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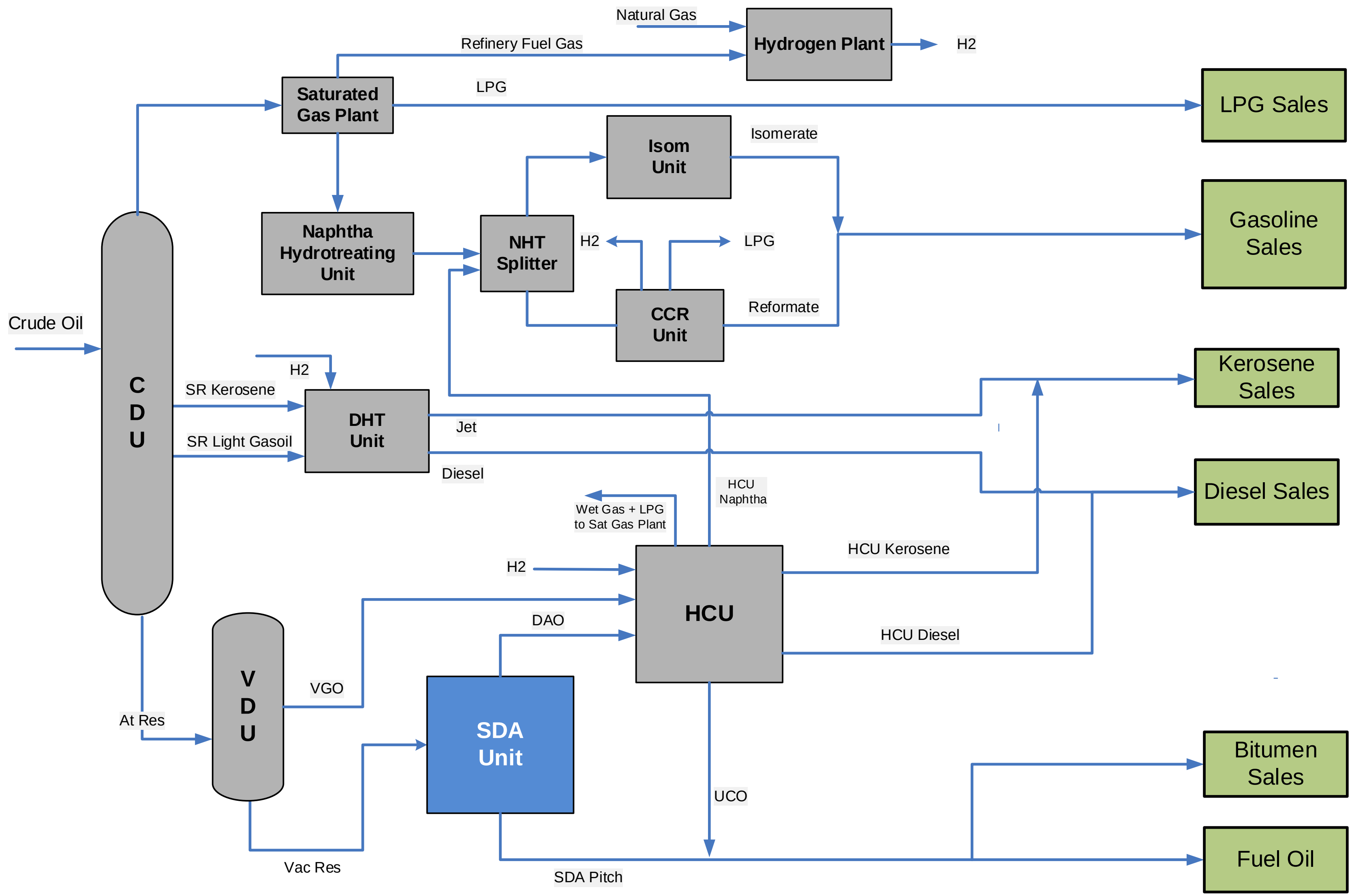
Solvent Deasphalting – Conversion Enabler

Honeywell UOP

5th December 2017 | Bottom of the Barrel Workshop | NIORDC, Tehran

Solvent Deasphalting (SDA)



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Agenda

Impact of heavy feeds on hydrocracking unit

Solvent Deasphalting process reduces contaminants in residue streams

Case study: Residue upgrading by SDA-HC

Residue Streams are Challenging to Process

- Contaminant levels increase with boiling range in most crudes
- Residue streams typically contain high sulphur, nitrogen, Conradson carbon, organometals and asphaltenes

Stream	Atmospheric Residue	Vacuum Residue
Sulphur, ppm wt	2.3	3.0
Nitrogen, ppm wt	**2600**	**4000**
Conradson Carbon, %wt	**8**	**16.3**
Ni + V, ppm wt	**83**	**164**
Asphaltenes, %wt	**1.5**	**3.1**

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Impact of Feed Contaminants on HC Unit Operation

1. ***Sulphur:*** Converts to hydrogen sulphide over hydrotreating catalyst. Competes for active sites on hydrocracking catalyst, reducing activity

2. ***Nitrogen:*** Converts to ammonia over hydrotreating catalyst. Reduces activity of hydrocracking catalyst

3. ***Conradson Carbon:*** Increases coke formation and shortens catalyst cycle

4. ***Metals Content:*** Vanadium and Nickel are catalyst poisons

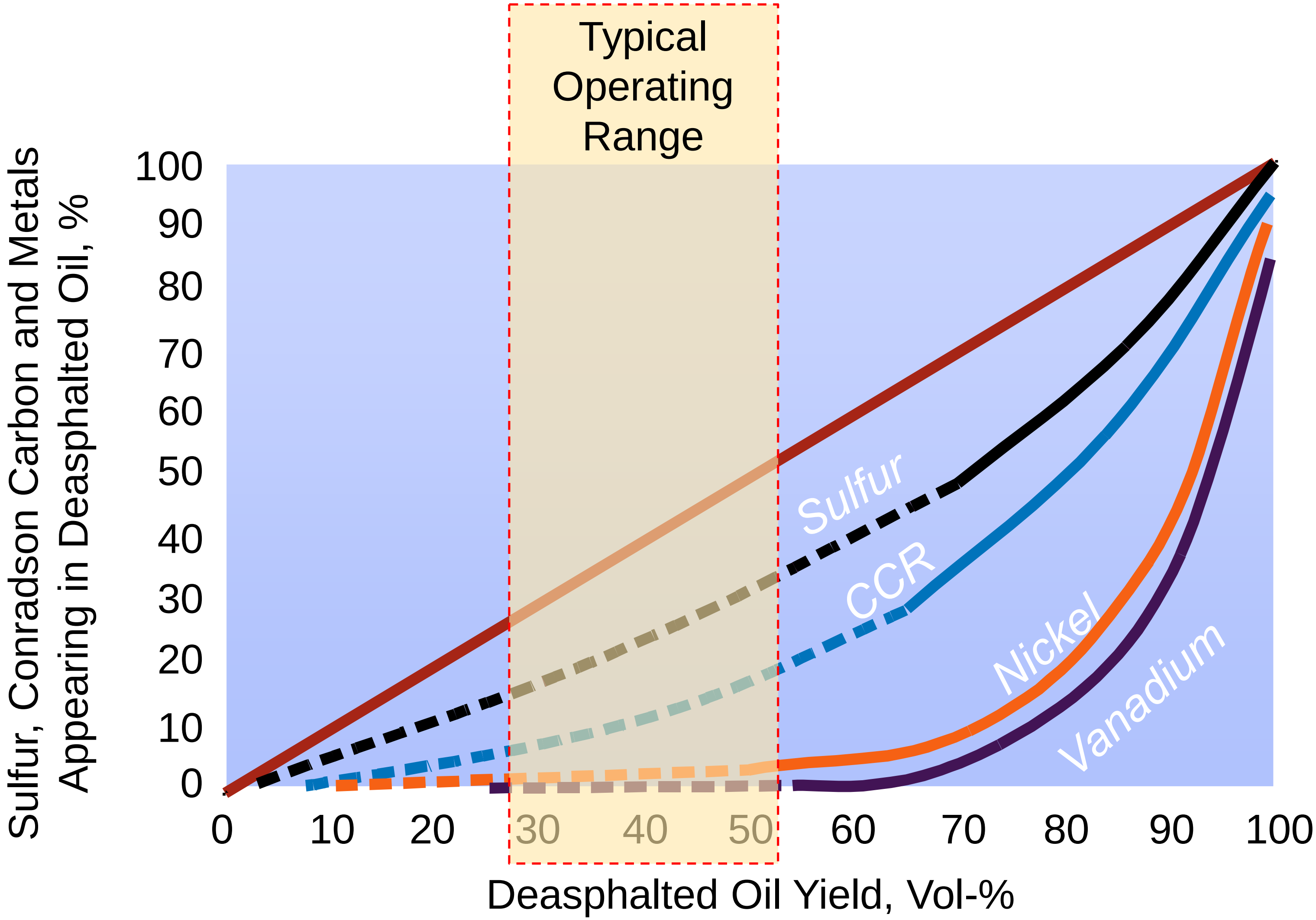
5. ***Asphaltenes:*** Indicative of heavy polynuclear aromatics (HPNA) precursors in the feed. Moderate levels cause rapid deactivation of catalyst and short cycle length.

SDA reduces contaminants to Hydrocracker

Solvent Deasphalting (SDA) Process

- Licensed technology for reduction of contaminants in feedstocks such as AR, VR by physical separation
- Reduces the contaminant (sulfur, nitrogen, Conradson carbon, asphaltene and Ni+V) contents of feedstocks to produce:
  - Deasphalted Oil (DAO) containing lower levels of contaminants
  - Pitch containing most of the feed contaminants
- Light liquid paraffins (typically C3 to C5 range) precipitate asphaltenes and resins from heavy oils
- Separation of DAO and solvent under either subcritical or supercritical conditions
- Combines commercially-proven process technology with proprietary extractor internals

Selectivity in Solvent Deasphalting



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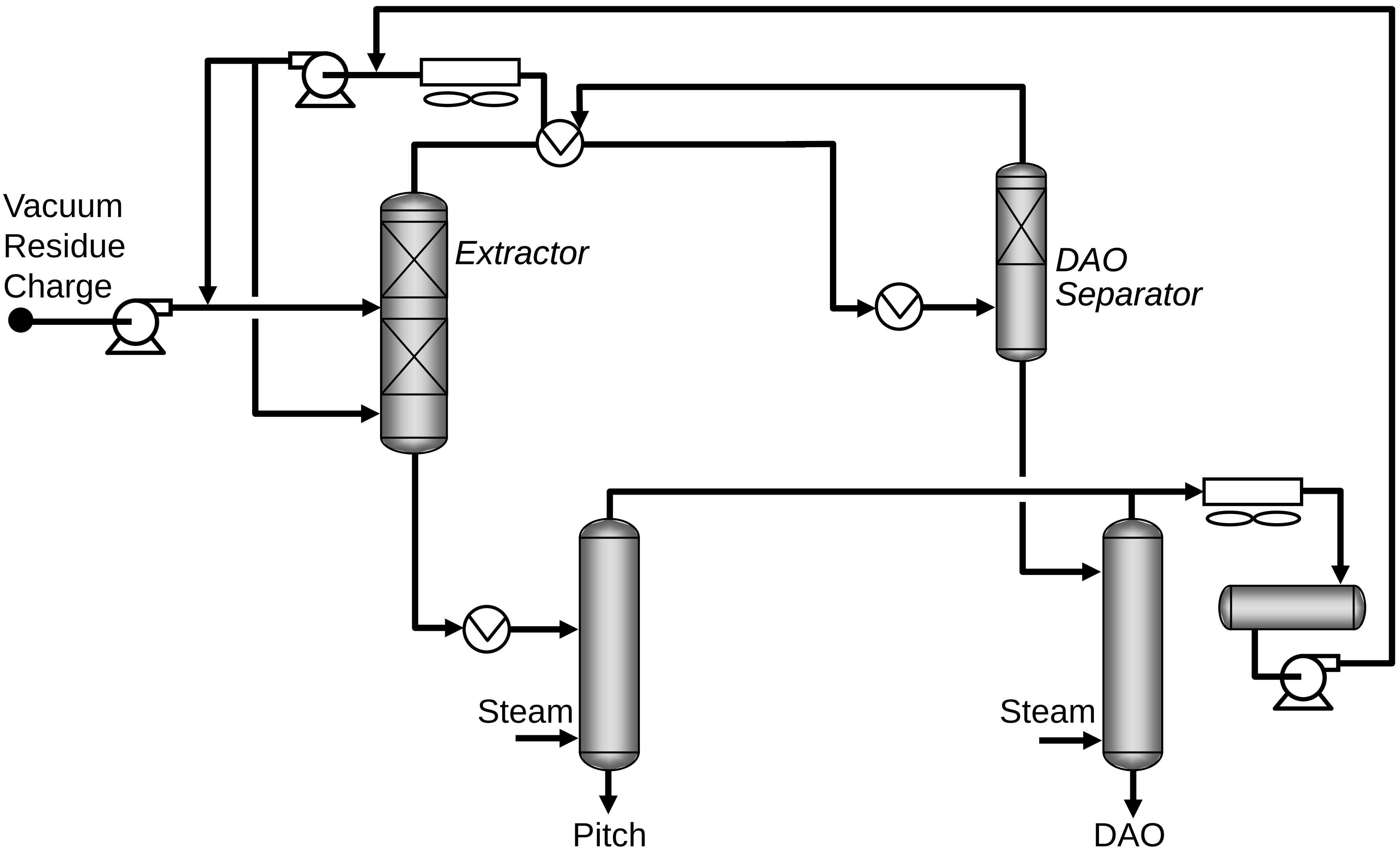
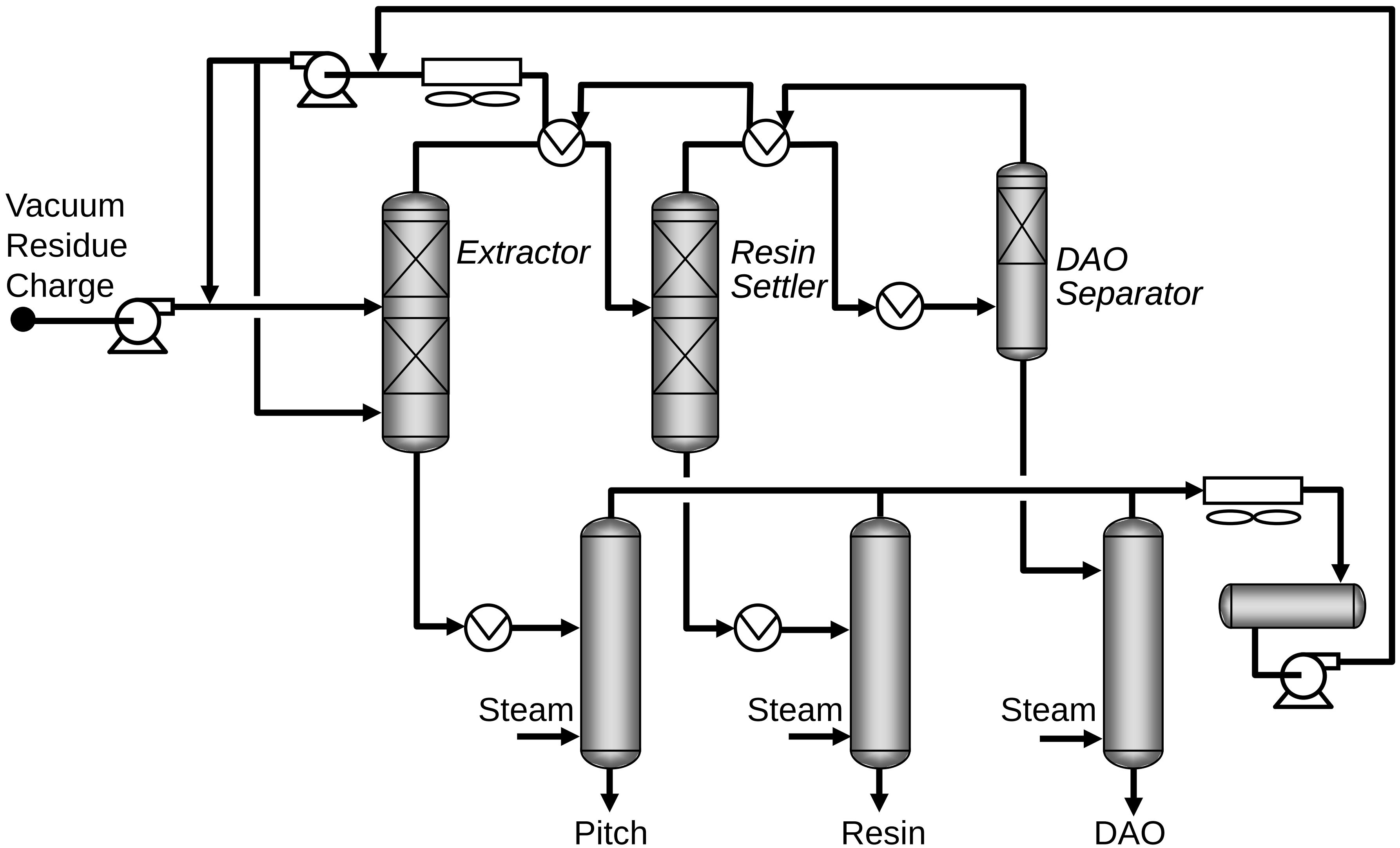
SDA Process (Two-Product Configuration)



SDA Process (Three-Product Configuration)



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Uses for SDA Pitch

- Fuel for steam / power generation
- Fuel for cement manufacturing
- Bitumen manufacturing

SDA Commercial Experience

- Combination of UOP and Foster Wheeler technology
- First unit licensed in 1973
- >45 units licensed with a combined capacity of >650,000 BPSD
- Both 2 product and 3 product configurations in successful operation

SDA Technology is Highly Cost Effective

- Low capital cost
  - Carbon steel equipment
  - Low pressure
  - No compressors

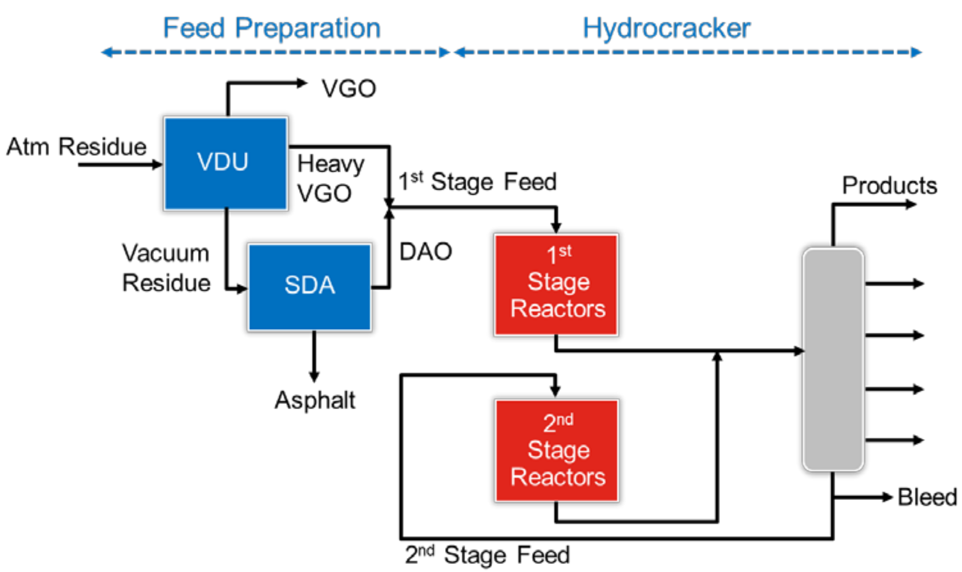
- Potential for very high local content

- Low solvent consumption and cost
  - Solvent typically C4s from refinery LPG system

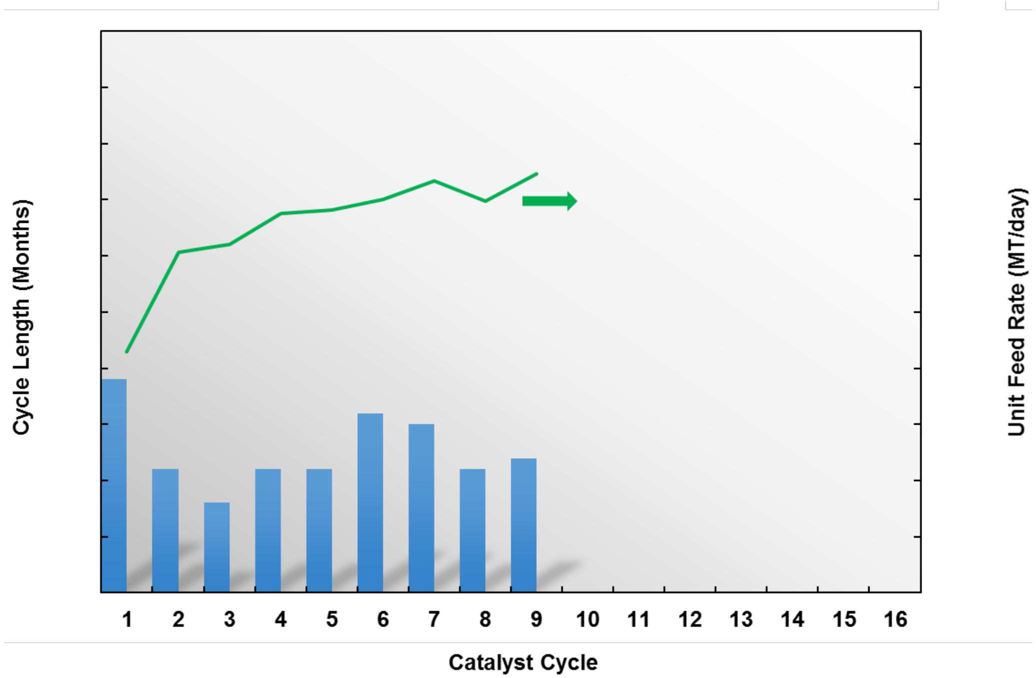
Low Cost – High Effectiveness

Case Study: Upgrading by SDA - Hydrocracking

- Two stage hydrocracking unit licensed by a competitor
  - Feed 25% DAO, 75% heavy VGO
  - Full conversion
  - Maximum kerosene and diesel



Initial Operating Cycles Highlighted Challenges with DAO Processing



- HPNA = Heavy Poly Nuclear Aromatics
  - Compounds with 7+ aromatic rings, e.g. tribenzcoronene

- First 9 cycles used competitor catalyst
- Average cycle length ~12 months
- Severe fouling of heat exchangers led to heater limiting unit
- Fouling of second stage catalyst top bed caused high pressure drop
- Deactivation of cracking catalysts from HPNAs
- DAO contains high levels of HPNA pre-cursors

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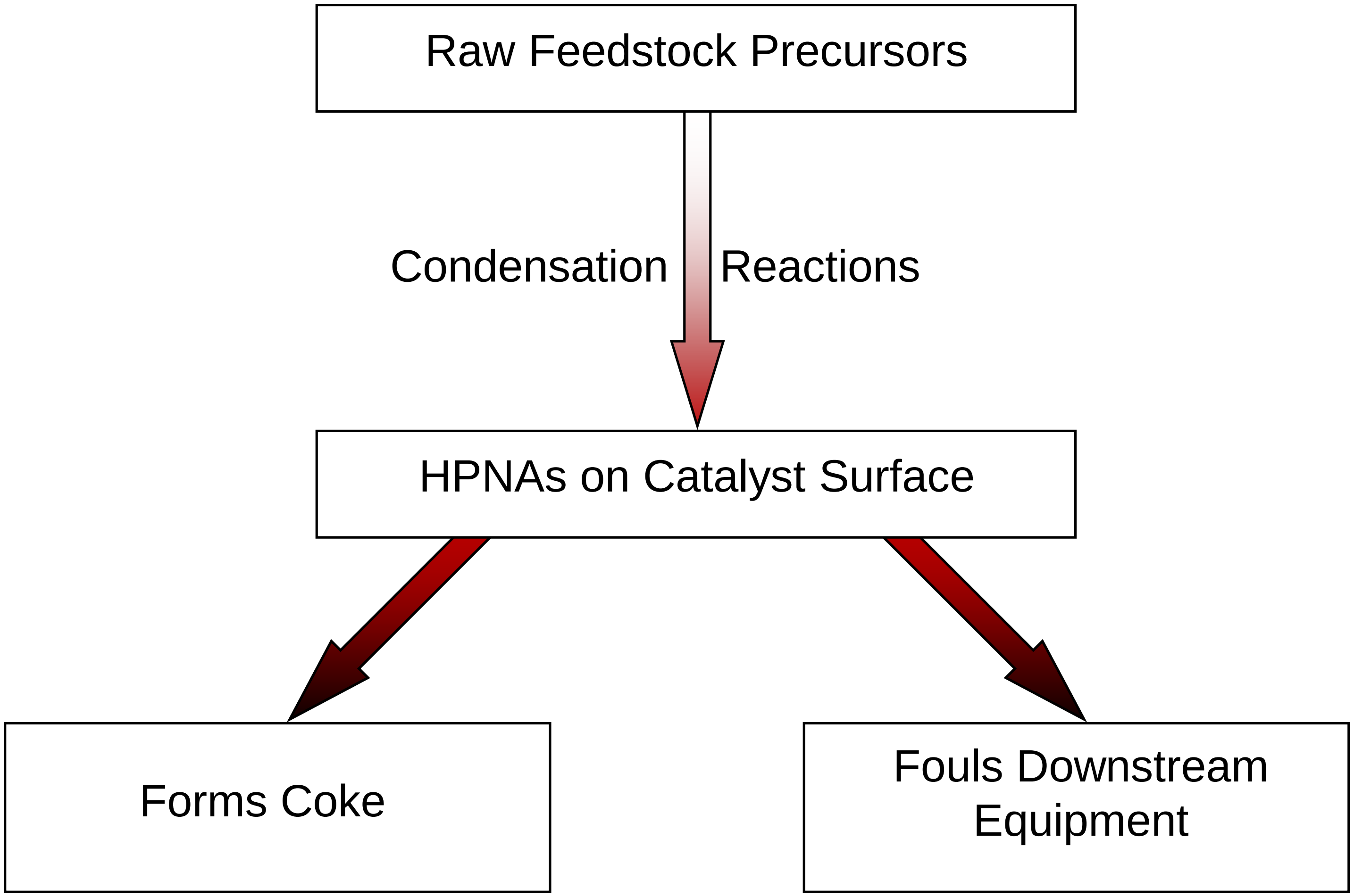
Why are HPNAs Important?



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UOP Catalyst & HPNA Management Technology Installed

- UOP catalyst loaded in Cycle 10
  - Catalysts with proven track record in DAO service
  - Supported with pilot plant work

- UOP HPNA-RM^{TM} module installed on recycle to second stage during cycle 10
  - Carbon bed technology to absorb HPNA

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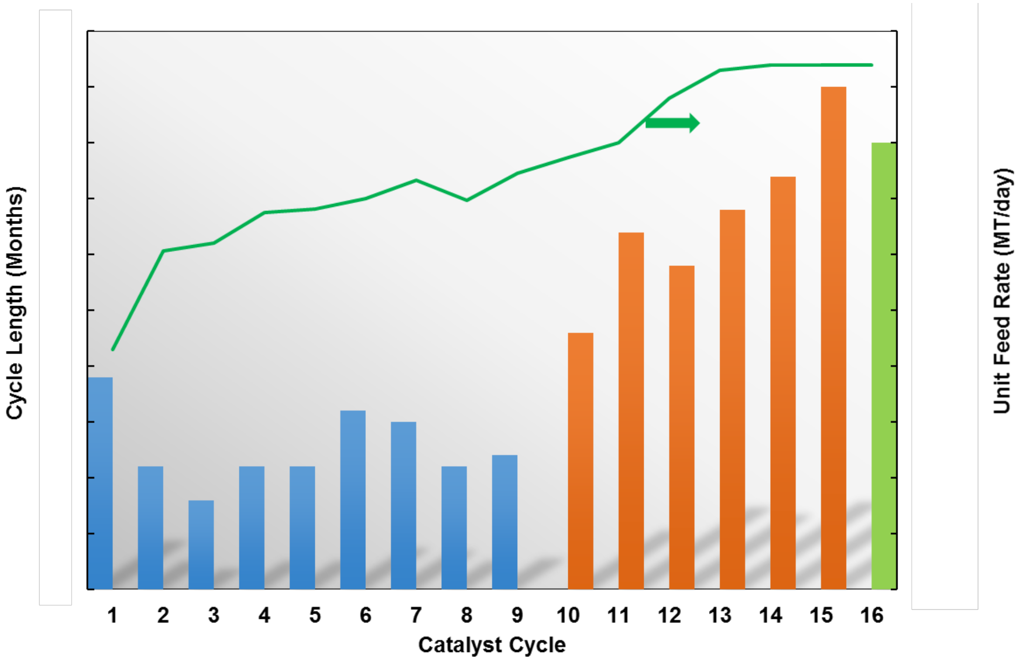
Step Change Improvement in Cycle Length



- Improvement achieved by:
  - Implementation of HPNA management technology
  - Catalyst system improvements
  - Continuous development of the unit by the refiner (e.g. filters, exchangers)

Significant Improvement in Unit Performance

- Capacity increased by 42%
- Cycle length increased by >300% - at higher feed capacity
- Refiner chose UOP catalysts for all following cycles
- Operation now limited by factors outside unit

UOP HPNA management is proven enabler for SDA-HC scheme

Summary - Benefits of adding SDA – HC Complex to an Existing Refinery

- Scenario:
  - 100,000 bpsd refinery with existing vacuum distillation and recycle hydrocracking unit
  - Add a new SDA unit
  - Revamp the hydrocracker - full conversion at higher capacity
- Project provides significantly higher refinery profitability
  - 40% decrease in fuel oil
  - 12% increase in refinery Euro V diesel production
  - Increase value of refinery products by around 170 million $/year
  - Payback on capital cost <4 years
- Optimisation of SDA – HC complex requires specialist knowledge
  - Balance fuel oil upgrading with impact on hydrocracker
  - Ensure pitch properties meet requirements for proposed use
  - Managing HPNAs is critical to successful operation – UOP has proprietary technology to achieve this

Basis: EuroV diesel 61.9 $/bbl, Fuel Oil 21.6 $/bbl

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