

Q&A and Technology Forum 2012

Q&A Transcript: Hydroprocessing Session

**Salt Lake City, Utah, USA
1-3 October 2012**

Volume 1 of 4

ISBN: 978-1-62748-715-3

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2012) by American Fuel & Petrochemical Manufacturers (AFPM)
All rights reserved.

Printed by Curran Associates, Inc. (2013)

For permission requests, please contact American Fuel & Petrochemical Manufacturers (AFPM)
at the address below.

American Fuel & Petrochemical Manufacturers (AFPM)
1667 K Street, NW, Suite 700
Washington DC 20006

Phone: (202) 457-0480
Fax: (202) 457-1486

info@afpm.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2634
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

HYDROPROCESSING Q&A SESSION.....	6
Introduction.....	6
Safety	8
Question 1: For refiners using Layers of Protection Analysis (LOPA) in their OSHA (Occupational Safety and Health Administration) PHA (Process Hazard Analysis) studies, how do you quantify the frequency and consequences of initiating events?	8
Question 1: Answer Book Response.....	15
CFH (Cat Feed Hydrotreater) Cracked Materials	19
Question 2: What are the operating constraints in co-processing coker naphtha in a ULSD (ultra low sulfur diesel) and/or a gas oil hydrotreater unit?.....	19
Question 2: Answer Book Responses	27
Lubricity.....	34
Question 3: How can lubricity be improved in ultra low sulfur jet fuel?	34
Question 3: Answer Book Response.....	40
Processing Shale-Derived Crudes.....	41
Question 4: What are the hydrotreating operating issues when processing shale-derived light, sweet, and highly paraffinic crudes such as Bakken, Eagle Ford, and Utica? What hydrotreating/catalyst strategies can offset any negative effects? What options are available to optimize the distillate hydrotreater(s) with these light, sweet crudes?	41
Question 4: Answer Book Responses	47
Question 5: What is the panel's experience with hydrotreater fouling/poisoning issues arising from processing synthetic or bitumen-derived crudes? How can the impact be mitigated?.....	53
Question 5: Answer Book Responses	60
Process Upset Response.....	67
Question 6: Following an emergency shutdown that includes the loss of the recycle gas compressor, is it possible to quantify the effect on catalyst deactivation? What are the Best Practices to minimize catalyst deactivation?	67
Question 6: Answer Book Responses	73
Hydrocracking.....	80
Question 7: What must a refiner consider when evaluating mild HC (hydrocracking) as a way of increasing diesel production in his/her gas oil hydrotreater?.....	80
Question 7: Answer Book Responses	89
Question 8: How do you improve cold flow properties in a hydrocracker?.....	99

Question 8: Answer Book Responses	109
Shutdown/Catalyst Handling	114
Question 9: What are the possible causes of high pressure drop in lower beds of HT (hydrotreater) and HC (hydrocracker) units? What techniques are used to diagnose the causes prior to shutdown? Are there any mitigation techniques or strategies to extend the cycle?	114
Question 9: Answer Book Responses	121
Question 10: Does hydrotreated product recycle count the same as fresh virgin feed for the catalyst break-in period?	122
Question 10: Answer Book Responses	124
Hydroprocessing	126
Question 11: How do you set your maximum endpoint targets (short residue, coker, and FCC) for a two-stage mixed feed HCU operating in distillate mode? What is the impact on catalyst life?	126
Question 11: Answer Book Responses	131
Question 12: For units originally designed as naphtha selective HCUs, what are the considerations for shifting selectivity to distillate production?	136
Question 12: Answer Book Responses	145
Question 13: What equipment size limitations set the maximum capacity for a single-train, high pressure, heavy feed hydroconversion unit (HCU ebullated-bed resid)? What are the other considerations?	148
Question 13: Answer Book Responses	154
Question 14: What are cycle life limiting factors in low pressure jet/kero hydrotreaters?. 158	
Question 14: Answer Book Responses	158
Question 15: What can be done to mitigate foaming and emulsion formation in our hydrotreater high pressure separator? Is there any favorable experience with injection of antifoam/chemical emulsion breaker?	160
Question 15: Answer Book Responses	166
Question 16: What is the commercial experience on the use of H ₂ membranes in hydrotreaters or hydrocrackers for H ₂ recovery? What is a reasonable membrane life given the sensitivity to fouling and temperature changes?	170
Question 16: Answer Book Responses	174
Question 17: Now that natural gas prices are low in North America, what options are available to increase refinery volume gain and product quality by exploiting low-cost hydrogen? Is the low hydrogen production cost impacting the economics between the selection of coking or hydrocracking?	176
Question 17: Answer Book Responses	183

Question 18: What are the economic incentives to justify upgrading reactor internals? What techniques have been utilized to assess the performance of existing reactor internals?.....	187
Question 18: Answer Book Responses	188
Question 19: Since API-932 (Waterwash Best Practices) was published, what has been the impact on reactor effluent air cooler washwater system design and reliability? Are there any active or ongoing studies to improve waterwash systems, in addition to API-932?	200
Question 19: Answer Book Response.....	203
Storing Cracked Stocks.....	206
Question 20: What is the industry experience with managing cracked feedstocks to avoid hydrotreater problems such as fouling and pressure drop?.....	206
Question 20: Answer Book Responses	210
Steam Quality.....	213
Question 21: High pressure strippers are an option for controlling VOCs in process condensate and managing export steam quality in a steam methane reformer hydrogen plant. What types of pH controls are being used?	213
Question 21: Answer Book Response.....	217
Preventative Maintenance	219
Question 22: What preventative maintenance program is applied to safety instrumented systems on a steam methane reformer that are Safety Integrity Level (SIL) rated?.....	219
Question 22: Answer Book Response.....	219
Increasing Diesel Cetane Index for Export.....	220
Question 23: What are some options for increasing the cetane index (CI) of diesel to more easily meet export market requirements?	220
Question 23: Answer Book Responses	223
Furnace Tube Rupture.....	231
Question 24: Given the potential consequences of back flow in high pressure hydroprocessing services, such as furnace tube rupture and pump shutdown, what layers of protection are being employed to reduce risk?	231
Question 24: Answer Book Response.....	235
Question 25: What is your philosophy for mitigating fouling and corrosion in reactor effluent cooler systems in hydrotreater or hydrocracker units during a short-term washwater pump failure scenario? How much time is allowed before initiating a unit shutdown?.....	238
Question 25: Answer Book Responses	240
Biofuels	241
Question 26: What catalyst and metallurgy design considerations are important when evaluating the co-processing of highly acidic renewable distillates? What can be done to mitigate carbon monoxide formation?	241

Question 26: Answer Book Response.....	241
Hydrogen.....	242
Question 27: What are the Best Practices around minimizing risk of catalyst or equipment damage during turndown operation of a steam methane reformer hydrogen plant?	242
Question 27: Answer Book Responses	244
Hydrotreating Unit	247
Question 28: What is the panel's experience in block mode operating between VGO and diesel modes? What is the frequency of change of mode and do they see any impact on catalyst activity after each switch?	247
Question 28: Answer Book Responses	250

Q&A and Technology Forum 2012

Q&A Transcript: Gasoline Processes Session

**Salt Lake City, Utah, USA
1-3 October 2012**

Volume 2 of 4

ISBN: 978-1-62748-715-3

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2012) by American Fuel & Petrochemical Manufacturers (AFPM)
All rights reserved.

Printed by Curran Associates, Inc. (2013)

For permission requests, please contact American Fuel & Petrochemical Manufacturers (AFPM)
at the address below.

American Fuel & Petrochemical Manufacturers (AFPM)
1667 K Street, NW, Suite 700
Washington DC 20006

Phone: (202) 457-0480
Fax: (202) 457-1486

info@afpm.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2634
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

Introduction to Session	5
Safety	7
Question 29: How many refiners are using Layers of Protection Analysis (LOPA) in their Process Hazard Analysis (PHA) studies? How do they quantify the frequency and consequences of initiating events?.....	7
Question 29: Answer Book Response.....	9
Question 30: How are water drains routed in alkylation units; for instance, in waterwash or propane drying services? What options exist for separation of the water and entrained light hydrocarbons? How can enclosed systems be monitored?.....	10
Question 30: Answer Book Response.....	12
Question 31: What is the panel's experience with temperature excursions (regeneration and otherwise) leading to the catalyst or equipment damage in reforming and isomerization units?.....	13
Question 31: Answer Book Responses	20
Alkylation	21
Question 32: What are the impacts of the presence of acetone in the alkylation unit feed? How is this formed in the FCC? Comment on both HF and sulfuric units.....	21
Question 32: Answer Book Response.....	23
Question 33: Increased feed sulfur increases acid consumption. How does it affect alkylate yield and/or alkylate properties?.....	23
Question 33: Answer Book Responses	27
Question 34: Fresh sulfuric acid fed to an alkylation unit can contain niter (nitrosylsulfuric acid) which may lead to excessive corrosion. What is niter; what does it do; can we test for it; and, how can we reduce the levels in our fresh acid?.....	28
Question 34: Answer Book Responses	30
Question 35: Does the panel have any experience intentionally producing a 'heavy' alkylate stream? What are the disposition options for this stream?	35
Question 35: Answer Book Response.....	36
Aromatics	37
Question 36: What is the panel's experience with the latest technologies used to control the bromine index (BI) in aromatic streams, other than clay treatment? How many units are operational, and how were these justified?.....	37
Question 36: Answer Book Responses	38
Isomerization.....	39

Question 37: What is the panel's experience in operating chlorided isomerization units, which were not designed specifically for benzene saturation, in a benzene saturation mode? How are operational parameters adjusted for the different operation?.....	39
Question 37: Answer Book Responses.....	40
Question 38: Does the panel have experience with mercury contamination of feedstocks to gasoline processing units? What are the typical crude sources that can potentially contain mercury? What units are likely to be most impacted, and how?	41
Question 38: Answer Book Responses.....	43
Blending.....	47
Question 39: What options are available for managing blend stream Reid Vapor Pressure (RVP) and pentane content during the summer blend season? Discuss operational changes in existing equipment, simple modifications, and large capital projects.	47
Question 39: Answer Book Responses.....	49
Question 40: What process options are available for U.S. refiners to economically make 10 ppm sulfur gasoline? Discuss impacts to other product qualities (such as octane and vapor pressure) and how these secondary effects impact the gasoline pool.....	50
Question 40: Answer Book Response.....	54
Question 41: Have the panel members considered 15% ethanol (E15) gasoline blending?..	56
Question 41: Answer Book Response.....	61
Jet Fuels	62
Question 42: What options are available to produce on-spec jet fuel from high total acid number (TAN) sources? What impacts these choices?.....	62
Question 42: Answer Book Response.....	63
Reformer.....	63
Question 43: In reforming units, what equipment could be susceptible to high temperature hydrogen attack (HTHA)? How are panelists approaching evaluation and replacement of equipment that could be susceptible to HTHA?	63
Question 43: Answer Book Response.....	69
Question 44: How is coke on catalyst in fixed-bed and moving-bed reforming units tracked? How is this data used to adjust the reactor inlet temperatures in order to maintain constant product octane?	71
Question 44: Answer Book Responses.....	74
Question 45: What is the maximum allowable limit for the iron content of a reforming catalyst? Is this limit the same for semi-regenerative and continuously-regenerative catalysts?.....	74
Question 45: Answer Book Responses.....	76

Question 46: Are refiners modifying the operating conditions in reforming units, for example, chloride on catalyst, in order to capture margin differences between natural gas, used as fuel, and liquid products?	77
Question 46: Answer Book Responses	84
Question 47: How often do you replace your reformer catalyst? What is monitored, and what triggers the replacement? How has the increased spread between natural gas prices and liquid product prices impacted these decisions?	86
Question 47: Answer Book Responses	87
Question 48: Discuss recent advances in reforming catalyst technology. What performance improvements are being researched?	88
Question 48: Answer Book Responses	89
Question 49: Does the panel have any experience using flexible thermocouples in the regeneration section of a moving-bed reforming unit? What considerations should be given to revamping units that do not have these installed?	89
Question 49: Answer Book Responses	91
Question 50: How do you monitor the integrity of internals, and how do you determine when to replace reforming unit reactor center screens? What is the typical life of the center screens, and when are repairs considered excessive?	91
Question 50: Answer Book Responses	92
Question 51: What is the panel's experience with recycle gas moisture analyzers?	93
Question 51: Answer Book Response.....	94
Question 52: What is your recommended method for mitigating fouling in reforming unit recycle compressors? Has any technique proven successful? Is anyone using reformate to clean the compressor online?	95
Question 52: Answer Book Responses	100
Question 53: What is the panel's experience with addressing reforming unit stabilizer salting?	101
Question 53: Answer Book Response.....	106
Question 54: Does the panel have experience chemically cleaning their reforming unit reactor circuit to minimize the lower explosive limit (LEL) when opening up equipment to the atmosphere in an effort to comply with environmental regulation? If so, is the chemical compatible with the catalyst?.....	107
Question 54: Answer Book Responses	108

Q&A and Technology Forum 2012

Q&A Transcript: Crude/Vacuum Distillation & Coking Session

**Salt Lake City, Utah, USA
1-3 October 2012**

Volume 3 of 4

ISBN: 978-1-62748-715-3

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2012) by American Fuel & Petrochemical Manufacturers (AFPM)
All rights reserved.

Printed by Curran Associates, Inc. (2013)

For permission requests, please contact American Fuel & Petrochemical Manufacturers (AFPM)
at the address below.

American Fuel & Petrochemical Manufacturers (AFPM)
1667 K Street, NW, Suite 700
Washington DC 20006

Phone: (202) 457-0480
Fax: (202) 457-1486

info@afpm.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2634
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

Introduction to Session	6
Introduction to Panelists	6
Safety	8
Question 55: Leaks in a vacuum system can result in oxygen ingress into the process. What are the panelists' experiences/practices with respect to safe sampling and monitoring of vacuum system off gas quality?	8
Question 55: Answer Book Responses	12
Question 56: Startup, shutdown, and upset conditions can result in abnormal pressure conditions in process equipment and connected utilities. What are the panel's experiences with reverse flow of hydrocarbon into the connected steam systems? What designs and practices are employed to prevent this?	13
Question 56: Answer Book Responses	17
Question 57: Do your CDUs/VDUs (crude distillation units/vacuum distillation units) employ automatic trip systems to mitigate tower level overfills? What is considered the Best Practice for high level detection and response?	19
Question 57: Answer Book Responses	21
Question 58: Does your site/company require the use of a chemical wash to mitigate possible pyrophoric scale hazards in columns with structured packed beds?	23
Question 58: Answer Book Responses	29
Crude Quality	30
Question 102: What methods are used to predict crude compatibility concerns with blending Canadian synthetic crudes with Gulf Coast refinery feeds? What are some precautions that can be taken to minimize the potential for crude incompatibility?	30
Question 102: Answer Book Responses	37
Question 103: Shale/tight oil processing has resulted in several reported issues, such as crude quality consistency, incompatibility, and fouling. What is the panel's experience processing of these crudes? What issues have been observed, and how have they been mitigated?	46
Question 103: Answer Book Responses	54
Question 104: How do you monitor for water slugs coming in the crude charge from tankage, and how do you control them? Has anyone automated your control scheme?	56
Question 104: Answer Book Responses	60
Question 59: What challenges have you faced from processing crudes that contain elevated levels of wax crystal modifiers or flow improver chemicals?	62

Question 59: Answer Book Responses	63
Desalting	64
Question 60: With an increasingly varied crude slate, how are you managing substantial variability in salt levels in desalted crude and overhead neutralizer rates? How can this impact the amount and location of amine salt and other deposition in the atmospheric tower and overhead system?	64
Question 60: Answer Book Responses	71
Question 61: Extensive use of upstream H ₂ S scavengers in crude oils can cause salt deposition in atmospheric tower overhead systems, as well as on atmospheric tower trays, particularly when trying to operate at lower naphtha endpoints. What adjustments in desalter operation are used to mitigate amine salt deposition?	74
Question 61: Answer Book Responses	76
Crude / Vacuum Distillation	80
Question 62: What are causes of foaming in crude pre-flash drums and towers, and what options are available to mitigate foaming?	80
Question 62: Answer Book Responses	88
Question 63: Crude and vacuum tower off gas production from bitumen crudes can be quite variable depending on feedstock quality. Please comment on observed off gas production when processing bitumen crudes.	91
Question 63: Answer Book Response	92
Question 64: Based on your experience, what are causes of fouling in the diesel/distillate draws of crude, vacuum, and coker fractionation towers? Does this migrate to downstream diesel hydrotreating units? What mitigation strategies are being employed to overcome these issues?	92
Question 64: Answer Book Responses	96
Question 65: Our vacuum column wash bed has lasted seven years in service and now needs to be replaced due to excessive coking and pressure drop. What is the typical life expectancy of the wash grid and packing? What is the panel's experience for the use of wash oil to the vacuum column wash section bed in gpm/ft ² (gallons per minute per square foot) with structured packing and/or grids in the bed? What is the recommended maximum slop wax draw temperature? Should a limit be set on this temperature?	99
Question 65: Answer Book Responses	104
Corrosion Control	107
Question 66: Some refiners are considering substituting potassium hydroxide for sodium hydroxide as a desalted crude treatment to lower overhead chlorides. What is the impact of this change on coker operation and other downstream units? What are the advantages and disadvantages?	107
Question 66: Answer Book Responses	108

Question 67: We have an atmospheric overhead system with inadequate waterwashing, and we experience fouling and corrosion issues in the bundle. What might be the pros and cons of making a bundle modification or installing direct water spray into the shell side of the atmospheric tower overhead condenser in terms of underdeposit corrosion and bundle life?	110
Question 67: Answer Book Responses	115
Question 68: After the operating temperature of the crude column overhead has been raised, corrosion rates in trim coolers' inlets have increased greatly. Ultrasonic thickness (UT) measurement has indicated some increase in local thinning, but not to the degree of actual damage. What are new trends for monitoring corrosion in distillation columns and overhead condensing systems?.....	121
Question 68: Answer Book Responses	124
Question 69: How do you detect that amine salts are forming and causing corrosion, either in the fractionator or other locations ahead of the water dew point? What are chemical and operational strategies for mitigation?.....	128
Question 69: Answer Book Responses	132
Delayed Coking / Heavy Oil.....	134
Question 70: What are your experiences with processing oil sludge in the delayed coker?	134
Question 70: Answer Book Responses	136
Question 71: Is there any test method for performance evaluation of silicon-based antifoam agent used in coker?.....	137
Question 71: Answer Book Responses	138
Question 72: What are Best Practices for steam rates in cokers, heater velocity steam, valve purge steam, and drum steamout? Do newer, double-fired heater designs use less steam? 140	
Question 72: Answer Book Responses	145
Question 73: What is your experience with coke bed instability?.....	148
Question 73: Answer Book Responses	149
Question 74: We have experienced leak issues around gaskets in cyclical and hot temperature services. What solutions have you developed to eliminate these issues?.....	150
Question 74: Answer Book Response.....	150
Question 105: What are the panelists' experiences with coke handling and coke fines management in the dewatering coke pit and circulating decoking water to protect equipment?.....	151
Question 105: Answer Book Responses	153
Maintenance	155

Question 75: Please describe your best turnaround practice for cleaning and inspecting heat exchanger bundles versus replacement. 155

Question 75: Answer Book Responses 160

Q&A and Technology Forum 2012

Q&A Transcript: FCC Session

**Salt Lake City, Utah, USA
1-3 October 2012**

Volume 4 of 4

ISBN: 978-1-62748-715-3

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2012) by American Fuel & Petrochemical Manufacturers (AFPM)
All rights reserved.

Printed by Curran Associates, Inc. (2013)

For permission requests, please contact American Fuel & Petrochemical Manufacturers (AFPM)
at the address below.

American Fuel & Petrochemical Manufacturers (AFPM)
1667 K Street, NW, Suite 700
Washington DC 20006

Phone: (202) 457-0480
Fax: (202) 457-1486

info@afpm.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2634
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

Introduction to Session	6
Safety	8
Question 76: The check valve on the air blower discharge line is designed to protect the blower from hot catalyst that backs into it when the blower fails. What type of valve is used in this service, where is it located, and what is done to ensure that it closes properly?	8
Question 76: Answer Book Responses	11
Question 77: For our emergency interlock system, we employ two-out-of-three voting systems for slide valve differential pressure transmitters. We use dedicated transmitter taps for each transmitter, but we get inconsistent readings. What can we do, regarding design and maintenance, to ensure that these transmitters read more consistently? What should we do if we are unable to achieve consistent readings?	15
Question 77: Answer Book Responses	19
Question 78: What inputs or trips are typically included in FCC flue gas expanders' and CO (carbon monoxide) boilers' safety interlock systems? Are there any governing standards [(e.g., API and NFPA (National Fire Protection Association))] that apply?	20
Question 78: Answer Book Responses	24
Question 100: During start-up, some refiners de-energize the electrostatic precipitator (ESP) for torch oil introduction but then re-energize for "stable" torch oil operations, while others will wait until FCCU feed is introduced and the FCCU is stable before energizing the ESP. We understand that some sites may keep the ESP energized during torch oil introduction. What is your current practice for ESP operations during start-up and shutdown involving air preheater firing, torch oil introduction and operation, and introduction of feed?.....	29
Question 100: Answer Book Responses	33
Operations	35
Question 101: How are operating changes being evaluated for risk and benefit? Are you using simulation models to confirm these changes? What are the implications of a management of change (MOC)? How are the operating boundaries confirmed?	35
Question 101: Answer Book Responses	36
Question 79: What tools are being used to monitor FCC performance? What are the key performance indicators and expectations?	37
Question 79: Answer Book Responses	43
Question 80: We are considering severe hydrotreating of our FCC feed. What yield shifts or unusual operating problems might we expect? What can be done to address these issues?	50
Question 80: Answer Book Responses	57

Question 81: Is there experience with continuous torch oil and/or air preheater firing; and if so, for what reasons? What are the demonstrated effects from doing either of these processes?	63
Question 81: Answer Book Responses	68
Question 82: Do you have any experience with the recycle of C4/C5 streams from the FCC gas plant back to the FCC? If so, what was your motivation? What is the system configuration, and what are the key operating parameters?	71
Question 82: Answer Book Responses	74
Question 83: What is the typical flashpoint for your slurry oil product? Can a flashpoint of 200°F or higher be achieved with steam stripping the main fractionator bottoms? What are your storage temperature guidelines? What lower explosion limit (LEL) and H ₂ S levels are found in the tank vapor space?.....	74
Question 83: Answer Book Responses	77
Question 84: What measures can be taken to reduce the residence time in the FCC main fractionator to offset slurry circuit fouling? What basis is used to determine the residence time in the main fractionator bottoms?	79
Question 84: Answer Book Responses	83
Question 85: What is the state-of-the-art design used to minimize the impact of coke in the FCCU main fractionator bottoms and remove coke from the bottoms draw and circulating circuit?.....	85
Question 85: Answer Book Responses	88
Question 86: What test method (e.g., ASTM D86, D1160, or D2887) do you currently use to determine the distillation of FCC gasolines, cycle oils, and fractionator bottoms?	91
Question 87: What are typical light cycle oil/fractionator bottoms distillation overlaps, and what can be done to improve separations to increase LCO recovery?	95
Question 87: Answer Book Responses	97
Catalyst	99
Question 88: What is the variation in fresh catalyst chemical and physical properties for your refineries? How do you determine acceptable tolerances for your fresh catalyst quality control?	99
Question 88: Answer Book Responses	101
Question 89: With the increase in rare earth costs, many units have decreased the rare earth oxide (REO) content or used rare earth substitutes in their FCC catalyst. What is your experience with these in terms of activity maintenance, delta coke, conversion, attrition, and yield selectivities? How have operating conditions changed?.....	103
Question 89: Answer Book Responses	108
Question 90: Can ZSM-5 be used to make propylene from high metal resid feeds? What is the effect of nickel and vanadium on this kind of operation?.....	115

Question 90: Answer Book Responses	119
Mechanical.....	122
Question 91: What FCC turnaround intervals are refiners achieving for units that do not take mini-turnarounds? Do longer intervals mean lower reliability between turnarounds?.....	122
Question 91: Answer Book Responses	124
Question 92: Describe the turnaround scope of work for the combustion air blower. Does it differ for units with turbo expanders? Do you work on the air blower every turnaround? Is this work performed by a general turnaround contractor or by the manufacturer? How often does this work become critical path?	128
Question 92: Answer Book Responses	129
Question 93: How do you manage regenerator cyclone life to ensure that you reach target turnaround intervals? Do you consider superficial velocity, inlet velocity, inlet loading, outlet velocity, etc.?	130
Question 93: Answer Book Responses	135
Question 94: What is your experience using specially designed automated isolation valves on the reactor overhead line for your de-blinding operation during the start-up of the FCCU? Will they dependably provide positive isolation after being in operation? How did you justify the installation cost (e.g., safety and economics)?.....	138
Question 94: Answer Book Responses	142
Question 95: What is the recommended Best Practice regarding the design of catalyst loading and unloading lines with respect to metallurgy, size, run lengths, bends/Ts, cleanout connections, etc.?	143
Question 95: Answer Book Responses	146
Environmental.....	148
Question 96: What is the CO boiler start-up and shutdown sequence with respect to the FCCU start-up and shutdown timing? What are the reasons for this sequence?	148
Question 96: Answer Book Responses	151
Question 97: What equipment do you employ to help eliminate ESP hopper and downcomer plugging with catalyst fines? What additional operating practices are used? What type of level detectors are in use on the ESP hoppers and/or catalyst storage silos? Are there any new level detection technologies that could be applied, perhaps from coke drum measurement detectors?	153
Question 97: Answer Book Responses	156
Question 98: What is your experience with the use of ammonia or steam in the FCC flue gas line in order to improve the operation of the ESP? Please comment on system configuration and operational issues.	157
Question 98: Answer Book Responses	160

Question 99: Have refineries experienced an increase in particulate emissions in the regenerator flue gas caused by oxygen enrichment of air to the regenerator?..... 162

Question 99: Answer Book Responses 163