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CATALYTIC MULTI-STAGE LIQUEFACTION OF COAL

TENTH QUARTERLY REPORT FOR THE PERIOD

1 JANUARY 1995 - 31 MARCH 1995

A.G. Cornelli
E.S. Johanson
L.K. Lee
V.R. Pradhan
R.H. Stalzer

FINAL

WORK PERFORMED UNDER CONTRACT

DE-AC22-93PC92147

HYDROCARBON TECHNOLOGIES, INC.
PO BOX 6047, NEW YORK & PURITAN AVENUES
LAWRENCEVILLE, NJ 08648

MAY 1995

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ABSTRACT

This quarterly report covers the activities of Catalytic Multi-Stage Liquefaction of Coal during the Period January 1 - March 31, 1995, at Hydrocarbon Technologies, Inc. in Lawrenceville, New Jersey. This DOE Contract Period was from December 8, 1992 to December 7, 1994 and has been extended to September 30, 1995.

The overall objective of this program is to produce liquid fuels from coal by direct liquefaction at a cost that is competitive with conventional fuels. Specifically, this continuous bench-scale program contains provisions to examine new ideas in areas such as: low temperature pretreatments, more effective catalysts, on-line hydrotreating, new coal feedstocks, other hydrogen sources, more concentrated coal feeds and other highly responsive process improvements while assessing the design and economics of the bench-scale results.

This quarterly report covers work on Laboratory Scale Studies, Continuous Bench-Scale Operations, Technical Assessment and Project Management.

SUMMARY

This report describes the following: i) laboratory support for bench run CMSL-09, ii) the laboratory-scale efforts for development of suitable catalysts for hydrocracking/depolymerization of waste plastics, iii) analysis of TBP fractions of distillates from CMSL-08, and iv) objectives and run-plan for bench run CMSL-09.

It is realized now that an effective acid catalyst, in a dispersed form, which can stand the conditions of coal liquefaction, is required for the complete depolymerization of plastics, especially HDPE. At HTI, we have been working on the development of such dispersed acidic catalysts, based on anion-modified iron oxides. The catalysts were synthesized and characterized for their surface areas, their activity for plastics hydrocracking was determined using 20 cc shaken microautoclaves. HTI's Fe catalyst was found effective in converting over 94% of mixed plastics (HDPE+Polystyrene) into light liquids and gases.

Since the new precursor of molybdenum, Molyvan-A, had never been tested at HTI heretofore, some microautoclave testing was carried out to screen its coal conversion activity in relation to Molyvan-L and HTI's Fe catalyst. Indeed, Molyvan-A, which is in a powder form (oil insoluble) and known to decompose under liquefaction conditions, resulted in over 85% coal conversion levels, 4 to 6 % higher than either Molyvan-L or HTI's Fe catalyst.

The analyses of true boiling fractions from bench run CMSL-08 was completed during this reporting period and confirms the hydrogen-rich and low boiling nature of the distillate products. The reactivity of residual oils, derived from coal during the CTSI operations, was studied in a series of microautoclave tests, and the results are covered in this report.

The next bench run in the CMSL Program, CMSL-09, was designed to be a dispersed catalyst-only run. This was the first time at HTI that no supported extrudate catalyst was to be used in the reactors except for in the in-line hydrotreater. The primary objective of this run was to determine the activities of molybdenum, added as Molyvan-A, and of iron, as HTI Fe catalyst, on the liquefaction of a Wyoming subbituminous coal. The run was designed to be a 40 day long operation, with the last ten days on a combined feed of coal and mixed plastics.

TASK 2 - LABORATORY SCALE STUDIES

LABORATORY STUDIES FOR HYDROCRACKING PLASTICS

The reaction of a HDPE and polystyrene (50/50 w/w) mixture was carried out in the microautoclaves (20 cc) in the presence of dispersed acidic catalysts, $\text{Al}_2\text{O}_3/\text{SO}_4$ and FeOOH/SO_4 , at 850°F, for 1 hr, and under 300 psig (cold) H_2 pressure. The results indicate about 98-99 W% conversion of the plastics (which are mostly THF-insoluble before reaction) into liquids (light, free flowing) and gases ($\text{C}_1\text{-C}_5$). Based on the difference in the reactor weights before and after reactions, the gas yields are estimated to be between 10-12 W% with the rest being light liquid (THF solubles). Further analysis of the THF soluble products indicated that it was completely soluble in cyclohexane. This result seems to be very encouraging considering that the other laboratories working on the plastics hydrocracking/depolymerization have been using a strongly acidic and more expensive zeolites (HZSM-5 or Y-Zeolite) for this reaction. Both the catalyst additives, indicated above, have been developed in-house at HTI. In order to verify this result and also search for optimum conversion conditions, additional microautoclave tests were conducted under "coal liquefaction conditions."

TABLE 1 ACTIVITY OF SULFATED CATALYSTS FOR HYDROCRACKING

Catalyst*	Temperature, °C	Time, min	Conv. based on THF Solubility
None	454	30	82.6, 82.4
$\gamma\text{-Al}_2\text{O}_3/\text{SO}_4$	454	30	92.2, 93.1
Fe Oxide/ SO_4	454	30	94.1, 94.8
$\text{SiO}_2/\text{Al}_2\text{O}_3$	454	30	83.8, 84.6
Y-Zeolite	454	30	87.2, 88.0

* All the runs were carried out using 3 g of HDPE plus 2 g of polystyrene as feed with 1 w/w of the catalyst; a cold H_2 pressure of 800 psig was used for these runs.

LABORATORY SUPPORT FOR BENCH RUN CMSL-09

As mentioned earlier, bench run CMSL-09 was designed to be an all dispersed catalyst-only run, investigating the activities of iron-based and molybdenum-based precursors. The activities of these catalyst precursors were first screened using HTI's 20 cc shaken microautoclaves. Following results have been obtained so far in the microautoclave testing of the dispersed catalysts (conducted under conditions similar to those in the first stage coal liquefaction reactor) for CMSL-09. As shown by these tests, Molyvan-A results in the highest coal conversion at 600 ppm Mo; another precursor of molybdenum, Molyvan-L, results in slightly reduced conversion levels. Sulfated iron catalyst at 6000 ppm of Fe shows slightly lower conversion. (This is expected due to higher intrinsic activity of molybdenum as compared to iron.)

TABLE 2 LABORATORY SUPPORT FOR CMSL-09

Precursor/Catalyst	Concentration	Temp., °C	Time, h	Conv. ^{1, 2}
Molyvan-A	616 ppm Mo	441	0.5	86.8 & 87.5
Molyvan-L	609 ppm Mo	441	0.5	83.5 & 82.8
HTI Fe Catalyst	6000 ppm Fe	441	0.5	80.6 & 80.2

¹ All these tests were carried out using 2.0 g of Black Thunder mine coal and 6.0 g of PFL; also DMDS was used as a sulfiding agent during these runs.

² Conversions are based on THF solubility of products.

RESIDUAL OIL REACTIVITY IN MICROAUTOCLAVES

The activity of residual oil derived from coal has been tested using HTI's 20 cc microautoclaves. Table 8, summarizes the results of the Microautoclave program evaluating the reactivities of various 975 F+ residual oils that were produced during CTSL operations in Bench Unit 227. Table 3 and Figures 1 and 2 summarize the results of this program.

A summary of the results follows:

- A) For Black Thunder Mine coal products, there was a relatively small variation (+/- 7%) in reactivity for second stage residual oils having a wide range of hydrogen contents (6.5-8.6 W%). However, a second stage product with the lowest hydrogen content (5.7 W%) did exhibit a very low reactivity, 58% of that of the reference second stage product. This lower hydrogen content product was from a CTSL operation where a very high proportion of CO² was fed to the operation which probably resulted in the poorer hydrogenation performance. (See Figure 1.)

- B) Illinois Coal products showed substantially higher residual oils reactivities than indicated for Black Thunder Mine products, by an average 59%, also with no relation to hydrogen content. A single test of a New Mexico Coal product indicated 34% greater reactivity than for the Black Thunder Mine products.
- C) For both the Black Thunder and Illinois coals, there was no clear relation of residual oil reactivity to catalyst age (time of operations) between 5 days of CTSL coal operations and 23 days. The usual deterioration of residual oil conversion performance as catalysts age during CTSL operations is, apparently, a direct deterioration of cracking performance of the CTSL catalyst, rather than an indirect effect of deteriorating hydrogenation performance. However, residual oils produced in modes of CTSL operation that result in very poor hydrogenation performance did exhibit low reactivity.
- D) For Black Thunder coal, a first stage product (from an operation with no catalyst in the first stage) showed a reactivity almost twice as great as that of the usual second stage products (see Figure 2), even though this product had a hydrogen content (6.1 W%) well below that of the normal range of second stage product hydrogen contents. There was a similar relationship of first stage/second stage reactivities in the current tests with New Mexico coal products. In tests in a previous Microautoclave program a first stage product (where there had been extrudate catalyst in both stages resulting in a higher hydrogen content, 7.2 W%) was almost three times as reactive as the second stage product, and its reactivity is promoted in a hydrogenating environment.
- E) The high reactivity of the three first stage products, indicates that the residual oils are not uniformly reactive, that this higher reactivity is not completely related to hydrogen content, and solvent fractionation characterization by cyclohexane and toluene. Possibly, a portion of the residual oil from the primary reaction of the coal, which largely derives in the first stage, is of higher reactivity than the balance of such oil. A possible analytical factor associated with this higher reactivity is the oxygen content.

TABLE 3. RESIDUAL OIL ACTIVITY IN MICROAUTOCLAVES

MICROAUTOCLAVE TESTS ON RELATIVE ACTIVITY OF RESIDUAL OILS PRODUCED IN CTSL COAL LIQUEFACTION OPERATIONS

Tests of Blends of 30% of Test Residuum with 70% HRI 5868 Coal Liquefaction Distillate

Tests on Second Stage Products Except as Noted

Tests at 825 F, 2000 psig hydrogen using HRI 5902P Presulfided Criterion C-317 Catalyst

or Recovered Second Stage Catalyst Run 260-04 Period 19

Low Severity - 7.5 Minutes*Grams Catalyst/Gram Blend High Severity - 30 Minutes*Grams Catalyst/Gram Blend

Reactivity Relative to Correlated Results for Run 227-55-23A Residuum

BLACK THUNDER MINE COAL PRODUCTS

CTSL RUN-PERIOD	Relative Reactivity		Residuum Analyses, W%							CTSL Resid. Yield W%, Dry Coal
	Low Sever Test	High Sever Test	Carbon	Hydrogen	Nitrogen	Sulfur	Total CHNS	CHX Insoluble	Toluene Insoluble	
227-55-23A	103	98	91.21	6.55	0.89	0.04	98.69	38.5	5.4	4.4
227-70-5	127	133* 104	89.78	7.92	0.25	0.06	98.01	1.8	0.1	2.2
227-70-12	123	93	90.16	8.59	0.28	0.00	99.03	2.1	0.9	3.6
227-71-13	103	58	90.19	5.73	0.68	0.00	96.60	34.4	6.2	0.9
227-75-9A (First Stg.)		188	88.20	6.09	1.84	0.18	96.31			29.1**
227-75-88 (Second Stg.)		97	89.62	6.79	1.08	0.05	97.54	21.1	1.2	4.7

ILLINOIS COAL PRODUCTS

CTSL RUN-PERIOD	Relative Reactivity		Residuum Analyses, W%							
	Low Sever Test	High Sever Test	Carbon	Hydrogen	Nitrogen	Sulfur	Total CHNS	CHX Insoluble	Toluene Insoluble	
227-66-5	170	141	89.97	8.69	0.47	0.04	99.17	9.8	1.9	1.4
227-66-14	177	102 147(7)	89.02	8.26	0.75	0.03	98.06	23.3	1.6	6.7
227-66-23	252	207	88.15	7.17	1.00	0.42	96.74	40.9	7.2	(10.7)
227-72-17	92(1) 144(2) 184(3) 132(4) 145(5)	105(1) 133(3) 133(6)	89.08	5.98	1.51	0.51	97.08	88.4	17.2	6.6

(1) Original Analysis on 8/12 (2) Repeat analysis on 8/12 (3) Repeat Analysis on 8/18 (4) Repeat Analysis on 9/12
(5) Retest Run CE-26, Run 260-04-19 Catalyst (6) Retest Run CE-25, Run 260-04-19 Catalyst
(7) Retest Run CE-27, Run 260-04-19 Catalyst

NEW MEXICO COAL PRODUCTS

CTSL RUN-PERIOD	Relative Reactivity		Residuum Analyses, W%							
	Low Sever Test	High Sever Test	Carbon	Hydrogen	Nitrogen	Sulfur	Total CHNS	CHX Insoluble	Toluene Insoluble	
227-68-17A (First Stage)		205	87.48	8.37	0.79	0.16	96.80	18.4	0.9	15.2***
227-68-16 (Second Stage)		132	88.98	8.05	0.68	0.04	97.75			5.8

* Microautoclave product sample possibly contaminated.

** Net formation in first stage, above amount recycled to stage (35.4 W% of dry Coal). No catalyst in first stage.

*** Net formation in first stage, above amount recycled to stage (28.0 W% of dry Coal).

TASK 3 - BENCH-SCALE STUDIES

ANALYSIS OF TBP FRACTIONS OF DISTILLATES FROM CMSL-08 (227-85)

The detailed analysis of the true boiling point (TBP) fractions from run CMSL-08 was completed during this reporting period and is summarized in Tables 4 through 8. As shown in these Tables, the coal-plastics coliquefaction Periods during CMSL-08 result in a higher percentage of lighter boiling fractions. The light naphtha fraction (IBP-177°C) also increased with an increase in feed plastics concentration from 25 to 33w%. Interestingly, the lighter fraction percentage decreased when HDPE alone was processed with coal (Period 22). The hydrogen contents of the naphtha, kerosene, and diesel fractions are also high, and the nitrogen and sulfur contents noticeably low. The API gravities of the TBP fractions are higher for the coliquefaction Periods than for the coal-only period. From the PONA analysis it can be seen that the aromatics fraction increased in going from coal-only to coal/plastics coliquefaction conditions. This is not surprising as a significant portion of the aromatic fractions from coliquefaction operations was comprised of alkyl benzenes, which are derived from the depolymerization of polystyrene present in the plastics part of the feed.

**TABLE 4. DETAILED ANALYSES OF TBP FRACTIONS
RUN 227-85-PERIOD 6**

TBP Distillation, %	IBP = 53.3°C			
		<u>W%</u>		
IBP-177°C		31.70		
177-260°C		48.90		
260-343°C		16.80		
343°C ⁺		2.60		
TBP Fraction [°C]	<u>IBP-177</u>	<u>177-260</u>	<u>260-343</u>	<u>343+</u>
API Gravity	53.0	29.4	23.1	21.0
Elemental Analysis [W%]				
Carbon	85.5	87.0	87.4	87.4
Hydrogen	14.1	12.8	12.5	12.6
Sulfur, ppm	50.0	54.9	59.0	140
Antek N, ppm	< 1.0	< 1.0	< 1.0	
Aniline Point, [°C]	41.1	40.6	55.0	
Flash Point, [°C]	<-6.7	77.2	137.8	
PONA [V%]				
Paraffins	20.1	13.3		
Olefins	1.5	3.5		
Naphthenics	69.8	53.2		
Aromatics	8.6	30.0		
Aromatics, W% (ASTM D2549)			27.9	16.6

**TABLE 5. DETAILED ANALYSES OF TBP FRACTIONS
RUN 227-85-PERIOD 11**

TBP Distillation, %	IBP = 45.6°C			
		<u>W%</u>		
IBP-177°C		37.90		
177-260°C		35.30		
260-343°C		21.10		
343°C ⁺		5.70		
TBP Fraction [°C]	<u>IBP-177</u>	<u>177-260</u>	<u>260-343</u>	<u>343+</u>
API Gravity	46.3	32.7	27.0	26.5
Elemental Analysis [W%]				
Carbon	86.9	86.5	86.5	86.3
Hydrogen	12.8	13.2	13.1	13.0
Sulfur, ppm	0.47	16.0	181.0	510
Antek N, ppm	< 0.2	< 0.5	< 0.5	
Aniline Point, [°C]	13.9	47.8	64.2	
Flash Point, [°C]	<-6.7	79.4	151.7	
PONA [V%]				
Paraffins	15.2	15.5		
Olefins	1.7	5.5		
Naphthenics	48.4	49.9		
Aromatics	34.7	29.1		
Aromatics, W% (ASTM D2549)			22.9	18.4

**TABLE 6. DETAILED ANALYSES OF TBP FRACTIONS
RUN 227-85-PERIOD 16**

TBP Distillation, %	IBP = 51.7°C			
		<u>W%</u>		
IBP-177°C		48.16		
177-260°C		33.30		
260-343°C		14.94		
343°C ⁺		3.60		
TBP Fraction [°C]	<u>IBP-177</u>	<u>177-260</u>	<u>260-343</u>	<u>343+</u>
API Gravity	45.7	32.0	25.4	25.1
Elemental Analysis [W%]				
Carbon	87.1	87.0	87.0	86.5
Hydrogen	12.6	12.9	12.7	13.3
Sulfur, ppm	<0.5	4.6	214	360
Antek N, ppm	<0.5	< 0.5	< 0.5	
Aniline Point, [°C]	10.0	43.9	60.0	
Flash Point, [°C]	<-6.7	79.4	151.7	
PONA [V%]				
Paraffins	15.0	17.8		
Olefins	1.7	3.2		
Naphthenics	43.8	44.3		
Aromatics	39.5	34.8		
Aromatics, W% (ASTM D2549)			30.0	18.5

**TABLE 7. DETAILED ANALYSES OF TBP FRACTIONS
RUN 227-85-PERIOD 20**

TBP Distillation, %	IBP = 51.1°C			
		<u>W%</u>		
IBP-177°C		38.50		
177-260°C		38.90		
260-343°C		17.80		
343°C ⁺		4.80		
TBP Fraction [°C]	<u>IBP-177</u>	<u>177-260</u>	<u>260-343</u>	<u>343+</u>
API Gravity	44.9	34.5	30.0	28.7
Elemental Analysis [W%]				
Carbon	86.6	87.6	87.1	86.6
Hydrogen	12.1	13.4	13.5	13.5
Sulfur, ppm	10.0	9.7	208.3	470
Antek N, ppm	< 1.0	< 0.5	0.9	
Aniline Point, [°C]	n/a	n/a	n/a	
Flash Point, [°C]	<-6.7	82.2	151.7	
PONA [V%]				
Paraffins	14.2	23.8		
Olefins	1.6	6.1		
Naphthenics	42.6	40.5		
Aromatics	41.6	29.6		
Aromatics, W% (ASTM D2549)			18.6	13.2

**TABLE 8. DETAILED ANALYSES OF TBP FRACTIONS
RUN 227-85-PERIOD 22**

TBP Distillation, %	IBP = 58.9°C			
		<u>W%</u>		
IBP-177°C		32.90		
177-260°C		38.40		
260-343°C		20.10		
343°C ⁺		8.60		
TBP Fraction [°C]	<u>IBP-177</u>	<u>177-260</u>	<u>260-343</u>	<u>343+</u>
API Gravity	48.8	30.7	24.1	23.7
Elemental Analysis [W%]				
Carbon	86.1	86.9	86.8	86.7
Hydrogen	13.5	12.9	12.6	13.4
Sulfur, ppm	50.0	< 0.5	10.3	450
Antek N, ppm	< 1.0	< 1.0	< 1.0	
Aniline Point, [°C]	27.5	45.0	60.6	
Flash Point, [°C]	<-6.7	76.7	154.4	
PONA [V%]				
Paraffins	15.8	13.1		
Olefins	1.3	3.3		
Naphthenics	60.4	56.1		
Aromatics	22.5	27.5		
Aromatics, W% (ASTM D2549)	23.3	16.8		

BENCH RUN CMSL-09 (227/38-87)

MULTISTAGE LIQUEFACTION OF BLACK THUNDER COAL USING AN ALL DISPERSED CATALYST REACTION SYSTEM

The run plan for CMSL-09 is shown in Table 9. This run will be carried out using a dispersed-catalyst-only, two-stage, back-mixed-reactor system. The two-stage conversion reactors will be preceded by a pretreatment reactor at lower temperature and half the volume of a conversion reactor; the pretreatment reactor will be used for sulfidation of the dispersed catalyst. Bench run CMSL-09 will be forty days long, comprising eight operating conditions (5 days each). The objectives of this bench operation will be:

- To determine the process performance for subbituminous coal liquefaction using a three-stage (including pretreater) dispersed-catalyst-only, back-mixed-reactor system.
- To investigate the effect of molybdenum concentration on overall process performance.
- To determine the activity of fresh molybdenum catalyst vs. recycled molybdenum catalyst.
- To study the effect of iron additive (in the presence of molybdenum), FeOOH/SO_4 , on process performance.
- To obtain a tie-point for process performance comparisons with Exxon's latest coal liquefaction run, RCLU 1, Condition 4 (Yield Periods 422-424).
- To obtain process performance data on plastics and coal coprocessing at higher severity and in a dispersed-catalyst-only system.

An in-line hydrotreater will be used during this run. Both the separator (O-1) overheads, including knockouts, and the ASOH will be sent through the hydrotreater. In order to obtain distillate samples that are not hydrotreated and to arrive at a mass-balance around the hydrotreater, it will be taken off-line during Periods 8 and 18, but will be brought back online immediately following these periods.

The run plan includes eight run conditions that are selected to meet the technical objectives specified above. For the first five run-conditions, 1 through 5, reactor temperatures and feed space velocities will be maintained constant. These conditions will study the effects of varying the addition rate of molybdenum precursor and the relative activities of fresh vs recycled molybdenum catalyst. It is expected that molybdenum will exist as MoS_x in the recycled solids (ash, char, and unconverted coal). Condition 5 will study the effect on overall process performance of adding 5000 ppm of FeOOH/SO_4 additive.

Condition 6 will simulate the same operating conditions as employed during Condition 4 (Yield Periods 422-424) of Exxon's RCLU Run 1. The objective will be to obtain a tie-point for process performance comparison. Conditions 7 and 8 will study the combined processing of coal and plastics.

Dispersed acidic catalyst, FeOOH/SO_4 , synthesized by aqueous precipitation in a solution containing sulfate anions, will be used during Conditions 5 through 8.

SYSTEM CONFIGURATION

CMSL-09 involves two equal volume backmixed reactors, one half volume (1000 cc) pretreatment vessel, and a fixed-bed hydrotreater. The high pressure slurry samples (about 300-500 g each) will be obtained both after the pretreatment vessel and after the first conversion reactor.

The reactors from existing units 227 and 238 will be used in this run with necessary repiping and equipment modifications. A hot-slurry mix tank system will be used during the run for slurry preparation. No supported catalyst will be used in any of the conversion reactors, except the hydrotreater.

COAL FEED

A subbituminous Black Thunder Mine Coal (HRI-6213), the same coal that was used in PDU 260-005 operations, will be used for CMSL-09 (227-87) bench run.

START-UP AND MAKE-UP OIL

L-814 : Tank 4 Oil

CATALYST

Hydrotreater:	Criterion C-411 Trilobe (HRI-6135)
Pretreater (to K-1 and K-2):	Molyvan-A, FeOOH/SO_4 , and 3 % H_2S relative to dry coal.

RECYCLED-DISPERSED CATALYST

Oil-free pressure filter cake, extracted with toluene, will be used as a source of recycled-dispersed catalyst. The extracted filter cake will be dried to remove any residual solvent (toluene) and analyzed for molybdenum-content. Based on this analysis, the flowrate of the dried, extracted filter cakes to the feed slurry will be determined.

Detailed CMSL-09 run plan, presented for internal use in this memo, covers only the first five Run Conditions (25 operating periods). The last 15 operating days, covering Conditions 6 through 8, are yet to be finalized for their actual operating conditions. The detailed run plan, as well as the analytical schedule for the last three conditions, will be determined by the end of third condition of CMSL-09.

TABLE 9. PROPOSED RUN PLAN FOR CMSL-09

Condition	1	2	3	4	5*	6	7	8
Periods	1-5	6-9	10-14	15-19	20-24	25-29	30-34	35-40*
Feeds, W%								
Coal	100	100	100	100	100	100	67	67
HDPE	0	0	0	0	0	0	13	33
Polypropylene	0	0	0	0	0	0	11	0
Polystyrene	0	0	0	0	0	0	9	0
Temp. deg F								
Pretreater	300	300	300	300	300	300	300	300
K-1	443	443	443	443	443	440	449	449
K-2	449	449	449	449	449	449	460	460
HTU	379	379	379	379	379	379	379	379
Space Velocity (Kg feed/hr/m3)	640	640	640	640	640	640	640	640
Slurry Cat. Conc. parts per million								
Mo: Molyvan-A								
-Fresh	200	300	150	0	300	100	300	300
-Recycled	0	0	150	300	0	100	0	0
Fe-Catalyst	0	0	0	0	0	10000	10000	10000

*Condition 5 will now be similar to Condition 2 provided Pressure Filtrations of the CAS bottoms are sustainable for recovery of resid containing solids-free recycle solvent.

ETPC: Exxon Tie-Point Condition (Ref. Exxon's RCLU Run 1 , Condition 4, Yield Periods 422-424)

**PERIOD 40 WILL STUDY THE CONVERSION OF HDPE ALONE IN CMSL-09 CONFIGURATION

TASK 4- TECHNICAL ASSESSMENT

No technical assessment activity was conducted during this quarter.

FIGURE 1

RELATIVE REACTIVITIES OF CTSL PRODUCT RESIDUA

Second Stage Residua - Microautoclave High Severity Test

FIGURE 2

REACTIVITIES OF FIRST AND SECOND STAGE RESIDUA

Microautoclave Evaluations – High Severity Test