant fraction of the HTO molecules are excited.

In order to tune the IR laser to maximize the absorption by HTO, the absorption must be detectable. The concentration of HTO must be greatly increased to determine the absorption spectrum. For the maximum absorption, αcl should be on the order of unity, so that A is approximately 0.63. Thus, we have

$$\begin{aligned} \alpha cl &= (10^{-18})c(4.6 \times 10^3) = 1 \\ c &= 2.17 \times 10^{14} \text{ molecules/cc.} \end{aligned}$$

At this concentration, the reaction cell contains $2.17 \times 10^{14} \times 242 = 5.25 \times 10^{16}$ molecules of HTO or less than 3 mCi of tritium, which is not an unreasonably large quantity of tritium to handle in the planned system.

UV Flashlamp The design of the reaction cell requires the UV flashlamp to have a small arc length (~ 2 -3 cm) so that it may be focused down the length of the cell. Moreover, the triggering rate for the flashlamp should be variable from 1 to 50 pps in accord with the Nd:YAG laser. Finally, the pulse width of UV flashlamp should be on the order of 1 to 10 μ sec since the lifetime of the vibrationally excited HTO molecules is expected to be ~ 10 μ sec.³ The flashlamp pulse should not be significantly shorter than 1 μ sec, since it takes 0.2 μ sec for the IR laser beam to traverse 50 m (0.8 μ sec for 250 m).

Xenon Corporation manufactures flashlamp systems that meet the above specifications. The flashlamps are pumped by 5-10 joules/pulse of electrical energy, $\sim 1\%$ of which is converted to radiation in the 1900-1950Å range according to the manufacturer. Therefore, the UV flashlamp produces $\sim 10^{17}$ photons/pulse that can photodissociate the vibrationally excited HTO molecules but not the unexcited H₂O molecules.

Returning to the previous example of 10 μ Ci/cc aqueous waste, we found that $\sim 25\%$ of the HTO molecules were excited by each IR laser pulse. The UV absorption cross section, α , is estimated to be 5×10^{-19} cm²/molecule.⁴ The UV path length is taken to be 1 m, so that the Beer-Lambert Law for absorption gives

$$\begin{aligned} A &= 1 - e^{-(5 \times 10^{-19})(10^9)(10^2)} \\ A &= 5 \times 10^{-8} \end{aligned}$$

The number of photodissociated HTO molecules is $(10^{17})(5 \times 10^{-8}) = 5 \times 10^9$ or 0.5% of the HTO molecules are photodissociated per pulse. Assuming the tritium atoms were scavenged by H_2 with 100% efficiency, the above system at 50 pps could treat on the order of 4 ml/hour of 10 μ Ci/ml tritiated aqueous waste, which is a very reasonable rate for a bench scale system.

HTO Spectrum Determination During this quarter further efforts were made to obtain a high resolution infrared spectrum of the HTO molecule. All of this work was done using HDO as a surrogate and an FTS-14 Digilab Spectrophotometer. This instrument makes multiple rapid scans of the spectrum and uses a minicomputer for control, data storage and analysis.

The initial spectrum was measured using 50% D_2O - 50% H_2O (~50% HDO) at 20 torr cell pressure. The cell was the same 7.5 cc volume, 5 cm path length cell used in previous measurements on the Beckman IR-12. Parameters for the initial run were set at 200 scans and 8 cm^{-1} resolution in order to compare the spectrum to that from the IR-12. The spectrum from 400-3950 cm^{-1} was superior in both intensity and resolution to that obtained from the IR-12.

Upon extending the number of scans to 600 and expanding the wave length scale around the 2720 cm^{-1} region (ν_1 for HDO is at 2719 cm^{-1} according to Herzberg⁵) a well isolated, broad peak at ~2720 - 2725 cm^{-1} was observed. It was apparent that the use of higher resolution would show more than one peak in this region. Therefore a 1000 scan run at 2 cm^{-1} resolution was made. All of the peaks were considerably sharper and more intense, however the one centered at 2723 cm^{-1} still appeared to have at least one shoulder.

At this point the spectrum was of sufficient quality to identify the ν_1 band for laser tuning, if the wavelength scale of the spectrometer were calibrated. In order to duplicate this run with HTO the necessary amount of tritium would be ~300 millicuries which is still relatively high for an uncontrolled area. For this reason a run was made using a 10% D_2O - 90% H_2O (by liquid volume) mixture which corresponds to 18% HTO. Cell pressure was again 20 torr and 5000 scans with 2 cm^{-1} resolution were made to obtain the spectrum. In the region 2900-2600 cm^{-1} a strong, isolated peak with at least one shoulder again appeared at ~2723 cm^{-1} . The relative intensity of this peak was much greater than in the previous spectra indicating there had been interference from D_2O lines. In addition, some regularity of wavelength

spacing (probably due to rotational bands) was discernible in the groups of smaller peaks on either side of the one at 2723 cm^{-1} .

Finally, a run was made with parameters of 10% D_2O - 90% H_2O , 2500 scans and 0.5 cm^{-1} resolution to attempt the resolve of the peaks at 2723 cm^{-1} . Two strong peaks, one at approximately 2721.5 and the other at 2722.7 cm^{-1} , of approximately equal intensity were found. There were also other peaks about half as intense 1-2 cm^{-1} on either side of the strong ones.

It appears that this spectrophotometer is capable of yielding the information on location and relative intensity of the HTO ν_1 infrared absorption needed for tuning the laser. Since the unnarrowed band width of the laser will be about 2 cm^{-1} , resolution should be no problem. According to Staats,⁶ the ν_1 absorption for HTO is expected to be in the range of 2200-2300 cm^{-1} . H_2O does not absorb appreciably in this range but T_2O does. However if the lower concentrations used in the last two experiments described above (1% T_2O ; 18% HTO) can be used, the T_2O absorption should not interfere seriously. Using lower concentrations of T_2O will also alleviate some of the problems of handling tritium in an uncontrolled area.

Accordingly, a cell similar to that used in the work described above has been procured and is being modified for the tritium work. An all metal system, except for windows and seals, has been designed to load the cell. Procurement of the components is underway.

Product Separation and Gas Flow System

A closed loop flow system has been designed and components procured to carry out the initial bench scale selective photolysis separation studies on HTO. A great deal of flexibility has been designed into the system so that both batch and continuous flow modes of operation and future modification can be accommodated. Moreover, the system has been designed so that samples of tritiated water can be prepared for spectrum determinations with either the Fourier transform spectrophotometer or by in situ measurement using the tunable IR laser and a monochromator.

The flow scheme for the reaction cell and production separation system is shown in Figure 1. Hydrogen stream supply and product removal are provided by two separate uranium beds. Tritiated water is introduced to the flow stream and the reaction cell via a water bubbler and

FIGURE 1 - Reaction cell and product separation system.

separated from the hydrogen stream, after selective exchange in the reaction cell, by absorption on a molecular sieve trap. A metal bellows pump provides the pressure drop for the flow mode of operation. The entire system is stainless steel with metal gasketed "Cajon" fittings used throughout. Flow and pressure are monitored with "Hastings" mass flow transducers and "Baratron" pressure transducers, respectively. An in-line one liter "Betatec" ion chamber is used for determining the tritium content and a "Panametric" hygrometer for determining the total moisture content of the flow stream. The system has a maximum flow capacity of 1000 std cc sec⁻¹ which corresponds to minimum residence time in the reaction cell of approximately 400 msec.

FUTURE PLANS

There are six major objectives for the next quarter:

- (1) construction and testing of the H₂O/H₂ flow system and reaction cell,
- (2) assembly and testing of the tunable IR laser,
- (3) alignment of the tunable IR laser, UV flashlamp and reaction cell,
- (4) tuning the IR laser to the maximum absorption band in HTO,
- (5) initiate feasibility experiments on the water detritiation by selective two-step photodissociation, and
- (6) obtain IR spectrum of HTO with the FTS-14 Digilab Spectrophotometer.

BACKGROUND

In order to minimize release of radioactive materials to the environment, we must develop safe handling and disposal methods for the radioisotopes being produced by the expanding nuclear power industry. Tritium is one of the most important of these radioisotopes, and usually appears as the oxide. In this form, tritium follows the natural water flow and is especially prone to environmental dispersal.

Isotopic separation processes need to be developed for the purpose of removing tritium from contaminated water streams. In the operation of a light water reactor, for example, all radioisotopic contaminants except tritium can be removed from the effluent stream by ordinary chemical and physical methods. Tritium removal in this case required special considerations.

The objectives of this study are:

- a. Determination of technical and economic factors of H_2/H_2O exchange as a possible detritiation process for treating tritium contaminated water from power reactor and fuel reprocessing plant operations,
- b. Determine suitability of hydrophobic exchange catalysts for use in water detritiation systems, and
- c. Establish through pilot scale testing, design criteria for detritiation systems capable of meeting the tritium control needs of the U. S. power reactor industry and ERDA site operations.

PRIOR WORK

Status of progress relative to objectives include: (1) A literature survey for information relating to economic factors for the H_2/H_2O exchange was completed. (2) An experimental design was developed for a proof-of-principle test system and a contract was established with Engelhard Minerals and Chemicals Corporation to

supply the catalyst and basic components for this system. (3) Preliminary process designs based on both a dual temperature cascade and a countercurrent single column enrichment and stripping scheme have been made.

ACCOMPLISHMENTS

Fabrication of the experimental catalytic water detritiation system was completed by Engelhard Minerals and Chemicals Corporation at their shop in Newark, New Jersey. Helium leak tests and inspection of the equipment showed the system acceptable for shipment to Mound Laboratory. The system was received at Mound and will be installed in the Tritium Effluent Control Development Laboratory.

The newly formed Nuclear Fuel Cycle & Production Division of the ERDA has prepared a draft of an agreement for a cooperative effort between Mound Laboratory and Chalk River Nuclear Laboratory in the area of catalytic exchange technology.

DISCUSSION

A trip was made to the Atomic Energy of Canada Limited - Chalk River Nuclear Laboratories, Chalk River, Ontario.

Discussions with Chalk River personnel revealed that considerable research and development has been directed toward a catalytic exchange process for heavy water production. They have studied several hydrophobic catalysts including catalysts from Engelhard Minerals and Chemicals Corporation. Based on their results with deuterium they feel a catalytic exchange process for detritiation of light and heavy water would be both feasible and economically competitive, although for heavy water production the process in its present state of development is not competitive with the GS (H_2S) process.

They expressed interest in a cooperative program with Mound Laboratory to share information on the catalytic exchange process. They have no data with tritium

and could benefit from Mound Laboratory's study. On the other hand, the deuterium data from Chalk River could speed the development of the catalytic exchange detritiation process at Mound Laboratory.

The newly formed Division of Nuclear Fuel Cycle and Production of the ERDA has prepared a draft of an agreement for a cooperative effort between Mound Laboratory

and Chalk River Nuclear Laboratory in the area of catalytic exchange technology.

FUTURE PLANS

Work will be directed toward installation of the experimental catalyst evaluation system in a glovebox in the development laboratory. Catalyst performance will then be investigated.

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Consultants

C. F. Curtiss
University of Wisconsin
C. F. Eck
Miamisburg, Ohio
H. W. Mattson
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D. F. Griffing
Miami University
R. E. Miers
Ft. Wayne, Indiana
G. W. Powell
Ohio State University
A. Shapiro
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