

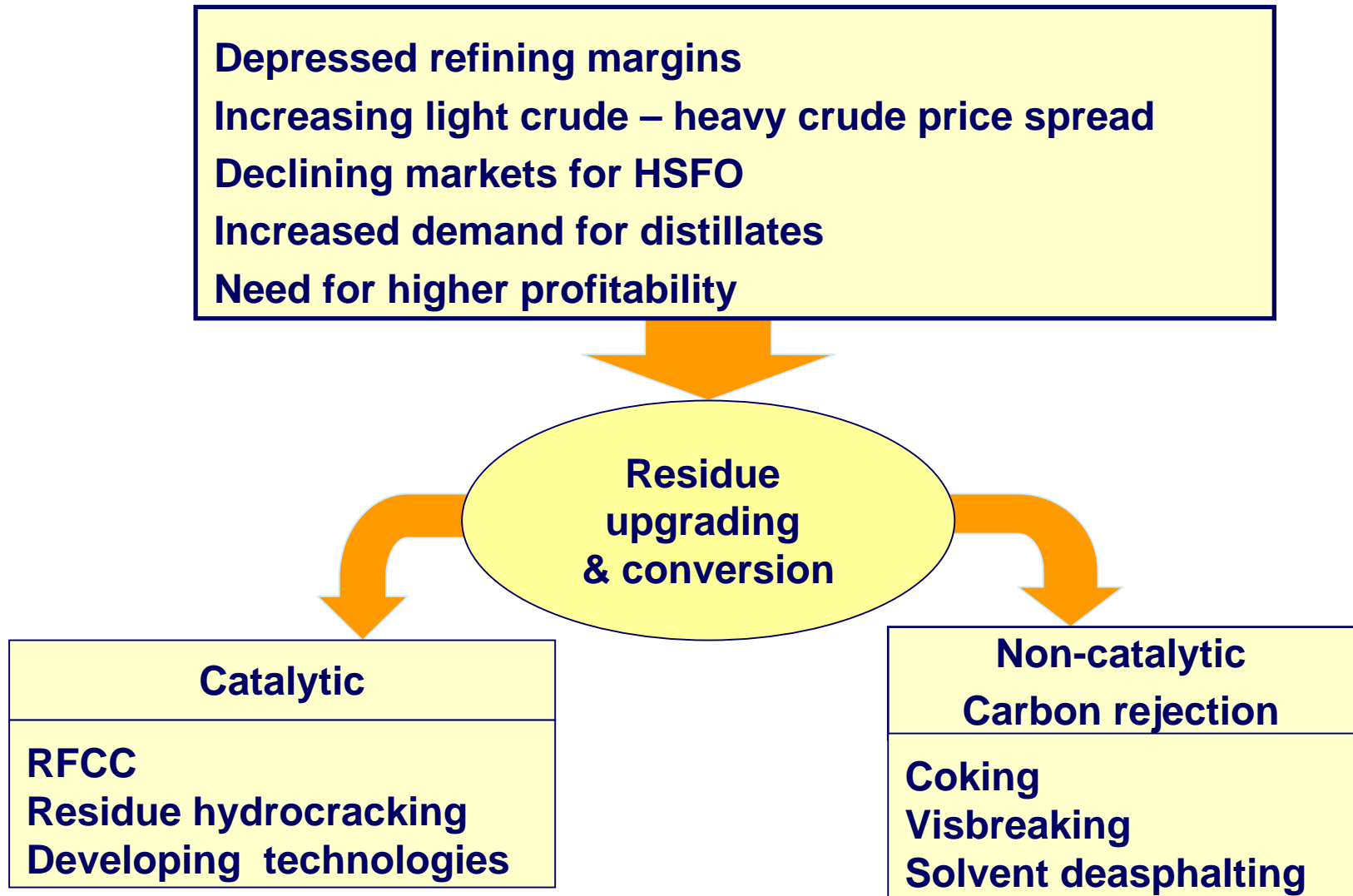


Cost effective residue upgrading: delayed coking, visbreaking & solvent deasphalting



John D. Elliott
Deputy Director for Refining & Coking
Houston, Texas

Residue upgrading – drivers & routes

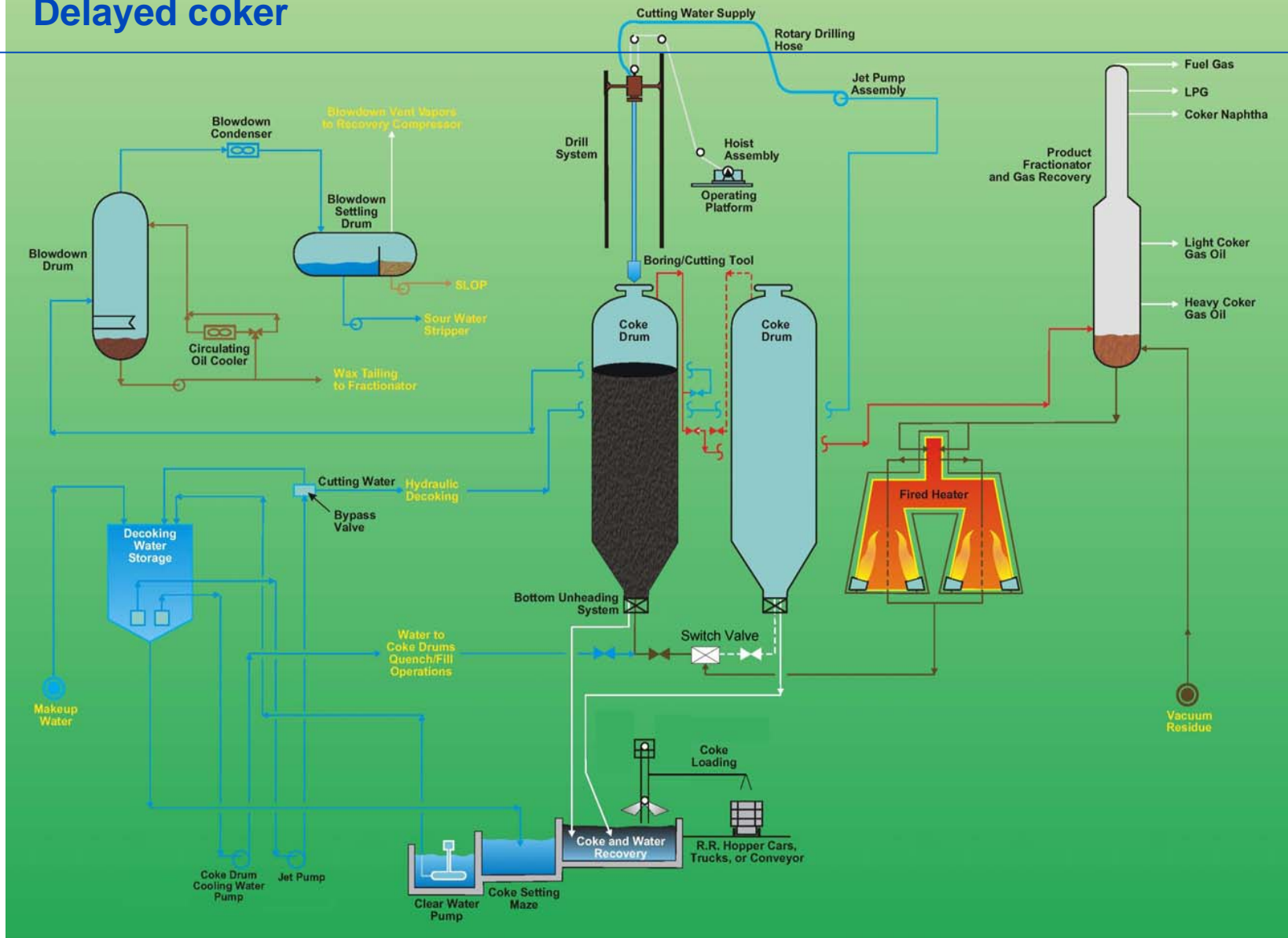


SYDECsm delayed coking

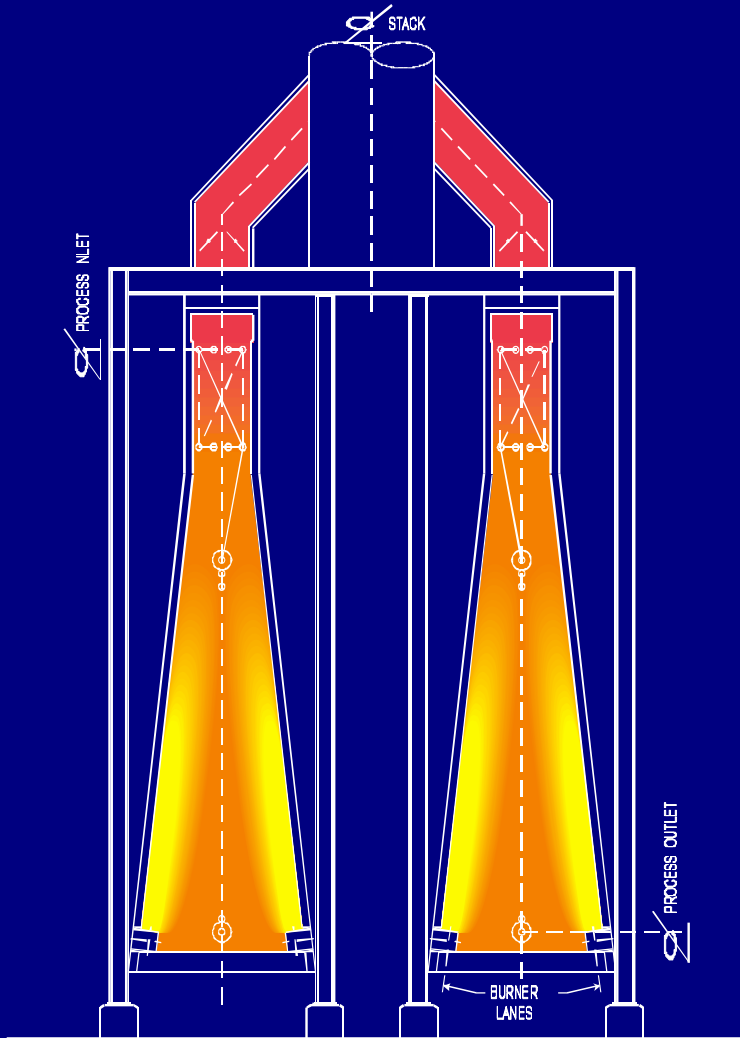
- Full conversion of residue to distillates
 - Full range of lighter products
 - Complete decarbonization of residue feed
 - Complete metals removal
- Fuel grade coking:
 - Maximum yield of clean liquid products
 - Low pressure coking / ultra-low recycle coking
- Anode coking
 - Lower sulfur / metals feeds

Cost effective residue upgrading: delayed coking, visbreaking & solvent deasphalting

Delayed coker

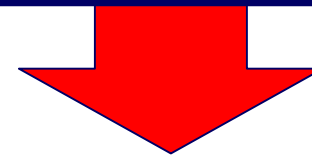


SYDECsm coker heaters



Long heater runs

- Advanced designs
- Double fired
- On-line spalling
- Low Na⁺ feed

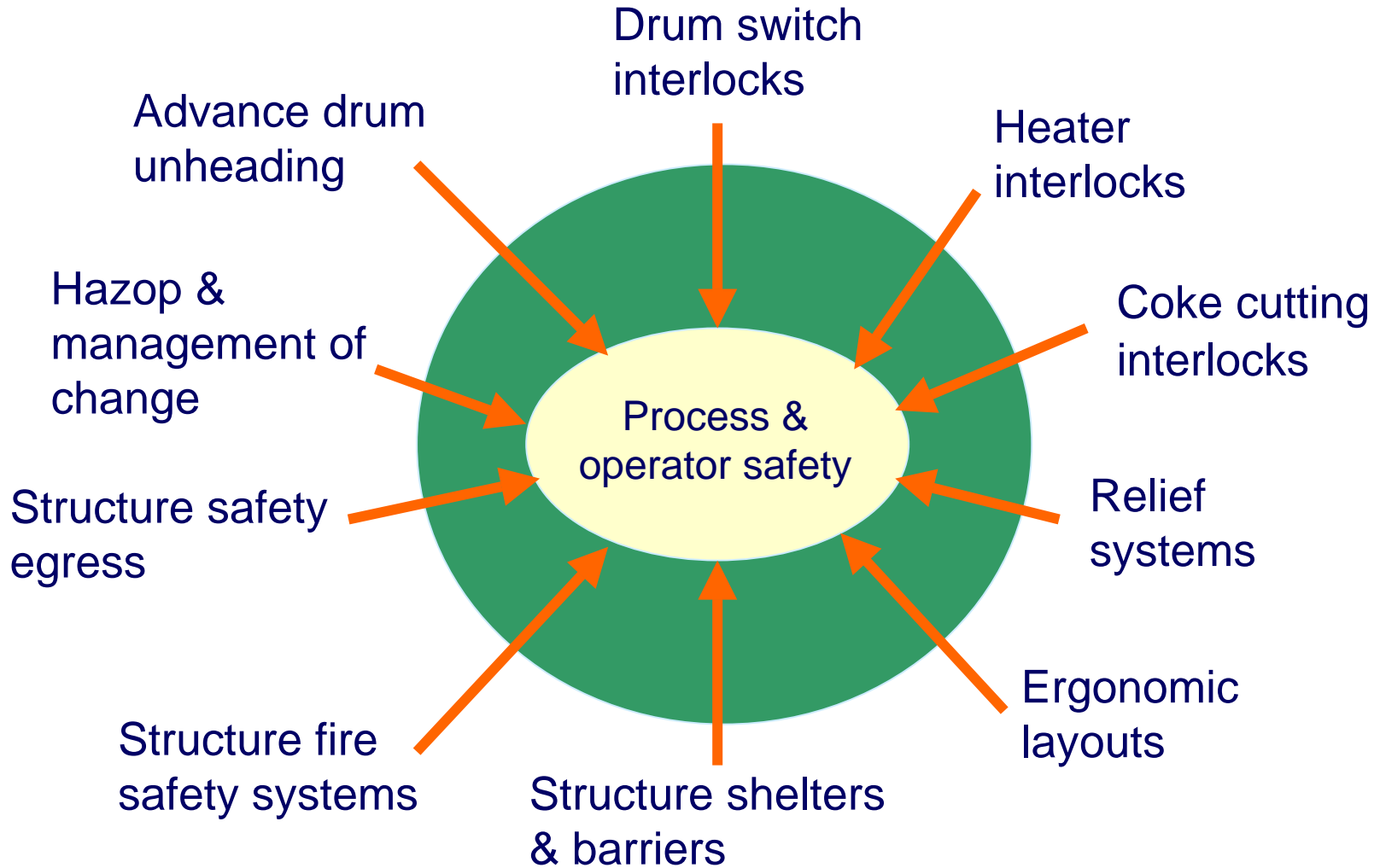


Reliable
operations

Environmental controls

- Enclosed blowdown system with recovery of vent vapors & unconverted oils
- Heater NO_x controls
 - SCR; low NO_x burners
- Coke particulates
 - Wind barriers & wetting systems to prevent windage loss
 - Wash stations for mobile equipment
 - Coke handling
 - **Enclosed conveyors or tubular conveyors**
 - **Covered storage “barns” and reclaimers**
- Water reuse
- Refinery sludge disposal

SYDECsm – design for safety



Coke disposal

- Fuel coke
 - Purchasers include utility stations and cement calcining operations. Increasingly: gasification
 - **High calorific value/ low ash**
 - High sulfur coke sold at discount to coal
 - Production is over 80 MM MTPA worldwide
 - **Low compared to coal**
 - **Will continue to edge out coal due to price discount**
 - Numerous, competitive marketing companies
 - Cost is low but the coker value is in the clean liquid products and the conversion of low value high sulfur fuel oil

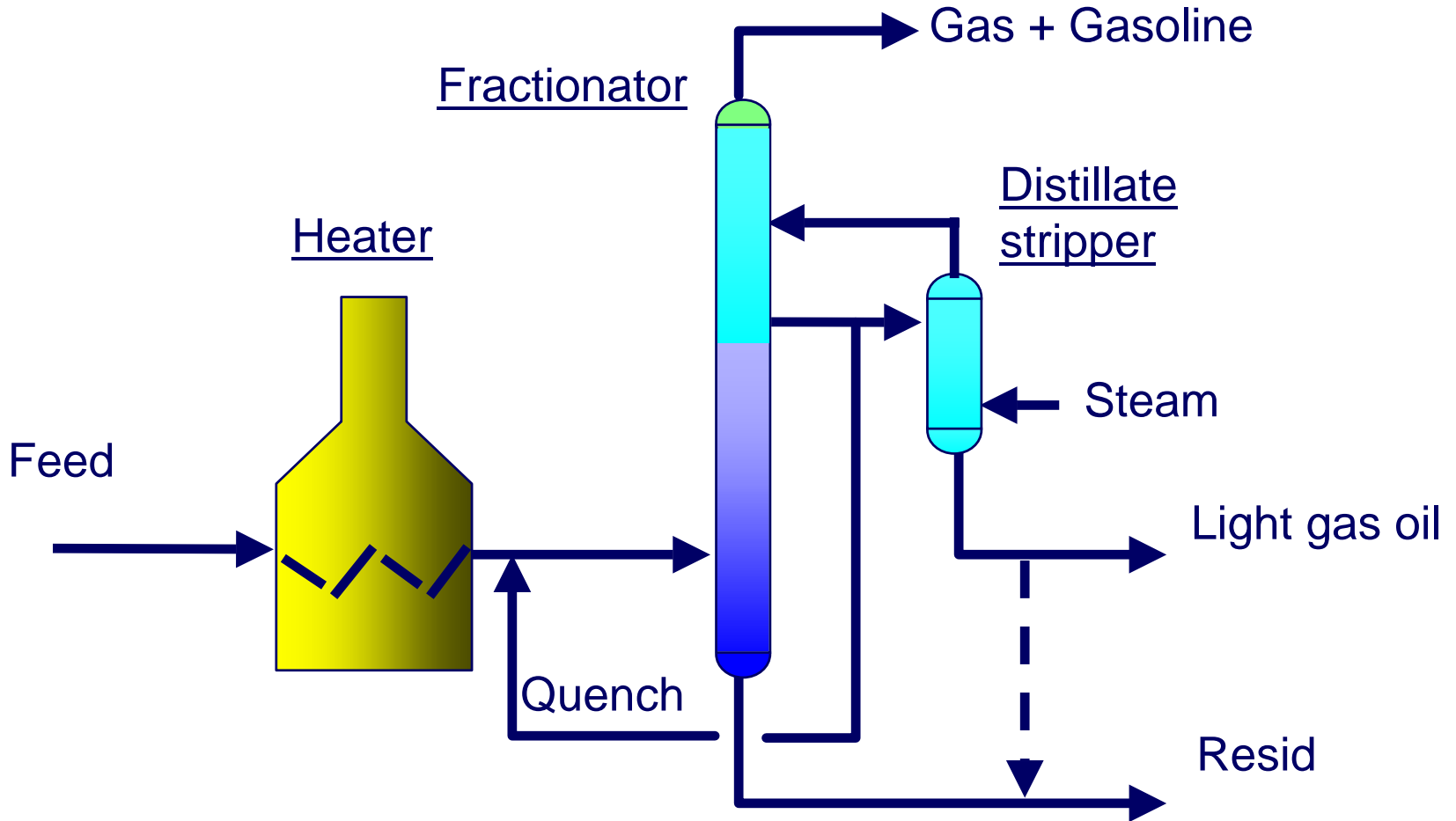
Benefits of delayed coking

- Proven technology
 - **Past experience: large available knowledge base on design, operations and maintenance**
- Strong 3rd party support services and equipment vendors
- Long turnaround periods: 5 Years +
- Fast execution of projects: <28 Months
 - **Fewer budget surprises: \$3,600 / BPSD**
 - **Short period of negative cash flow**
- Good margins
 - **Fast realization of project payback**
- Anode product coke for low sulfur / metals feed
- Modern designs are safe and clean
- By product fuel coke is easily marketed

Visbreaking: technology overview

- Mild thermal conversion process
 - Limited by product stability
- Primarily used to reduce fuel oil cutter stock
 - Can produce VB VGO for FCC or hydrocracker
 - Utilizes relatively low cost equipment
 - No hydrogen, low pressure design
- Two types:
 - Coil - heater only conversion
 - Soaker - heater plus soaking vessel
- Configure with recycle gas oil thermal cracking for higher conversion (with or without vacuum tower)

Typical coil visbreaker layout



Benefits of visbreaking

- High sulfur fuel oil reduction
- Use less distillate for cutter – available for more valuable transportation distillate fuels
- Low cost upgrading
- Refinery remains in fuel oil market
- Low cost per barrel (\$900 / BPSD)

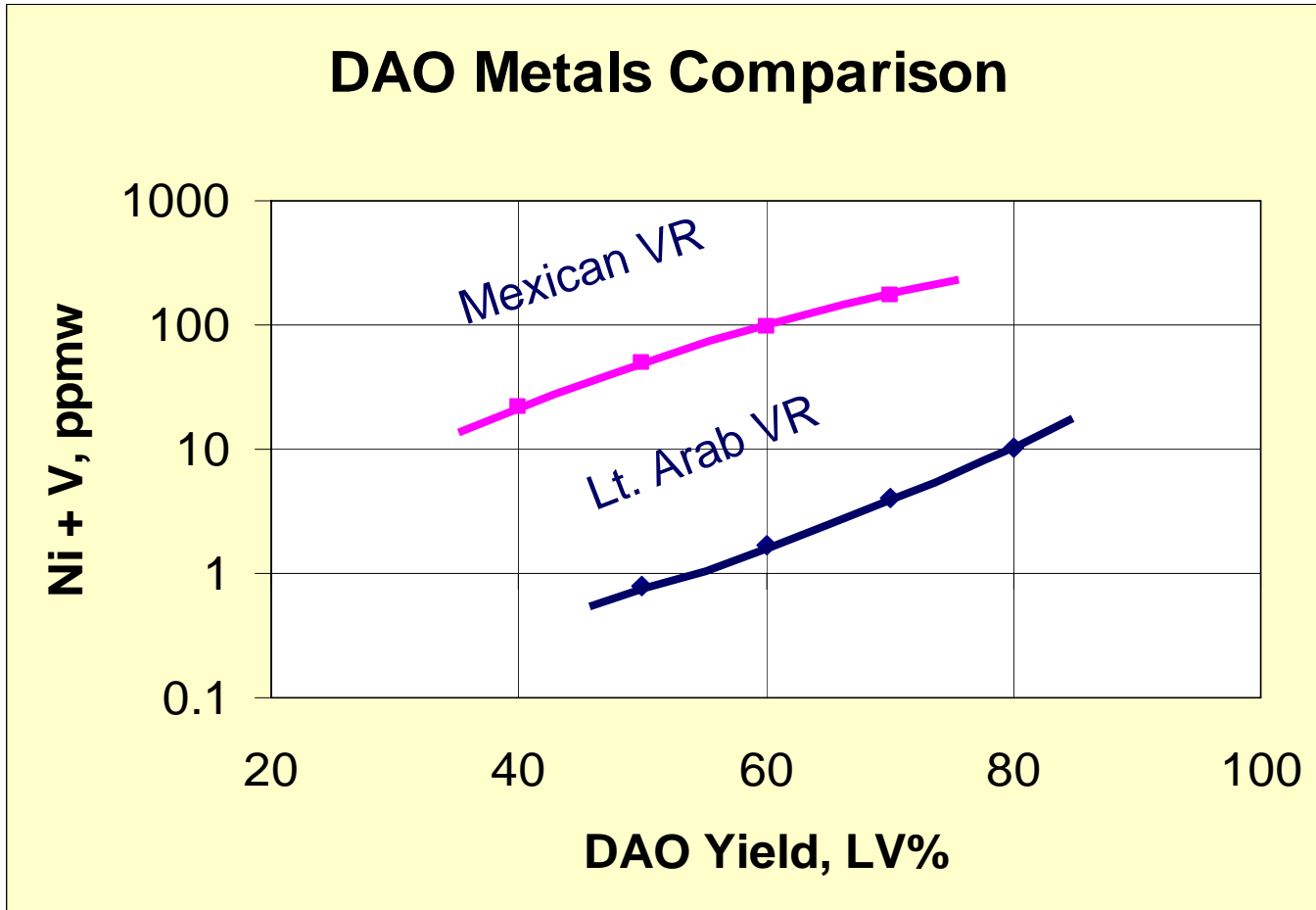
Solvent deasphalting

- Separation not conversion
 - Decarbonization by extracting asphalt fraction and recovery of hydrogen rich DAO fraction
- Variation in solvent mix & operating conditions to achieve desired separation
- Reduction in fuel oil if pitch is blend component.
- Features of process
 - Supercritical solvent recovery
 - Multistage counter current extractor with packed beds
- Can be combined with SYDECSM for ASCOTSM process

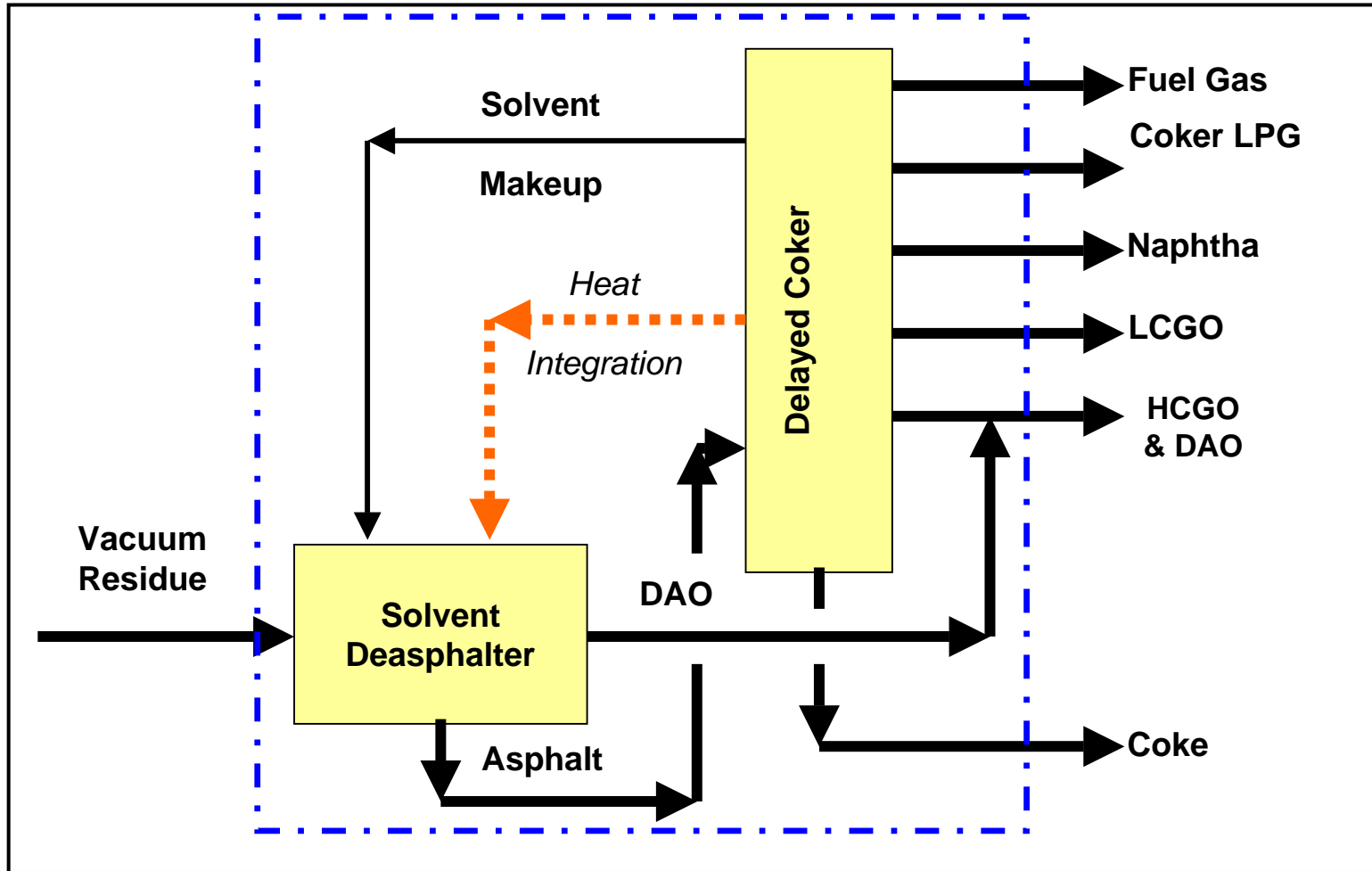
Benefits of solvent deasphalting

- Bottom-of-Barrel upgrading at low TIC
 - \$1,300 / BPSD
- Separation not conversion
- Yields and DAO properties controllable
 - DAO has relatively high H content (i.e. not cracked)
- Lower OPEX with supercritical solvent recovery
- Asphalt pitch can be used as fuel component or gasified to make power, steam and H₂

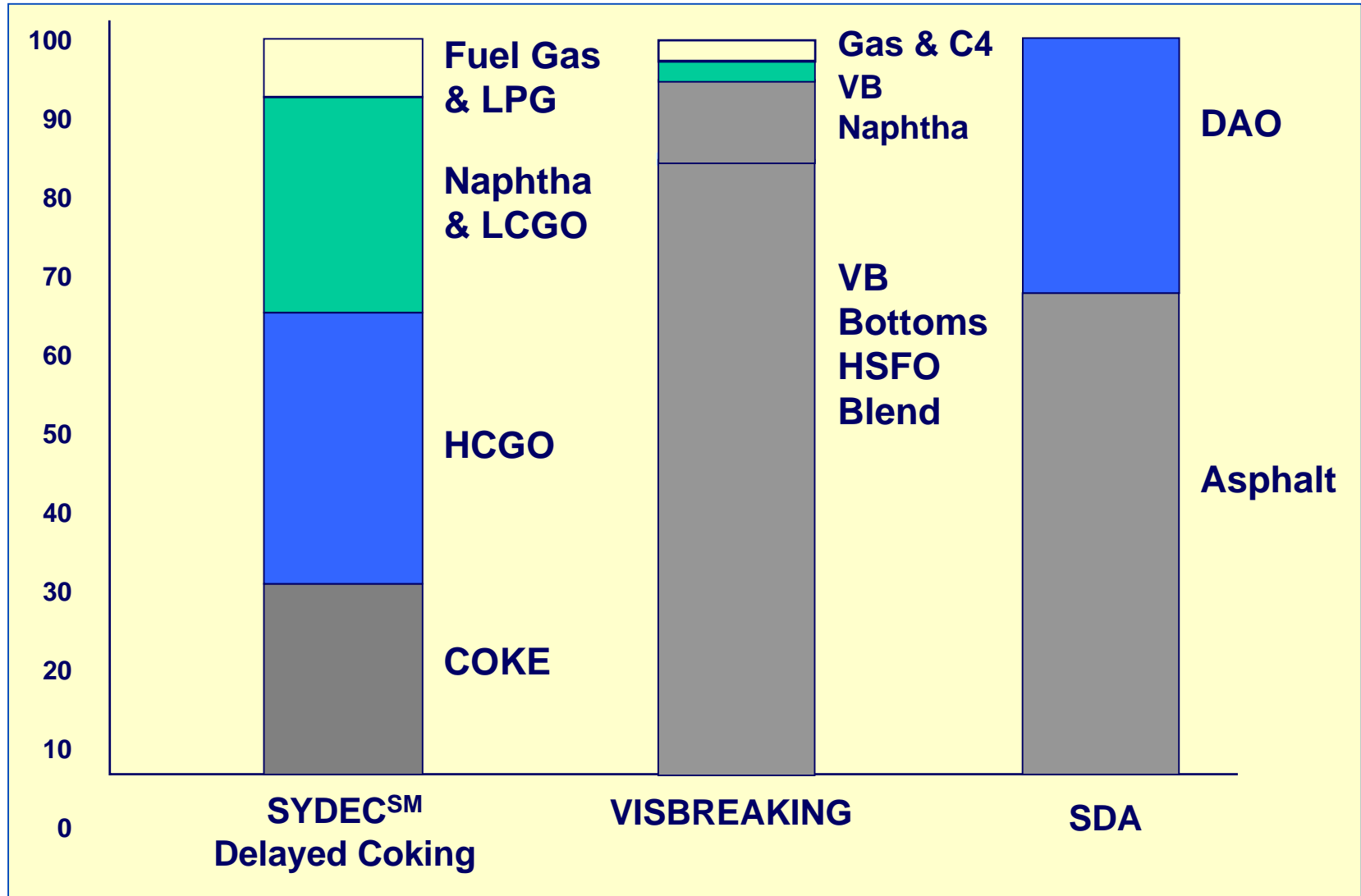
SDA: DAO properties for different crude resids – Ni+V



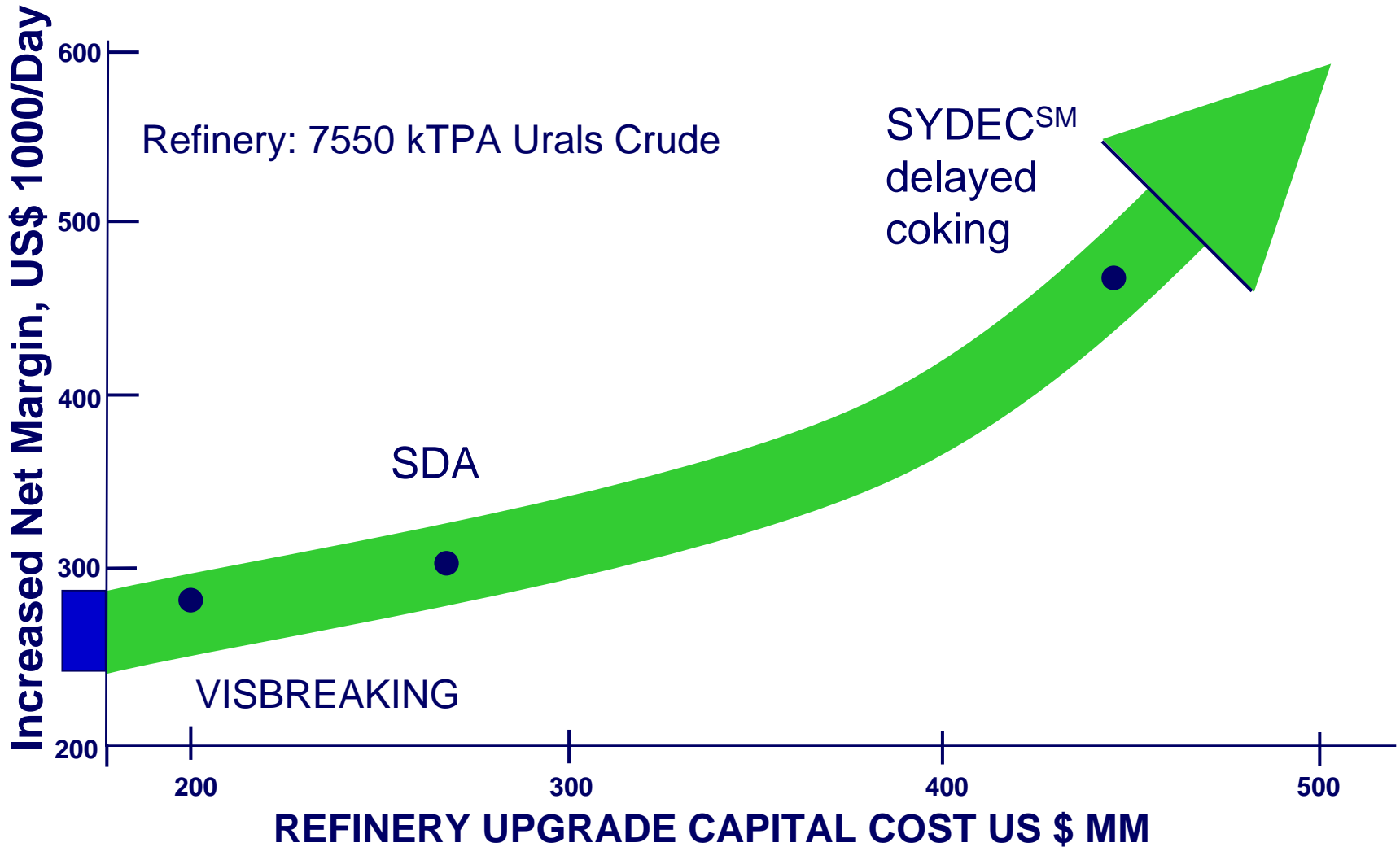
ASCOTSM: SDA & coking



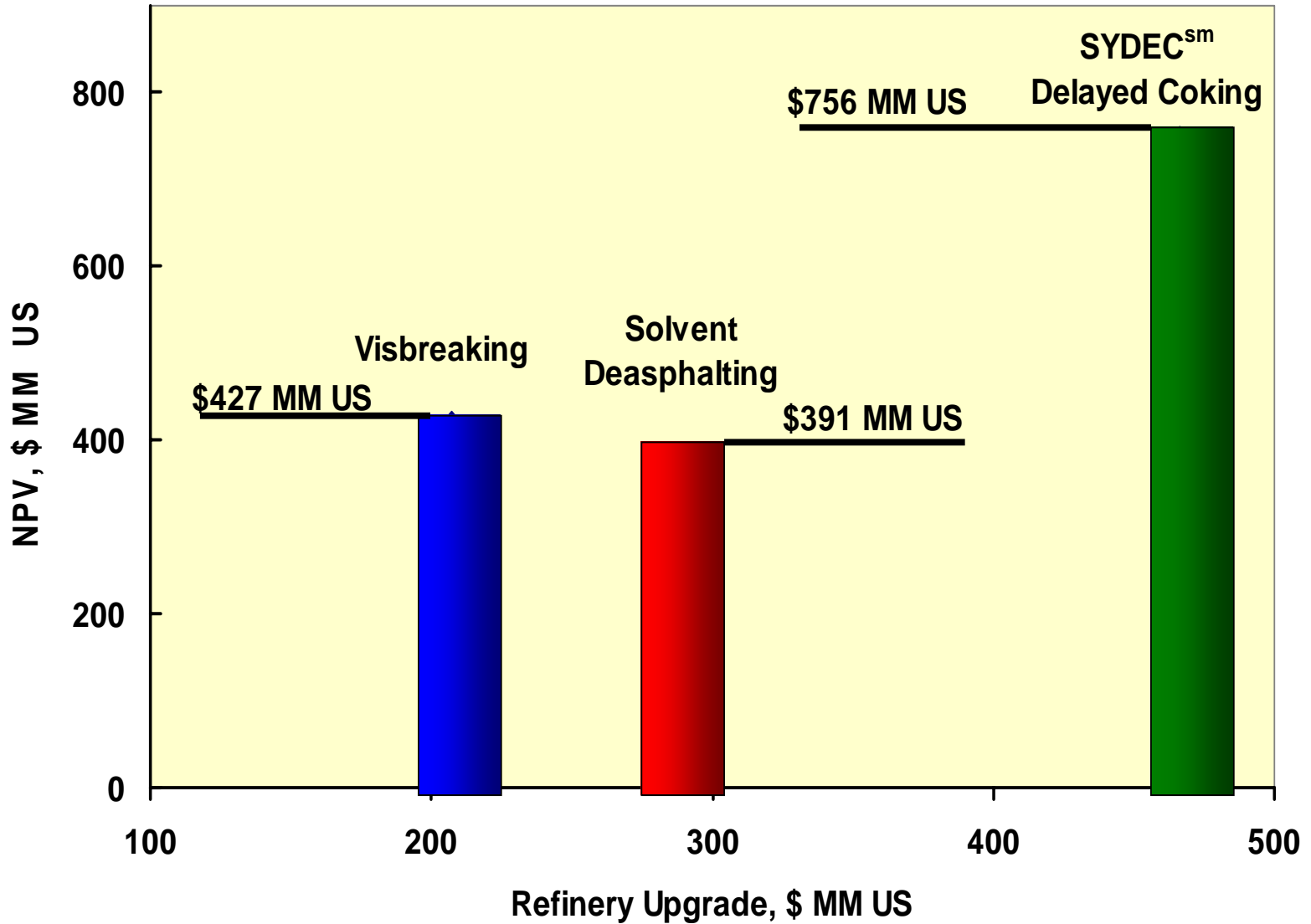
Conversion comparison



Residue conversion economic comparison



Net present value



Conclusion

- Process economics make non-catalytic carbon rejection processes an important residue conversion path for the foreseeable future.
- All three processes are proven & reliable
- Only coking can eliminate HSFO production
- Best solution for bottom-of-barrel upgrading & residue conversion is unique for each refinery
- **Foster Wheeler provides technology for delayed coking, and for visbreaking & SDA together with UOP**



Thank you



John D. Elliott
Deputy Director for Refining & Coking
Houston, Texas

John_elliott@fwhou.fwc.com

www.fwc.com