Equilibrium Catalyst Inc

FCC Catalyst & Logistical Management

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State of the Art Facility

- Houston Pine Vista – Fully operable 6/1/2011
- Facility Specifics
  - 11.5 Acres
  - 55,000 SF of warehouse
    - Can store approximately 3500 tons of fresh catalyst
  - 50,000 SF of covered concrete
  - 8 additional acres of concrete space
  - 800 feet of rail – capable of handling 10 rail slots
  - 37 additional storage vessels – capable to maintain 3500 tons of inventory
  - Facility will maintain full bagging operation including bag-house
- Classification Capability
  - Capability to classify approx 25 tpd of catalyst
  - ECI can create a high fine ecat to load through additive loaders to allow you to reduce 0-40 in your fresh catalyst
  - Reduce fresh 0-40 from 12-14 to 8-10 (Every 12 tons purchase = $1mm/yr)

Catalyst Selection Process

How do you select the right catalyst?

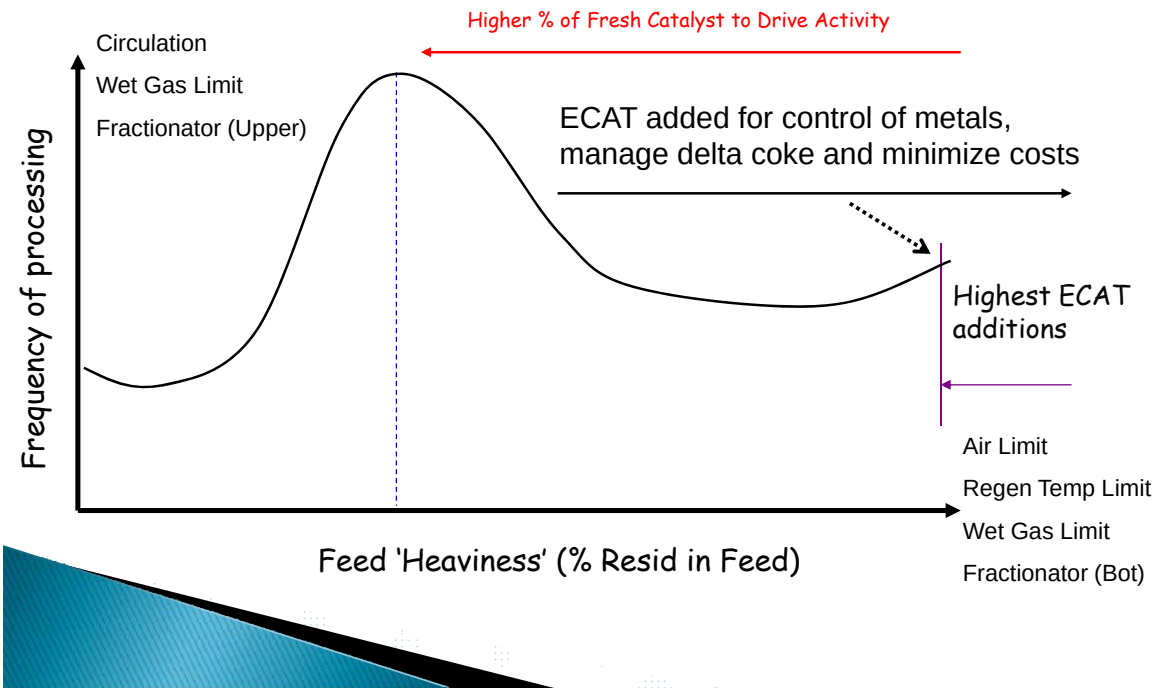
- FCC Optimization is 80% Feed / 15% Unit Hardware / 5% Catalyst
  - The key is to understand the probability distribution of your feed (light – heavy)
  - Clearly understand how each feed historically operated in the unit (Unit limitations)
  - Design a catalyst strategy that provides you the best means to operate your feed spectrum given your unit limitations
- Keys to Catalyst Selection
  - Need to understand the effective activity needed in your circulating ecat (delta coke optimization)
  - Need to clearly decide on the target selectivities (gasoline / LCO / LPG)
  - Need to clearly understand budget restrictions (you all have one)
  - Design a catalyst strategy to meet the target circulating ecat activity
    - Function of catalyst architecture
    - Effective catalyst activity
    - Daily addition rate
    - Metals tolerance
    - Unit deactivation
    - Unit feed rate

Economics of Change in Coke

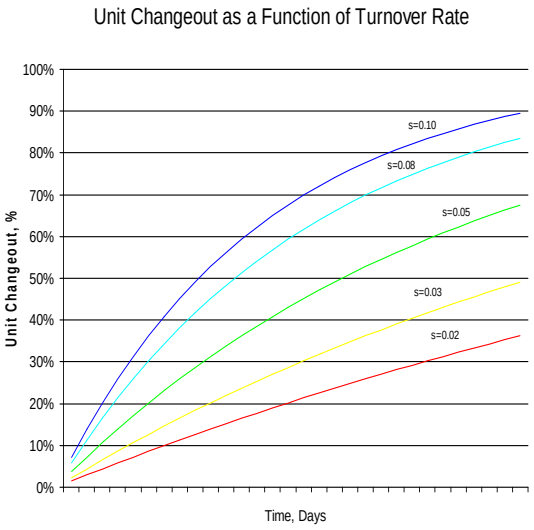
Case Number			1	4
Case Title			Base Case October 2008	Prediction Coke Selectivity Const Cat Adds
Total Net Profit	**$/DAY**		1035461	1002657
Unit Net Profit	**$/BBL**		7.91	7.66
Combined Fresh Feed	---			
-Combined Feed Rate	**BPD**		130866.0	130866.0
-API Gravity	**Deg API**		24.4	24.4
Riser/ Reactor Conditions	---			
-Feed Temperature	**Deg F**		636.2	636.2
-Riser Outlet Temperature	**Deg F**		995.4	995.4
-Cat/Oil Ratio	**WT/WT**		5.63	5.55
-Catalyst Circulation Rate	**TON/MIN**		81.3	80.2
Regenerator Conditions	---			
-Regen Bed Temperature	**Deg F**		1324.3	1328.7
Fresh Catalyst	---			
-Total Make-up Rate	**T/DAY**		11.38	11.38
-Surface Area	**M2/GM**		316	316
Equilibrium Catalyst	---			
-Activity	**MAT %**		72.6	72.2
Conversion				
-Fresh Feed Conversion (as Produced)	**Vol %**		77.09	76.44
-Fresh Feed Conversion Cut Point	**Deg F**		420	420
-Fresh Feed Conversion (430 F Cut Point)	**Vol %**		77.82	77.18
Product Yields				
Weight Percent Basis	---			
-H2+C1+C2+C2O	**Wt %**		2.95	2.99
-Coke	**Wt %**		3.91	3.91
-Total C3 + C4	**Vol %**		27.50	26.94
-C5+ Gasoline (430 F Cut Point)	**Vol %**		63.14	62.77
-Light Cycle Oil (430 F to 650 F)	**Vol %**		10.35	10.61
-Decant (650 F +)	**Vol %**		11.83	12.20
-C3+ Liquid	**Vol %**		112.82	112.53

- Resid units need to make every attempt to always lower unit delta coke
- All metals increase unit delta coke
- A modest shift in catalyst coke can cost the refinery > $0.25 / bbl

How do you design a fresh cat / ecat system for varying feed quality?



Effect of Catalyst Addition Rate on Unit Change Out Rate



- P=1-e(-sft)
  - 2% Turnover Rate Completes 36% Change out in 30 days.
  - 5% Turnover Rate Completes 50% Change out in 19 days.
  - 10% Turnover Rate Allows 50% Unit Change out in 9 days.
  - Basis: f=0.75

Y= (Yo*s)/(s+k)

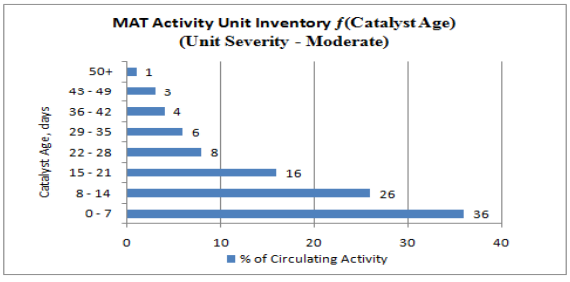
Catalyst Activity Calculation

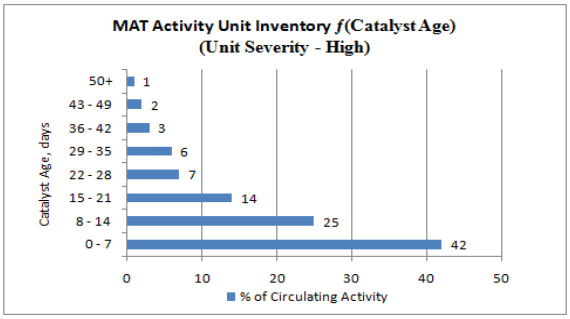
Unit Inventory = 360 tons

Y – Unit MAT	Yo – Fresh Catalyst MAT	s – Turnover Rate	K – Deactivation Coefficient	Catalyst Additions, TPD
70	81.25	0.0556	.047	20
70	85	0.033	.047	12
70	80	0.066	.047	24
70	79	.077	.047	28

- Unit Activity can be Maintained by Varying Fresh Catalyst Activity and Addition Rate.

Effect of Catalyst Age on Unit Activity





- Very Important for Resid Unit to always attempt to decrease the age distribution of circulating catalyst
- Older Catalyst
  - Decrease Yield of Gasoline, C3=
  - Increase Yield of Slurry, Coke
- Must attempt to find optimal way of maximizing catalyst addition rate

Catalyst Addition Rate

What is the optimal addition rate?

- Benefits of Higher Catalyst Addition Rate
  - Higher Catalyst Addition Rate will lower Unit Metals Levels
    - Lower Metals on Circulating ECAT will always provide higher valued yields
  - Higher Catalyst Addition Rate will decrease the average age of the catalyst in the circulating inventory
    - Lower Catalyst Age will always provide higher valued yields
- Harm from Higher Catalyst Addition Rate
  - Increase in fresh additions from current baseline will increase catalyst budget
  - Sometimes excessive addition rate of base fresh catalyst can increase delta coke and force regenerator bed temp above design limitation

ECAT Opportunity

ECI

- ECI Can Provide Customized ECAT Solution
  - ECI will provide ECAT with consistent target properties (TSA/MSA/ReO/Ni+V)
  - Establish the key targets to compliment current fresh catalyst properties
  - Remove 1 TPD of fresh catalyst and replace with 2 TPD of ecat
  - Ecat utilized must be designed with the following key features:
    - ZSA of ecat must be higher than ZSA of current circulating catalyst inventory
    - MAT activity should be 2-3 numbers higher than MAT of current circulating catalyst inventory
    - Total FCAT / ECAT additions must reduce metals on the circulating catalyst inventory compared to current baseline operation

ECAT Opportunity

ECI

- Successful design and implementation of purchased ecat will provide a FCC unit the following opportunity:

  Design a catalyst addition strategy to increase total additions
  New strategy will achieve decrease in circulating metals
  New strategy will lower catalyst inventory age
  New strategy will lower slurry
  New strategy will increase LCO, Gasoline, LPG yields
  New strategy will lower total catalyst costs

FCC Blending Services

New Purchasing Practices

- As refinery economics have deteriorated, some organizations have embraced alternative procurement strategies to maintain desired yields and reduce total operating costs:
  - More frequent bids with domestic suppliers to increase competition
  - Consider blending multiple supplier catalysts together
    - Potential for best in class yield selectivity benefits
    - Increase catalyst flexibility to meet changing selectivity preferences
      - Change from Max Gasoline to Max LCO to increase in LPG
    - Potential for cost reduction as you attempt to work with supplier to open competition at low cost opportunities

FCC Blending Services

Cost Effective Alternatives

- Our Goal is to get customers to think differently about how to purchase FCC catalyst:
  - Design a formulation to be 50-70 % primary technology and 30-50 % cost capability
    - More effective use of purchased ecat if suitable
    - Leverage testing 2nd choice / new technology
    - Entice suppliers to provide short term low cost opportunities to prove technology

ECI has multiple facilities strategically placed to blend all key components together

ECI Pine Vista Facility Blending

ECI Pine Vista Facility
Classifier

FCC Blending Services
Z-ECAT

FCC Equilibrium Offer
12-Mar-12

Equilibrium Catalyst, Inc.
P.O. Box 73312
Metairie, LA 70033

These catalysts are presently available in these quantities, either from storage, or from the refinery generating them. No guarantee can be made as to their continued availability, nor quantity. The analysis given below is a "weighted average" based on the actual equilibrium analysis sheets and input from the supply refinery as to the composition of their inventory. Since operating conditions may vary and since we do not control such conditions, we must DISCLAIM ANY WARRANTY EXPRESSED OR IMPLIED, with regard to results obtained from the use of these products.

ID #	FRESH	CATALYST	MAT	Ni	V	SA	MXSA	AL2O3	Na	REO	0-40	0-80	APS	ABD	Fe	p
E-Cat Target Values																
ECI ID #7	B	High Z-Ecat #1	75	300	400	180	65	36.8	0.28	1	7	58	83	0.82	0.55	1.45
ECI ID #8	B	High Z-Ecat #1	74	375	500	155	55	37.6	0.24	1	7	58	83	0.79	0.46	1.40

Analysis of High Z-Ecat

Notes: Refiner added 27% High ZSM-5 Level Ecat to unit starting Dec 27, 2009.

Unit Equilbrated ~ Feb 1, 2010.

Unit shows substantial increases in C3= and C4= yields.

ECI estimates High ZSM-5 Ecat to contain equivalent activity of 300 pounds of High Zeolite content ZSM-5 per ton of Ecat.

Comparison below show pre High Z Ecat additions (Oct 26, 2009 - Dec 27, 2009) vs Equilbrated High Z Ecat Operation (Feb 1, 2010 - Mar 29, 2010)

8 weeks before High Z Ecat Addition	71	132	44	1934	2130	0.91	0.30	2.62	1669	912	0.06	2.63	3.87	1.10	4.42	0.88	3.52	1.29	1.66	1.20	1.59	0.81	0.58	5.74	15.66	49.27	18.17	11.02	3.19
8 Weeks after High Z Ecat equilibrated	72	140	49	1535	1606	0.86	0.27	2.18	1359	952	0.46	2.68	3.73	1.40	6.89	0.99	4.48	1.59	2.09	1.49	2.32	0.84	0.59	7.49	21.25	44.42	17.65	10.74	3.25

Date Taken	FACT wt%	SA m2/g	MSA m2/g	Ni ppm	V ppm	Fe wt%	Na wt%	REO wt%	Ca ppm	K ppm	P wt%	DG wt%	H2/C1 ratio	C3 wt%	C3= wt%	NC4 wt%	IC4 wt%	C4=1 wt%	TC4=2 wt%	CC4-2 wt%	IC4= wt%	C3=IT ratio	C4=IT ratio	C4= wt%	LPG wt%	GASO wt%	LCO wt%	BOT wt%	COKE wt%
29Mar10	70	131	46	1605	1894	0.87	0.3	2.17	1386	900	0.42	2.5	3	1.3	6.4	0.9	4.1	1.5	2	1.4	2.2	0.83	0.59	7.1	19.8	44.3	18.6	11.5	3.4
25Mar10	71	145	50	1589	1832	0.84	0.27	2.2	1302	914	0.45	2.6	3.98	1.4	6.7	1	4.3	1.6	2.1	1.5	2.3	0.84	0.59	7.5	20.9	44.5	17.9	11.1	3.1
22Mar10	72	145	49	1615	1762	0.84	0.28	2.17	1289	927	0.46	2.6	4.11	1.3	6.5	0.9	4.1	1.6	2.1	1.5	2.3	0.85	0.61	7.5	20.3	45.7	17.8	10.6	2.9
18Mar10	73	140	49	1589	1622	0.85	0.27	2.17	1312	906	0.45	2.8	4.32	1.5	7.2	1	4.7	1.6	2.1	1.5	2.4	0.84	0.58	7.6	22.0	44.8	17.3	9.5	3.8
15Mar10	71	145	50	1577	1591	0.84	0.28	2.19	1255	931	0.47	2.8	4.16	1.4	7	1	4.5	1.6	2.1	1.5	2.3	0.83	0.59	7.5	21.4	43.6	17.8	10.9	3.6
11Mar10	71	138	49	1638	1610	0.85	0.27	2.11	1242	887	0.49	2.6	3.29	1.4	7.1	1	4.5	1.6	2.1	1.5	2.4	0.84	0.59	7.6	21.6	43.1	18.2	11.1	3.5
08Mar10	72	139	50	1624	1655	0.83	0.27	2.17	1519	890	0.5	2.7	3.76	1.5	7.4	1	4.6	1.6	2.1	1.5	2.4	0.84	0.59	7.6	22.1	43.1	17.6	10.7	3.7
04Mar10	72	135	47	1579	1566	0.83	0.28	2.17	1231	878	0.54	2.7	4.16	1.4	7.1	1	4.4	1.6	2.1	1.5	2.4	0.84	0.6	7.6	21.5	44.3	17.3	10.7	3.4
01Mar10	72	139	48	1668	1560	0.9	0.29	2.15	1333	951	0.5	2.8	4.09	1.4	7.1	0.9	4.4	1.6	2.1	1.5	2.4	0.84	0.6	7.6	21.4	44.1	17.3	10.7	3.6
25Feb10	71	145	51	1681	1632	0.86	0.28	2.19	1351	929	0.43	2.5	4.16	1.2	6.4	0.9	4	1.5	2	1.4	2.2	0.84	0.6	7.1	19.6	44.7	18.3	11.1	3.7
22Feb10	73	145	51	1521	1456	0.85	0.27	2.23	1339	931	0.46	2.8	3.77	1.4	7.1	1	4.6	1.6	2.2	1.5	2.4	0.84	0.59	7.7	21.8	44.9	17.3	10	3.1
18Feb10	73	148	51	1351	1371	0.81	0.27	2.21	1287	895	0.44	2.8	3.61	1.5	7	1.1	4.8	1.6	2.2	1.6	2.3	0.83	0.57	7.7	22.1	45.1	17	9.7	3.4
15Feb10	72	143	50	1430	1441	0.87	0.27	2.17	1403	965	0.43	2.7	3.33	1.4	6.9	1	4.6	1.6	2.1	1.5	2.3	0.84	0.58	7.5	21.4	44.8	17.5	10.7	2.7
11Feb10	72	139	47	1397	1529	0.89	0.26	2.16	1399	995	0.43	2.7	3.34	1.6	7.1	1.1	4.9	1.6	2.1	1.5	2.3	0.83	0.56	7.5	22.2	44.1	17.4	10.5	3.3
08Feb10	71	139	47	1381	1582	0.9	0.26	2.16	1441	1030	0.43	2.7	3.37	1.4	6.9	1	4.6	1.6	2.1	1.5	2.3	0.84	0.58	7.5	21.4	44.3	17.3	11.4	2.8
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01Feb10	71	136	[illegible]	[illegible]	1623	0.95	0.27	2.22	1555	1136	0.4	2.6	3.57	1.3	6.5	1	4.4	1.6	2	1.5	2.2	0.83	0.58	7.3	20.5	45.1	17.9	11.3	2.6

Summary

- ECI provides multiple ways to help provide you lowest cost options for FCC catalyst optimization
  - Fresh Catalyst Blending
  - Incorporation of Purchased ECAT
- The use of Ecat has sound technical fundamentals for use in a unit attempting to maintain unit yields at the lowest $/day cost
- Addition Rate is critical for success in implementing a ecat/fcat strategy
  - Remove 1 TPD of Fresh Catalyst and replace with 2 TPD of Ecat
  - Ultimate Ratio of FCAT / ECAT is unit specific
- The use of Ecat will increase unit conversion via:
  - ***Lower Circulating Ecat Metals***
  - ***Decrease in the unit age distribution***
- The use of Ecat will decrease ***$/day catalyst costs***
- ECAT key targets properties must be supplied consistently to best optimize the FCC unit
- Ecat has successfully been utilized in various units that process gas oil, mild and heavy resid