

# **Q&A and Technology Forum 2013**

## **Gasoline Processes Q&A Session**

**Dallas, Texas, USA  
7-9 October 2013**

**Volume 1 of 4**

**ISBN: 978-1-63266-167-8**

**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© (2013) by American Fuel & Petrochemical Manufacturers (AFPM)  
All rights reserved.

Printed by Curran Associates, Inc. (2014)

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](mailto: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](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

## TABLE OF CONTENTS

GASOLINE PROCESSES .....	6
Introduction to Session .....	6
Introduction of Panelists .....	7
Safety .....	9
Question 1: What is a typical hydrofluoric (HF) acid inventory (pound of acid per bpd C5+ alkylate), and what steps are refiners considering to reduce this volume? What other risk mitigation steps are refiners considering for their HF units?.....	9
Question 1: Answer Book Responses .....	10
Question 2: Have sealless pumps (magnetic drive or canned pumps) been used successfully in HF and sulfuric acid alkylation units? What services are considered for this equipment? .....	11
Question 2: Answer Book Responses .....	13
Question 3: What drives the decision to load presulfided, presulfurized, or oxidized catalyst in naphtha hydrotreaters? What are the different safety considerations for each case? .....	14
Question 3: Answer Book Responses .....	16
Tight/Shale Oil.....	18
Question 4: Is there any experience producing on-specification jet fuel without any sulfur/mercaptan treating, including any form of caustic, from feedstocks produced from ‘tight’ formations? What other jet specifications are adversely impacted by the changed feedstock? .....	18
Question 4: Answer Book Responses .....	19
We are not aware of any finished, on-specification jet fuel produced without some sort of processing to remove sulfur and/or sulfur compounds including H <sub>2</sub> S (hydrogen sulfide), mercaptans (thiols), and thiophenols. Typically, we see caustic extraction and/or sweetening processes or hydrotreating processes utilized to remove sulfur or change the sulfur compounds to less objectionable forms. If these sulfur contaminants are not addressed, the fuel will likely fail to meet specifications including Thermal Stability (ASTM D3241), Copper Corrosion (ASTM D130), Mercaptan Sulfur (ASTM D3227), and/or Doctor Tests (ASTM D4952-12). In addition, caustic treating or hydroprocessing methods may be required to meet Acidity (ASTM D3242) specifications.....	19
Question 5: Reforming of feedstocks from ‘tight oil’ crudes offers unique challenges such as low naphthene and aromatic (N+A) content, lighter feed, and differences in coke yield. What are refiners doing to address these challenges and generate opportunities for these new crudes?.....	20
Question 5: Answer Book Responses .....	22

Question 6: Has isomerization become more important as feedstocks have become more paraffinic with the increased processing of ‘tight oil’ feedstocks? Do ‘tight oil’ feedstocks contain more benzene?.....	25
Question 6: Answer Book Responses .....	27
Alkylation .....	28
Question 7: Given challenges in gasoline Reid vapor pressure (RVP), benzene, low-carbon fuels, and other requirements, are refiners considering expansion or other changes to make more alkylate? Has increased catalytic polymerization become a consideration? .....	28
Question 7: Answer Book Responses .....	30
Question 8: What is the industry experience with deisobutanizer (DIB) feed pre-heat exchanger or reboiler fouling? What are the typical causes of the fouling? How do you mitigate this problem? Comment on both HF and sulfuric technologies. ....	31
Question 8: Answer Book Responses .....	33
Question 9: What are the latest strategies for feed dispersion and mixing in HF and sulfuric acid alkylation? How does mixing affect alkylate endpoint? Does better mixing allow for operations at reduced I/O ratios via increased olefin charge rate or operating against isobutane constraints? .....	34
Question 9: Answer Book Responses .....	36
Question 10: What is the industry experience with continuous online acid strength analyzers in HF and sulfuric acid services? Please comment on accuracy and reliability. ....	37
Question 10: Answer Book Responses .....	39
Question 11: What changes have refiners made in metallurgy from design specifications? What recommendations have the licensors incorporated into new specifications based on experience and user feedback? Comment on both HF and sulfuric acid alkylation. ....	40
Question 11: Answer Book Responses .....	42
Blending .....	44
Question 12: Gasoline blending is becoming more difficult due to the increases in quality specifications; lower sulfur and benzene, for example. What changes are being made to blending facilities and operations to accommodate these changes? Please discuss tankage allocations, working inventories, online analyzer needs, procedural changes, in-line blending, etc. ....	44
Question 12: Answer Book Responses .....	45
Question 13: What are the typical causes for failing JFTOT and aviation turbine (AVTUR) specifications?.....	46
Question 13: Answer Book Responses .....	49
Catalytic Reforming .....	50
Question 14: What is industry experience of using tri-metal (platinum-rhenium with promoter) catalysts? .....	50

Question 14: Answer Book Responses .....	52
Question 15: What is the Best Practice process for sampling, handling, and measuring research octane (RONC) and naphthene content in reformer feed and product? Are refiners considering online RONC and/or other property monitoring? .....	53
Question 15: Answer Book Response.....	56
Question 16: What is the typical carbon monoxide (CO) concentration in the reformer net gas? How is the CO content measured? What are the potential effects to downstream units from the CO?.....	58
Question 16: Answer Book Responses .....	60
Question 17: How many continuous reforming operators have completed a catalyst change while the unit continues to operate? What variables should be taken into account when planning such a change? .....	61
Question 17: Answer Book Responses .....	63
Question 18: What are some typical causes for high pressure drop across regenerator dust collectors in continuous reforming units? Is anyone using continuous blowback on the bags? .....	65
Question 18: Answer Book Responses .....	66
Question 19: How are refiners managing low-coke operations in continuous reforming? ..	67
Question 19: Answer Book Responses .....	68
General.....	70
Question 20: What investment, operational, or processing options are available to upgrade or convert gasoline streams to higher value products? .....	70
Question 20: Answer Book Response.....	71
Isomerization.....	73
Question 21: What is the maximum olefin content allowed in isomerization unit feed? Are levels encountered different between C4 and C5/C6 units? What are the major concerns and limiting factors? What is the effect of olefins on the mole sieve used for drying the feed?..	73
Question 21: Answer Book Responses .....	74
Question 22: What considerations in caustic scrubber operation or design are available to mitigate caustic carryover and corrosion? Discuss differences between various services. ..	76
Question 22: Answer Book Responses .....	79
Question 23: What are the operating strategies for C5/C6 isomerization units with current fuels regulations? Are units being run primarily for benzene saturation with changes in operating parameters, feed sources, and treating being made to account for seasonal differences in gasoline pool RVP?.....	80
Question 23: Answer Book Response.....	81
Naphtha Treating .....	82

Question 24: For refiners who have naphtha splitter columns, either upstream or downstream of a hydrotreater, how many of these towers experience overhead corrosion issues? Has oxygen played a role in any experienced corrosion? What solutions exist to mitigate the issues? .....	82
Question 24: Answer Book Responses .....	84
Question 25: What issues are encountered when introducing cracked naphthas into units that were not originally designed for the higher olefin content? What other contaminants should be considered when making this change in operation; e.g., silicon, nitrogen, and sulfur?... 86	
Question 25: Answer Book Responses .....	89
Regulatory Compliance .....	95
Question 26: How will the ISO 8217 Marine Fuel Oil Hydrogen Sulfide (H <sub>2</sub> S) specification (less than 2 ppm H <sub>2</sub> S in the liquid phase) affect refiners? Do any refiners plan to implement the standard, and what procedural or equipment changes are likely needed in order to meet the specification? .....	95
Question 26: Answer Book Responses .....	97
Question 27: What options are refiners considering to address upcoming Tier 3 Fuel Standards [10 wppm (weight parts per billion) annual average sulfur in gasoline]?.....	99
Question 27: Answer Book Responses .....	102
Question 28: Is the changing quantity of pentanes and pentenes in refinery streams and tightening gasoline regulations leading to operators considering different processing strategies in order to maintain gasoline blend pool specifications? Comment on increased pentene alkylation, decreased pentane isomerization, or other disposition sources. ....	105
Question 28: Answer Book Responses .....	107

# **Q&A and Technology Forum 2013**

## **Hydroprocessing Q&A Session**

**Dallas, Texas, USA  
7-9 October 2013**

**Volume 2 of 4**

**ISBN: 978-1-63266-167-8**

**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© (2013) by American Fuel & Petrochemical Manufacturers (AFPM)  
All rights reserved.

Printed by Curran Associates, Inc. (2014)

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](mailto: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](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

## TABLE OF CONTENTS

HYDROPROCESSING .....	6
Introduction to Session .....	6
Introduction of Panelists .....	7
Safety .....	9
Question 29: What are the industry practices to take samples around high-pressure equipment which contain light hydrocarbon and H <sub>2</sub> S? How do you ensure the samples are handled safely and representative of sample stream? .....	9
Question 29: Answer Book Response.....	10
Question 30: What are your design practices for reactor skin thermocouple requirements in a hydrotreater and a hydrocracker for startups and safe operation? .....	11
Question 30: Answer Book Responses .....	19
Feed Poisons and Fouling .....	22
Question 31: What is the threshold concentration of arsenic and phosphorus requiring a dedicated trap system? How are the arsenic and phosphorus trap systems specified, and what are the controlling mechanisms? .....	22
Question 31: Answer Book Responses .....	28
Question 32: What is a typical range of HDM (hydrodemetallization; metals removal) in a gas oil hydrotreater? Can HDM decline rapidly when metals in the feed become excessive relative to catalyst system design? Is there a point when metals in the feed are so high that they “overwhelm” the demet (demetallization) and main bed catalyst, resulting in lower percent of HDM? .....	34
Question 32: Answer Book Responses .....	37
Question 33: What is the philosophy or criteria for optimizing catalyst bed grading material to prevent high reactor pressure drop from feed containing significant amounts of Fe (iron)? .....	40
Question 33: Answer Book Responses .....	47
Question 34: When processing cracked naphtha, what is done to ensure that polymerization of the diolefins/olefins will not result in pressure drop problems in a reactor or upstream equipment? .....	54
Question 34: Answer Book Responses .....	57
Tight Oil Crudes .....	60
Question 35: When processing tight oil crudes, are lower bed pressure drop problems in VGO/resid hydrotreater reactors a concern? If so, what mechanisms explain this issue? ...	60
Question 35: Answer Book Responses .....	62

Question 36: Has the increased use of tight oil crudes and western Canadian crude been correlated with increased metals and solids in diesel, gas oil or vacuum resid? .....	64
Question 36: Answer Book Responses .....	70
Question 37: How does the increased processing of tight oil (Eagle Ford, Bakken, etc.) affect hydroprocessing operations? With lighter feeds and less sulfur, how can the hydroprocessing reactors and catalyst systems be tailored to optimize performance? What other factors in economics replace volume gain when processing these lighter feeds (i.e., impact on FCC yields, gasoline blending, minimizing cetane giveaway, etc.)? .....	71
Question 37: Answer Book Responses .....	76
Optimization .....	80
Question 38: Elaborate on the relative value of the various distillate feed streams in a refinery (i.e., straight-run diesel, light atmospheric gas oil, light vacuum gas oil, light cycle oil, coker distillate, kerosene, coker naphtha, heavy cat naphtha, and other) when considering maximum saturation and volume swell in high-pressure ULSD service. ....	80
Question 38: Answer Book Responses .....	85
Question 39: There is a drive to target the highest endpoint possible on all distillate feed streams when maximizing overall diesel production. Are there feed streams that should be targeted first, considering operational impacts of such optimization, impacts to catalyst performance and life cycle, as well as cutpoint optimization between distillate units and the FCC? .....	89
Question 39: Answer Book Responses .....	95
Question 40: Economic drivers dictate the need to process more difficult feedstocks, such as cracked stocks and diesel feeds with high distillation endpoints. What are typical guidelines regarding minimum hydrogen partial pressure for a given feedstock? (High-level answer with details will be discussed in the Hydroprocessing P&P.) .....	100
Question 40: Answer Book Responses .....	110
Question 41: In an effort to increase margins on hydrotreating units, what strategies and/or new technologies are refiners employing to minimize utility usage? What are the economics and reliability of adding a power recovery turbine? .....	117
Question 41: Answer Book Response.....	120
Question 42: Occasionally we make off-color jet (pink, blue, or green). What are the causes, and what can be done to correct this? .....	123
Question 42: Answer Book Responses .....	125
Tier 3 Fuels .....	127
Question 43: Can FCCU feed pre-treatment achieve the new Tier 3 gasoline sulfur targets without post-gasoline treatment? What criteria are used to select the optimal combination of pre-treatment and post-treatment severities to meet the Tier 3 objectives?.....	127
Question 43: Answer Book Responses .....	133

Catalyst Handling.....	136
Question 44: What are refiner’s practices or procedures to remove catalyst from a reactor when the catalyst will not free flow dump? What is the industry's experience with hydrodrilling for removal of non-free-flow catalyst from fixed-bed units? .....	136
Question 44: Answer Book Responses .....	138
Question 45: What are the procedures/rules governing the transportation and disposal of catalyst contaminated with arsenic, mercury, barium, or other heavy metals? Are there maximum limits for any of these? .....	139
Question 45: Answer Book Response.....	141
Hydrocracking.....	142
Question 46: What are the main considerations in converting a fuel hydrocracker into lubes services in terms of equipment modifications and catalyst selection? .....	142
Question 46: Answer Book Response.....	146
Question 47: What evaluations are required for hydrocracking units to increase conversion due to processing heavier feedstocks? .....	147
Question 47: Answer Book Responses .....	150
Catalyst Loading .....	152
Question 48: What are the typical guidelines for reactor loading if the decision is to not fully load with catalyst? Is it acceptable to short-load a reactor, and what are the recommended minimum and maximum distances below the inlet distributor? .....	152
Question 48: Answer Book Responses .....	153
Question 49: What are the criteria for levelness during dense loading of a catalyst bed? What are the preferred monitoring techniques, and what is the best approach to correct an uneven bed profile if it is detected? .....	155
Question 49: Answer Book Responses .....	161
Design, Construction, and Revamp .....	164
Question 50: What are the technology evaluations and engineering studies required for revamping a diesel hydrotreating unit to substantially increase throughput?.....	164
Question 50: Answer Book Responses .....	170
Question 51: For hydroprocessing reactor modifications that involve the addition or removal of distribution trays and flexible thermocouples, what is your Best Practice for welding support rings or support lugs on a reactor wall? What is your Best Practice for removal of these items when they are no longer required? .....	173
Question 51: Answer Book Responses .....	175
Question 52: What is the configuration of thermocouples that can be used to effectively monitor radial temperature differences, and what is the acceptable radial temperature spread in hydrotreaters/hydrocrackers?.....	177

Question 52: Answer Book Responses .....	185
Hydrogen Production .....	189
Question 53: With respect to hydrotreating, what is the typical (CO + CO <sub>2</sub> ) impurity in hydrogen produced from pressure swing adsorption (PSA): 10 ppm or 50 ppm? What problems can be expected if the (CO + CO <sub>2</sub> ) exceed this value? If the hydrotreaters can handle higher than (CO + CO <sub>2</sub> ), is it possible to run the PSAs harder and produce more hydrogen?.....	189
Question 53: Answer Book Responses .....	193

# **Q&A and Technology Forum 2013**

## **Crude & Vacuum Distillation and Coking Q&A Session**

**Dallas, Texas, USA  
7-9 October 2013**

**Volume 3 of 4**

**ISBN: 978-1-63266-167-8**

**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© (2013) by American Fuel & Petrochemical Manufacturers (AFPM)  
All rights reserved.

Printed by Curran Associates, Inc. (2014)

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](mailto: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](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

## TABLE OF CONTENTS

CRUDE & VACUUM DISTILLATION and COKING Q&A SESSION .....	5
Introduction to Session .....	5
Introduction of Panelists .....	6
Safety .....	8
Question 54: Please comment on both personnel and process safety concerns when transporting and receiving crude via rail and truck. What laboratory analyses support this effort? .....	8
Question 55: In a recent turnaround, we successfully de-gassed and de-greased our crude tower but discovered residual mercury. What techniques have been used to mitigate this issue? .....	13
Question 55: Answer Book Response .....	15
Crude/Vacuum Distillation .....	16
Question 56: With the current domestic conventional and unconventional crudes available, what incompatibility issues are observed from the tank farm through the crude unit? What mechanical, operational, and chemical strategies are employed to minimize these impacts? .....	16
Question 56: Answer Book Responses .....	22
Question 57: What problems are associated with processing crude with high solids content? What steps can be taken to reduce or remove these solids from the crude? .....	24
Question 57: Answer Book Responses .....	29
Desalting .....	30
Question 58: What issues are experienced at the desalter and pre-heat train when recirculating brine at the desalter? .....	30
Question 58: Answer Book Responses .....	31
Question 59: How does improper control of desalter washwater and brine affect crude unit overhead pH? .....	32
Question 59: Answer Book Responses .....	37
Question 60: What has been done to address corrosion problems either inside your desalter or in the brine handling circuit? .....	38
Question 60: Answer Book Responses .....	40
Crude/Vacuum Distillation .....	41
Question 61: What are some of the potential strategies to mitigate iron carryover from the desalter? .....	41
Question 61: Answer Book Responses .....	43

Energy Conservation.....	45
Question 62: What criteria are used to evaluate the performance of crude pre-heat train exchangers to support a decision to clean any portion?.....	45
Question 62: Answer Book Responses .....	49
Question 63: How are refiners monitoring and controlling the efficiency of fired heaters? Are adjustments made to fuel gas composition to improve heater performance? .....	51
Question 63: Answer Book Responses .....	56
Crude Vacuum Distillation .....	59
Question 64: How do you select the proper metallurgy for crude overhead (OVHD) system to increase reliability? .....	59
Question 64: Answer Book Responses .....	61
Question 65: Please share experiences in crude tower fouling from organic and/or phosphorous-containing deposits.....	63
Question 65: Answer Book Responses .....	70
Crude Oil Quality.....	70
Question 66: What strategies should be considered to adjust for phosphorous in crude oil to protect downstream catalyst and processing units? .....	70
Question 66: Answer Book Responses .....	73
Question 67: When heat input is limited at the vacuum heater, what are the issues with bypassing crude tower overflash around this heater? .....	74
Question 68: For those refiners seeing an increase in vacuum overhead chloride concentration at constant desalted crude salt content, what are the consequences and how can they be controlled? .....	76
Question 68: Answer Book Responses .....	79
Question 69: What are some of the advantages and challenges in processing FCC slurry in a vacuum tower along with conventional atmospheric residue streams? .....	80
Question 69: Answer Book Responses .....	82
Question 70: What are the key areas to target when contemplating crude unit modifications to enable effective tight oil processing? In addition to these modifications, what other problem areas become evident once the actual processing begins? .....	83
Question 70: Answer Book Responses .....	87
Coking.....	88
Question 71: How do you rebalance your coker operation when processing atmospheric tower bottoms at your FCC during tight oil processing?.....	88
Question 71: Answer Book Responses.....	89

Question 72: What are potential causes of damage to the top section of coker main fractionator trays? What mechanical and process considerations are used in designing the top section trays for more reliable operation?.....	89
Question 72: Answer Book Responses .....	92
Question 73: What is the current design philosophy in the lower section of a coker main fractionator (from tower bottoms up to first product draw) for controlling product quality and coke fines buildup? .....	94
Question 73: Answer Book Responses .....	99
Question 74: How effective are the following decoke methods in a delayed coker furnace: online spalling, mechanical pigging, and steam air decoking?.....	101
Question 74: Answer Book Responses .....	109
Question 75: What are the potential problems or negative impacts of utilizing FCC slurry/decant oil as coke drum OH (overhead) line quench oil? .....	111
Question 75: Answer Book Responses .....	112
Question 76: What has been the industry experience in mitigating the impact of solids in the feed or coke fines in the fractionator side draws and recycled cutting water? .....	112
Question 76: Answer Book Responses .....	116

# **Q&A and Technology Forum 2013**

## **FCC Q&A Session**

**Dallas, Texas, USA  
7-9 October 2013**

**Volume 4 of 4**

**ISBN: 978-1-63266-167-8**

**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© (2013) by American Fuel & Petrochemical Manufacturers (AFPM)  
All rights reserved.

Printed by Curran Associates, Inc. (2014)

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](mailto: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](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

## TABLE OF CONTENTS

FCC.....	5
Introduction to Session .....	5
Introduction to Panelists .....	5
Safety .....	7
Question 77: What are the consequences associated with continuing to operate the FCC without main fractionator bottoms cooling circulation?.....	7
Question 77: Answer Book Responses .....	8
Question 78: What procedures (maintenance and operational) are being used to minimize risk when swinging the blind between the reactor/main fractionator? .....	9
Question 78: Answer Book Responses .....	12
Question 79: How do you mitigate the risk of falling coke deposits from the reactor plenum chamber and vapor line during initial vessel entry? .....	16
Question 79: Answer Book Responses .....	18
Question 80: We have coke deposits in the plenum chamber and vapor line and are concerned the deposits may spall off or ignite during refractory dryout. What precautions should be taken to avoid re-igniting these coke deposits during the dryout? .....	19
Question 80: Answer Book Responses .....	22
Environmental.....	24
Question 81: How do CO (carbon monoxide) and NO <sub>x</sub> (nitrogen oxide) emissions change when you operate at low regenerator temperatures? What can be done to mitigate any increases? .....	24
Question 81: Answer Book Responses .....	27
Question 82: For those operating units with electrostatic precipitators (ESPs), share your experience with using SO <sub>x</sub> (sulfur oxide) reduction additives and their impact on: 1) ESP performance, 2) stack opacity, and 3) filterable solids mass rate. ....	30
Question 82: Answer Book Response.....	31
Question 83: Wet flue gas scrubber NO <sub>x</sub> removal technology often results in excessive nitrates in the purge water. What are refiners doing to limit nitrates going to their wastewater treatment plant?.....	31
Question 83: Answer Book Responses .....	34
Catalyst .....	36
Question 84: What are the commercial experiences with low rare earth and zero rare earth SO <sub>x</sub> reduction additives? What are the incentives to return to traditional products now that rare earth prices have returned to historical levels?.....	36
Question 84: Answer Book Responses .....	39

Question 85: What are the advantages and disadvantages of catalyst mesoporosity [100 to 600 ångström (Å) diameter pores] in VGO (vacuum gas oil) operations? .....	41
Question 85: Answer Book Responses .....	45
Question 86: What are the advantages and disadvantages of pre-blending FCC additives with FCC catalyst? What is the experience with incorporating FCC additive functionality into the catalyst particles? .....	49
Question 86: Answer Book Responses .....	54
Process .....	58
Question 87: The operation of a resid FCC can be challenging as more of its feed is hydrotreated to meet ULSG and ULSD specifications. What changes can be made to improve its operation? .....	58
Question 87: Answer Book Responses .....	61
Question 88: What FCC products are candidates for blending into jet fuel? What are the limitations and considerations? .....	64
Question 89: How are FCC simulation models being used as part of routine performance monitoring and optimization? .....	64
Question 89: Answer Book Responses .....	68
Question 90: Regenerator flue gas often contains hydrogen and/or light hydrocarbons, even in the presence of excess oxygen. What are the likely sources of these materials? What are the implications of operating under these conditions? .....	75
Question 90: Answer Book Responses .....	78
Question 91: What FCC operating variables can be used to control the formation of acetone? What typical acetone concentrations are observed? .....	79
Question 91: Answer Book Responses .....	81
Question 92: What experience is there with cracking whole crudes in the FCC? What are the considerations for new crude sources? .....	83
Question 92: Answer Book Responses .....	90
Mechanical/Reliability .....	97
Question 93: Which key process indicators (KPIs) are tracked in a typical FCC unit health monitoring program, and what is the frequency these indicators are measured? .....	97
Question 93: Answer Book Responses .....	102
Question 94: What methods do you use to determine the condition or remaining life of reactor and regenerator cyclones? .....	106
Question 94: Answer Book Responses .....	109
Question 95: What failure mechanisms have you observed in cyclone or cyclone support systems? What is the typical time to failure? .....	111
Question 95: Answer Book Responses .....	113

Question 96: What are the typical causes of dipleg plugging/fouling? How can the plugging/fouling be avoided? What is the experience with clearing diplegs online?.....	117
Question 96: Answer Book Responses .....	120
Tight Oil.....	123
Question 97: What operational or design changes can be employed to address heat balance issues – e.g., catalyst circulation limits, low regenerator temperatures – associated with processing tight oil-derived feeds? .....	123
Question 97: Answer Book Responses .....	128
Question 98: What catalyst changes can be made to minimize the negative effects of low delta coke that result from processing increased amounts of tight oil-derived FCC feed? .....	132
Question 98: Answer Book Responses .....	136
Question 99: Tight oil-derived FCC feeds are known to contain high levels of contaminant iron (Fe) and calcium (Ca). What catalyst design features are important for minimizing their effects? What level of these contaminants can be tolerated? What lab procedures can accurately simulate Fe and Ca contamination?.....	140
Question 99: Answer Book Responses .....	146
Question 100: What specific changes in yields and product qualities might be expected when processing large percentages of tight oil-derived feeds? What operational changes can be made to address any problems created by these effects? .....	151
Question 100: Answer Book Responses .....	153