Kinetics Process Improvements, Inc.

Independent Consultants & Engineers

Serving to Improve, Decarbonize & De-bottleneck

- ***Ammonia Plants*** (Integration with gH2)
- ***Methanol Plants*** (Oxygen Enrichment)
- ***Primary Reformers*** (Electrification)
- ***CO2 Removal Systems*** (Tech-Evaluations)
- ***Decarbonization Solutions*** (Green-Blue Ammonia & Methanol Plant Studies)

PROJECT FEASIBILITIES

- Technology Evaluation
- Project Cost Estimate
- Risk Assesment
- Due Dilligence
- Economic Evaluation

REVAMP STUDIES

- Capacity/Efficiency Improvements
- Plant Energy Audits
- Reformer Re-ratings
- MIC™ Revamp without major compressor upgrades
- Synloop Optimizer

CUSTOM PROCESS TRAINING

- Process & Technology
- Equipment:
  - Monitoring Techniques
  - Reliability Reviews
- Plant Modeling

PROCESS DESIGN & ENGINEERING

- Basic Engineering Pkg
- Pilot Scale Up
- Process Simulations
- Converter Modeling

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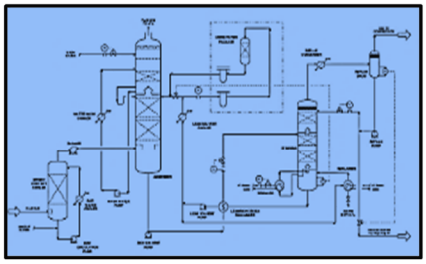
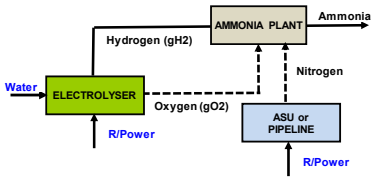
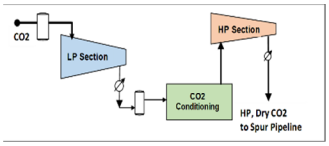


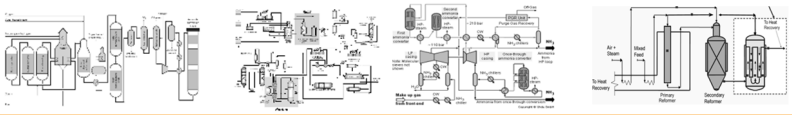
INTEGRATION STUDIES
GREEN H2 & O2 ENRICHMENT



CO2 COMPRESSION & DEHYDARTION



TECHNOLOGY EVALUATION
FOR CO2 REDUCTION & USE



OWNER'S ENGINEERS FOR EVALUATING & EXECUTING DECARBONIZATION SOLUTIONS

Decarbonization Consulting Advisory & Engg. Studies

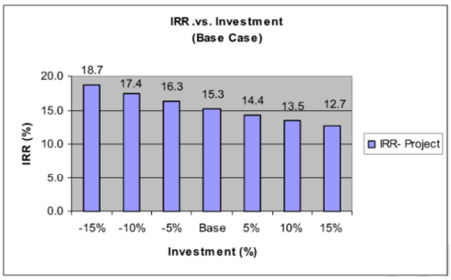
Project Definition & Planning
Project Configurations
Technology Assessment
Project Risks & mitigation
Project Pre-feasibility
Project Cost Estimates
Design & Engg. Management
Critical Technical Reviews

SINCE 2005

Consulting to Decarbonize

by KPI Consulting, Houston

KPI *has provided project development management and consulting services for over a dozen projects. KPI led the successful development of Four large projects as* ***"Owner's Engineers"*** *including a major Propylene derivatives complex in Saudi & ongoing CCS project at USGC. Our breadth of technology expertise coupled with our* ***experience with various Decarbonization options*** *provide the value addition for new projects and upgrading the existing facilities.*



Expertise

- Ammonia Tech & Economics
- Methanol Tech & Economics
- H2 Production Tech & Economics
- OTF H2 Cost & Economic Analysis
- Ethylene & PDH Technologies
- SMR & ATR Syngas Technologies
- CO2 Capture Technologies (Pre & Post)
- CO2 Compression & Dehydration
- gH2/bH2 Integration Studies
- O2 Enrichment studies
- Green-Blue H2 & O2 Evaluation
- Strategic Project Planning
- Project definition & management
- Project Configuration Evaluations
- Technology & Risk Evaluation
- Due diligence- overall project
- Project Cost Estimates & Economics
- Project Pre-Feasibility
- Licensing/BEP Agreements reviews
- Project Execution support
- Critical Technical Reviews
- Simulation modeling

Resources

- Team of SME's- Houston office
- Working relations with Licensors
- Proven modeling & sizing tools
- Cost data base *(updated regularly)*

Projects/Studies Handled

- Green-Blue H2/NH3/MeOH Studies
- O2 Enrichment Studies
- g/bH2-NH3 Integration Studies
- Electric Pre-reformer
- CO2 Capture Feasibility Study
- CO2 Compression & Dehydration
- New Decarb Techn options studies
- Ammonia plant studies
- Methanol & value chain Studies
- Pet coke to Chemicals Studies
- Propane Dehydro (PDH) project
- Ethylene & value chain study
- Propylene value chain Project
- Oxo-Alcohol & derivatives project
- Acrylic Acid & derivatives project

References

SABIC, Advance Petrochemicals, Saudi Chevron, Tasnee, Chemanol, Methanol Holdings, Modi Group, D7 Petrochem, YCI, CFI, Nutrien, Yara, OCI, Dyno Nobel, CSBP Chemanol, Statoil, PPGPL, USGC

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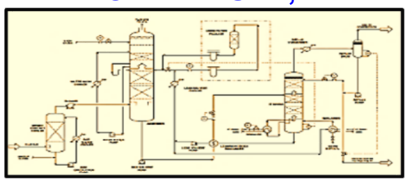
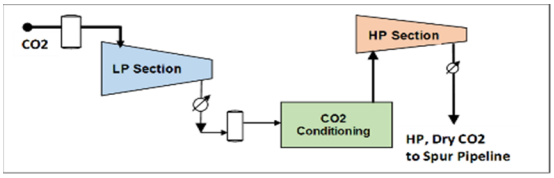
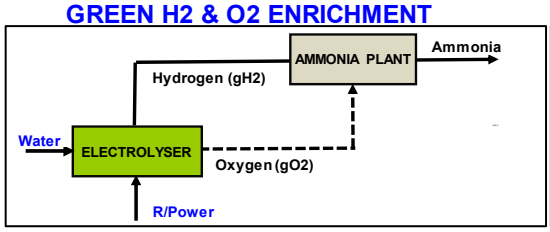
KINETICS PROCESS IMPROVEMENTS
KPI

CO2 CAPTURE, DEHYDRATION & COMPRESSION STUDIES

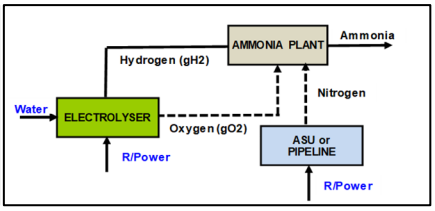




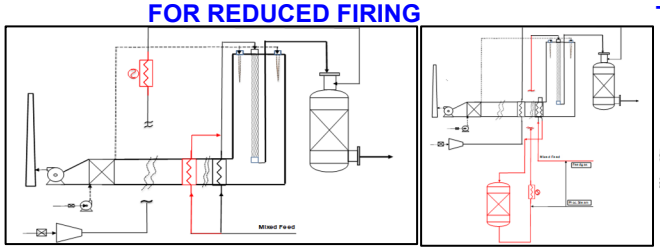
INTEGRATION STUDIES
GREEN H2 & O2 ENRICHMENT



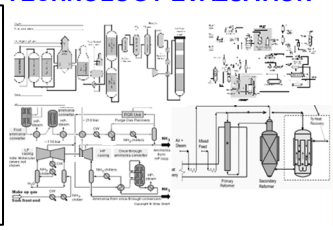
GREEN AMMONIA PLANT STUDIES



STUDY TO RECONFIGURE & ELECTRIFY FOR REDUCED FIRING



ATR & CO2 REDUCTION TECHNOLOGY EVALUATION



Decarbonization Strategies & Solutions in Ammonia, Methanol & Petrochem Plants

Green-Blue H2 Integration Studies
Oxygen Enrichment Studies
CO2 Capture Feasibility Studies
CO2 Compression & Dehydration
H2 Compression & O2 removal
Oxygen Compression
New Technology Evaluation
Plant Impact & Engg Studies
Risk Assessment
Cost Estimates

COMPLETED SEVERAL DECARBONIZATION & CCS ENGINEERING STUDIES WITH COST ESTIMATES

SINCE 2005

Decarbonization Pathways & Solutions

by Kinetics Process Improvements, Houston

***KPI**-Houston is an **Independent Process Technology & Consulting for Strategic analysis with in-depth Studies for CO2 abatement pathways in Ammonia, Methanol & Petrochem plants.** Also design and engg expertise in CO_2 capture, dehydration, Compression, Liquefaction including (g/b) H2 integration, and O2 Enrichment*

Expertise & Services

- **Strategic Analysis & Studies**
  - ✓ CO2 abatement Options
  - ✓ Green-Blue H2/NH3 options
  - ✓ Oxygen Enrichment
  - ✓ Ammonia Cracking
  - ✓ Plant Integration & Impact
  - ✓ New Technologies Evaluation
  - ✓ Project Risks
  - ✓ Costs & Economics
- **CO2 Capture Technologies**
  - ✓ Pre-Combustion (syngas)
  - ✓ Post-Combustion (Flue gas)
- **CO2 Dehydration & Clean-up**
  - ✓ Glycol units
  - ✓ Adsorbents/Molecular Sieves
- **CO2 Transportation**
  - ✓ CO2 Liquefaction
  - ✓ CO2 Compression
- Supercritical CO2 Equip. specs
- H2 & O2 Compression Specs
- Owner's Engineers

"Two Patents pending- Reducing CO2 footprint in Primary Reformers

Methodology

- Integration with gH2/bH2
- Electrify & O2 Enrichment
- Reconfigure to reduce Firing
- CO2 Capture & Utilization

Tools

- Simulation modeling & sizing
- Extensive Cost database
- Rigorous Economic models

Studies/Projects References

- gH2/NH3 Engg Study- 400 tpd
- gH2/NH3 integration study
- CCS study (2 x3000 tpd CO2)
- CO2 Capt/ Comp/ Dehy study
- CO2 Capture from Flue gas
- CCS study (3900 tpd CO2)
- Electric Pre-reforming Study
- O2 Enrichment Study

End Users Served

- **CFI, Nutrien, Dyno Nobel, Yara, OCI**
- **Chemanol, CSBP, Statoil, USGC**

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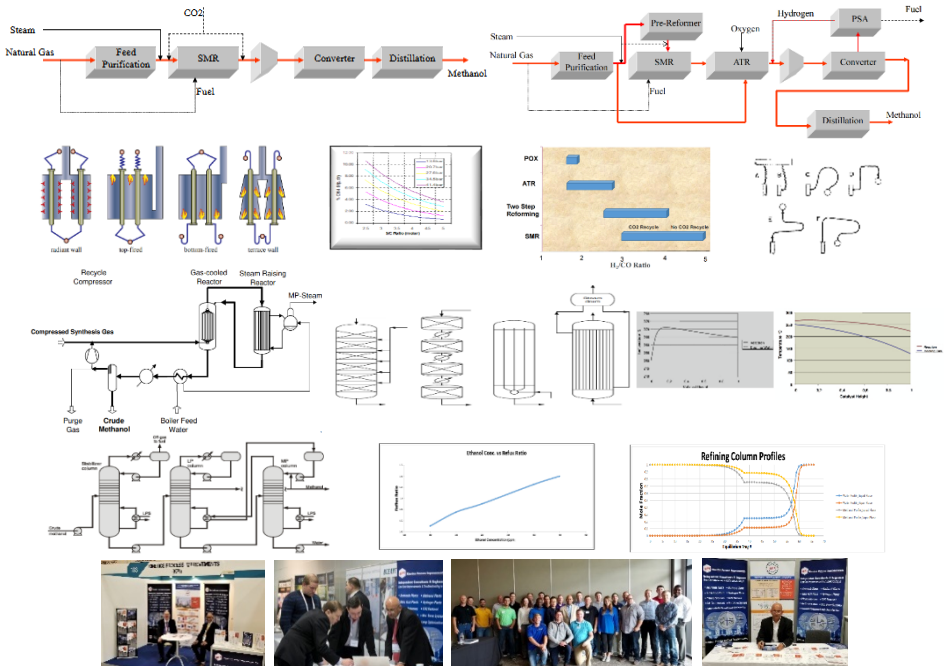
KINETICS PROCESS IMPROVEMENTS KPI

"Completed over a dozen Engineering studies and six successful upgrades of pre-combustion CO2 capture units"



Methanol Plants Revamping Auditing & Troubleshooting Services

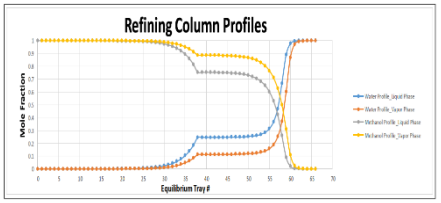
Practical & Cost-Effective Solutions to Improve Capacity, Efficiency Reliability & CO2 Footprint

STUDIED METHANOL PLANTS FROM 300 TPD TO 5400 TPD. COMPLETED OVER 100 REVAMP STUDIES

SINCE 2006

Methanol Plants Revamping & Audits

by Kinetics Process Improvements, Houston



KPI**-Houston is an **independent Process Technology, Design & Engg Consulting** group specializing in Ammonia & Methanol Plants Revamps since 2006 to improve Capacity, Efficiency, Reliability & CO2 footprint. **Over 100 Revamp Studies completed

Objectives & Key Benefits

- To Improve Plant Capacity, Efficiency, Reliability & CO2 footprint
- Identify Best Revamp Options using Cost-Benefit Analysis
- Practical & Cost-effective Solutions

Resources & Expertise

- Simulation modeling of Complete Methanol Plant for all Process Configurations including ATR
- Rigorous modeling of Reformers
- Re-rating Compressors
- Modeling Methanol Reactors
- Rating & Optimizing Synloop
- Methanol Distillation modeling
- Basic Design Package
- Equipment sizing tools
- Experienced Team

References

Methanex, SABIC, Celanese, Methanol Holdings, AMPCO, Koch Methanol, Chemanol, Syngas Energy

Methanol Plant Services

- Revamp for higher capacity & η
- Revamp for improved Reliability
- Revamp to reduce CO2 footprint
- CO2 injection for higher capacity
- To Co-produce Ammonia study
- Upgrading Primary Reformer
- Plant Performance Audits
- Basic Engineering of Revamp
- Methanol Loop upgrade
- Methanol Distillation upgrade
- Optimizing Steam System
- Cooling Water System upgrade
- SCR for NOx Reduction
- Value Engineering
- Critical Equipment Reviews
- Equipment design upgrade
- Project Cost Estimate
- Risk Assessment
- Technology/Project Evaluation
- Derivatives Feasibilities
- Expert Witness- Engg. Disputes

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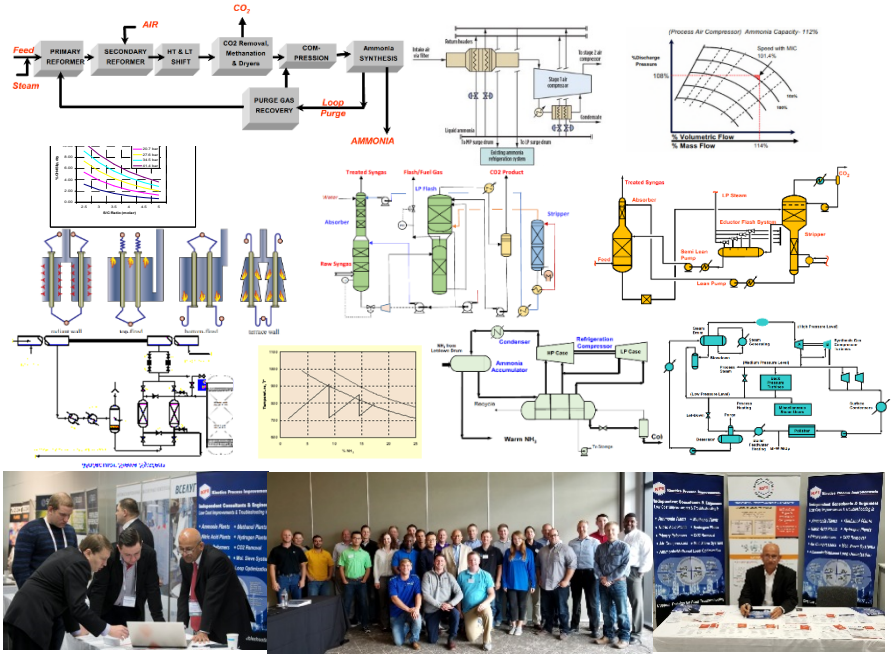
KINETICS PROCESS IMPROVEMENTS
KPI



Ammonia Plants Audits, Revamps & Troubleshooting Services

Practical & Cost-Effective Solutions to Improve Capacity, Efficiency, CO2 Emissions & Reliability

REVAMP EXPERIENCE IN AMMONIA PLANTS FROM 400 TPD TO 4000 TPD

SINCE 2005

Ammonia Plants Audits & Revamps

by Kinetics Process Improvements, Houston

*KPI-Houston is an **independent Process Design & Engineering Consulting** group specializing in Ammonia & Methanol Plants Revamps and Troubleshooting since 2006 to improve Capacity, Efficiency and Reliability. Houston & Bahrain offices.*

Objectives & Key Benefits

- **To improve Plant Capacity, Efficiency and Reliability**
- **Identify Best Revamp Options using Cost-Benefit Analysis**
- **Practical & Cost-effective Solutions**

Resources & Expertise

- ***Integrated Suction Chiller*™ to upgrade Process Air Compressor**
- **Electric Pre-Reforming**
- **Reformer Rating and Re-harping**
- **CO2 Removal System Revamps- - a/MDEA & Benfield systems**
- **Rating & Optimizing Converters**
- **Modeling of Complete Ammonia Plants of different Configurations**
- **Rigorous modeling of Reformers**
- **Re-rating with Compressor models**
- **Basic Design & Engineering**
- **Equipment sizing/rating**
- **Project Cost Estimation**
- **Experienced Team**

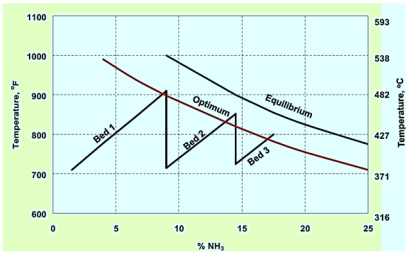
References

CFI, NUTRIEN, OCI, SABIC, DYNO NOBEL, CNC N2000, AUM, PLNL, CHEMANOL, METHANOL HOLDINGS, LSB, CSBP

***Integrated Chiller*™ Patented granted**
Pending Patent for Electric Pre-Reformer

Ammonia Plant Services

- **Plant Performance Audits**
- **Plant De-Bottlenecking**
- **Green H2 integration Studies**
- **O2 Enrichment Studies**
- **Revamp for higher Capacity**
- **Revamp for improved Efficiency**
- **Basic Engineering of Revamp**
- **Rerating Primary Reformer**
- **Reformer Re-harping studies**
- **CO2 Removal System upgrades**
- **Mol-Sieve System upgrade**
- **Ammonia Loop upgrade**
- **Ammonia Refrigeration upgrade**
- **Compressors/Turbine upgrades**
- **Optimizing Steam System**
- **Cooling Water System upgrade**
- **Root-cause analysis**
- **CO2 reduction options**
- **Value Engineering**
- **3rd Party Design Reviews**
- **Critical Equipment Reviews**
- **Equipment design upgrade**
- **Cost Estimating**
- **Project Feasibility**
- **Technology/Project Evaluation**
- **Risk Assessment**
- **Derivatives Feasibilities**



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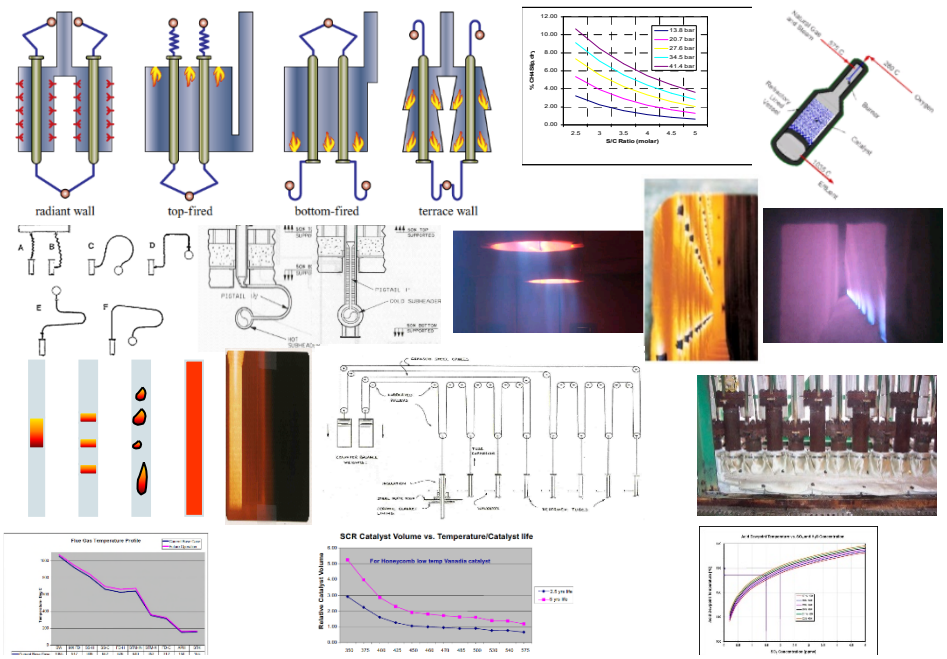
KINETICS PROCESS IMPROVEMENTS
KPI



Reformers Revamping & Troubleshooting Services

for
Ammonia
Methanol
Hydrogen
Oxo-Syngas Plants

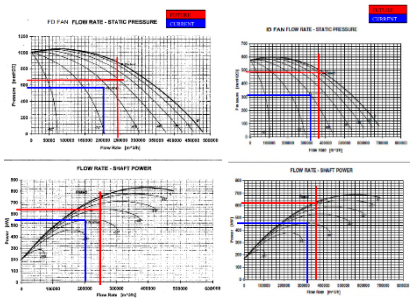
HOLISTIC APPROACH TO INCREASE REFORMING CAPACITY. OVER 60 REVAMP STUDIES COMPLETED

SINCE 2006

Revamping & Re-Rating Reformers

by Kinetics Process Improvements, Houston

KPI**-Houston is an **Independent Process Technology, Design & Engg Consulting** group specializing in Ammonia & Methanol Plants Revamps since 2006 to improve Capacity, Efficiency, Reliability & CO_2 footprint. **Over 100 Revamp Studies completed



Objectives & Key Benefits

- **To Improve Plant Capacity, Efficiency, Reliability & Emissions**
- **Identify Best Revamp Options using Cost-Benefit Analysis**
- **Practical & Cost-effective Solutions**

Resources & Expertise

- **Rigorous Reformer modeling**
- **Experience in all Reformer types**
- **Experience in Re-rating Radiant Section/Coils**
- **Experience in designing & optimizing Convection Section/Coils**
- **Experience in Burners & Combustion System upgrades**
- **Experience with APH, ID FD Fans**
- **Integrated Chilling*** *(patented)*
- **Basic Design Package**
- **Experienced Team of Process, Technology, Thermal Engineering**

References

CFI, NUTRIEN, SABIC, CSBP, CHEMANOL, METHANEX, METHANOL HOLDINGS, SYNGAS Energy, OCI

* ***Two Patents granted and one pending to reduce firing & CO_2 footprint in Ammonia & Methanol plant Reformers***

Reformer Revamp Services

- **Reforming System upgrades**
- **Radiant Section & Coil Re-rating**
- **Reformer Re-harping Studies**
- **Convection Replacement Studies**
- **Estimate Max. TMTs**
- **SCR sizing NOx Emissions**
- **Reliability Review all systems**
- **Basic design & API datasheets**
- **Customized Training**

Reformer Troubleshooting

- **Reformer Performance Audits**
- **Review & Analysis of Design & Operational Limitations**
  - **Process & Controls issues**
  - **Heat transfer limitations**
  - **WHB/Steam System issues**
  - **Pressure drop/draft issues**
  - **Temperature excursion issues**
  - **Combustion & Firing issues**
  - **Air Preheater issues**
  - **FD and ID Fan limitations**
  - **SCR/NOx issues**

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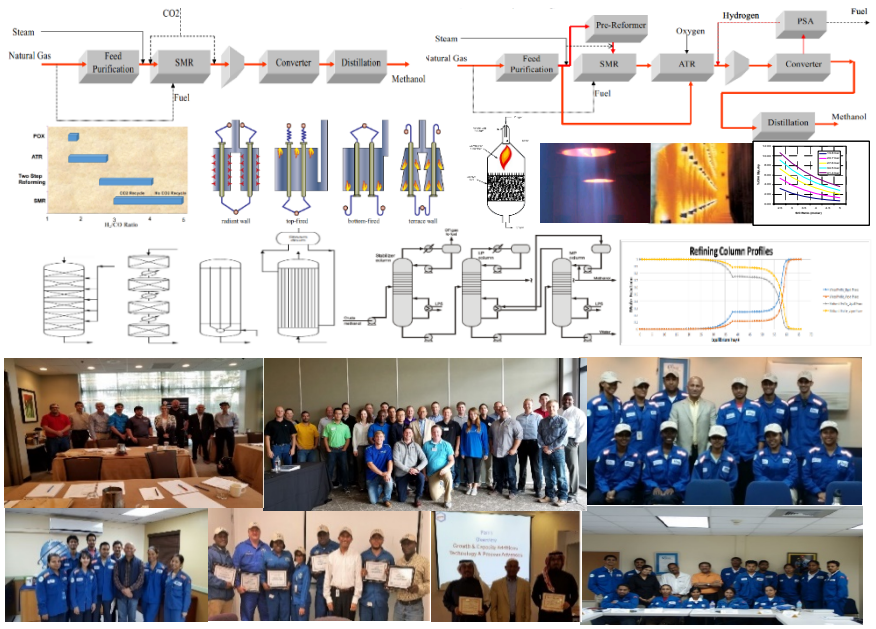

Methanol Production & Troubleshooting Training

Including

Best Practices
Lessons Learned
Equipment Monitoring
Improvements Tips
(Customized, as needed)

SIMPLE PRACTICAL IMPROVEMENTS & TROUBLESHOOTING TIPS

METHANOL TRAINING SINCE 2006

Methanol Plant Training Workshop

by Kinetics Process Improvements, Houston

OBJECTIVE: ***The comprehensive workshop provides practical insights with a focus on process, reforming, troubleshooting, performance improvements in Methanol Plants to improve monitoring, maintenance, reliability & safety***

OVERVIEW

- Process & Technology advances
- Process configurations & analysis
- Best Practices/Lessons Learned

PROCESS & TROUBLESHOOTING

- Improve Reforming performance
- Minimizing pressure drop
- Improve Compressor capacity
- Optimize Synloop for max production
- Improve Methanol Purification
- Improve Steam system
- Process monitoring techniques
- Case studies/Lessons learnt
- Plant Modeling & Evaluation

CATALYST CONSIDERATIONS

- Feed Purification
- Reforming- Pre/Primary/ATR
- Methanol Synthesis

METHANOL DISTILLATION

- Distillation Schemes
- Methanol quality issues
- Minimize Energy consumption

PRIMARY REFORMER/ATR

- Thermodynamics and Chemistry
- Reformer Arrangements
- All about Radiant Tubes
- Primary & ATR problem issues
- Critical design features
- Key Operating Variables
- Burners, Draft & Combustion
- Air Preheater & considerations
- Controls & Safety Systems
- NOx mitigation- pre-& post treatment
- Startup & Shut down consideration
- Catalyst evaluation techniques
- Efficiency evaluation & monitoring

METHANOL SYNLOOP

- Converter types & Loop configurations
- Optimize loop for max production
- H2 recovery & CO2 addition

PERFORMANCE MONITORING

- Primary Reformer Heat Balance, ATE
- Reformer Thermal Efficiency
- Compressor/Turbine Efficiency
- Heat Exchanger/Convection Fouling

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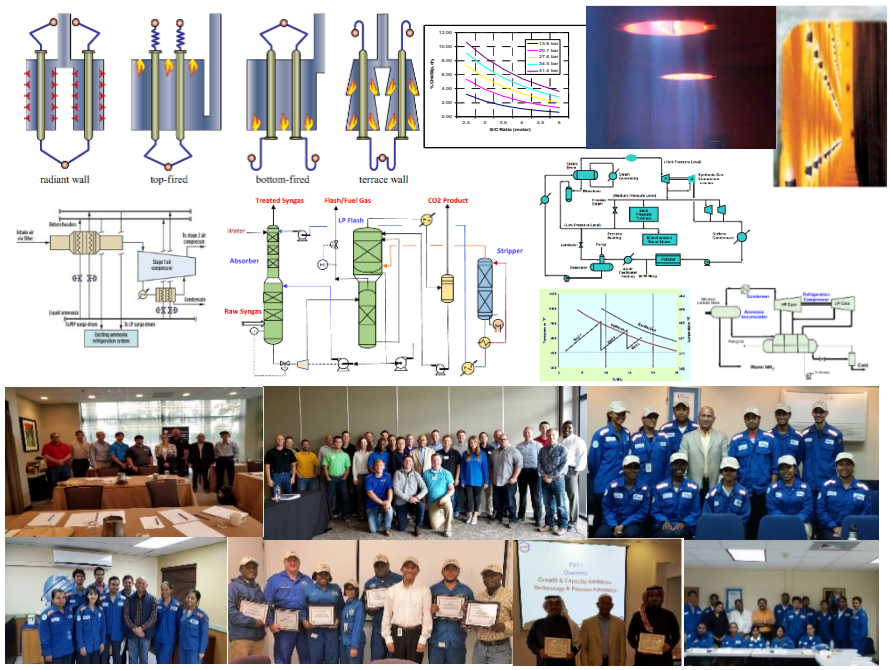
TRAINING FORMAT

- ***Interactive Q&A for practical learning***
- ***What-if scenarios for improvements***
- ***Analysis of Practical Case Studies***
- ***Models to demo Plant sensitivity***
- ***Simple to follow training material***

TARGET GROUP

- ***Process/Operation Engr's***
- ***Production Sup'dt/Supervisors***
- ***Project/Mechanical Engineers***
- ***Reliability & Safety Engineers***
- ***Business development/Analysts***

REFERENCES: ***METHANEX, METHANOL HOLDINGS, SABIC, CELANESE, AMPCO*** *(Trained over 600 candidates with many repeats*



Ammonia Production & Troubleshooting Training

Including

Best Practices
Lessons Learned
Equipment Monitoring Improvements Tips
(Customized, as needed)

SIMPLE PRACTICAL IMPROVEMENTS & TROUBLESHOOTING TIPS

AMMONIA TRAINING SINCE 2006

Ammonia Plant Training Workshop

by Kinetics Process Improvements

OBJECTIVE: ***The comprehensive workshop provides practical insights with a focus on process, reforming, troubleshooting, performance improvements in Ammonia Plants to improve monitoring, maintenance, reliability & safety***

OVERVIEW

- Process & Technology advances
- Process configurations & analysis
- Best Practices/Lessons Learned

PROCESS & TROUBLESHOOTING

- Improve Reforming performance
- Minimizing inerts in MUG
- Minimizing pressure drop
- Improve Compressor capacity
- Improve CO2 removal performance
- Improve Mol. Sieve performance
- Cryogenic Purifier modeling & issues
- Optimize Synloop for max production
- Improve Ammonia Refrigeration
- Improve Steam system
- Process monitoring techniques
- Case studies/Lessons learnt
- Plant Modeling & Evaluation

CATALYST CONSIDERATIONS

- Feed Purification
- Reforming- Pre/Primary/Secondary
- Shift- LTS/HTS
- Methanation
- Ammonia Synthesis

PRIMARY REFORMER

- Thermodynamics and Chemistry
- Reformer Arrangements
- All about Radiant Tubes
- Critical design features
- Key Operating Variables
- Burners, Draft & Combustion
- Air Preheater & considerations
- Controls & Safety Systems
- NOx mitigation- pre- & post treatment
- Startup & Shut down consideration
- Re-harping considerations
- Catalyst evaluation techniques
- Efficiency evaluation & monitoring

AMMONIA SYNLOOP

- Converter types & Loop configurations
- Ammonia Refrigeration
- Optimize loop for max production
- H2 recovery improvements

PERFORMANCE MONITORING

- Primary Reformer Heat Balance, ATE
- Reformer Thermal Efficiency
- Compressor/Turbine Efficiency
- Heat Exchanger/Convection Fouling

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- ***Interactive Q&A for practical learning***
- ***What-if scenarios for improvements***
- ***Analysis of Practical Case Studies***
- ***Models to demo Plant sensitivity***
- ***Simple to follow Training material***

TARGET GROUP

- ***Process/Operation Engr's***
- ***Production Sup'dt/Supervisors***
- ***Project/Mechanical Engineers***
- ***Reliability & Safety Engineers***
- ***Business Development/Analysts***

REFERENCES: ***CFI, NUTRIEN, SABIC, CNC, N2000, PLNL, AUM, ADVANSIX, MOSAIC*** *(Trained over 600 candidates with many repeats)*

Kinetics Process Improvements, Inc.

Independent Consultants & Engineers

Serving to Improve, Decarbonize & De-bottleneck

- ***Ammonia Plants*** (Integration with gH2)
- ***Methanol Plants*** (Oxygen Enrichment)
- ***Primary Reformers*** (Electrification)
- ***CO2 Removal Systems*** (Tech-Evaluations)
- ***Decarbonization Solutions*** (Green-Blue Ammonia & Methanol Plant Studies)

PROJECT FEASIBILITIES

- Technology Evaluation
- Project Cost Estimate
- Risk Assesment
- Due Dilligence
- Economic Evaluation

REVAMP STUDIES

- Capacity/Efficiency Improvements
- Plant Energy Audits
- Reformer Re-ratings
- MIC™ Revamp without major compressor upgrades
- Synloop Optimizer

CUSTOM PROCESS TRAINING

- Process & Technology
- Equipment:
  - Monitoring Techniques
  - Reliability Reviews
- Plant Modeling

PROCESS DESIGN & ENGINEERING

- Basic Engineering Pkg
- Pilot Scale Up
- Process Simulations
- Converter Modeling

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