Solvent De-asphalting of Short Residue :

Indigenous Technology and Further Development

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SYMPOSIUM
ON
SOLVENT EXTRACTION REVISITED
FEBRUARY 5TH – 6th , 2010
IIChE (NRC) Auditorium

Solvent Deasphalting

- Introduction
- Deasphalting solvents
- Process variables
- Solvent recovery
- Lube & conversion feed-stock preparation
- New Approaches
- Summary

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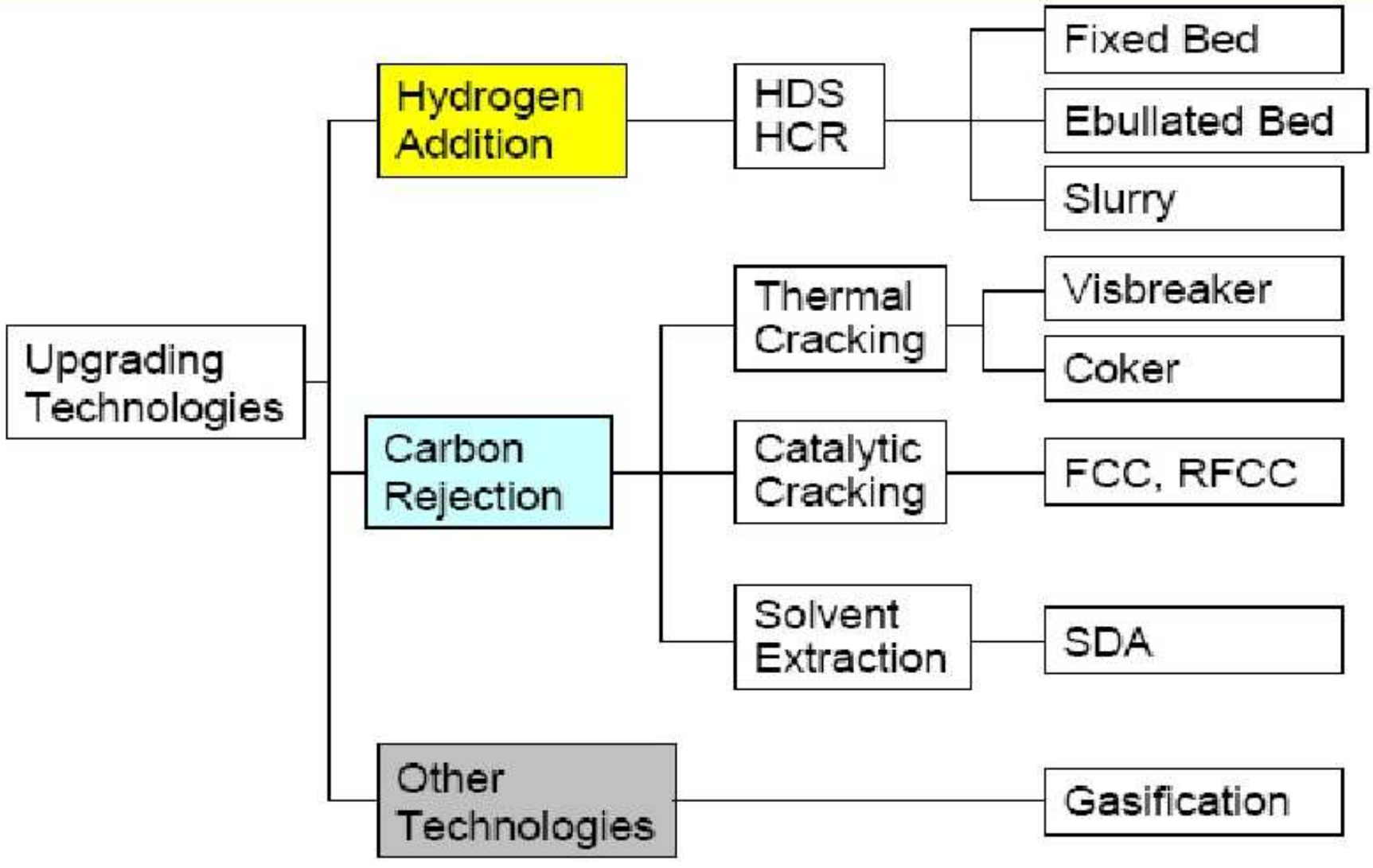
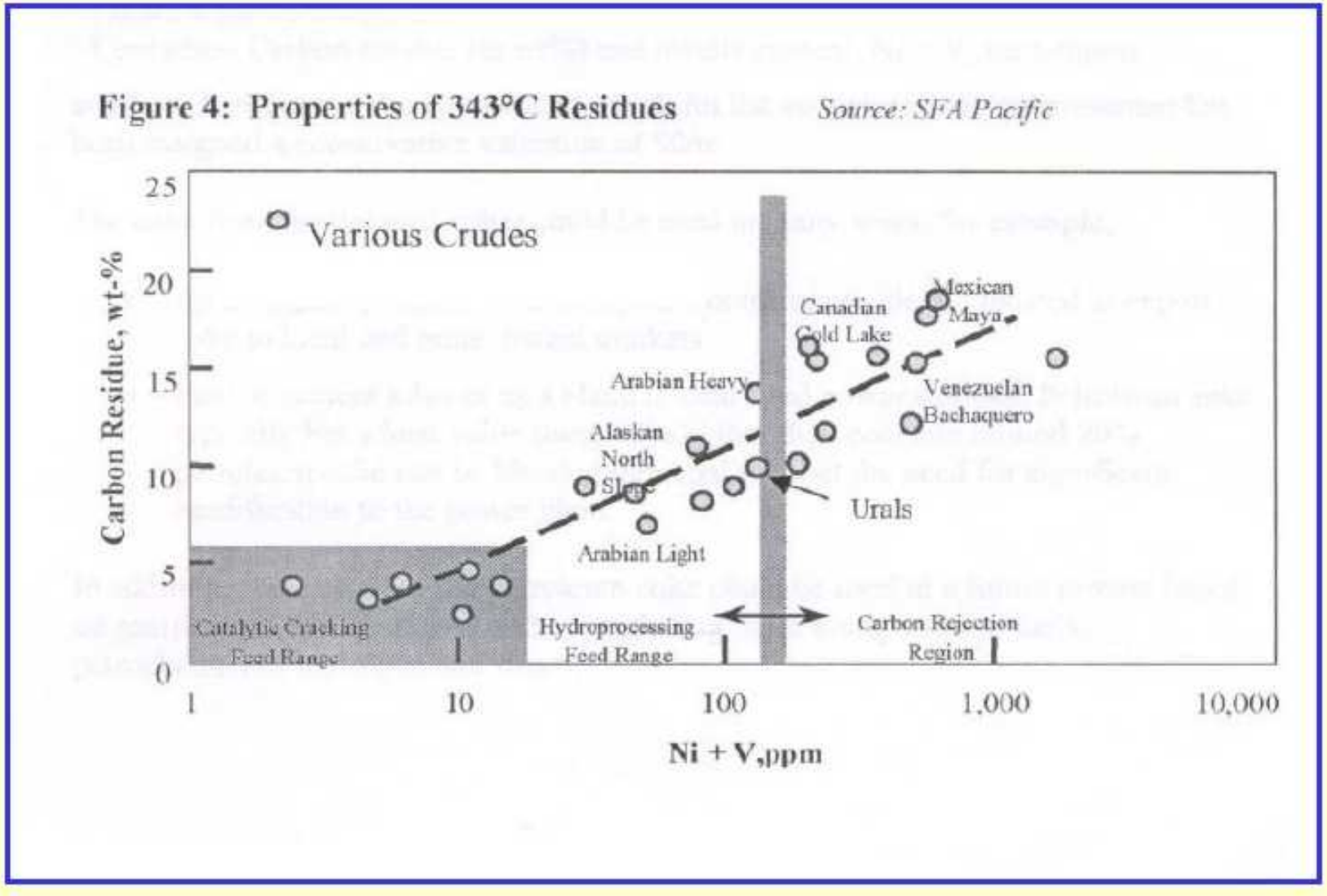
Residue Upgrading Processes



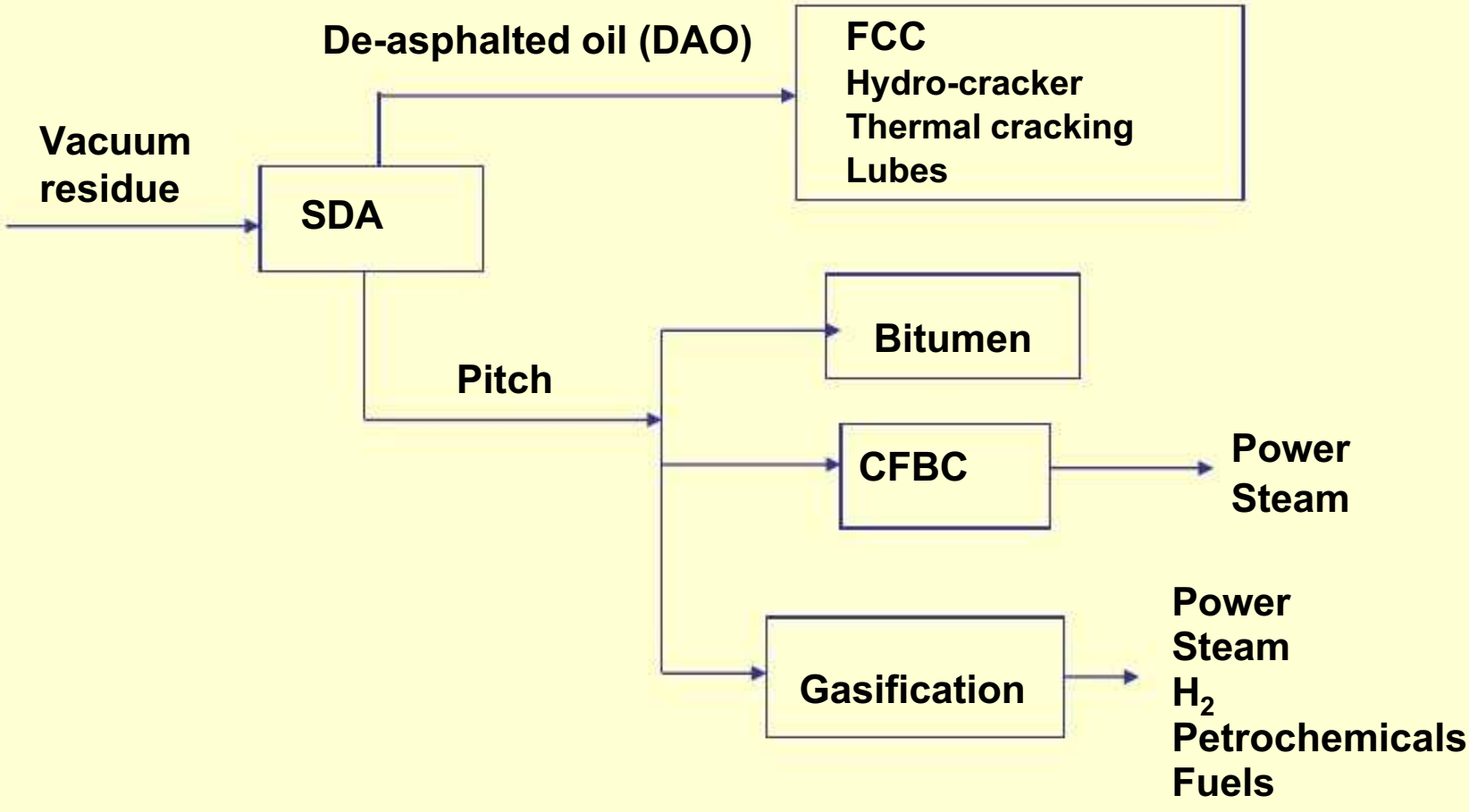
Residue Upgrading Choice of Process



SOLVENT DEASPHALTING

- A physical – separation based residue up-gradation process, separates vacuum residue on the basis of both molecular type & size.
- Produces extra heavy viscosity lube base stock and / or feedstock for conversion units.
- Pitch or Asphalt is obtained as bottom product

Applications of solvent deasphalting



Deasphalting Solvents

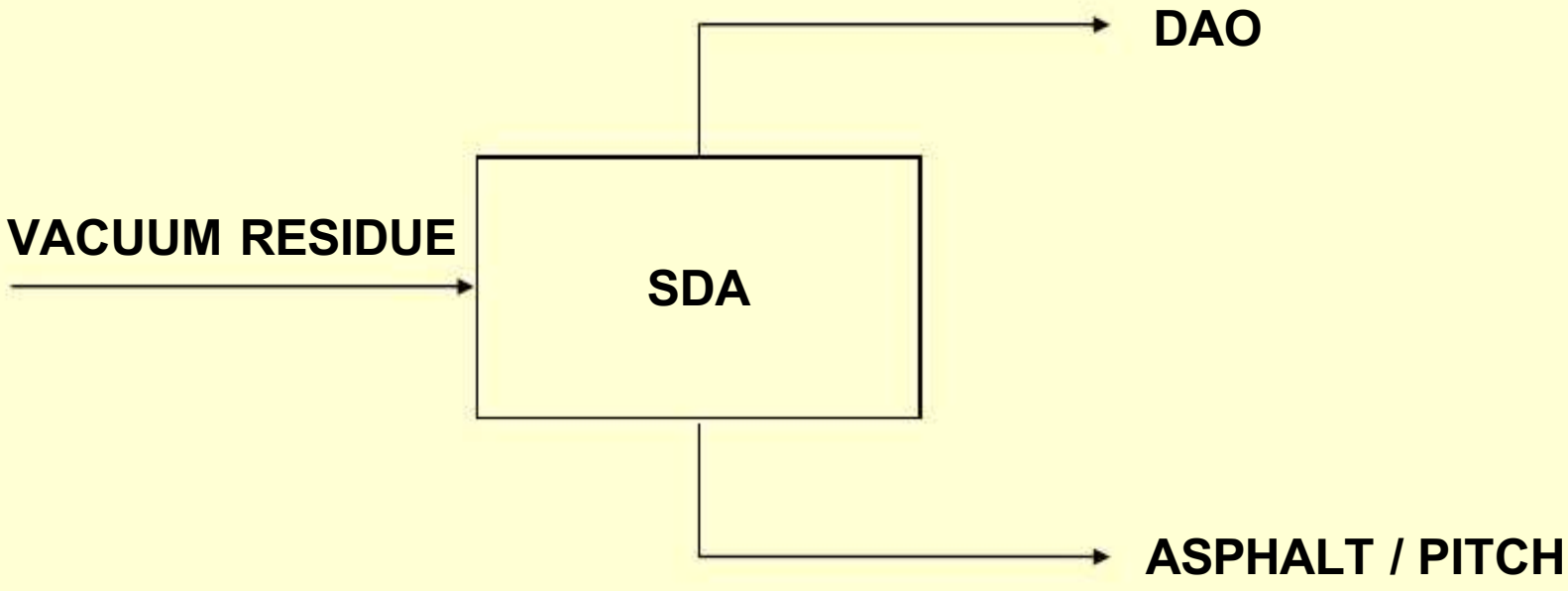
Commercially used solvents are

- **LIGHTER SOLVENTS : PROPANE & ISOBUTANE**
  - Higher selectivity
  - Reject all resins and asphaltenes
  - Suitable for production of lubes oils
- **HEAVIER SOLVENTS : n-BUTANE, PENTANE (n& i) and LIGHT NAPHTHA**
  - -- Less selective than the lighter solvents
  - Produce higher yields of DAO/DMO (suitable as conversion feedstocks)

General Properties Deasphalting Solvents

- Solubility of oil decreases with increase in temperature
- More selective at higher temperatures
- Exhibit lower critical solution temperature

Product Applications



- DAO and Asphalt are not finished products
- Require further processing

Processing of DAO

PROCESSING FOR

LUBE : **Lube production increased by approx 20%**

CRACKING : **1/3rd of cat. cracking feed in a refinery can be DAO**

HYDROTREATING : **Economical, consumes less hydrogen, less investment**

Processing of Asphalt

Process

BLENDING : Tailor made asphalt (bitumen) or fuel oil

VISBREAKING : Minimizes need or cutter stock

GASIFICATION : Hydrogen, steam and power production

DEASPHALTING: PROCESS VARIABLES

- **SOLVENT COMPOSITION**
  - Blends of light hydrocarbon solvents
  - Increased operating flexibility

- **SOLVENT-TO-FEED RATIO (S/F)**
  - Selectivity improves by increasing S/F at constant DAO yield
  - Economically optimum S/F is used

- **TEMPERATURE / TEMPERATURE GRADIENT**

  Oil solubility in solvent
  - Decreases with increase in temp. (optimum temps)
  - Temp. gradient improves separation between DAO-Asphalt phases

- **PRESSURE**
  - Maintained above V.P. of solvent at operating temperatures.

LUBE APPLICATIONS OF DEASPHALTING

PROPANE DEASPHALTING (PDA)

- **PDA PRODUCES DAO FOR:**

  - Heavy lube oil base stock / bright stock
  - Cylinder oils

- **OPERATING CONDITIONS:**

  - Temperatures : 50 to 80°C
  - S/F (vol /vol) : 6 to 10
  - Pressure more than vap. pr. of the solvent

Lube Oil Base Stock (Bright Stock) Production From Dao

- **CONVENTIONAL ROUTE**
  - **Solvent refining**
  - **Solvent dewaxing and**
  - **Hydro finishing**

- **HYDROPROCESSING ROUTE**

- **DESIRED QUALITY OF DAO FOR BRIGHT STOCK**

  - VISCOSITY, cSt, @100°C : 28 – 32
  - CCR, WT% : < 2.0

- **QUALITY OF DAO FROM REFINERIES:**

	HALDIA	**CPCL**	**HPCL**
KIN. VISC. cSt @98.9°C	36-42	35-38	28-32
CCR, wt%	1.7 – 2.0	1-1.2	1.5-2.2

PROPANE DEASPHALTING - STATUS

PLANT	CAPACITY, MMT/A	TECHNOLOGY
HPCL, MUMBAI	548,000	IIP / EIL
CPCL, CHENNAI	574,000	IIP / EIL
IOC HALDIA	650,000	ROMANIAN/ EXPANSION BY EIL / ROSE

- All plants produce LOBS(BS)
- Solvent recovery : evaporation mode / supercritical mode
- Development of know-how for supercritical mode is recently done by IIP,EIL & HPCL

Heavier Solvent Deasphalting

Heavier solvents:

- **C_3/C_4 MIX**
- **n – BUTANE**
- **PENTANES (n & i)**
- **LIGHT NAPHTHA**

Produce higher yields of DAO / DMO compared to propane

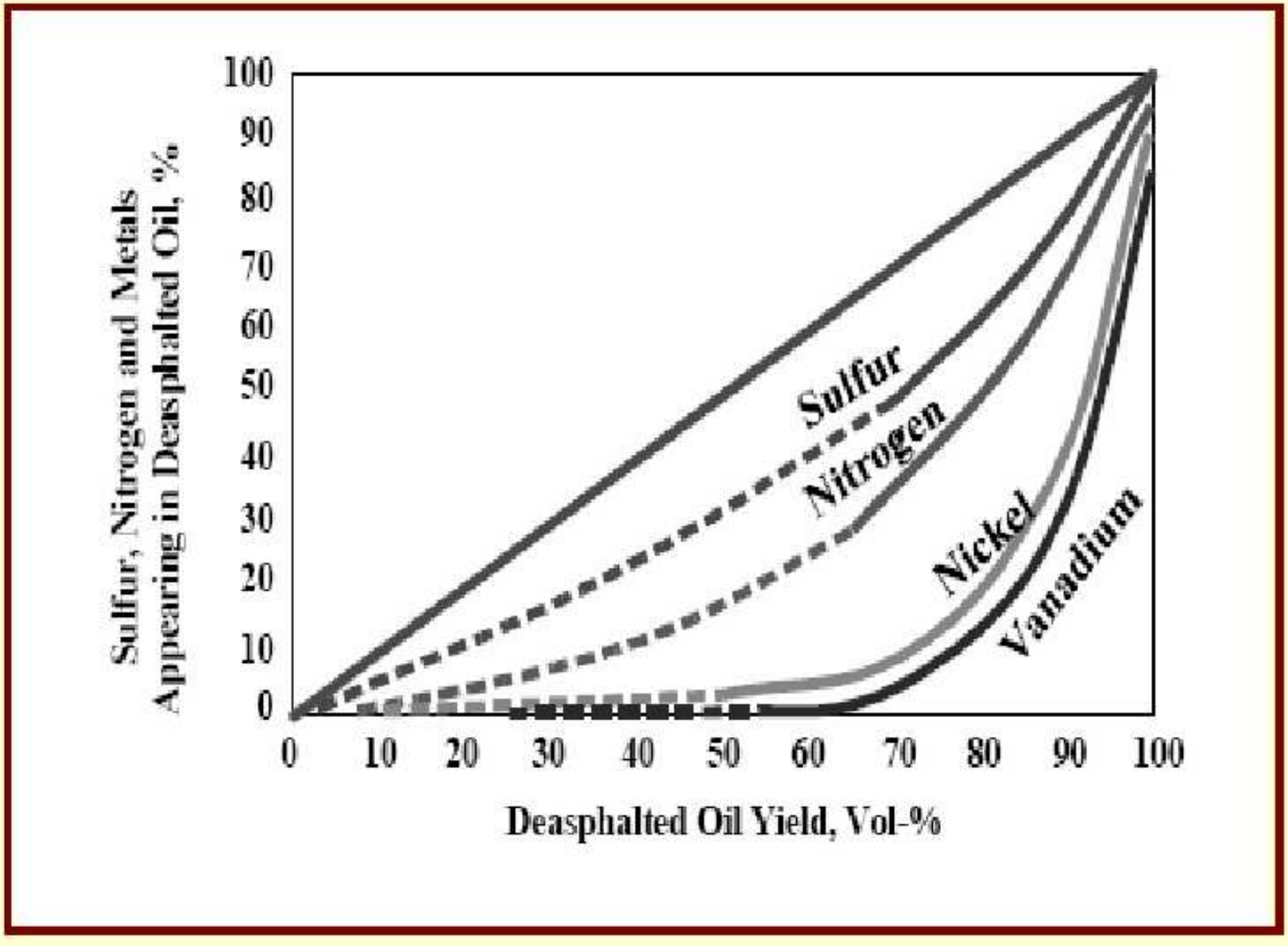
Status

- No application in India so far

COMPARISON OF SOLVENT (C_3 – C_5)

Solvent	Feed (SR)	Propane (C_3)	Propane – butane (C_3/C_4)	Butane (C_4)	Pentane (C_5)
		DAO			
Yield, wt%	100	29	46.8	67.3	82.8
API gravity	6.6	21	16	12.1	10.3
Viscosity, cSt @ 100°C	1900	35	110	340	800
CCR, wt%	22.1	1.5	5.0	10.6	14.0
Sulphur, wt%	4.29	2.60	3.0	3.6	3.9
Asphaltenes, wt%	--	--	--	--	--
Metals, ppm					
"V"	70	1.1	2.5	7	23
"Ni"	21	0.3	0.7	2.1	7
		ASPHALT			
Sp. Gravity	--	1.047	1.089	1.116	1.175
Sof. Pt. (R&B), °C	--	160	225	270	390
PEN. (25°C, 100g, 5 sec.) 1/10 mm	--	5	0	0	0
(Feed : Arabian medium V.R)					

DAO Yield - Quality Relationship



General Operating Conditions of SDA Units Vs. Type of Solvent

OPERATING CONDITIONS	PROPANE	BUTANE	PENTANE
EXTRACTION RANGE (°C)	50 – 80	100 – 130	170 – 210
PRESSURE RANGE (MPa)	3.5 – 4.0	≃ 4.0	≃ 4.0
SOLVENT RATIO (VOL.)	6 – 9	4 – 7	3 - 5

Solvent Recovery From DAO & Asphalt Phases

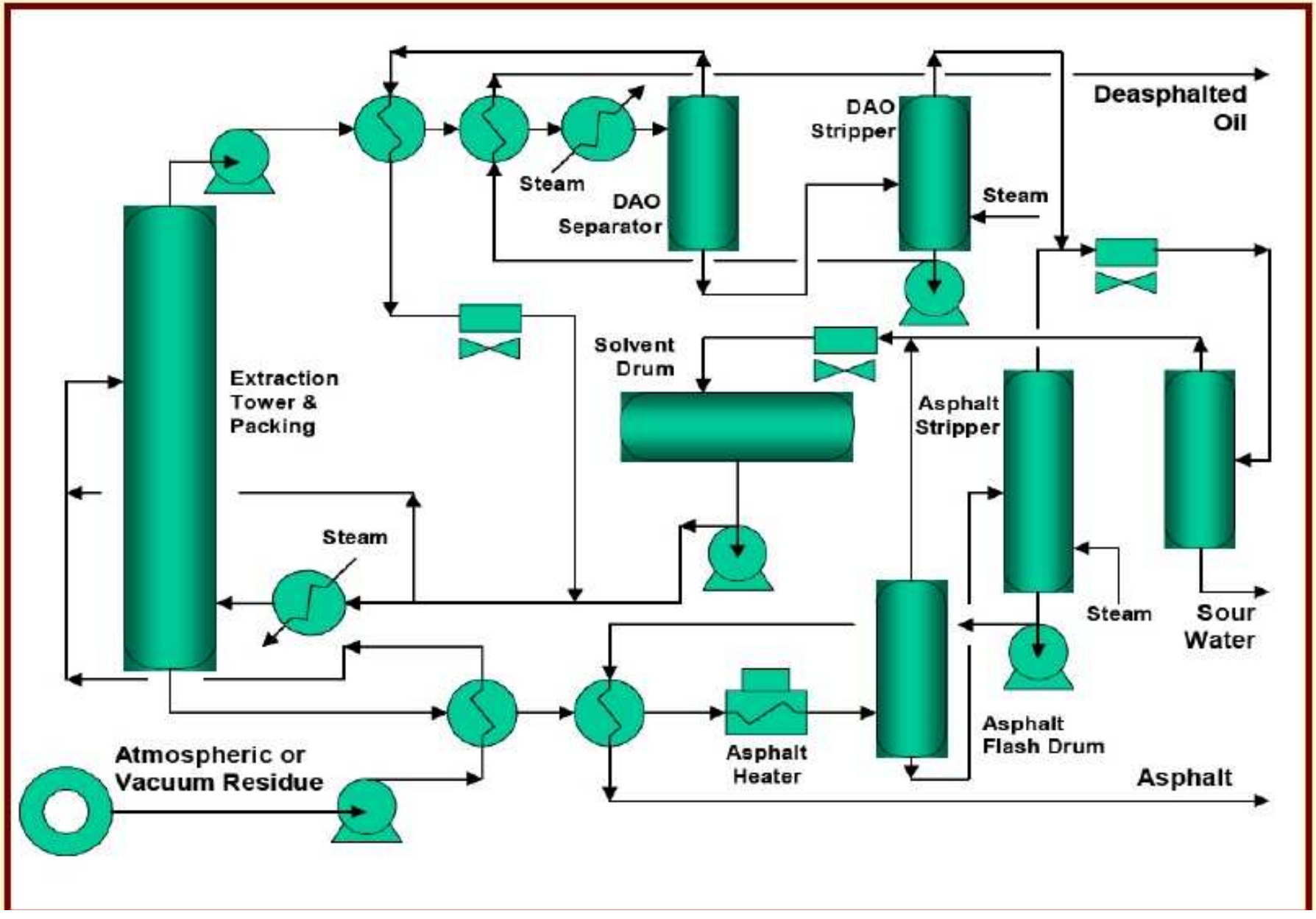
- **EVAPORATIVE MODE**
  - Multiple effect evaporation (up to 3 stages)
  - Series of progressively lower pressure flashes followed by stripping

- **SUPERCRITICAL MODE (FOR DAO/DMO PHASE)**
  - Phase separation at / above critical temperature of solvent
  - 85 to 93% solvent recovered as lighter phase for heat exchange and recycle in the process
  - Recovered solvent has very low DAO content
  - Remaining solvent from DAO recovered by flashing / stripping

Advantages of Supercritical Solvent Recovery

- More energy efficient approach
- Utilities savings up to 40% (with heavier solvents)
- More compact unit
- Savings in capital investment for grass-root plants (15 to 25%)

Supercritical Solvent Recovery



Deasphalting For Conversion Feedstock Preparation

Conversion Feed-stocks

- **VGO**

  Produced through vacuum distillation (broad cut ~ 370-540°C, typical)

- **DAO / DMO**

  Produced through heavier solvent deasphalting

Feed Stock Characteristics and Their Affects

Feedstock for conversion processes like FCC and Hydro-cracking require control on contents of following impurities

- **NITROGEN**
- **SULFUR**
- **METALS (Ni & V)**
- **CCR**
- **ASPHALTENES**

Effect of Impurities

- **NITROGEN**

  Nitrogen compounds neutralize acidic function of catalyst, essential for cracking

- **SULFUR**

  Causes corrosion and catalyst poison

- **METALS**

  Deposit irreversibly on catalyst surface, influence life of catalyst

- **CCR / ASPHALTENES**

  Coke precursors

Typical feed stock impurities - Limitations

Feed to Unit	Nitrogen, Wt%	Sulphur, Wt%	CCR, Wt%	Metals (ppm)
FCC	0.20	2.5	2.0	2
RFCC	--	--	8.0	30-50
Hydrocracking	0.12	3.0	1.5	3

Solvent Deasphalting – New Approaches

- **Residue Decarbonization Process / Technology (RDCP)**
  - The process uses self catalysed reactor and combines with solvent deasphalting
  - Non-coking reactor produces light cuts / distillates
  - Heavy liquid phase is sent to deasphalting
  - Light cuts and deasphalted oil are blended to yield product for further processing
  - Yield of liquid products increases about 10 wt%

- **SDA process is being applied in many ways allowing the refiner to move towards zero fuel oil production**