



Kinetics Process Improvements, Inc.

KPI SERVICE PROFILE AMMONIA & METHANOL PLANTS

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KPI, Inc.

16000, Park Ten Pl.,
Suite#903
Houston, TX-77084
USA

Phone: (281) 773-1629
Fax: (832) 565-9360
Email: process@kpieng.com



Attachments

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ATTACHMENT-I
KPI Services

KPI is an independent consulting and engineering group based in Houston since 2006 with an expertise in Ammonia, Methanol & light olefins-based Petrochemicals facilities.

Our key services include:

- I. **Supporting new project development** with project feasibility, Technology sourcing/evaluation, Project risk assessment, review of Licensing/BEP/Off-take Agreements, Initial cost estimates, and economics, developing project scope definition for Licensors, EPC and also support during the project execution phase with critical reviews as “**Owner’s Engineers**”. Successfully performed ‘Owner’s Engineers’ role for more than six projects.
- II. **Supporting existing** facilities with cost effective and practical solutions to troubleshoot & improve the capacity, efficiency, reliability, and Carbon footprint using our independent analysis & tools. Many successful operating references with over 150 revamps studies and upgrades completed globally.
- III. **Providing comprehensive and custom training-** Ammonia, Methanol & Ethylene plants. Completed custom training for more than 600 candidates for major producers.

In the past 16 years, KPI has completed over 150 different projects globally with Ammonia and Methanol producers and project developers. The Ammonia producers included CFI, Yara, Nutrien, OCI, Dyno Nobel, SABIC, LSB, Incitec, Caribbean Nitrogen, N2000, AUM, PLNL, etc. The Methanol related producers included Methanex, Celanese, Methanol Holdings, SABIC, AMPCO, Chemanol & Syngas Energy etc.

Our **experience in Ammonia and Methanol** spans in Technology, design/engineering/operations, Critical design reviews, Risk assessment, Techno-Economic project analysis, Feasibility studies, Troubleshooting, reducing Carbon foot print, Reliability improvements & Training from small to mega plants with all the latest configurations all major licensors including KBR, Uhde/TK, Topsoe, Casale, Linde for Ammonia and Air-liquide/Lurgi, Topsoe, JM for Methanol. ***[We carried out over a dozen studies for production of Blue, Green Ammonia including their integration with existing plants to reduce CO2 footprint with and without incremental production. In addition to this, we also carried out several engineering & economic studies for the CO2 capture (from flue gas & process) with supercritical Compression for sequestration]***

We conducted customized training (~700 candidates) for all major Ammonia & Methanol producers.

We have the proven design and economic-analysis tools to carry out an independent and critical project, design and risks reviews. Our design tools include Process Simulation modeling, Reactor kinetic models, Equipment Sizing/rating, Cost Estimation, Economic modeling for project IRR/Cash-flow analysis etc.



ATTACHMENT-II

Specific Experience in Ammonia Plants

- **Revamp study from 2425 to 3000 & 3100 stpd** including Cost estimate with preliminary engg. (Uhde/TK)
 - **Revamp study from 1750 to 1950 stpd** with cost estimate (KBR) successfully implemented in parts
 - **Revamp study from 1100 to 1550 stpd** – (KBR) successfully implemented
- Most of the Revamp Studies also included Budgetary Cost Estimates in KPI's scope*
- Revamp Study **to integrate gH₂ & gO₂** with incremental capacity increase in existing 1800 stpd Ammonia Plant (KBR)
 - Revamp Study **to integrate gH₂ & gO₂** with incremental capacity increase in existing 2425 stpd Ammonia Plant (KBR)
 - Revamp Study **to convert two existing Ammonia Plants to gNH₃ using gH₂ & replacing with Electric drivers (1650 mtpd)-** (KBR & Topsoe)
 - Comprehensive design review of a new Ammonia Synloop & its offsites using pure H₂ & N₂ for 1630 mtpd Ammonia plant (Casale)
 - Process evaluation of KAAP converter performance to maximize/optimize Ammonia production (KBR)
 - Techno-Economic study of Green Ammonia for US location- including Electrolyzer for H₂ (1000 mtpd x 3 & 3000 mtpd)
 - Techno-Economic Study of Green Ammonia for Saudi location- using Electrolyzed H₂ & Pipeline Cryo-Nitrogen (400 mtpd & 700 mtpd)

 - Design Review of new **Ammonia plant using Petcoke + Bio-Feed** with a net zero CO₂ emissions (Casale Synloop)
 - Design Review for **conversion of existing Ammonia plant feed from gas to coal**

 - Revamp study- **aMDEA CO₂-R** system to reduce CO₂ slip from 3000 to <300 ppmv (single stg- KBR/BASF- 1200 stpd Ammonia) (Successfully implemented with less than 100 ppmv CO₂ slippage for 1200 tpd plant)
 - Revamp study- **aMDEA CO₂-R** system (2800 stpd to 3000 tpd, two-stage with re-absorber) (Uhde/TK & BASF)
 - Revamp study- **aMDEA CO₂-R** system to reduce high CO₂ slip (2500 tpd, two-stage system) (KBR/BASF)
 - Revamp study- **aMDEA CO₂-R** system (1750 tpd to 1950 tpd, single-stage with LP flash) successfully implemented
 - Conversion study- **MEA to aMDEA CO₂-R** system (500 tpd, single-stage) successfully implemented
 - Process study & basic engineering for the conversion of an existing single-stage **aMDEA CO₂-R** system to two-stage design (KBR/BASF)
 - Revamp study, design, engineering & supply to troubleshoot **Benfield CO₂-R** system in two different 2100 stpd plants (Big success at a fractional cost compared to the Licensor's option) (KBR/UOP)
 - Revamp Study and PDP of **Benfield CO₂-R** system (2100 mtpd Ammonia)- successfully implemented & presented (Uhde/TK & UOP)

 - Revamp study of Reformer to replace **Convection section** -process & thermal design with new specs 1200 stpd Ammonia plant (KBR)
 - Revamp study of Reformer **Radiant Re-harping**- provided new radiant coil design & preliminary specs with capacity upgrade (KBR)
 - Revamp study of Reformer **Convection section** for TMT and metallurgy upgrades with cost estimate (Uhde/TK) 2425 stpd Ammonia plant
 - Revamp study of Reformer **Radiant & Convection sections** for capacity upgrade with cost estimate (KBR) 1800 stpd Ammonia plant
 - Engineering Study + cost estimate to reduce firing and CO₂ emissions in Primary Reformer using an **electric pre-reformer (Topsoe)**
 - Engineering Study + cost estimate to reduce firing and CO₂ emissions in Primary Reformer **by re-purposing convection coils (Topsoe)**
 - Revamp study of Reforming section with addition of integrated suction chiller for 4 Ammonia plants (3 KBR, 1 Uhde/TK)

 - Revamp of Molecular Sieve systems in two plants to increase the life of Mol. Sieve – 2 yrs to 7+ years (KBR) 1800 stpd- successfully implemented

 - Detailed Evaluation of Technology for licensor selection from 4 Licensors for Saudi location (Uhde/Topsoe/KBR/Linde) [as 'Owner's Engineer']
 - Performance Audit Study with improvements for 1750 stpd Ammonia plant (KBR design)
 - Performance Audit Study with improvements for 1800 stpd Ammonia plant (KBR design)
 - Performance Audit Study with improvements for 1850 stpd Ammonia plant (KBR design)
 - Performance Audit Study with improvements for 2750 stpd Ammonia plant (KBR design)
 - Performance Audit Study with improvements of 2800 stpd Ammonia plant (Uhde/TK design)

 - Engineering study to produce Ammonia using off-gases from Methanol/CO plant with cost estimates (Topsoe)
 - Engineering study to produce Ammonia using off-gases from Methanol plant with cost estimates (JM)
 - Engineering study to produce Ammonia using off-gases from Ethane Cracker with cost estimates (Lummus)
 - Engineering study to produce Ammonia using off-gases from PDH with cost estimates (Lummus)

 - Engineering Study + Cost Estimate for **CO₂ (Compression & Dehydration)** for four different NH₃ plants
 - Engineering Study + Cost Estimate for **CO₂ (Compression + Dehydration)** system (3000 tpd CO₂ x 2 trains)
 - Engineering Study + Cost Estimate for **CO₂ (Compression + Dehydration)** system (3900 tpd CO₂)
 - Engineering Study- **400 & 1200 stpd CO₂ capture from Reformer Flue gas** with Cost estimate
- [as 'Owner's Engineer']
- Provided 3 days of customized 'Ammonia plant training' for >650 'Process and Plant Engineers/Operations' since 2006
 - Three Patents for Ammonia Process Improvements & decarb (assigned in Sept 2017, 2019, and 2021) + one pending



ATTACHMENT-III

Specific Experience in Methanol Plants

- Owner's Consultant for 5400 tpd Methanol, CO and Acetic Acid Plants - Saudi Arabia
- Revamp study to expand Methanol capacity using CO₂ injection- 2300 tpd to 2750 tpd- Saudi Arabia
- Implementation with performance review of Methanol upgrade (2300 to 2750 stpd)- Saudi Arabia
- Revamp study of 2500 tpd to 3000 tpd Methanol plant-Chile
- Revamp study 1200 to 1550 tpd Methanol plant using CO₂ injection-USA
- Led Design & Engineering of 800 tpd Ammonia converted to 1900 tpd Ammonia plant- USA
- Design rating of an Old Methanol plant relocation for new conditions & a new Reformer (USA)
- Revamp study of Methanol Reformer for Reliability & capacity upgrade (USA, Trinidad, Saudi)
- Revamp study of Methanol Reformer for feedstock conversion- Natural gas to LPG (Saudi)
- Revamp study of Methanol plant to co-produce Ammonia (Saudi, USA)
- Independent evaluation of Methanol Technologies of Licensors for a new project in Saudi location
- Small Methanol plant design development (300 tpd) with cost estimates- USA
- Audit Study with improvements in reliability and efficiency of 1500 stpd Methanol plant-USA
- Revamp study to upgrade the Methanol loop with new Steam raising converters
- Revamp study to upgrade the Methanol purification system to minimize effluent streams (USA)
- Study to produce Ammonia using off-gases from 700 tpd Methanol plant & its upgrade (Saudi)
- Engineering studies for conversion of 5 different Ammonia Plants to Methanol plants- USA
- Feasibility study of 5000 tpd Methanol plant with Acetic Acid & other derivatives- Trinidad
- Feasibility study of 5400 tpd Methanol plant- USA
- Design review of a Coal to Ammonia/Methanol study- USA
- **Pre-feasibility with process modeling of 500 mtpd green Methanol Synloop using gH₂ & CO₂ - USA**
- Sourcing & Evaluation of Methanol Rector system from China (for a US project)
- Methanol & Ammonia plant training (customized) for more than 600 Process/Operations Engineers (*Small to World-scale plants including ATR*) (USA, Saudi Arabia, Trinidad, Equatorial Guinea)



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ATTACHMENT- IV

Specific Experience as “Owner’s Engineers”/Project Feasibility- Petrochemicals, Ammonia & Methanol Plants- with Green & Blue options to Decarbonize

KPI team worked as “Owner’s Engineers” for several projects (*refer a partial list below*) and carried out a number of pre-feasibility studies of several Petrochemicals and Syngas derivatives projects (including Green & Blue Ammonia, CO₂ Capture-Compression & Dehydration) in the US, Saudi Arabia, Trinidad, & India. Our services included:

- *Early Project definition and facilitation with various licensors*
- *Analysis and Feasibility for optimum Products & Project configuration*
- *Techno-Economic Evaluation, Due diligence with Risk Assessment/mitigation*
- *Sourcing, Evaluating & Negotiating the Specialty Technology & Other Licenses*
- *Initial Capital Cost estimates*
- *Project Rate of Return Analysis using our in-house Economic models*
- *Project Scoping Definition*
- *RFQ & ITB review/recommendations of Licensors/E&Cs*
- *Facilitating technology partners & review of project Partnership arrangements*

A partial list of projects and handled are listed below:

- ✓ **From 2006 to 2010, KPI played a key role (as Owner’s Engineers) in developing a world scale Acrylic Acid/Esters project (~ 1.7 billion USD) for a Saudi company (D7 Petrochem).** KPI’s scope included sourcing, evaluating technologies, due diligence/risk assessment followed by review & negotiation of all the six license/BEP agreements (*with Dow, Topsoe & Huiyui*) as well as review of Feedstock agreements (*with ARAMCO/ SATORP, SABIC & others*) including preparation of site allocation package with plot plan & environmental items for *Royal Commission*. Initial Project capital cost estimate with project returns for SIDF & other potential lenders. In the next phase, our scope included to lead all the six Basic design packages, followed by Basic design package of Propylene export terminal near Jubail (Saudi Arabia)
- ✓ Owner’s Engineers for a new Ammonia Plant of 400/700 MTPD using off-gases from Methanol/ CO plants (Saudi Arabia)
- ✓ Methanol derivatives project feasibility for Methanol producer in Trinidad- including Acet Acid, POM, DMF, Mixed Amines
- ✓ Various Petrochemicals feasibilities for Advance Petrochemicals Co- Saudi Arabia
- ✓ Acrylic Acid & Oxo project feasibility- India
- ✓ Carbon black, DMDS & LABSA feasibilities Advance Petrochemicals, Saudi Arabia
- ✓ Propane Dehydrogenation (PDH) project feasibility & design reviews- Saudi Arabia
- ✓ C3 derivatives project feasibility for Chemanol, Saudi + JV partner facilitation
- ✓ Feasibility of Natural Gas-Syngas to Ethanol for Saudi location
- ✓ Consultant for new PDH project- 650 KTA Propylene capacity (Saudi Arabia)
- ✓ Owner’s consultant to upgrade Old Methanol plant along with a new Reformer & purification section (USA)
- ✓ Pre-feasibility of Ethanol plant & derivatives via reforming of Natural gas (Saudi Arabia)
- ✓ Pre-feasibility of Ethylene Oxide & specialty derivatives (Saudi Arabia)

GREEN AMMONIA

- ✓ **Green Ammonia feasibility with Cost estimates for Chemanol (400/700 mtpd)-Saudi**
- ✓ **Green Ammonia pre-feasibility-1000 mtpd (USA)**
- ✓ **Green Ammonia pre-feasibility-3000 mtpd (USA)**

BLUE AMMONIA

- ✓ Engineering Study-CO₂ capture from Reformer Flue gas + Clean-up & Compression (with Cost estimate)- USGC location
- ✓ Engineering Study to integrate Green Electrolysis H₂ in Ammonia Plant (1800 STPD)- USA
- ✓ Engineering Study + Cost Estimate for CO₂ Compression & Dehydration & CWT system (3000 tpd CO₂ x 2 trains)- USA
- ✓ Procurement quality specs for CO₂ Compressors, motors & LO/SO system for a CCS project (3000 tpd CO₂)- USA
- ✓ Engineering Study + Cost Estimate for CO₂ (Compression & Dehydration) system (2200 tpd CO₂)- USA



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ATTACHMENT-V KPI Team & Resources

Our team includes several Process experts having worked with different Ammonia process & other leading licensors.

V.K Arora, PE (Director- Process Technology & Project Management)

US citizen & registered Chemical Engineer in the State of Texas. Over 35 years of diversified hands-on experience in Licensing/technology, improvements, management, development of Ammonia, Methanol & Petrochemicals Projects including many studies. Experience in Plant Design/Simulation, Critical Equipment design, Basic & Detailed Engineering, Troubleshooting, Startup and Supervision with Licensors, E&Cs and Operating Companies (KBR, SABIC, Shell, CBI Lummus).

Carried out more than 100 revamp studies, basic engineering in Ammonia & Methanol plants. Also experienced in various specialized equipment including process/thermal design, troubleshooting & operation of Steam Reformers, Cracking heaters and Refinery/Petrochemical Fired Heaters.

Published & presented more than two dozen Technical Papers including a chapter in McGraw-Hill Handbook on Petrochemicals in 2004. Three patents on Ammonia Process improvements and a patent for NOx removal reactor

R Lin, PE (Principal Process Consultant- Ammonia Technology)

US citizen with MS Degree in Chemical Engineering. Over 35 years of experience in Ammonia Technology improvements, Design, Engineering and troubleshooting. Worked with KBR Ammonia process & technology for over twenty-two years

J Larsen, PE (Principal Process Consultant- Ammonia Technology)

US citizen with MS Degree in Chemical Engineering. Over 35 years of experience in Ammonia Technology improvements, Design, Engineering and troubleshooting. Worked with KBR, Uhde/TKIS, Haldor Topsoe in the Ammonia technology group for over thirty years.

J Eduardo (Principal Systems Engineer)

Degree in Chemical Engineering with over 14 years' experience in the process and systems engineering field with KBR. Experienced with a wide variety of Ammonia, Urea, refining, petrochemical, coal gasification, and gas processing projects including offsite and utility systems. Scope of work of these projects ranged from conceptual studies to complete EPC

James Lee (Expert Consultant- Ammonia, Urea & Melamine)

US citizen with MS Degree in Chemical Engineering Over 40 years of process design, development, engineering and troubleshooting experience in the fertilizers and synthesis gas-related chemicals including Ammonia, Urea & Melamine plants. More than 17 years of experience with Ammonia, Methanol & Urea plant process & Technology group of KBR as Process Manager - including the startup of many world-scale KBR Ammonia plants & Urea plants. Nearly 20 years of experience in the Melamine Process development & plant operations. Holder of six patents in the improvements relating to Ammonia, Urea & Melamine Processes.



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John Brewer, PE (*Principal Consultant- Reformers, Petchem Furnaces- Technology & Designs*)

US citizen and former Chief Engineer for Stone & Webster's Furnace and Fired Heater division with more than 35 years' experience. He studied Chemical Engineering at the University of Birmingham and holds a number of patents relating to Cracking Furnaces

J. Foglieta, PE (*Process Consultant- AG removal, Gas processing, LNG & Refining*)

*Professional Licensed Chemical Engineer of 40 years' experience in process technology and project engineering for the hydrocarbon processing industries. Specific experience includes Acid gas removal, gas processing, petroleum refining, and LNG. Responsibilities included technology development, process design, and evaluation of facilities, sizing, and selection of process equipment, safety analysis, construction, start-ups, and operations troubleshooting. **Gas processing** experience includes the design, engineering, and startup of several major NGL Turbo expander units, nitrogen rejection plants, gas conditioning units, NGL fractionation, development of LNG technology, sulfur recovery and refinery fuel gas liquids recovery units. Co-chair of facilities design forum of GPA. More than a dozen patents including Turbo expander plant improvements*

R. Tiwari, PE (*Consultant-Mechanical Design/Engineering*)

US citizen with a Master's degree in Mechanical Engineering with 30 years' experience in the Mechanical Design & Engineering of major Petrochemicals & Refineries equipment. Specializes in Fitness for service evaluation, Finite Element analysis, critical high-temperature pipe stress analysis, Root cause analysis & Structural analysis

V Patel (*Compressors, Pumps- Rotating Equipment*)

US citizen with a degree in Mechanical Engineering with 40 years' experience in the design & troubleshooting and implementation of large compressors, pumps for the major Chemicals, Petrochemicals & Refineries. Worked with various EPC companies including KBR & Technip

Luis Torres (*Consultant- Equipment and Piping Layout*)

US citizen with a degree in Mechanical Engineering with 35 years' experience in the Piping & Equipment layout in major Petrochemicals & Refineries.

I. Marin (*Consultant- Civil & Structure*)

US citizen with a Master's degree in Mechanical Engineering with 20 years' experience in the Mechanical Design & Engineering of major Petrochemicals & Refineries equipment. Specializes in Civil & Structural analysis

S. Mahajan, PE (*Instrumentation & Controls Engineer*)

Degree in Electrical Engineering with experience of 30 years. Worked with Flour, Lummus & Technip in Houston.

Mike Monteith, PE (*Consulting Engineer-Certified Cost Estimator*)

US citizen with a degree in Mechanical Engineering and Certified Cost Estimator using Aspen K base. Total experience of 25 years including 8 years as a Cost estimator with Flour, Houston.



Kinetics Process Improvements, Inc.

ATTACHMENT-VI

Process Design, Modeling, Sizing & Engineering Tools

- **Process**

Our Process & Kinetic models are well tested & proven with actual performance in many Ammonia & Methanol plants

- Proven and tested Simulation models for Ammonia & Methanol plants:
 - **Complete Ammonia, Methanol Plants** of all configurations including ATR (**PROII, DESIGN II, VMG**)
 - Kinetic model for Ammonia & Methanol converter performance & catalyst estimates (**MATLAB- In-house**)
 - Rate based model for CO₂ removal systems (**Protreat** for **aMDEA, Benfield** & related solvent combinations)
 - Steam Reforming model- thermal rating and sizing (**PFR-** commercial software)
 - Glycol based dehydration system (**Protreat & VMG**)
- Rigorous **Steam System model** with built-in steam properties & macro driven modules for steam turbines, WHB etc.
- Rigorous **NH₃ Refrigeration System model** with built-in Ammonia properties & macro driven modules of Compressor/Flashes
- Rigorous **Molecular-Sieve System model** for 13X & 4A Mol Sieves-with built-in properties & macros
- Sizing & Rating of Heat Exchangers/Air-Coolers (HTFS, HTRI)
- Combustion & Efficiency estimate of Reformers & Fired Heaters (in-house)
- Ethane & Propane Refrigeration System with built-in properties & macro driven modules of Compressor/Flashes
- Estimation of Steam rates for Steam Turbines (in-house)
- Rating of Cooling Tower (in-house & CTI)
- Sizing of Packed and Trayed Columns (Simulators & of different vendors)
- The pressure drops across the Catalyst beds (in-house)
- Hydraulics of Pump/piping loops and power estimate (in-house)
- Piping network Hydraulic model (KORF, in-house)
- Flare system modeling
- Relief System design per API codes
- Control valve, Orifice & RV sizing (in-house, vendor)
- Rating of Centrifugal/Recip/Screw Compressors (in-house & of vendors)
- Sizing and rating of Two & Three phase Separators (in-house)
- Plus, many more in-house Process and Engineering design programs

- **Project Economics & Cost Estimate**

- Rigorous Project Economic Model for NPV & IRR estimate (in-house)
- Aspen K-Base for Cost Estimation (and in-house cost database)

- **Mechanical**

- AutoCAD & 3D Navisworks
- CADWorx for Plant 3D modeling
- Ceaser II for Piping Stress Analysis
- STADD for Steel Structure
- PV Elite, Code ware & COMPRESS for Static Equipment design



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ATTACHMENT-VII

KPI References (partial)

Clients Served:

- ABB Lummus Global, USA
- American Acryls, USA
- BP Gas Company, Trinidad
- Dammam 7 Petrochemicals, Saudi Arabia
- Injaz Petrochemicals, Saudi Arabia
- Hovensa Refinery, USA
- **Ar-razi/SABIC, Saudi Arabia**
- **Saudi Methanol, Saudi Arabia**
- Tasnee Petrochemicals, Saudi Arabia
- Larsen & Tuboro, India
- Medra Arabia, Saudi Arabia
- SNC-LAVALIN, Canada
- **Caribbean Nitrogen Company, Trinidad**
- **Proman, Trinidad**
- CB&I, USA
- Koppers, Inc., USA
- Advance Petrochemical Co, Saudi Arabia
- **CF Industries, Donaldsonville/Port Neal/Yazoo, USA**
- Methanol Holdings Company, Trinidad
- Ejmali Petrochemicals, Saudi Arabia
- **Nutrien, Trinidad**
- **Methanex, Trinidad**
- Lummus, Saudi Arabia
- Ibn Rushd/SABIC, Saudi Arabia
- Ibn-Zahr/SABIC, Saudi Arabia
- **Al-Bayrouni/SABIC, Saudi Arabia**
- OCI, Netherland
- **PLNL, Trinidad**
- Modi group, India
- **Chemanol, Saudi Arabia**
- **N2000, Trinidad**
- Mustang Engineering, USA
- **YPFB Fertilizers, Bolivia**
- **QAFCO, Qatar**
- Saudi Chevron, Saudi Arabia
- Phoenix Park Gas Processing, Trinidad
- **Syngas Corporation, USA**
- Ascend Performance Materials, USA
- Texas Petrochemicals, USA
- **Mosaic Company, USA**
- **Advansix/Honeywell, USA**
- **Celanese, USA**
- BASF, USA
- Dow Chemicals, USA
- **Yara, Australia**
- **Yara, Canada**
- **LSB Industries, USA**
- **Dyno Noble, USA**
- **IFCO/OCI, USA**
- **Natgasoline- Proman/OCI, USA**
- **AMPCO Methanol, Equatorial Guinea**
- Medra Arabia, Saudi Arabia
- **Eolic Green Ammonia, USA**

Jobs Completed:

- Lead role in the project development of Acrylic Acid/Esters including Butanol/Syngas & Utilities including technology sourcing, selection, risk assessment and negotiation of all three licensed Technology & Basic Engineering agreements (Saudi Arabia)
- Supervision, Improvements, and Management of Basic Engg for Acrylic acid/Esters including Butanols & Syngas (Saudi Arabia)
- Techno-Economic Evaluation of several Petrochemicals Projects- including Acrylic Acid/Esters, Acrylonitrile, PDH, Syngas for Oxo-alcohols, Carbon Black, Integrated Refinery & Petrochemicals (Saudi Arabia)
- Due diligence for a potential acquisition of LNG, NGL plant Licensor (USA)
- Review of Propylene Feedstock & Product off-take agreements (Saudi Arabia)
- Refinery Crude Fractionation Revamp & Energy Improvement study (USA)
- Refinery Delayed Coker gas plant Revamp study (USA)
- Process Design of a Gas Condensate Stabilizer (Aruba)
- Energy Improvement Study for a Thermal Oxidizer for Acrylic Acid plant (USA)
- Hydrogen plant simulation to support dynamic simulator for training (USA)
- Owner's Consultant for 5000 mtpd Methanol Plant +CO (ATR based) Saudi Arabia)
- PMC for a large Nitrogen generation system design and execution (Saudi Arabia)
- Feasibility study including a design review of a Coal to Ammonia/Methanol project (USA)
- Study for the conversion of an Ammonia plant feed from gas to coal (USA)
- Basic Engg to revamp single stage CO2 removal aMDEA system to two stages for an Ammonia plant (Simulated aMDEA)
- Ammonia plant training more than 500 plant Process/Operations Engineers (Trinidad, USA, Saudi)
- Methanol plant training for more than 150 plant Process/Operations Engineers (mid to Mega plants with ATR) (SA, USA, Trinidad)
- Nitric Acid Plant Training for over 30 Process/Operations Engineers (Trinidad)
- Urea Plant Training for 30 Process/Operations Engineers (Trinidad)
- Methanol Reformer training for SABIC Engineers- two weeks long covering all process/mechanical/inspection aspects (Saudi)
- Expert review of the Ammonia plant loop conversion from gas to coal feed (USA)
- Process development to produce Tar via thermal cracking of Pyrolysis Fuel Oil (USA)
- Study & Basic Engg for Methanol Plant Cooling water network to de-bottleneck production (Trinidad)
- Ammonia Plant troubleshooting study of Benfield Solution carry-over the problem to minimize production loss (Trinidad)
- Process & Startup advisory by KPI team of three Engineers for Metathesis & Polypropylene Plants start-up (Saudi Arabia)
- Consultant for the Propane Dehydrogenation Plant- 650 KTA Propylene capacity (Saudi Arabia)
- Engineering & Procurement of Column internals to troubleshoot Benfield system of two Ammonia Plants (2x2000 TPD, Trinidad)
- Propylene export & logistics (via port) expansion study including Marine loading with Cost estimate (Saudi Arabia)
- Due diligence study for a new acrylic acid & Ester's complex (India)
- Acrylic acid/Butanol plant Effluent treatment options study (Saudi Arabia)
- Pre-feasibility study of a new Oxo-Alcohol & Syngas plant with Capex & IRR sensitivity (India)
- Basic design package for Propylene transport, refrigeration, storage & export facility (Saudi Arabia)
- Tank farm basic design (Hydrocarbon and utilities storages) (Saudi Arabia)
- Review of design & operation of Molecular Sieve system to reduce pressure drop & improve sieve life
- Process design & costing of H2/CO plant using LPG feed as part of the Oxo-Alcohol unit (Saudi Arabia)
- Pre-feasibility study of Methanol Plant with Acetic Acid & other derivatives with Capex estimate (Trinidad)
- Customized Process Training of Melamine plant- for Process Engrs/Sr. Operating personnel (Eurotechnica Process)



Kinetics Process Improvements, Inc.

KPI References (partial) cont...

- Basic & Detail Engg with Supply of Internals of Molecular Sieve System for Two Ammonia Plants- 1750 TPD capacity (Trinidad)
- Process design improvement for SRU/TGTU- to meet emissions target (Bahrain)
- Feasibility Study for 5400 tpd Methanol plant (USA)
- Feasibility study for 5000 tpd Methanol with derivative plants (Trinidad)
- Basic Engg and FEED for 600 MMSCFD Gas Plant for high Ethane Recovery and Rejection (Trinidad)
- 600 MMSCFD Gas Plant for high Ethane Recovery and Rejection (Trinidad)
- Ammonia plant Seawater Cooling Tower and Cooling system revamp study & Engg study for higher capacity (Trinidad)
- License sourcing & Technology evaluation for a new Ammonia-Urea complex (Bolivia)
- Detail revamp study of two Ammonia Plants (1750 TPD)- to improve energy & capacity (Trinidad)
- Process study of Ammonia production using off-gases from Methanol & CO plants (Saudi Arabia & USA)
- Debottlenecking study of 600 MMSCFD Gas plant to significant improvement in C3 recovery (Trinidad)
- Owner's Engineers for a new Ammonia Plant of 400/700 MTPD using off-gases from Methanol & CO plants (Saudi Arabia)
- Independent design rating & review of an Old Methanol plant relocated to new conditions with a new Reformer (USA)
- Pre-feasibility of Ethanol plant & other derivatives via reforming route of Natural gas (Saudi Arabia)
- Pre-feasibility of Ethylene Oxide & specialty derivatives (Saudi Arabia)
- Basic & Detail Engineering- Gas plant revamp for additional C3 recovery (600 MMSCFD plant- Trinidad)
- Study & Basic Engg for Reformer Re-harpping to increase Ammonia production (USA)
- Troubleshooting & reliability improvements study for C4 Dehydrogenation facility (USA)
- Study & Basic Engineering for CO2 system (aMDEA) to reduce high CO2 slip in Ammonia Plant (USA)
- Troubleshooting and upgrading of an existing Scrubber system in Nitric Acid Plant for NOx abatement (USA)
- Design of a new Acid Scrubber system for high-efficiency NOx removal in Nitric Acid plant (USA)
- 600 MMSCFD Expander based gas plant upgrading study (Trinidad)
- Ammonia Plant Reformer Revamp with a new Convection Design Study (1200 stpd- Kellogg type Reformer) (USA)
- Ammonia Revamp study from 2800 stpd to 3100 stpd (USA)
- Ammonia Plant Revamp Engineering & Project Cost Estimate (3100 stpd) (USA)
- Ammonia Plant Cooling Water System upgrading study (USA)
- Two-stage aMDEA CO2 Removal System Revamp study with cost estimates (3000 stpd) (USA)
- Audit Study of 1750 stpd Ammonia Plant (KBR design) (USA)
- Audit Study of 1850 stpd Ammonia Plant (KBR design) (USA)
- Troubleshooting Two-stage aMDEA System to reduce CO2 slip from 3000 to <500 ppmv (2500 mtpd Ammonia plant- Nigeria)
- Revamp & upgrading of CO2 Compressors for Urea Plant from 4600 stpd to 6000 stpd along with Cost Estimate (USA)
- Rerating of an old Primary Reformer of an Ammonia Plant with CO2 addition (USA)
- Revamp Study of Benfield CO2 Removal System for 2100 MTPD Ammonia Plant (Canada)
- Engineering study of large products/utilities Tanks to replace fuel gas with an inert system to reduce CO2 emissions (Trinidad)
- Process Design Pkg of Revamped items following Benfield CO2 Removal System for 2100 MTPD Ammonia Plant (Canada)
- Design, Sizing & Cost estimate of a new Mixed Feed convection coil for 2520 stpd Ammonia Plant Reformer (USA)
- Engineering Study for CO2 capture from Reformer Flue gas + Clean-up & Compression to 2000 psi (USA)
- Engineering study of gH2 addition to 2200 mtpd Ammonia plant (USA)
- Engineering Study to integrate Green Electrolysis H2 in Ammonia Plant (1775 STPD)- USA
- Engineering Study + Cost Estimate for CO2 (Compression & Dehydration) system (3000 tpd CO2 x 2 trains)-USA
- Engineering Study with modeling to change MEA to aMDEA for CO2 removal system of Ammonia Plant- USA
- Review of all major Purchase packages for CCS project (3000 tpd CO2)-USA
- Engineering Study to reduce CO2 emissions in Primary Reformer with an electric pre-reformer and patented schemes- Nigeria
- Audit and revamp study for 2800 stpd to 3100 tpd Ammonia plant (USA)
- Pre-FEED study for CO2 Compression and dehydration (3900 stpd CO2) from an Ammonia plant (USA)
- Upgrading of aMDEA CO2 removal system for 1000 tpd Ammonia Plant (USA)
- Independent Process/Engg design review of new Ammonia Synloop with external pure H2 & ASU N2- 1630 mtpd (USA)
- Engineering study of gH2 & gO2 in 1800 stpd Ammonia plant for incremental capacity (USA)
- Engineering study of gH2 in 2800 stpd Ammonia plant for incremental capacity and reduced CO2 footprint (Nigeria)
- Troubleshooting study with modeling of Ammonia Synloop with new converter to resolve higher temperature issues (USA)
- Engineering Study to convert two large Ammonia plants to green using gH2 and replacing steam to motor drives (Netherlands)
- Engineering study of gH2 & gO2 in 2425 stpd Ammonia plant for incremental capacity (USA)

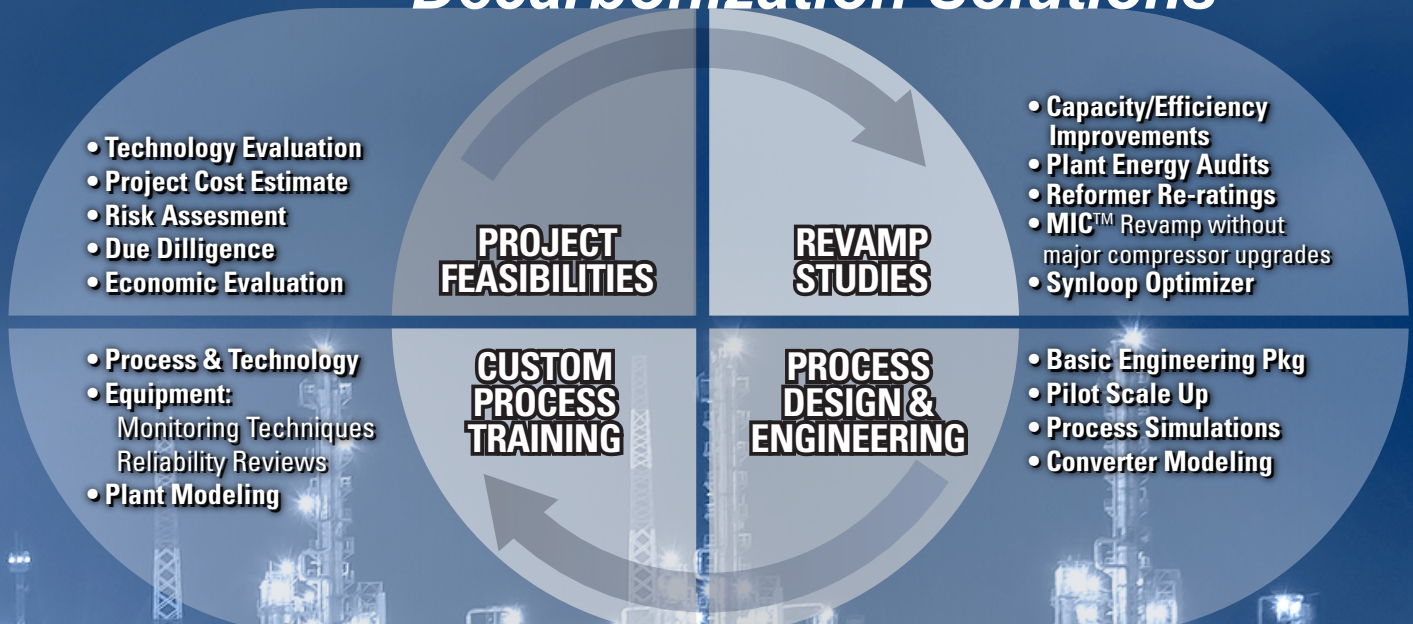


Kinetics Process Improvements, Inc.

Independent Consultants & Engineers

Serving to Improve, Decarbonize & De-bottleneck

- **Ammonia Plants** (Integration with gH2L...)
- **Methanol Plants** (Electrification & Replacement with Electric Drivers)
- **Primary Reformers** (Tech-Evaluations)
- **CO2 Removal Systems** (Green-Blue Ammonia & Methanol Plant Studies)
- **Decarbonization Solutions**

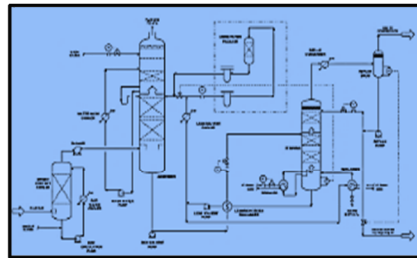


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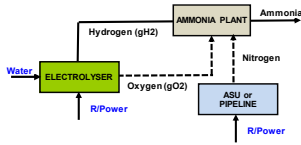
16000, ParkTen Place, Suite#903, Houston, TX- 77084 (USA)

Phone: 281-773-1629 • Fax: 832-565-9360

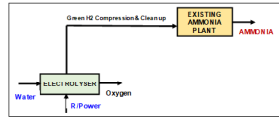
E-mail: process@kpieng.com • Web: www.kpieng.com



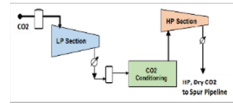
GREEN AMMONIA PLANT STUDIES



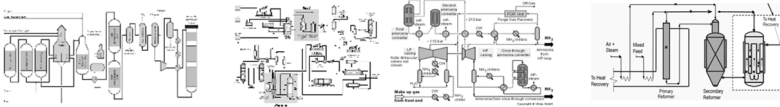
INTEGRATION STUDIES- gH2 & gO2



CO2 COMPRESSION & DEHYDRATION



TECHNOLOGY EVALUATION-RISK ASSESSMENT-MITIGATION



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*

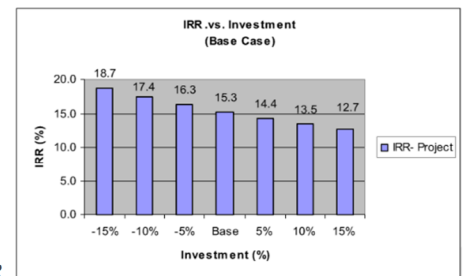
OWNER'S ENGINEERS FOR EVALUATING & EXECUTING DECARBONIZATION SOLUTIONS-STUDIES

SINCE 2005

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 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
- O2 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

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 Tech 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

Resources

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

KPI Consulting

16000 Park Ten Pl., Suite#903

Houston- 77084 (USA)

Phone: 281 773 1629

Fax: 832 565 9360

Email: info@kpieng.com

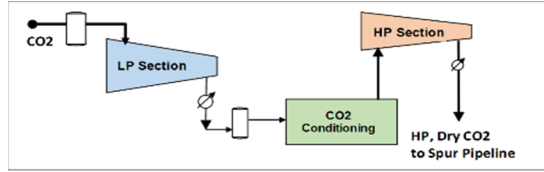
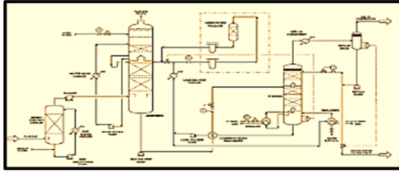
Web: kpieng.com, kpieng.net



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

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

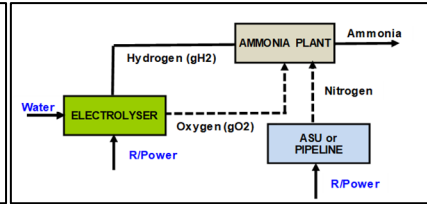
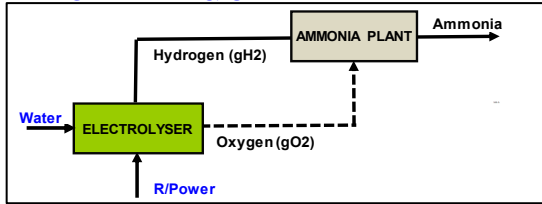
CO₂ CAPTURE, DEHYDRATION & COMPRESSION STUDIES



INTEGRATION STUDIES

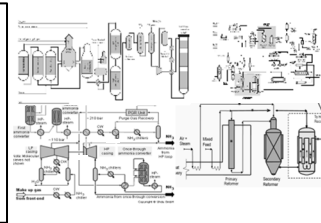
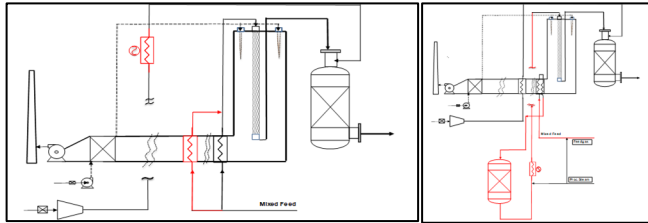
GREEN AMMONIA PLANT STUDIES

GREEN H₂ & O₂ ENRICHMENT



STUDY TO RECONFIGURE & ELECTRIFY FOR REDUCED FIRING

ATR & CO₂ REDUCTION TECHNOLOGY EVALUATION



COMPLETED A DOZEN DECARBONIZATION & CCS ENGINEERING STUDIES WITH COST ESTIMATES

Decarbonization Pathways & Solutions

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
- 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
- O₂ Enrichment Studies

End Users Served

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

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 Evaluations
Plant Impact & Engg Studies
Risk Assessment
Cost Estimates*

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Kinetics Process Improvements

16000 Park Ten Pl.,
Suite#903

Houston- 77084 (USA)

Phone: 281 773 1629

Fax: 832 565 9360

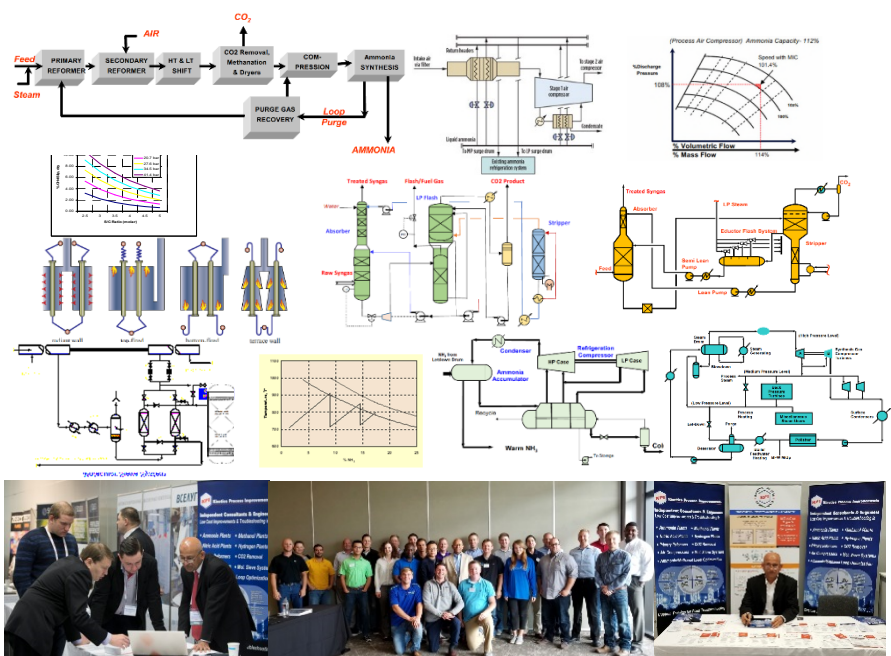
Email: process@kpieng.com

Web: kpieng.com, kpieng.net



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

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



Ammonia Plants Audits, Revamps & Decarbonization Solutions & 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 | Decarb

by Kinetics Process Improvements, Houston

KPI-Houston is an independent Process Design & Engineering Consulting group specializing in Ammonia & Methanol Plants Audits, Revamps, and Decarbonization solutions to improve Capacity, Efficiency, Reliability & reduce CO2 footprint

Objectives & Key Benefits

- To improve Capacity, Efficiency, Reliability & CO2 Footprint
- 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
- **Green/Blue Ammonia development**
- Reformer Re-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

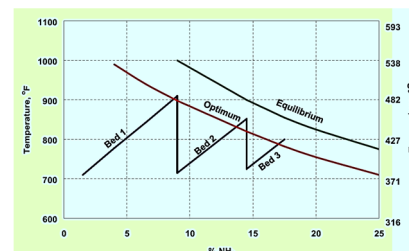
Client References

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

*Integrated Chiller™ Patent granted
Pending Patent for Electric Pre-Reforming*

Ammonia Plant Services

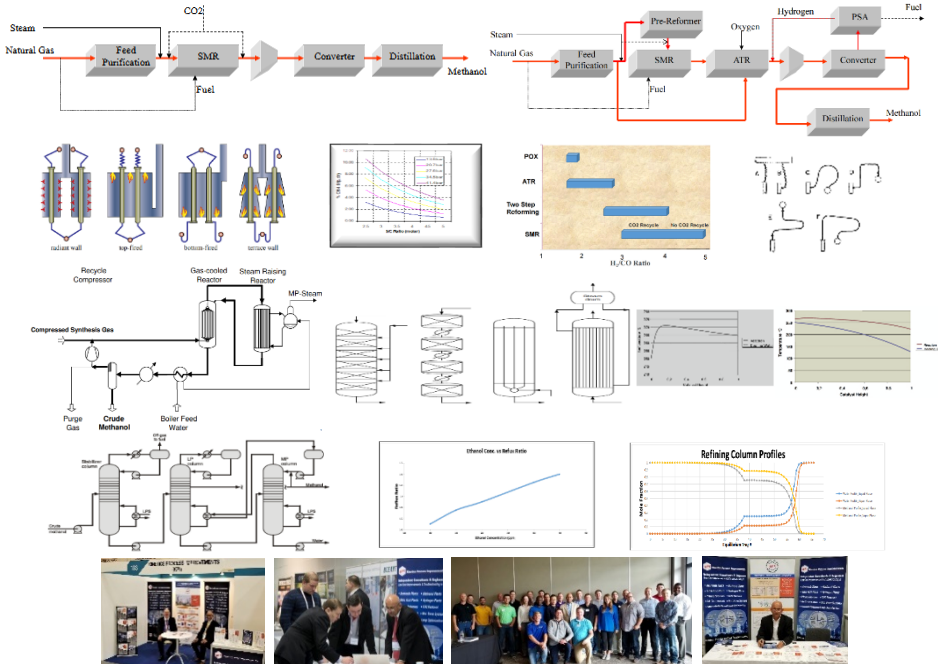
- Plant Performance Audits
- Plant De-Bottlenecking
- **Green H2 integration Studies**
- **O2 Enrichment Studies**
- **ATR based Ammonia Study**
- Revamp for higher Capacity
- Revamp for improved Efficiency
- Basic Engineering of Revamp
- Rerating Primary Reformer
- Reformer Re-harping studies
- CO2 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 Capture & Compression**
- Value Engineering
- 3rd Party Design Reviews
- Critical Equipment Reviews
- **Green/Blue Ammonia Feasibility**
- Project Feasibility
- Technology/Project Evaluation
- Risk Assessment



Kinetics Process Improvements

16000 Park Ten Pl., Suite#903
Houston- 77084 (USA)
Phone: 281 773 1629
Fax: 832 565 9360
Email: process@kpieng.com
Web: kpieng.com, kpieng.net





Methanol Plants Audits, Revamps & Decarbonization Solutions & Services

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

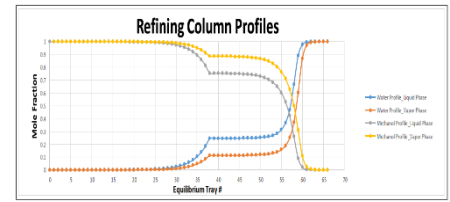
STUDIED METHANOL PLANTS FROM 300 TPD TO 5400 TPD. COMPLETED OVER 100 REVAMP STUDIES

SINCE 2005

Methanol Plants: Audits | Revamps | Decarb

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
- **Decarbonization Solutions**
- Rigorous modeling of Reformers
- Re-rating Compressors
- Modeling Methanol Reactors
- Rating & Optimizing Synloop
- Methanol Distillation modeling
- Basic Design Package
- Equipment sizing tools
- Experienced Team

Client References

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

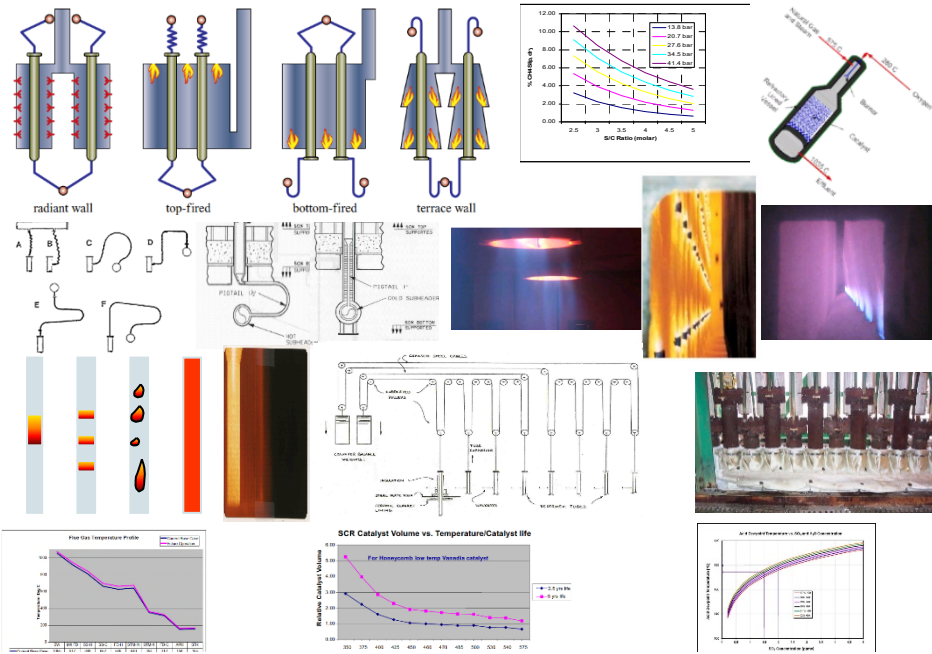
Methanol Plant Services

- Revamp for higher capacity & η
- Revamp for improved Reliability
- **Upgrade to reduce CO2 footprint**
- **CO2 injection for higher capacity**
- **Co-production 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

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 Houston- 77084 (USA)
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Reformers Revamping & Troubleshooting Services

for
**Ammonia
Methanol
Hydrogen
Oxo-Syngas Plants**

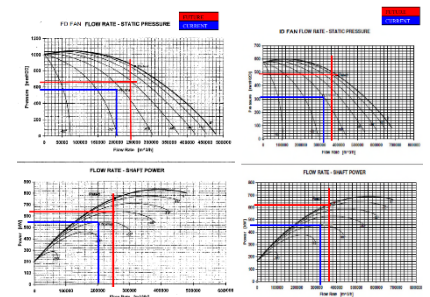
HOLISTIC APPROACH TO INCREASE REFORMING CAPACITY. OVER 60 REVAMP STUDIES COMPLETED

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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 & CO₂ 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, OCI, CHEMANOL, METHANEX, METHANOL HOLDINGS, SYNGAS Energy, CSBP

* Two Patents granted and one pending to reduce firing & CO₂ footprint in Ammonia & Methanol plant Reformers

Reformer Revamp Services

- Reforming System upgrades
- Radiant Section & Coil Re-rating
- Reformer Re-harping Studies
- Convection Re-rating Studies
- Convection section upgrades
- SCR configuration studies
- Reliability Review all systems
- Basic design & API datasheets
- Customized Training

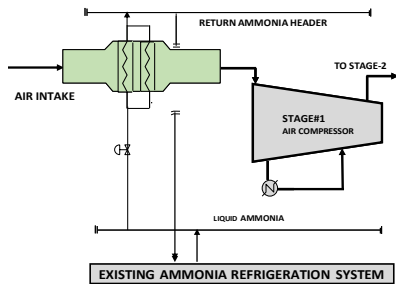
Reformer Troubleshooting

- 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

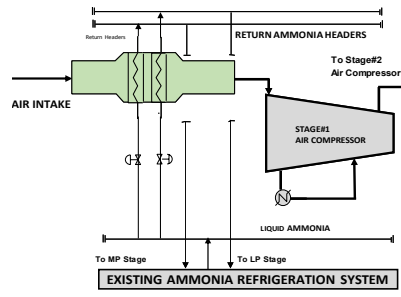
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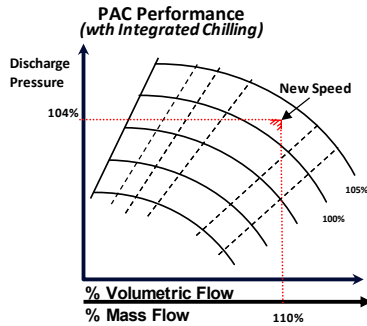
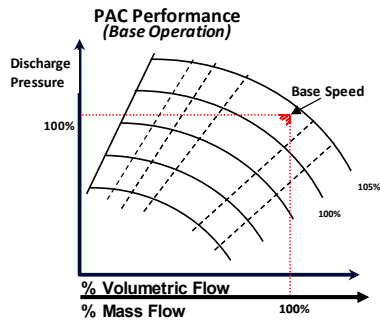




SIC™ - Single Stage Integrated Chilling



MIC™ - Multi Stage Integrated Chilling



'INTEGRATED CHILLING' PROVIDES MAXIMUM CAPACITY UPGRADE OF PAC WITH LEAST CAPEX & OPEX

“Integrated Chilling” to Upgrade Process Air Compressors
 More Reforming
 Reduced Inerts
 More Ammonia
 Less CO2 Emissions

SINCE 2005

Integrated Chilling to Upgrade PAC* Maximize Reforming with Lowest Capex & Opex

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**

Integrated Chilling

- Integrated Chilling uses existing Ammonia Refrigeration System with Process Air Compressor (PAC)
- Single or Multistage Scheme
- No Additional Compressor

Benefits of Integrated Chilling

- 110% PAC Capacity-with Single Stg
- No Utilities for Integrated Chiller
- Least Cost & Space requirement
- Least incremental power for PAC
- Reduced firing in Reformer
- Reduced CO2 footprint
- Efficient Synloop with lower inerts

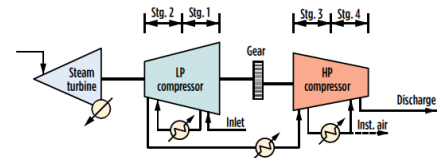
*PAC- Process Air Compressor

Services

- Integration Study with PAC
- Basic Design Package
- Provide Performance Guarantees
- Engineering & Supply thro' approved Vendors

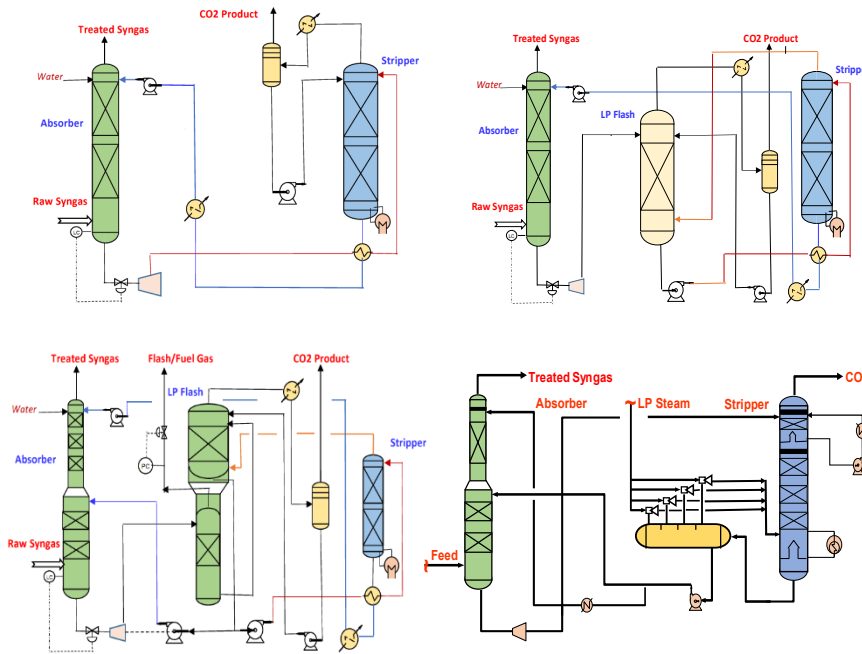
References

- Approved for two large Ammonia Plants
- Three Patents granted (2017, 2019 & 2021)
- One Patent pending- Reformer CO2 reduction
- Refer “Increase Reforming Capacity”
- “N2 & Syngas Conference, 2018”



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CO2 Removal Systems Revamping & Upgrading

aMDEA & Benfield Systems for Higher Capacity Reduced CO2 Slip Improved Reliability

IMPLEMENTED MANY SUCCESSFUL REVAMPS OF AMDEA & BENFIELD CO2 REMOVAL SYSTEMS

SINCE 2006

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

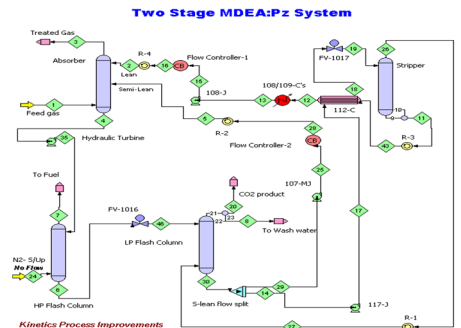
- **Proven Simulation modeling**
 - ✓ aMDEA Systems
 - ✓ Benfield Systems
- Holistic approach
- Evaluation of Column internals
- Evaluation & sizing Flash Drum
- Evaluation & Sizing Ejectors
- Evaluation & Sizing Reboilers
- Equipment evaluation & sizing
- Revamp Cost Estimates
- Basic Process Design 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:**
 - ✓ Simulation modeling
 - ✓ Engineering Study
 - ✓ Equipment Evaluation & sizing
 - ✓ Budgetary Cost Estimation
- **Revamp objectives included:**
 - ✓ Reducing CO₂ Slippage
 - ✓ Higher Capacity
 - ✓ Equipment adequacy & sizing

Client References

CFI, Yara, LSB (for various sites)
Nutrien, CNC, N2000



Kinetics Process Improvements

16000 Park Ten Pl.,
Suite#903

Houston- 77084 (USA)

Phone: 281 773 1629

Fax: 832 565 9360

Email: process@kpieng.com

Web: kpieng.com, kpieng.net

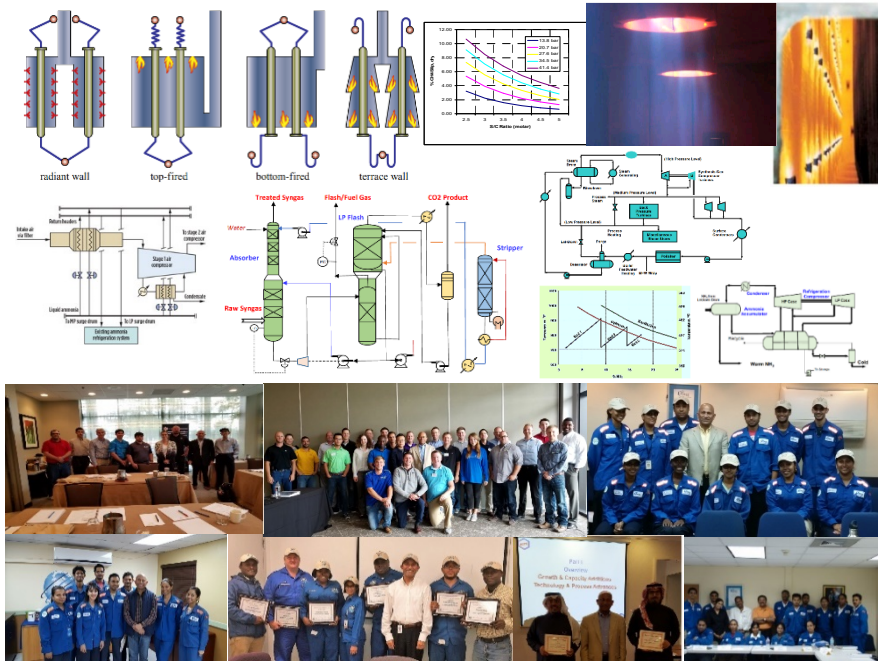


Ammonia Production & Troubleshooting Training

Including
Best Practices
Lessons Learned
Process Insights

Equipment Monitoring
Improvements Tips
(Customized, as needed)

AMMONIA TRAINING SINCE 2006



SIMPLE PRACTICAL IMPROVEMENTS & TROUBLESHOOTING TIPS

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
- Options to reduce CO2 footprint
- Cryogenic Purifier performance
- 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

Kinetics Process Improvements, Inc.

16000 Park Ten Pl., Suite 903,
 Houston, TX 77084 (USA)
 Phone: (+1) 281 773 1629
 Fax: (+1) 832 565 9360
 Email: process@kpieng.com
 Web: kpieng.com, kpieng.net



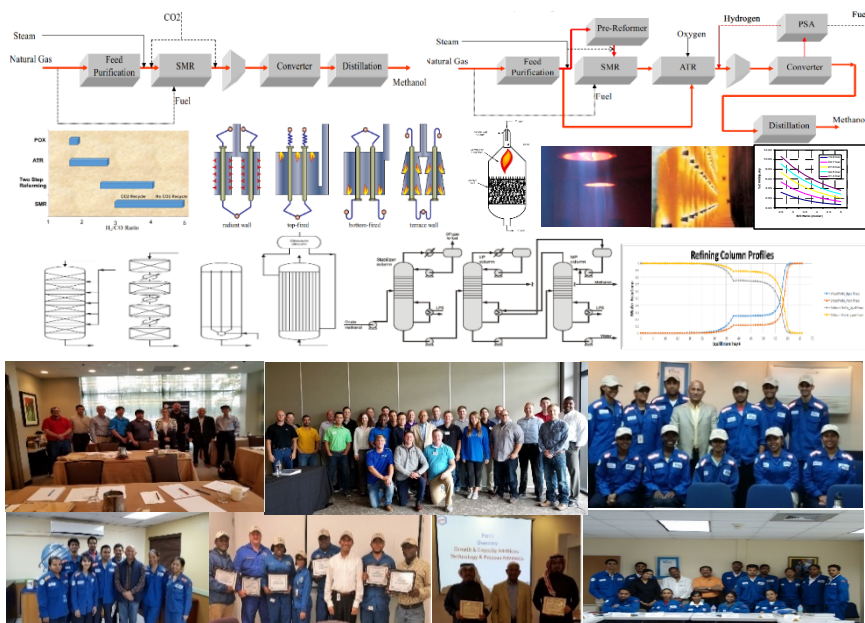
TRAINING FORMAT

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



Methanol Production & Troubleshooting Training

Including
Best Practices
Lessons Learned
Process Insights
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*

Kinetics Process Improvements, Inc.

16000 Park Ten Pl., Suite 903,
 Houston, TX 77084 (USA)
 Phone: (+1) 281 773 1629
 Fax: (+1) 832 565 9360
 Email: process@kpieng.com
 Web: kpieng.com, kpieng.net



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*

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
- Options to reduce CO2 footprint

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

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



KPI, Houston has been providing an **independent Project Consulting & Advisory Services for Business Solutions** since 2006. KPI's core strengths are in various process technologies in the Hydrocarbon sector, including the light Olefins, derivative Petrochemicals as well as Ammonia, Methanol & derivatives.

KPI has completed over 150 projects globally for more than 60 clients, including roles as **"Owner's Engineers"** for two large projects in Middle East. As **"Owner's Engineers"**,

KPI team spearheaded the **development and implementation of a large Propylene derivatives complex** for a Saudi location to produce **Acrylic Acid, Oxo-Alcohols/Syngas and Acrylic Esters**. It is currently in operation. KPI also developed a new **Ammonia Project** utilizing off-gases from existing Methanol/CO plants for Saudi location. Lately, KPI handled various studies and projects related to **Green and Blue Ammonia** including O2 enrichment and CCS in US, Europe, Australia, Trinidad and Africa.

KPI has **completed over 100 project feasibilities, technology evaluations, due diligence & risk assessments & strategic advisory** for new facilities. KPI goes extra miles to investigate and generate creative options to provide real value as cost effective, practical and innovative solutions, often improving Capacity and Energy Efficiency for existing Ammonia, Methanol, Ethylene and PDH plants.

***TECHNOLOGY- ENGINEERING-PROJECT MANAGEMENT
EXPERIENCE - KNOWLEDGE - EXPERTISE***

Trusted Partner, "Owner's Engineers"

- ***Capital Project Development***
- ***Asset Performance Improvements***
- ***Facilitating Project Resourcing & Partnering***
- ***Strategic Advisory & Risk Assessment-Mitigation***
- ***Customized Plant Training***



OWNER'S ENGINEERS

**PROJECT DEVELOPMENT
EXPERT CONSULTING & ADVISORY
GREEN & BLUE
AMMONIA, METHANOL & LIGHT OLEFINS**

OWNER'S ENGINEERS

**Independent Technology and Engineering Consultants
Technical, Commercial and Financial Due Diligence
Asset Performance Analysis and Improvements
Optimization of Resource Monetization**

**Supplement Your Scarce Key Resources
Global Reach - Global Value - Global Success**

PROJECT CONSULTING FOR CLIMATE CLEAN UP



**16000, Park Ten Pl. Suite# 903
Houston, TX 77084 (USA)**

Phone: (281)-773-1629

Fax: (832)-565-9360

E-mail: process@kpieng.com

Web: www.kpieng.com, www.kpieng.net

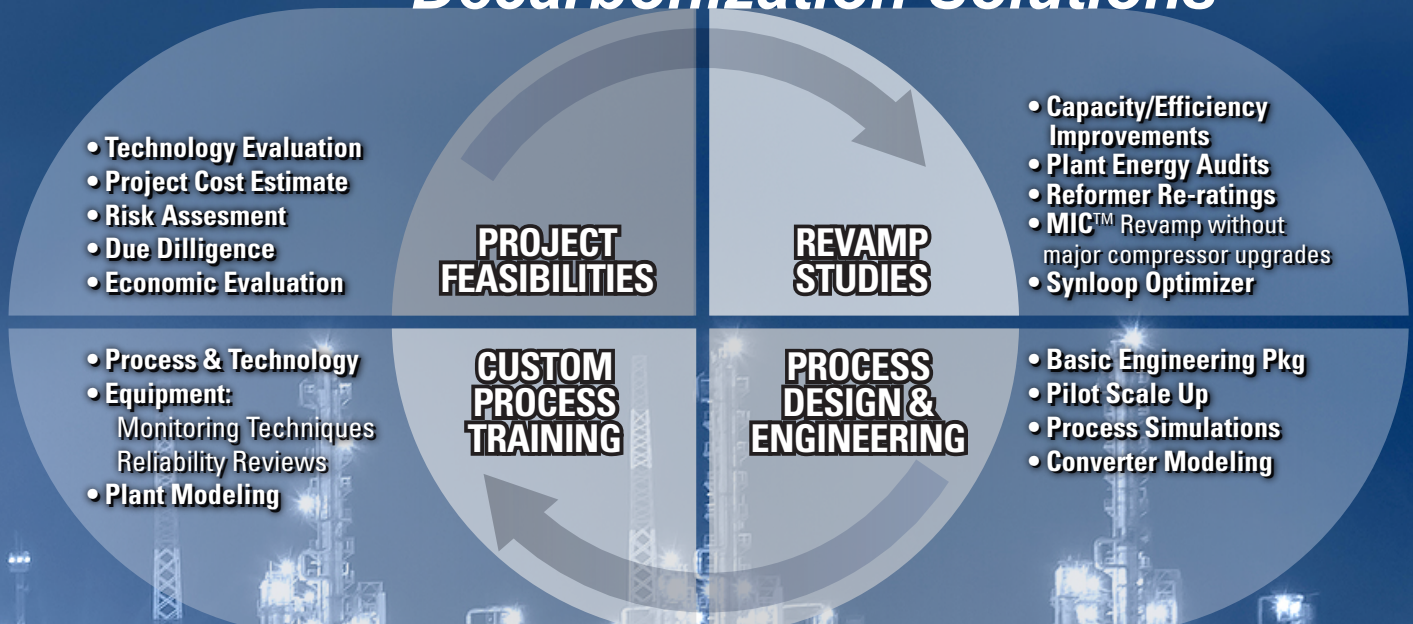


Kinetics Process Improvements, Inc.

Independent Consultants & Engineers

Serving to Improve, Decarbonize & De-bottleneck

- **Ammonia Plants** (Integration with gH2L...)
- **Methanol Plants** (Electrification & Replacement with Electric Drivers)
- **Primary Reformers** (Tech-Evaluations)
- **CO2 Removal Systems** (Green-Blue Ammonia & Methanol Plant Studies)
- **Decarbonization Solutions**



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