



ESDU SPG-M5-2

Modelling of shell-and-tube heat exchanger undergoing crude oil fouling

Unamended
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CROF Sub-Project G: control and mitigation

Modelling of shell-and-tube heat exchanger
undergoing crude oil fouling

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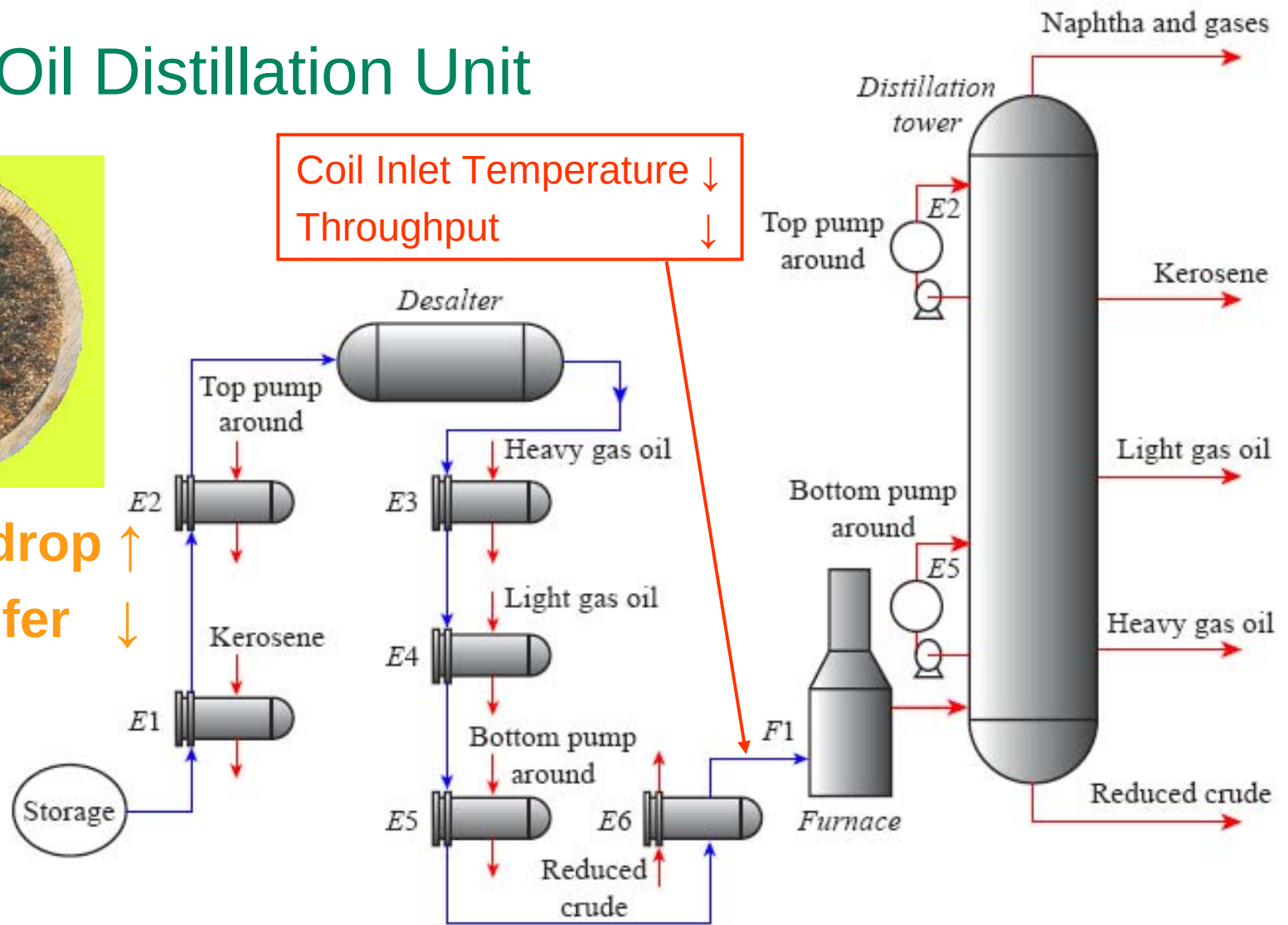
Supervisor: Prof. Sandro Macchietto

CROF meeting 27/09/07

Crude Oil Distillation Unit



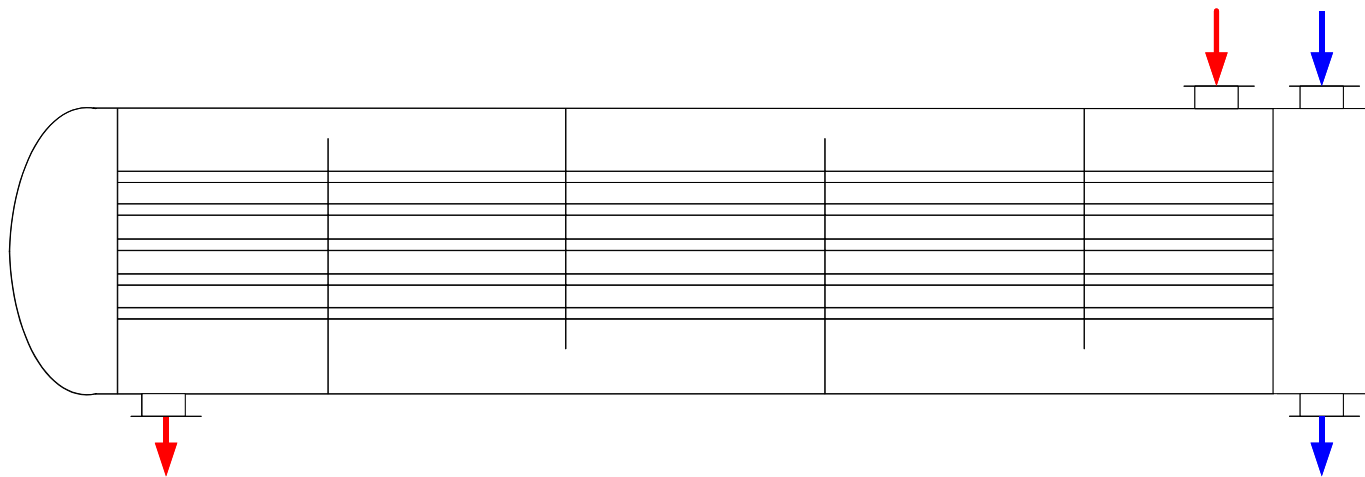
Pressure drop ↑
Heat transfer ↓



ESDU, 2000. Heat exchanger fouling in the pre-heat train of a crude oil distillation unit. *Data Item 00016*.

Objective

To model detailed dynamic behaviour of Pre-heat Train's HEX undergoing fouling



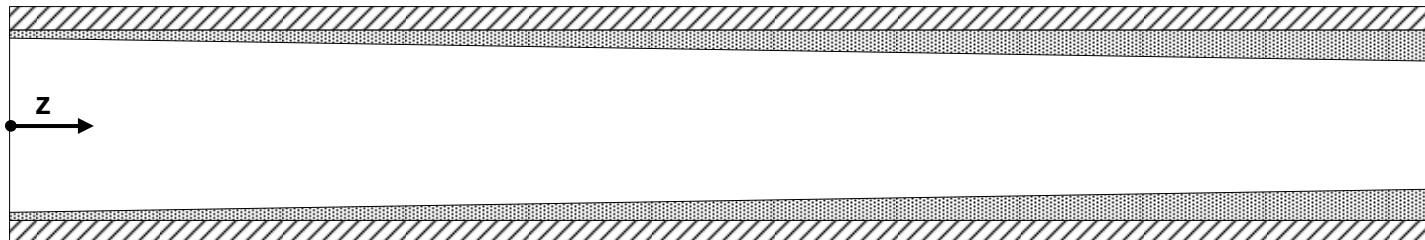
Roadmap:

1. Tube side model: process simulator
2. Shell side model: CFD
3. Interface tube side with shell side

Done so far: tube side model

Mathematical model for a **single** tube that considers:

- Distributed domain
- Constant shell-side temperature
- Crude oil physical properties
- Fouling model: R_f dependency on process conditions (T, v) and time
- Fluid-dynamic interactions with fouling layer



Crude oil physical properties

$^{\circ}\text{API}$ relationships

•PROs:

- Simple relationship
- Few inputs required ($^{\circ}\text{API}$, Temperature)

•CONS:

- Simplistic way of considering crude composition
- No antifoulants

Equation of State

•PROs:

- Accurate (considers also P)
- Reflect change in chemical composition rather than SG
- VLE calculations

•CONS:

- Highly dependent on the model chosen
- GC analysis or ASTM curves required