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

IRR.vs. Investment (Base Case)

5% 10%

Base

Investment (%)

13.5 12.7

15%

RR- Project



OWNER'S ENGINEERS FOR EVALUATING & EXECUTING DECARBONIZATION SOLUTIONS-STUDIES

Consulting to Decarbonize [Blue-Green Options]

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 green & Blue Ammonia plants at USGC. Our breadth of technology expertise coupled with our **experience in various Decarbonization options** provide the value addition for the new projects as well as upgrading the existing facilities.

Expertise

- Ammonia Tech & Economics
- Methanol Tech & Economics
- H2 Production Tech & Economics
- OTF H2 Cost & Economic Analysis
- SMR & ATR Syngas Technologies
- CO2 Capture Technologies (Pre & Post)
- CO2 Compression & Dehydration
- gH2/bH2 Integration Studies
- 02 Enrichment studies
- Green-Blue H2 & NH3 Evaluation
- Ethylene & PDH Technologies
- 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
- Working relations Equipment Suppliers
- Proven modeling & sizing tools
- Cost data base (updated regularly)

Projects/Studies Handled

- Green-Blue H2/NH3/MeOH Studies
- 02 Enrichment Studies
- g/bH2-NH3 Integration Studies
- Electric Pre-reformer
- CO2 Capture Feasibility Study
- CO2 Compression & Dehydration
- New Decarb Tech options studies
- Ammonia plant studies
- Methanol & value chain Studies
- Pet coke to Chemicals Studies
- Propane Dehydro (PDH) project
- Ethylene & value chain study
- 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

Completed several Green & Blue Ammonia and gH2/gO2 integration studies as well as CO2 Capture, Compression and Dehydration with total Cost Estimates



-5%

20.0

-15% -10%

(%) 10.0

RR

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

CO2 CAPTURE, DEHYDRATION & COMPRESSION STUDIES



Decarbonization via Blue & Green Solutions in Ammonia, Methanol & Petrochem Plants

Green-Blue Ammonia Feasibility Green 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

SINCE 2005

Decarbonization Pathways & Solutions

COMPLETED SEVERAL DECARBONIZATION & CCS ENGINEERING STUDIES WITH COST ESTIMATES

by Kinetics Process Improvements, Houston

KPI-Houston is an **Independent Process Technology & Consulting for in-depth analysis Studies for CO2 abatement pathways in Ammonia, Methanol, H2 & Petrochem plants.** Also design and engg expertise in CO₂ 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
 - ✓ gH2/gO2 integration studies
 - ✓ Ammonia Cracking
 - ✓ Plant Integration & Impact
 - ✓ New Technologies Evaluation
 - ✓ Project Risks & mitigation
 - ✓ 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
 - CO2 Compression
 Superprint and CO2 Equip
- 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 or Seq
- gH2 via Renewable energy

Tools

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

Studies/Projects References

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

End Users Served

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



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CO2 Removal Systems Revamping & Upgrading aMDEA & Benfield Systems for

Higher Capacity Reduced CO2 Slip

IMPLEMENTED MANY SUCCESFULL REVAMPS OF AMDEA & BENFIELD CO2 REMOVAL SYSTEMS

Revamping CO2 Removal Systems

By Kinetics Process Improvements, Houston

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

Revamp Experience

- aMDEA Systems
 - ✓ Single & Two Stages
 - ✓ Single-stage with LP flash
 - ✓ HP flash CO₂ recovery
 - ✓ Vac. Flash with LP Flash
 - ✓ Conversion of MEA to aMDEA
- Benfield Systems
 - ✓ With all Activators in use
 - ✓ All Process Configurations
 - ✓ Conversion to aMDEA study

Expertise & Services

- Proven Simulation modeling
 - ✓ aMDEA Systems
 - Benfield Systems
- Holistic approach
- Evaluation of Column internals
- Evaluation & sizing Flash Drum
- Evaluation & Sizing Ejectors
- Evaluation & Sizing Reboilers
- Equipment evaluation & sizing
- Revamp Cost Estimates
- Basic Process Design Package

References

- Revamp Engineering Studies:
 - ✓ aMDEA- 1200 tpd Ammonia *
 - ✓ aMDEA- 3000 tpd Ammonia
 - aMDEA- 2520 tpd Ammonia *
 - ✓ aMDEA- 1950 tpd Ammonia *
 - Benfield-2200 tpd Ammonia *
 - Benfield-2200 tpd Ammonia *
 - Benfield-2250 tpd Ammonia *

*Successfully Implemented

Revamp approach/scope:

- $\checkmark \quad {\sf Simulation\ modeling}$
- Engineering Study
- ✓ Equipment Evaluation & sizing
- ✓ Budgetary Cost Estimation
- Revamp objectives included:
 - ✓ Reducing CO₂ Slippage
 - ✓ Higher Capacity
 - ✓ Equipment adequacy & sizing

End Users

Nutrien, CNC, N2000, LSB

CFI & YARA (for various site locations)



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Kinetics Process Improvements, Inc.

Independent Consultants & Engineers Serving to Improve, Decarbonize & De-bottleneck

- Ammonia Plants
- Methanol Plants
- Ethylene Plants
- PDH Plants

(Integration with gH2) (Oxygen Enrichment) (Electrification) (New Tech evaluations)

(Green-Blue Ammonia & Methanol Plant Studies)

Decarbonization Solutions





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