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# Strategy of Takreer on R&D for Sustainable Future of Refining Industry

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Sultan Al Bigishi
Vice President
Operations Division
Ruwais Refinery


Abu Dhabi Oil Refining Company (TAKREER)

# Takreer Strategic Focus Areas

1. To create and maintain conditions under which Takreer's refining business and Environment can co-exist in productive harmony to fulfill the socioeconomic requirements of present and future generations of UAE

2. To ensure growth of Takreer's Oil refining industry in scale and complexity to ensure full utilization of natural resource, while striving for continuous improvement in product quality to sustain Environment

3. To make Takreer's refining business more competitive while enhancing the risk mitigating capabilities by developing technological edge by mastering crude oil refining technologies with the support of R&D

4. To focus on Refinery emission reductions for sustainability of environment by actively promoting enabling technologies in TAKREER's R&D initiatives

# Develop Platform for Sustainable Growth



| Challenges | Initiatives |
| --- | --- |
| Meeting increasing local demand | Increasing Refining capacity from 22 to 42 MMTPA; Gasoline: 2.5 to 5.4 MMTPA ;Gas Oil 4.7 to 12 MMTPA |
| Increase Refining Value | Base Oil, Bottom up-gradation: Delayed Coker/ RFCC |
| Meet more stringent prod. specifications | Meeting EURO-V Gasoline/ Gas Oil specifications |
| Expand Product Basket: Value added products | Base Oils; Propylene |

**R&D is identified as one of the Key elements in sustaining the change to meet TAKREER's key objectives**

# Research & Development at TAKREER

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**2006 - 2009**

TAKREER Research Center: **Initiation; Planning; Start-up**

Japan Cooperation Center, Petroleum (JCCP)
Idemitsu Kosan Co. (IKC)

**2010 - 2013**

**Development:** Commissioning testing equipment
Studies related to existing equipment conducted
Work for full integration of existing refinery is in progress

**2014 - 2017**

**Establishment:**
Strong support to existing units
Trouble shooting and optimization of integrated refinery
To be a gateway to technology and innovation: Catalyst, Process and Product Development

# TAKREER R&D: Vision/Mission & Objectives

**Vision:**

- To become a leading Research Center in the field of refining technology, process and product development.

**Mission:**

- To support and Develop TAKREER core refining activities as well as assist in technology transfer and Human resource development with local and international institution and Universities

**Objectives:**

- Ensure stable operation through troubleshooting
- Optimization of Process conditions and selection of most effective catalyst
- Save energy and reduce environmental impact through process integration
- Implement most advanced technology through in-house and collaborative R&D
- Develop workforce through trainings and internships

# TRC Support & Collaboration

## REFINERIES: Process Licensors/ Catalyst Providers

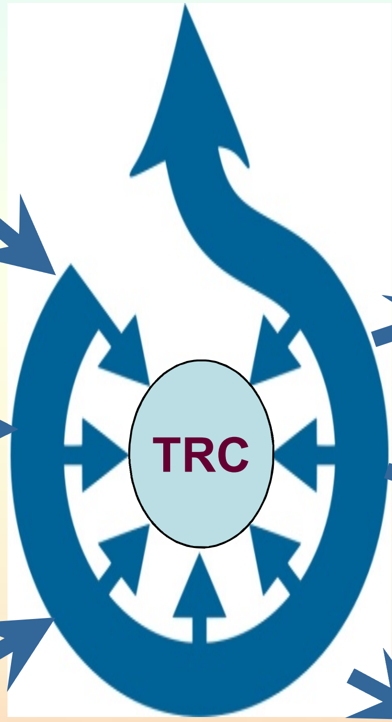
JCCP / IKC: Support
Japan Petro. Energy Center
Japan Petro. institute
Tech universities Japan

**Support**

Petroleum Institute: New catalysts/ Modeling

**Collaboration**

Future OPCOs Research center: Boroge Innovation center; Masdar Institute; UAE University




**Large Scale Pilot plants: Hydro-treating; Hydro-cracking; Reformer**

Lab Analysis: to support pilot plants; Refinery special testing needs; Assay analysis

**Process Engineering; Modeling and Simulation**

# TRC Support …..

## Pilot Plant Testing

- Designed and Procured pilot plant units to mimic refinery processes
- Started purchasing large scale pilot plant units (more than 100 CC catalyst volume): Used for yield prediction and product quality assessment
- Substantially invested in hydro-treating, hydro-cracking and reformer pilot plant units
- For processes like isomerisation, alkylation and adsorption plans are made to acquire smaller pilot plants

# TRC Support …..

## Catalysis

- Analyze and understand root causes of catalyst malfunction, deficit in activity, faster deactivation, lack of selectivity and poor mechanical strength
- Fast screening of various commercial catalysts in order to select the most suitable catalyst for the relevant processes/ application
  - Actively involved in RFCC catalyst formulation and improvement to maximise propylene yield
- ACE-MAT (Advance Catalyst Evaluation/ Micro Activity Test) unit is under procurement: this unit is planned to support day to day operation of RFCC unit
- Reaction kinetic modeling: To translate in to mechanisms and models capable of predicting catalyst performance at actual conditions of commercial units

# TRC Support …..



## Process

- Improve product quality and provide necessary support to meet specifications
- Energy efficiency: target for more efficient energy distribution and minimize energy consumption of units by improving energy integration
- Limit emissions NOx, Sox and other atmospheric pollutants
- Introduce sources of renewable energy
- Close monitoring and trouble shooting of refinery operations
- Building detailed simulation models for all important units of refineries
- Using refinery-wide modeling tools for process studies and developing yield vectors for various feed and process conditions for optimization studies

# TRC Support …..

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## Lab Analysis

- Providing timely analysis of characterization of feed, assessing product qualities etc
- Support pilot plants testing requirement
- Support refinery testing and trouble shooting requirements
- Laboratory features standard and sophisticated testing methods and equipment
- Typical testing instruments:
  - Distillation methods, density, viscosity, cold flow properties, sulfur, trace nitrogen, CHN, high temperature simulated distillation, TBP and vacuum distillation, metals etc
  - Involvement in ASTM round-robin tests is planned

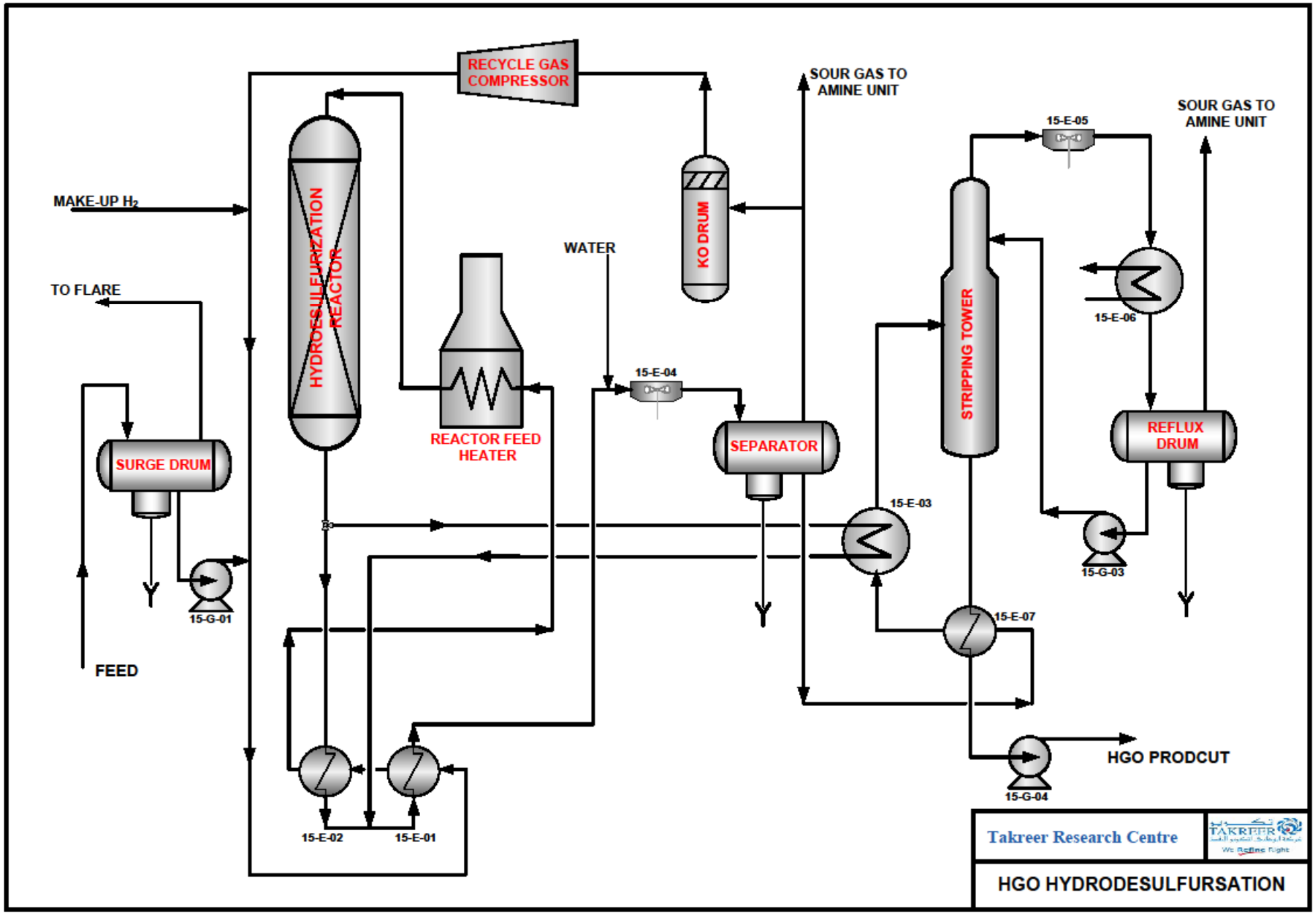
# Activity Programs at TRC :

- RFCC catalyst testing: initial investigations; selected optimum catalyst to maximize propylene production
- Reducing hydrogen consumption in Gas Oil hydrotreater: 30% reduction in H2 consumption with reactor pressure adjustments
- Crude Assay analysis: development of crude and condensate assay. Full assay report has been generated for Khuff condensate
- Refinery-wide simulations featuring rigorous reactor models are finalised
- Energy conservation in reformer units: Identify and recommend areas of improvement
- Assessing performance of Gas Oil hydrotreating catalyst to produce lowest possible sulfur content with various feed options
- Studying utilisation of idling gas oil hydrotreater to produce 10 ppm S Gas Oil

# Catalyst Selection Case Study

**A case study for extending the life of old Gas Oil Hydrotreater for producing 10 ppm S Gas Oil by using new generation catalysts**

# Extending the life of an old Gasoil HydroDeSulphirisation unit using new generation catalysts



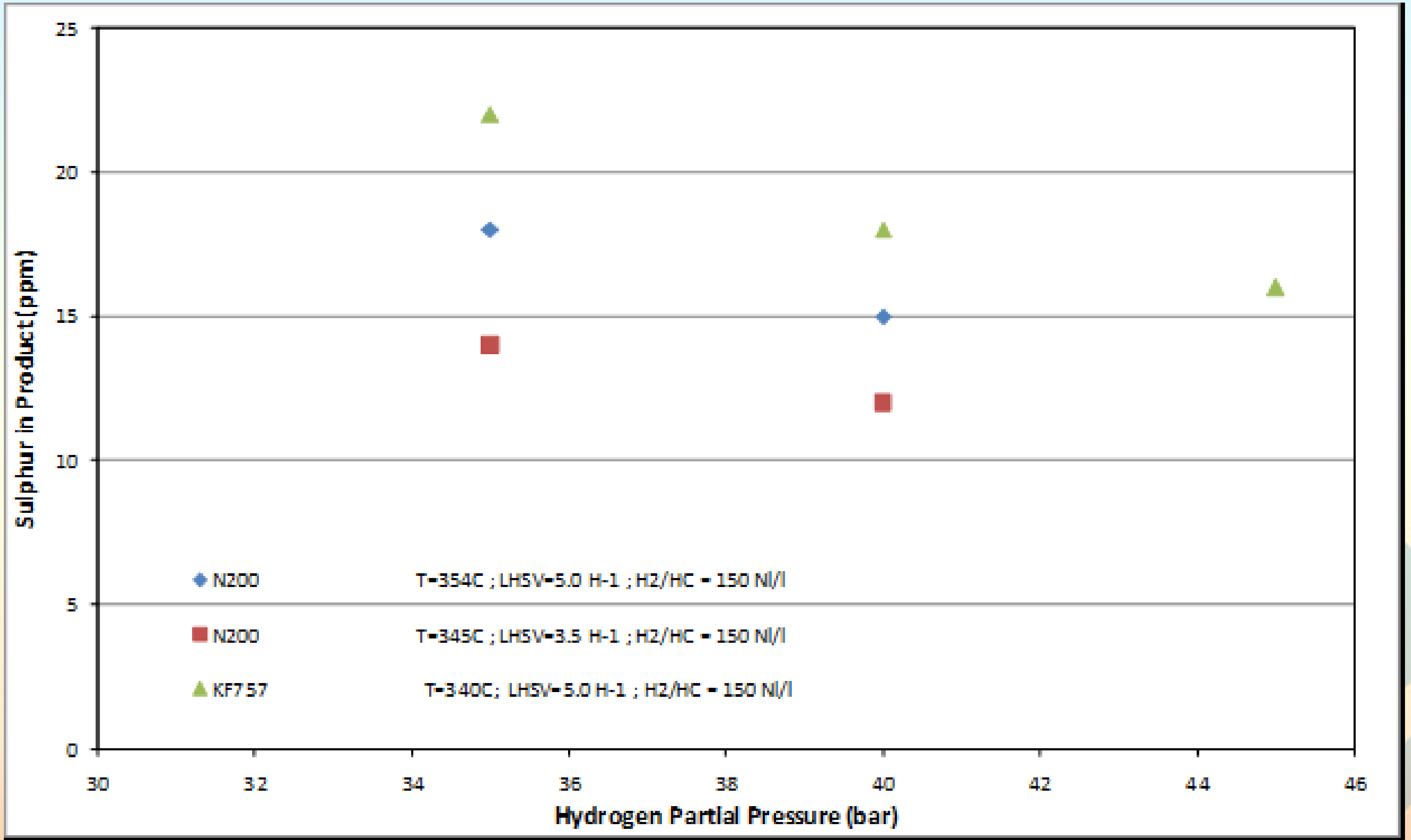
## Constraints

- **Flexibility : To study the possibility of processing feeds ranging from Kero to heavy Gas oil**

- **No investment : No additional investment in the form of additional reactor or new compressor.**

- **Need of a more active, polyvalent and stable catalyst**

# Effect of Hydrogen Partial Pressure

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# Effect of Hydrogen to Hydrocarbon Ratio

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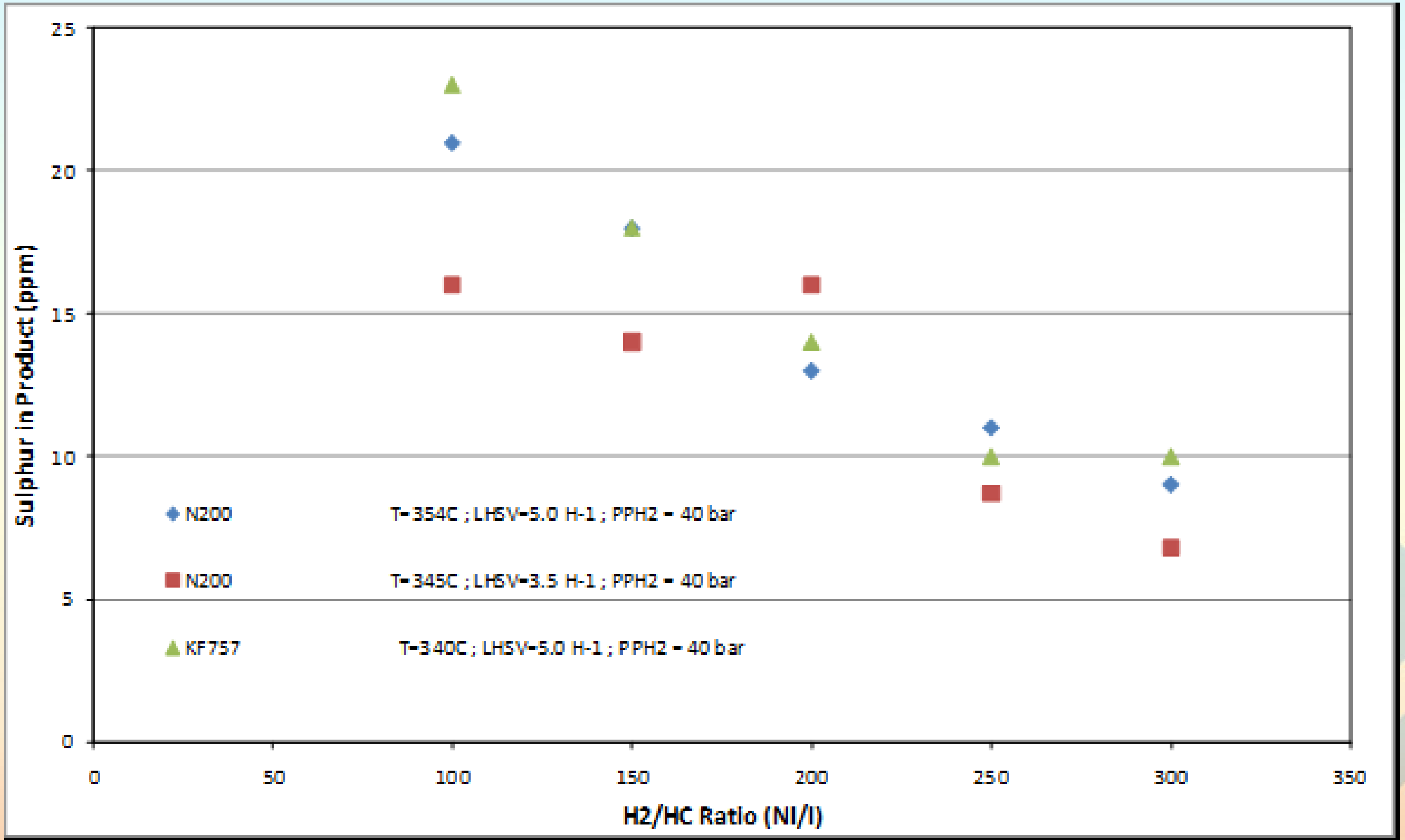


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# Feed - Analysis Results

| Tests | Feeds | | | | |
|---|---|---|---|---|---|
| | LGO | HGO | GO 500 | LGO + HGO Mixture | Kerosene |
| Density, kg/l | 0.8259 | 0.8559 | 0.8384 | 0.8405 | 0.7916 |
| Sulphur, mg/kg | 3271 | 9128 | 374 | 6294 | 999 |
| Distillation (D 86) | | | | | |
| IBP | 189 | 230 | 226 | 207 | 154 |
| 5 % Rec. | 231 | 275 | 251 | 243 | 167 |
| 10 % Rec. | 242 | 289 | 260 | 254 | 171 |
| 20 % Rec. | 251 | 302 | 272 | 265 | 177 |
| 30 % Rec. | 258 | 311 | 282 | 274 | 183 |
| 40 % Rec. | 263 | 318 | 291 | 281 | 188 |
| 50 % Rec. | 267 | 324 | 300 | 289 | 194 |
| 60 % Rec. | 270 | 331 | 311 | 298 | 202 |
| 70 % Rec. | 274 | 339 | 324 | 310 | 210 |
| 80 % Rec. | 278 | 350 | 339 | 326 | 220 |
| 90 % Rec. | 284 | 364 | 360 | 350 | 232 |
| 95 % Rec. | 290 | 376 | 375 | 366 | 241 |
| FBP | 300 | 387 | 385 | 378 | 249 |

# Test Points & Results

| Feed | Pressure | LHSV | H2/HC | T | Sulphur in liquid product |
|---|---|---|---|---|---|
| - | (bar) | ($h^{-1}$) | $Nm^3/m^3$ | (°C) | (ppm) |
| LGO | 40 | 3.5 | 150 | 315 | 202 |
| LGO | 40 | 3.5 | 150 | 354 | 7 |
| LGO | 40 | 5 | 150 | 354 | 18 |
| LGO | 40 | 5 | 100 | 354 | 21 |
| LGO | 40 | 5 | 300 | 354 | 9 |
| LGO | 45 | 5 | 150 | 354 | 15 |
| LGO | 35 | 5 | 150 | 354 | 16 |
| LGO | 40 | 3.5 | 150 | 350 | 7.2 |
| LGO | 40 | 3.5 | 150 | 345 | 14 |
| LGO | 40 | 3.5 | 100 | 345 | 16 |
| LGO | 40 | 3.5 | 250 | 345 | 8.7 |
| LGO | 40 | 3.5 | 300 | 345 | 6.8 |
| LGO | 40 | 3.5 | 150 | 354 | 5.3 |
| 500 ppm GO | 40 | 3.5 | 150 | 354 | 130 |
| Mix 50-50 (LGO-HGO) | 40 | 3.5 | 150 | 354 | 455 |
| HGO | 40 | 3.5 | 150 | 354 | 1396 |
| Kero | 40 | 3.5 | 150 | 300 | 9 |

## Process considerations

- **With or without amine scrubbing**
  - Acceptable level of H2S in the recycle gas
- **Stripping**
  - Reboiler  vs Steam
- **Heat Requirement**
  - Exchanger on/off
- **Distribution Tray**
  - Adequacy: different feeds and flowrates

# Final Assessment

- **Unit can produce 10 ppm Sulphur content**
- **Unit can process different feeds**
- **Unit can absorb extra capacity**
- **No capital investment with the new generation catalyst**

# Path Forward: 2013 - 2015

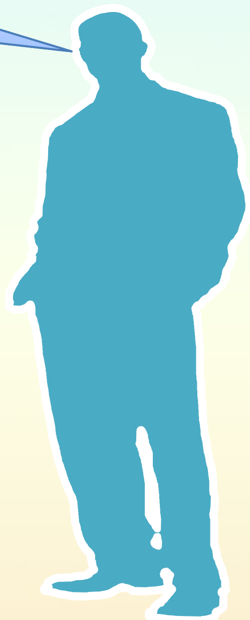
- Further Development of Catalyst Evaluation Technologies
  - Addition of FCC catalyst evaluation
- Enhance Support to Refineries:
  - Upgradation of existing process simulators and building new ones for refinery expansion units
  - Trouble shooting and optimisation of refinery units with real time monitoring
  - Establishment of Material and Corrosion Res. Laboratory
- Developing skills and improving competencies of TRC staff using IKC facilities and expertise
- Collaboration with universities and institutions
- Knowledge sharing: Promoting TRC research activities to scientific and industrial communities

# Future Opportunities in R&D Area:

- **Carbon Black and Anode Grade Coke quality modeling and assessment.**
- **Emission Models (Stock, Fugitive and Ambient)**
- **Electrical / Control Network Modeling and simulation**

  **(for Reliability, Resistant of Loss Reduction, Contingency Analysis)**
- **Naturally Occurring Radio-active Material (NORM) models for decontamination.**
- **Civil Structure Integrity due to gulf environmental condition**

Any Questions?



# THANK YOU

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