


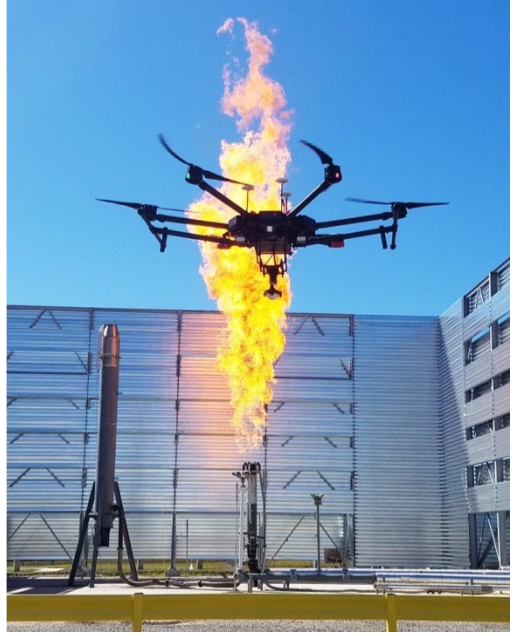


BOOSTING ASSETS PROFITABILITY WITH AROMATICS COMPLEX MODERNIZATION

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OUTLINE

- Aromatics market overview
- Capturing profitability boost potential
- Liquid phase xylenes isomerization
- Parex™ unit cost effective optimization
- Sulfolane™ unit enhancements

CHINA CHEMICAL INDUSTRY : ENVIRONMENTAL CHALLENGES

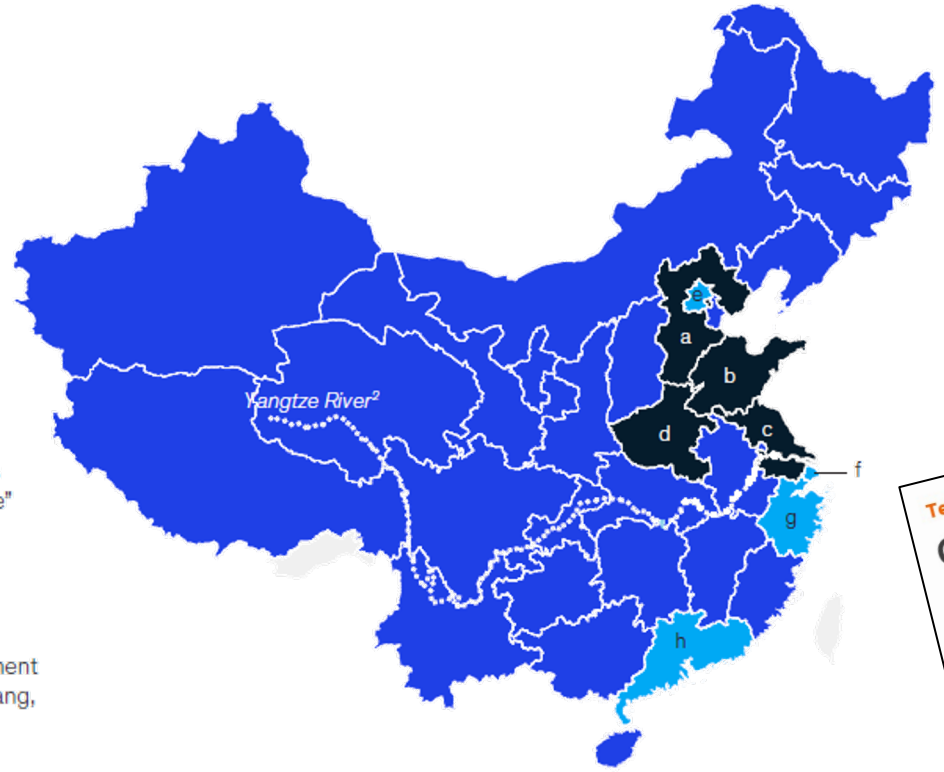
Three levels of environmental rules and enforcement are emerging across China—with an overall trend to much higher standards for the chemical industry.

Share of China's chemical-industry output1 represented by regions under each category of rules and enforcement, %

49 **Radical change**
Aggressive performance targets and strict enforcement (all along the Yangtze River and in a. Hebei, b. Shandong, c. Northern Jiangsu, and d. Henan)

30 **Moderately strengthened**
Moderate increases in targets and enforcement (most of China's regions, excluding "radical change" and "always strict" regions)

21 **Always strict**
Stable targets and strict enforcement (in e. Beijing, f. Shanghai, g. Zhejiang, and h. Guangdong)



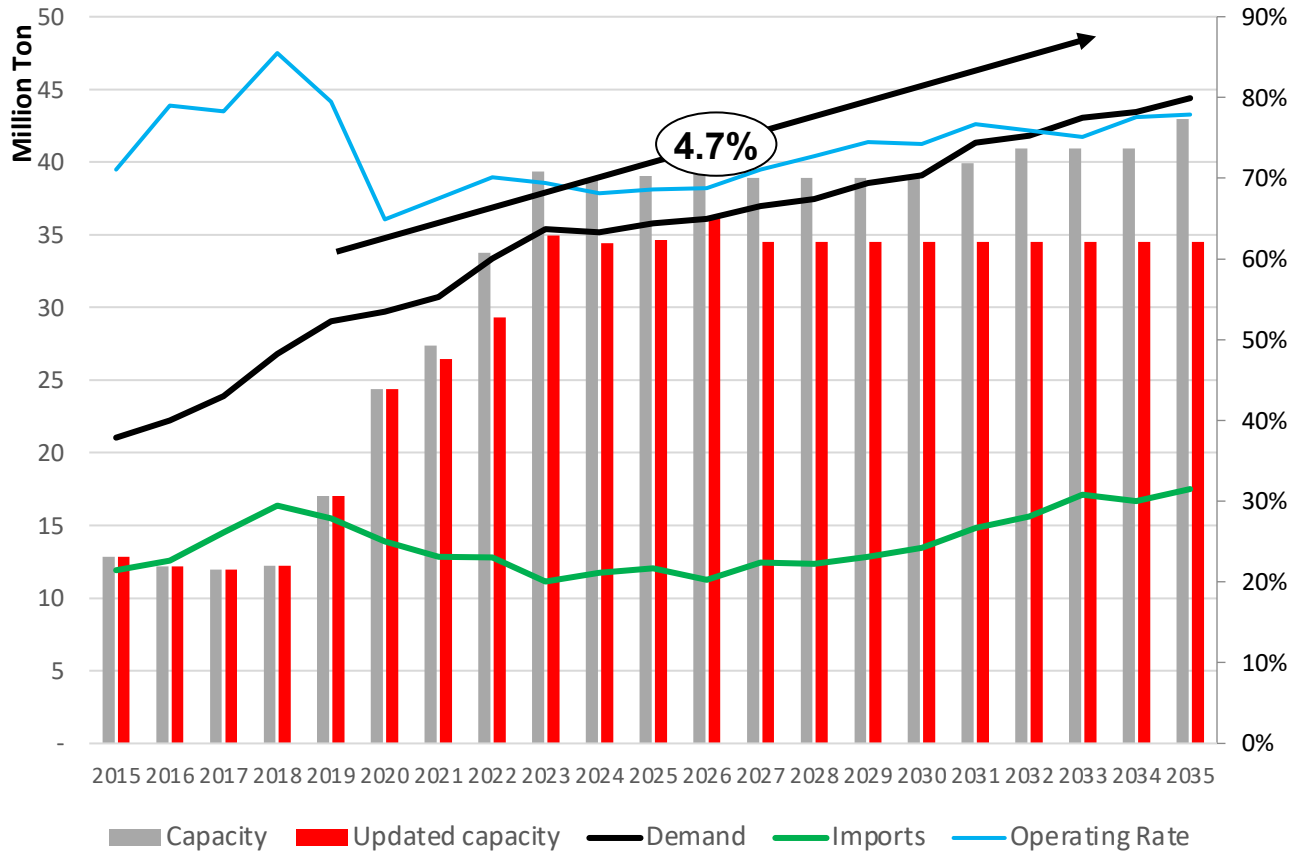
Technology
China's Inner Mongolia to end cryptocurrency mining, ban new steel, coke projects

So What?

- Difficult to get approval for new (or recently announced) chemical plants to start execution; **hence multiple project cancellation**
- Energy efficiency measures in High GHG regions forcing plants to reduce operating rate; **hence limited potential to increase operating rates**

China's tightening rules making chemical industry to limit expansion

P-XYLENE MARKET: CHINA DYNAMICS



Source: WoodMac UOP Analysis

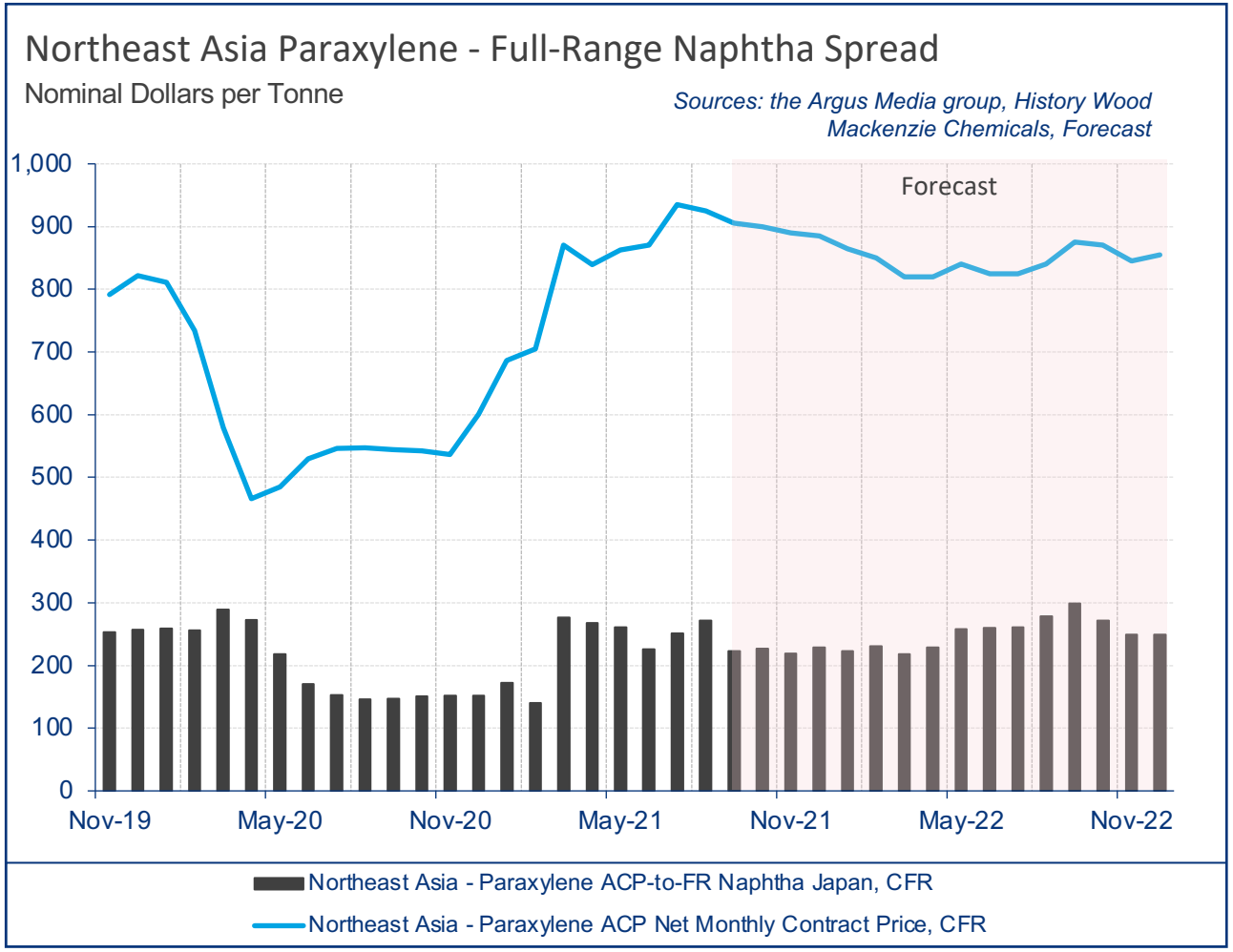
- Strong demand growth thru 2031 (4.7% CAGR)
- +5 M MTA of capacity to be cancelled due to environmental concerns
- Number of projects reported slowing execution
- Projected demand keeps growing while capacity additions post 2023 will be delayed significantly
- Imports to reduce but hover in +10M MTA range with potential to increase

So What?

- Projects cancellation will add +5M MTA to projected PX imports to China
- Slowing projects will add to that number
- PX operating rates getting affected due to energy efficiency measures, thus restricting supply

China pX supply getting restricted resulting in continued imports

PROJECTED PX SPREADS REVEAL OPPORTUNITY



- **Recent market rationalization presents opportunity for existing producers**
- **Projected feed/products spread look attractive to producers that reduced their CCOP**
- **Further CCOP reductions can assure better profitability going forward**

UOP offers cost effective and rapidly implementable technology upgrades

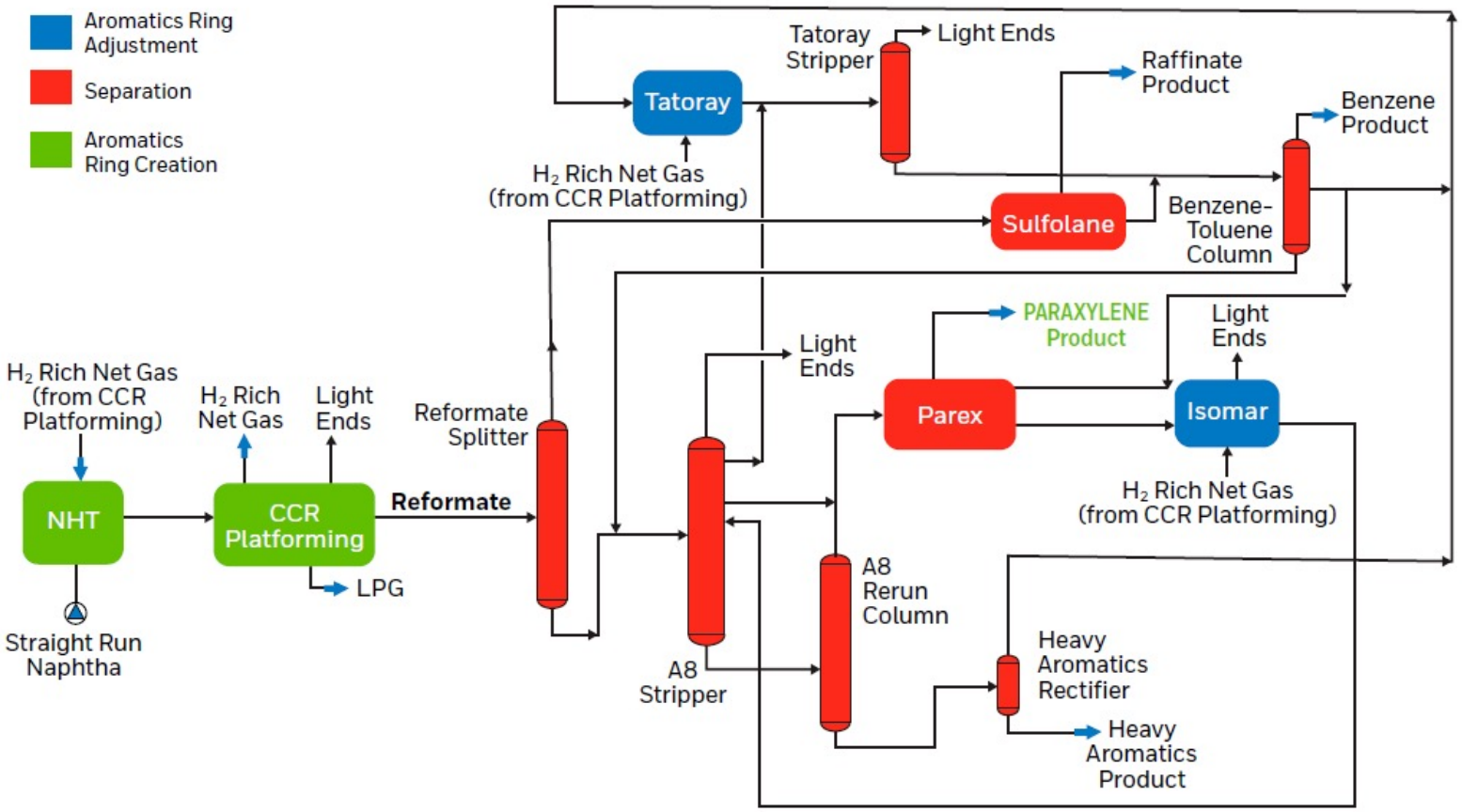
LD PAREX AROMATICS COMPLEX

Paraxylene is produced from naphtha derived from crude oil or condensates

UOP aromatics complex units

- Sulfolane
- Tatoray
- Parex
- Isomar

- Latest design, catalysts, and adsorbents allow to maximize the CCOP reduction
- Parex adsorbents ADS-47/50
  - Over 25% higher throughput per unit volume
  - Up to 20% utility reduction, $2-5/MT of pX profitability improvement
- Tatoray™ Catalysts TA-30/32
  - Increased activity, yield, and longevity
  - Over $4/MT of pX profitability improvement through higher yield and utilities reduction
- Isomar™ Catalyst I-500
  - Increased activity and yield
  - ~$4/MT of pX profitability improvement through higher yields and utilities reduction



CCOP REDUCTIONS WITH LIQUID PHASE ISOMERIZATION

LIQUID-PHASE XYLENE ISOMERIZATION (LPXI)

UOP has developed a liquid-phase process for xylene isomerization, with the following goals:

- Maintaining similar approach to equilibrium
- Reducing utility consumption per MT of PX produced
- Reducing CAPEX for new units

The LPXI flow scheme is very simple – it does not require a fired charge heater, a recycle gas compressor, or hydrogen in the feed.

Operated in tandem with vapor-phase Isomar, LPXI derives utility benefits in heavy desorbent and light desorbent parex complex.

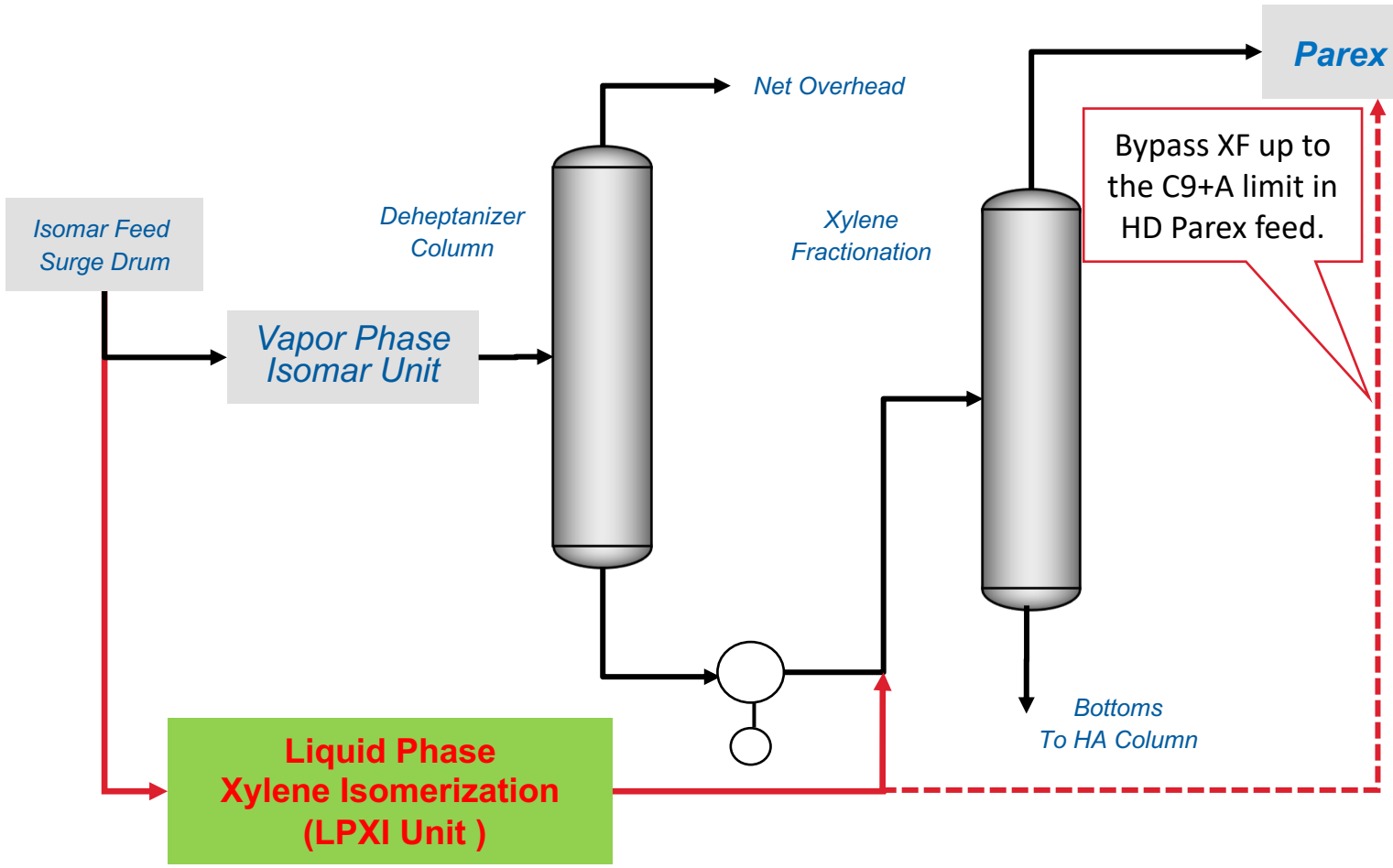
Provides low CapEx option to reduce CCOP in UOP Aromatics complexes

LPXI Commercialization Planned by end of 2021

ADVANTAGE OF UOP LPXI-

- Energy saving with low temperature operation and no phase change.
- High paraxylene selectivity
- Low selectivity towards heavies C9+A in Rx effluent.
- Able to operate at a range of 4-8 WHSV to fit customer integration needs and available equipment.
- Low Xylene loss.
- LPXI catalyst does not require sulfiding, or any other special startup procedures.

LPXI INTEGRATION WITH PAREX UNITS



- Part of Parex unit raffinate is sent to LPXI Unit
- LPXI effluent bypasses De-C_7 and Xylene Fractionation (partially for HD Parex) allowing **additional throughput**.
- **Reduces overall heat required for PIX loop.**
- **Enables more efficient mix xylene conversion to pX product.**
- Keep vapor phase Isomar within reasonable turndown conditions
- Enables additional energy optimization in the vapor phase Isomar Unit.

LPXI provides throughpug and utility benefits with more efficient feed optimization.

CASE STUDY : LPXI IN HEAVY DESORBENT SCHEME

Customer: Northeast Asia

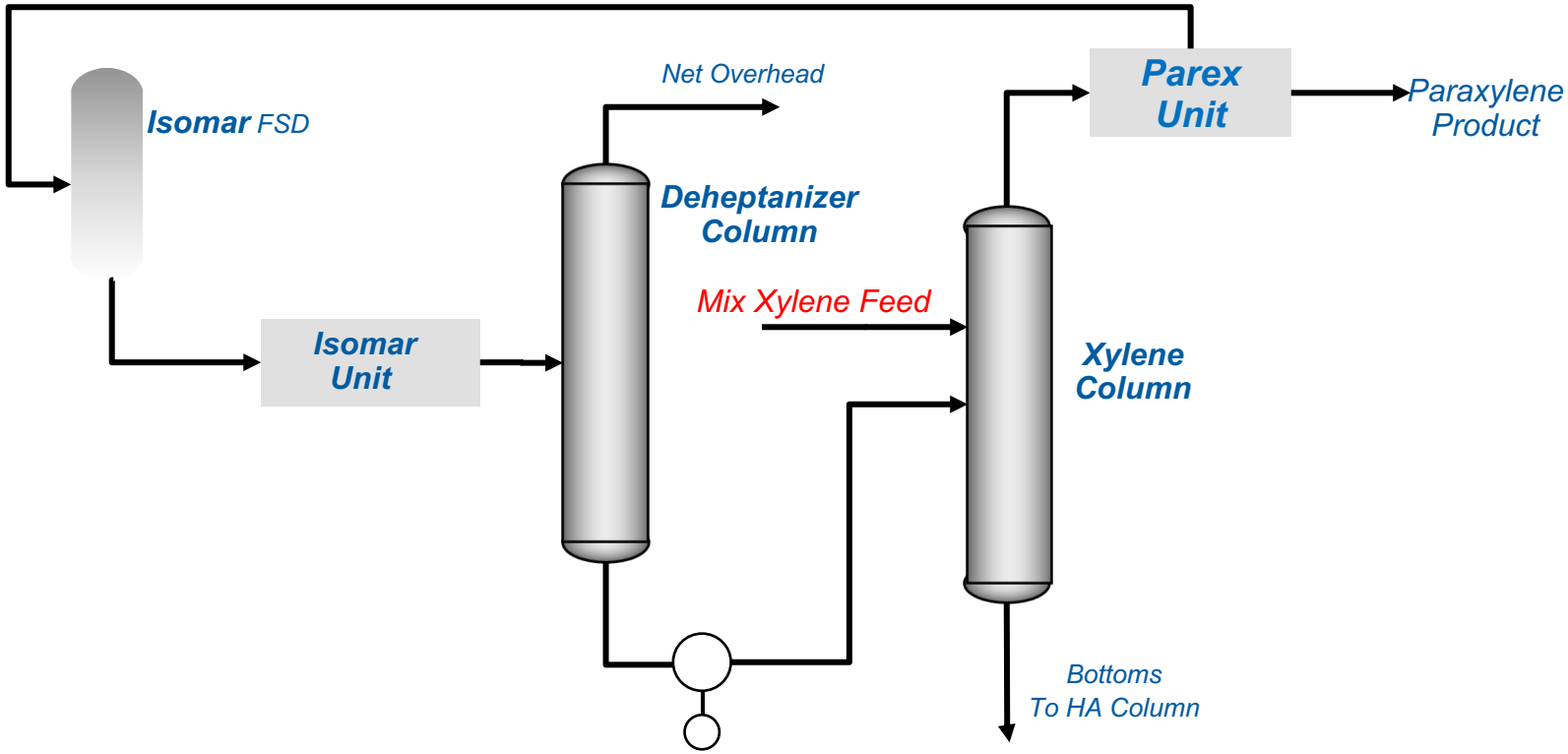
PX Capacity : ~900 KMTA

Adsorbent : Previous generation

Objective : to reduce energy consumption in PIX loop

Constraints :

- Bottleneck in Isomar Reactor section.
- HP Steam consumption in Deheptanizer reboiler.



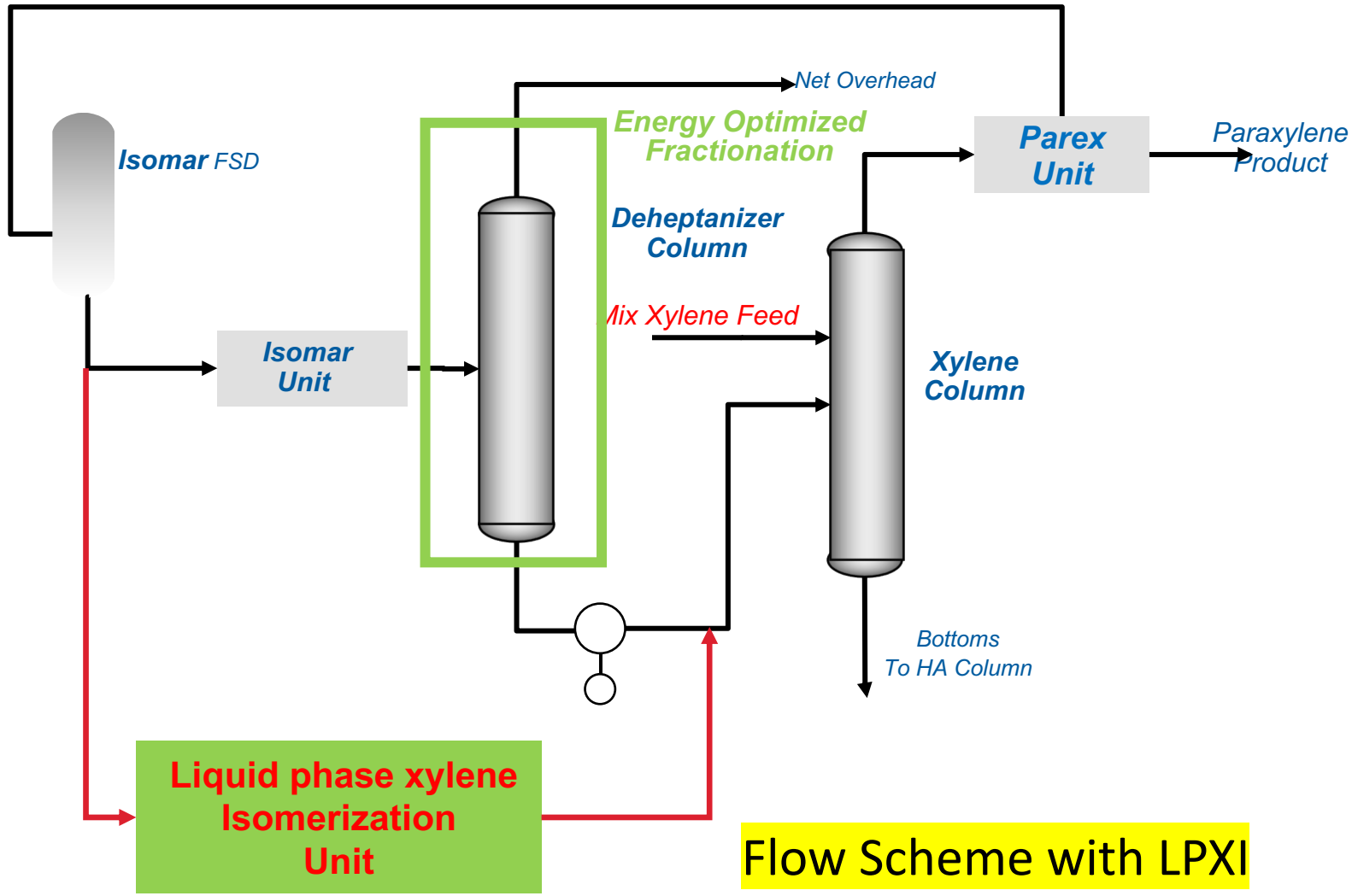
Existing Flow Scheme

Opportunity to reduce utility consumption in PIX loop

CASE STUDY : CONTINUED

Recommended Scheme with LPXI Unit:

- Reduced overall heat required for PIX loop – **6% of PIX loop utility)**
- Enables additional energy optimization in Isomar Unit.
- Contributed towards lower xylene loss in PIX loop-translated in more PX production.



Flow Scheme with LPXI

~6% utility reduction in PIX loop with LPXI introduction.

CASE STUDY: BENEFITS OVERVIEW

Overall Study Economics:

- Utility Savings : >MM$4/year
- PX production benefit : ~M$500/year

Modest capital investment and plot space required

Simple Payback : 2.7 years

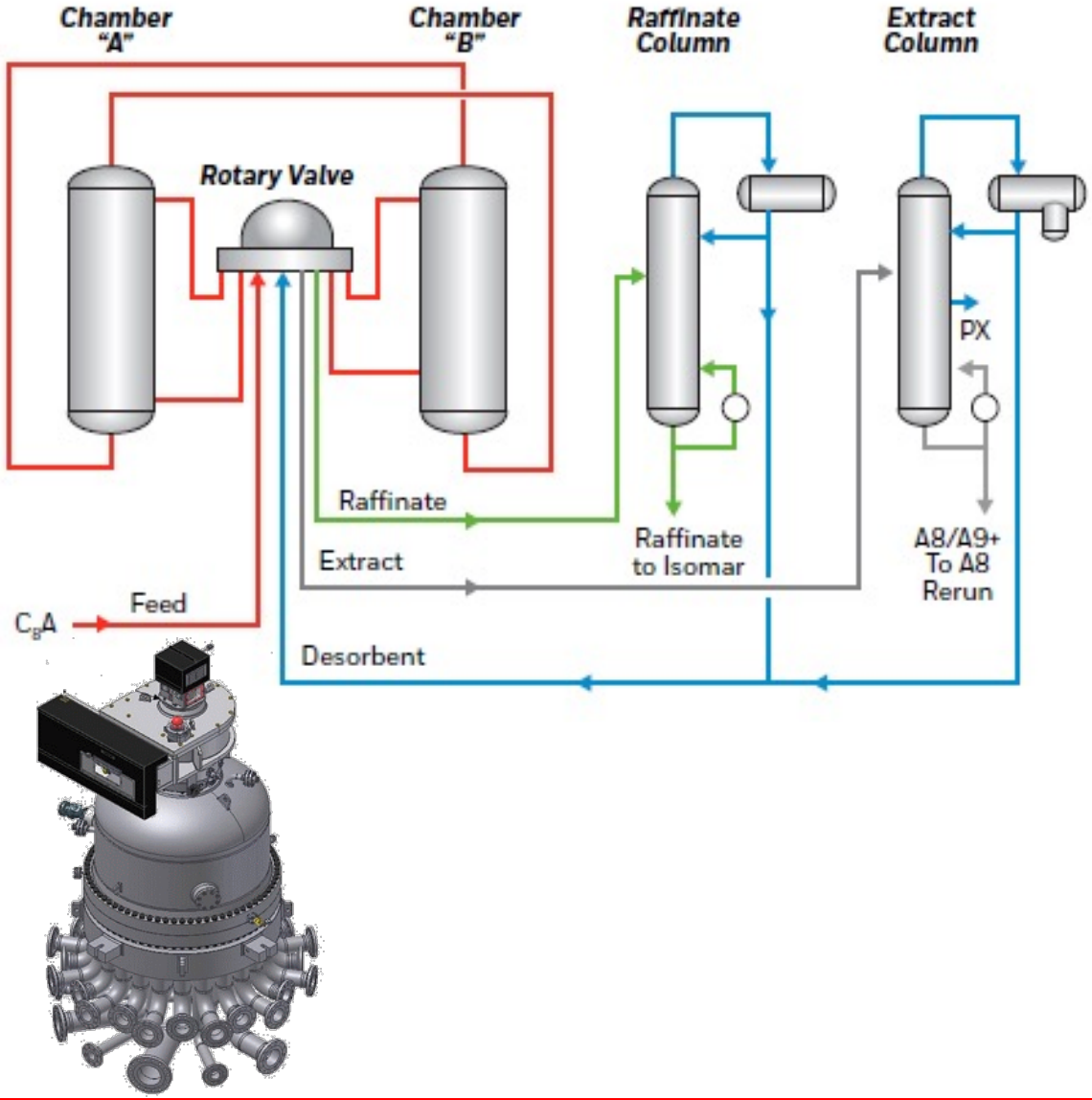
Net CCOP savings : near $6/MT of PX

Key driver for project economics - utility reduction and low XL in LPI.

CCOP REDUCTIONS WITH COST EFFECTIVE PAREX UNIT OPTIMIZATION

UOP PAREX PROCESS

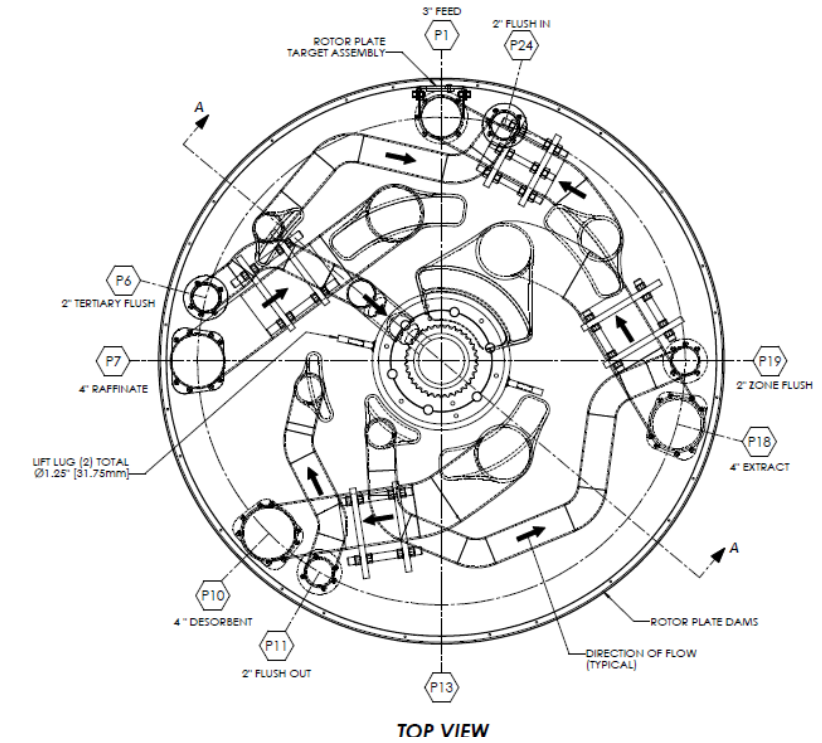
- UOP Sorbex technology – adsorptive separation to recover paraxylene (pX) from mixed xylenes
- Simulates counter-current flow of liquid feed over a bed of adsorbent (solid molecular sieve) using a Rotary Valve (RV)
- First Parex process introduced in 1971
  - Efficient, mechanically simple, reliable
- Lines between chambers and RV used by different in and out net streams
  - Volume is modest, but if not handled correctly may require appreciable alternative measures
  - Correct handling of material held in lines requires flushing



Majority of all new pX production based on UOP Parex process

ROTARY VALVE ENHANCEMENTS

- Older generation Parex Units can benefit from flush optimization
- Flush addition: purge line full of raffinate
  - Debottlenecks the adsorbent chambers, fractionation columns thereby increasing capacity and reducing column traffic
  - Capacity increase: 2-4%, higher for MX Sorbex units.
    Utilities reduction: 1-3%
  - Equipment modifications required
- Flush addition: purge line full of desorbent
  - Reduces desorbent flow to raffinate column thereby reducing column traffic and decreasing reboiler duty
  - Utility reduction: 5-10% reboiler duty
  - Equipment modifications required
- Either of the flush additions requires UOP ACCS control system upgrade



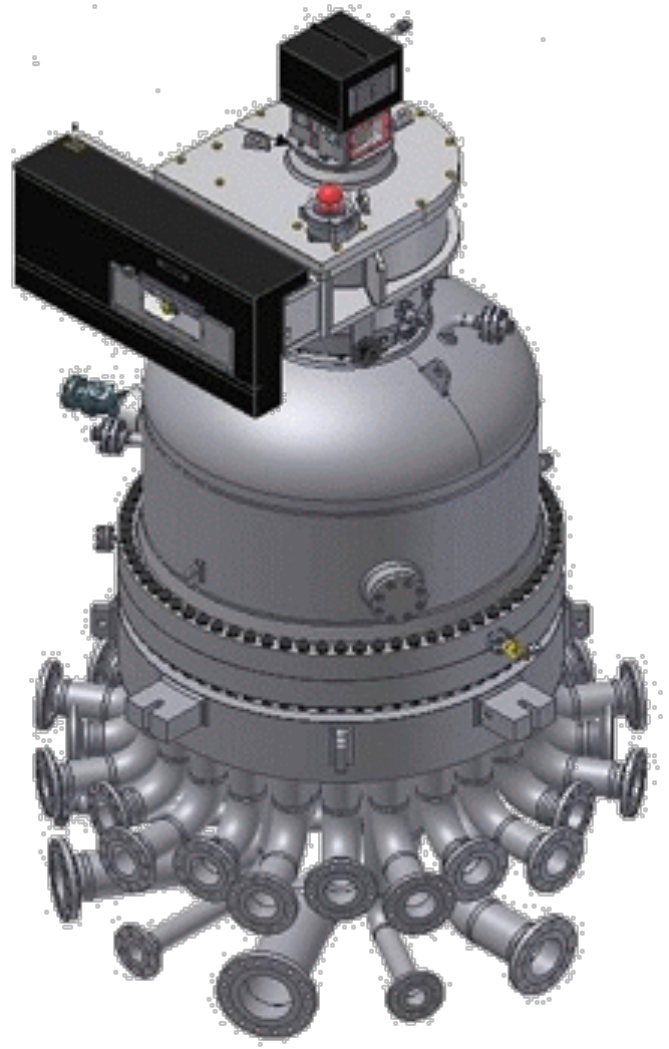
Modest investments, quick implementation, rapid payback

ADDITIONAL ENHANCEMENTS

- Operating zones optimization
  - Improves adsorbent bed utilization to either utilities reduction or capacity increase
  - Capacity increase: 1-3%, or
    Utilities reduction: 1-3%
  - Equipment modifications not required

- Existing flush modifications
  - Reduces/enriches flow to extract column thereby reducing column traffic and decreasing reboiler duty
  - Utility reduction: site specific, up to 25% reboiler duty reduction
  - Equipment modifications – minor piping/pumping changes

- Minor UOP ACCS control system upgrade required

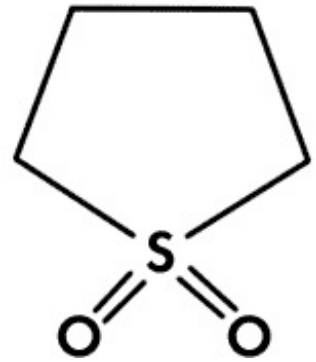


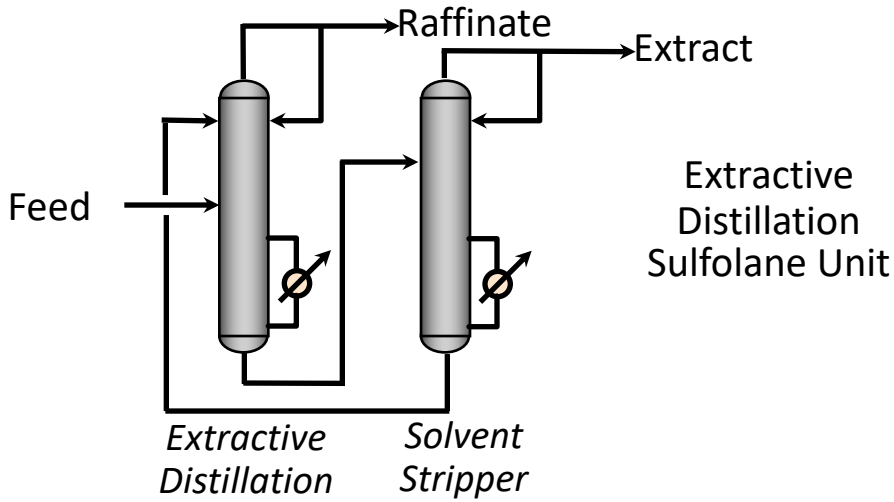
Minor investments, very quick implementation and payback

CCOP REDUCTIONS WITH COST EFFECTIVE SULFOLANE UNIT ENHANCEMENTS

AROMATICS EXTACTION: SULFOLANE UNIT

- Sulfolane Solvent
  - Sulfolane is the most often used solvent in the world for extracting aromatics.
  - Sulfolane is a commodity chemical available from many suppliers.
  - Non toxic and not nitrogen containing
  - Almost 60 years of reliable use
- Recent advances in data availability and analysis combined with enhanced modeling capabilities enable improvements
  - Both process optimization and modifications are included
  - Improvements applicable to new designs and revamps
  - Optimized process offers over 10% in utilities reduction
  - Process change requires minor flow scheme modifications and equipment additions and delivers over 20% in utilities reduction
  - Savings in a revamp scenario would depend on a specific unit design
- Improvements applicable to reformate or pygas derived feeds
- Work targeting additional 10-20% utilities saving/capacity increase is currently underway





UOP delivers continuous improvements to aromatics technologies

Q&A