



ESDU-SPC-M7-1

Apr.08: Modelling of asphaltenes deposition and removal in crude distillation units

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Modelling of asphaltenes deposition and removal in Crude Distillation Units

Part of the CROF Theme III:
Fundamental Transfer Processes

Sub-Project C

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SUB-PROJECT C: OBJECTIVES

Currently, fouling rates in a CDU are calculated using semi empirical “fouling threshold” models.

The objectives of sub-project C are to:

- To investigate the **fundamental mechanisms** leading to deposition and removal.
- To **predict** the deposition and removal rates as a function of the relevant system parameters.
- To integrate within sub-project C information from plant data and other Sub-Projects and to **validate** the modelling predictions against experimental observations (obtained in Sub-Projects E and F).

FOULING IN HEAT EXCHANGERS OF CRUDE DISTILLATION UNITS

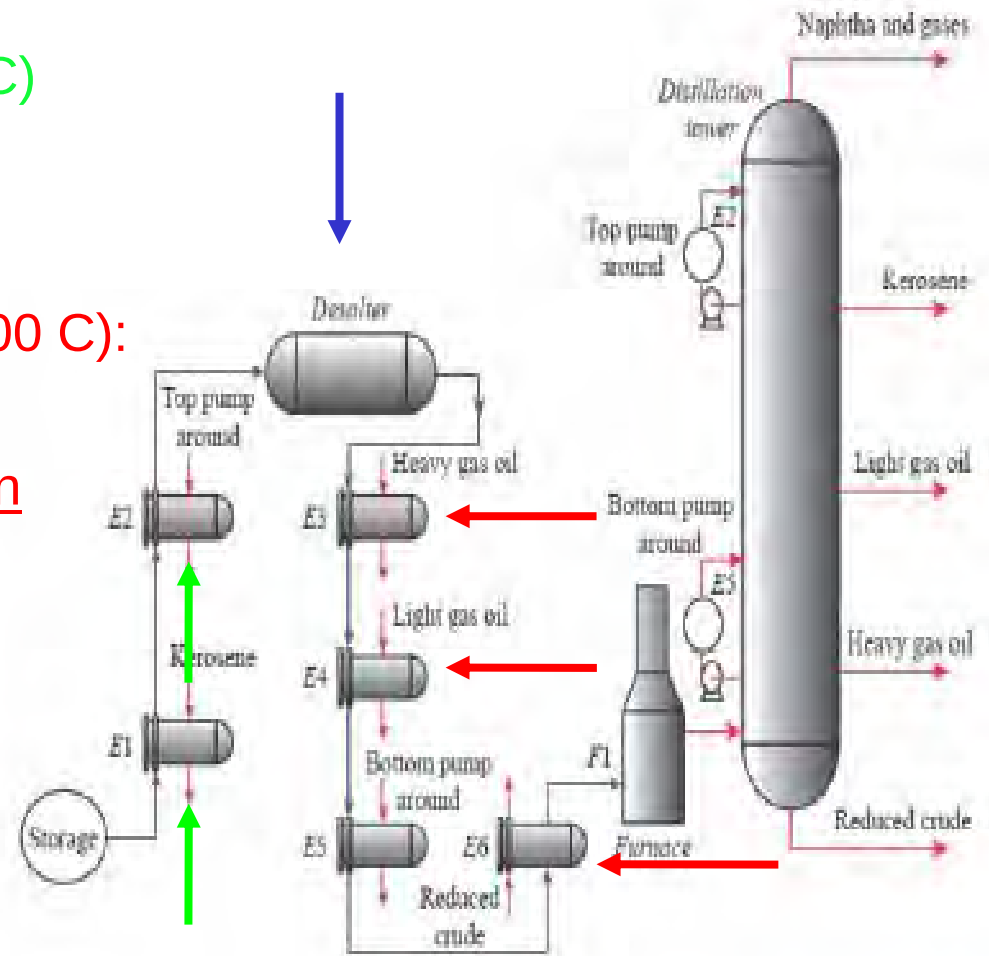
Heat exchangers in CDU use the largest fraction of the energy needed in oil refining and fouling of those units accounts for large energetic losses

First heat exchanger train (110-150 C)

Desalter

Second heat exchanger train (230-300 C):

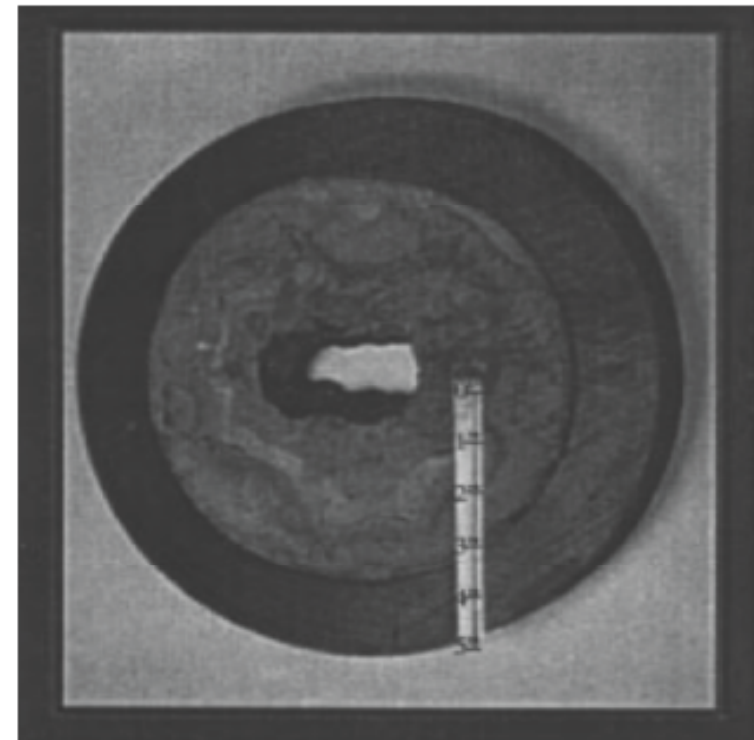
Heavy organic fouling deposition



FOULING IN HEAT EXCHANGERS OF CRUDE DISTILLATION UNITS

ORGANIC COMPONENTS DEPOSITS

- Some components **aggregate** and **deposit** when T increases
- Reduced thermal conductivity due to fouling resistance **R_f**
- **Pressure drops**
- Plugging phenomena - Lichaa [1975]
- Energy needed for refining increases
- **Economic** and **environmental** issues



FOULING IN HEAT EXCHANGERS OF CRUDE DISTILLATION UNITS

Accurate **predictions** and understanding of fouling composition, mechanisms of production, **deposition** and **removal** are needed

Empirical or semi-empirical correlations are currently used (TEMA) mainly based on data-fitting without fundamental understanding of physical, chemical, dynamic and mechanical processes involved

New approach combining:

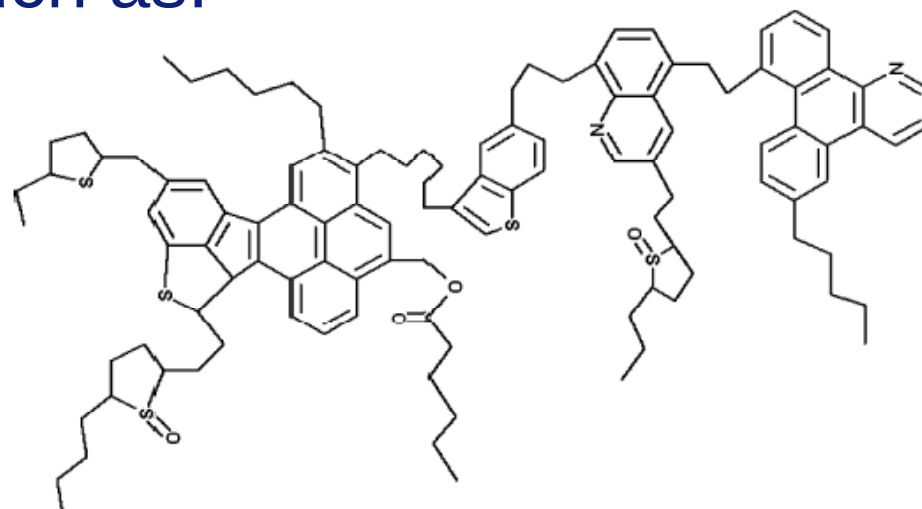
- Mass, momentum, energy conservation
- Heat conduction
- Chemical equilibria

PROBLEM CHARACTERIZATION: ASPHALTENES

Heavy organics in crude oil include waxes, resins, asphaltenes, diamondoids. In this particular case deposition is mainly caused by **asphaltenes**

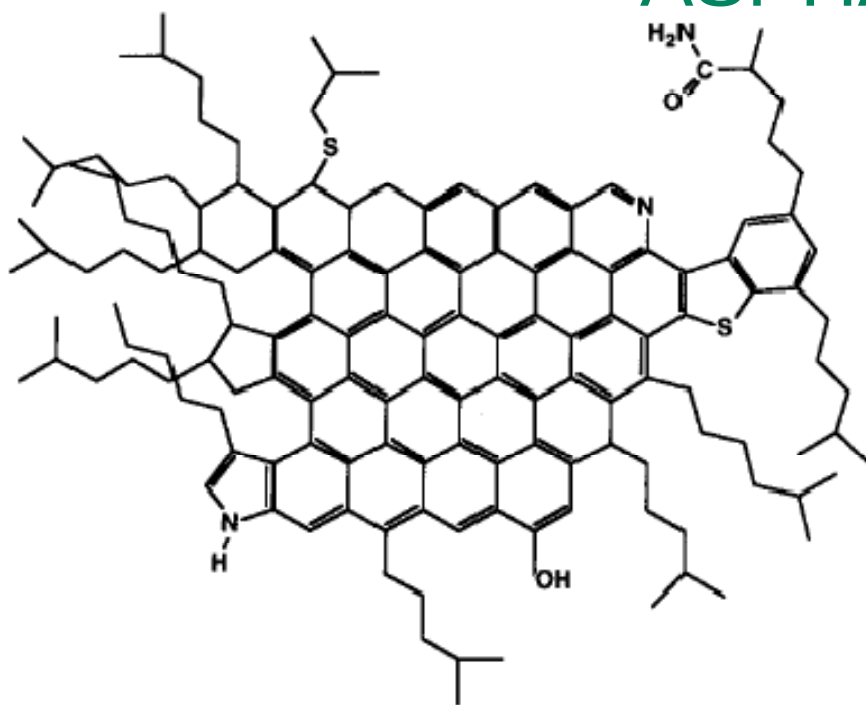
Deposition and flocculation mechanisms involve different phenomena such as:

- Reactions
- Aggregation
- Flocculation



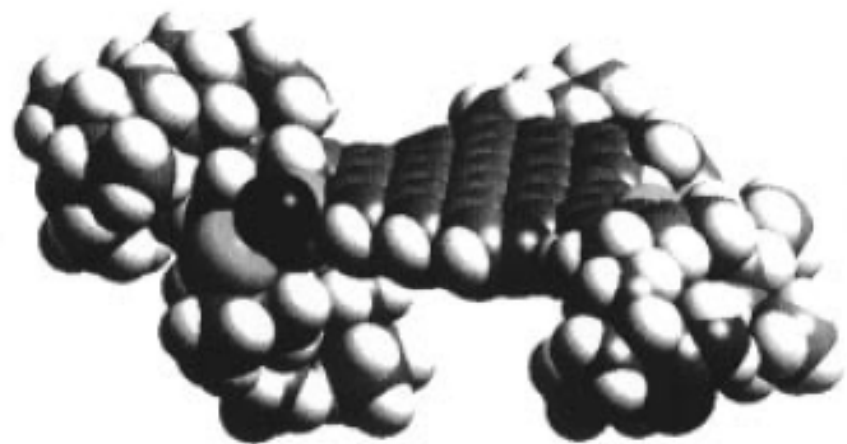
Asphaltene molecule - Long et al. [2007]

PROBLEM CHARACTERIZATION: ASPHALTENES



Aspalthene molecule 2D - Mugich et al. [1995]

- Molecules ~ 1 micron
- Aggregates of several hundred microns



Aspalthene molecule 3D - Mugich et al. [1995]

Aggregation $f(x, \tau, T, P)$

SEQUENTIAL EVENTS IN FOULING

