



ESDU-SPG-M7-3

Apr.08: Detailed dynamic behaviour of pre-heat train HEX's undergoing fouling

Unamended
Issued October 2010

**Imperial College
London**

1

CROF Sub-Project G

Control and mitigation of fouling in crude distillation units

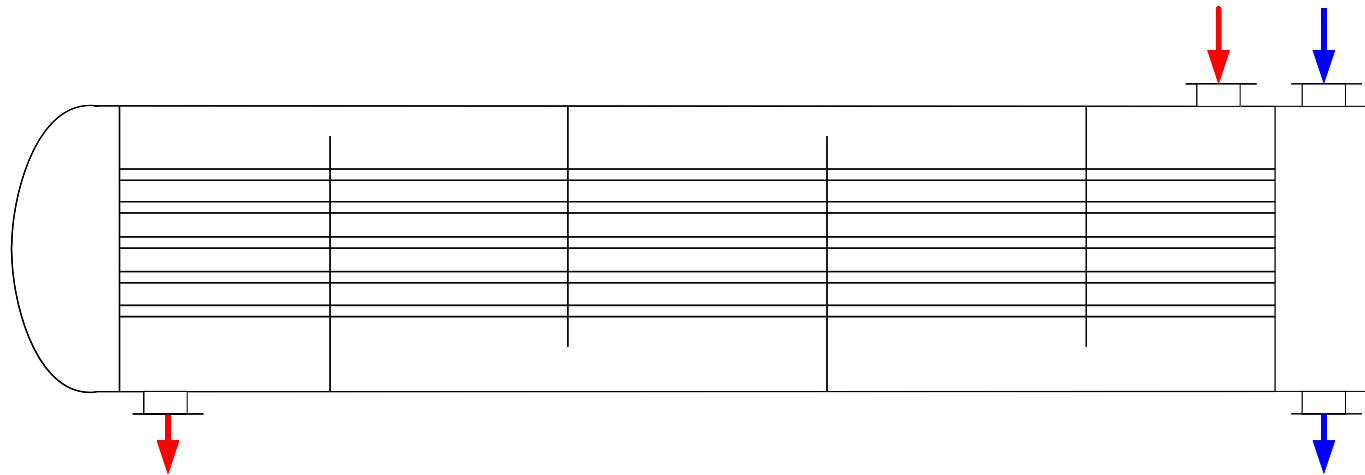
Francesco Coletti

Supervisor: Prof. S. Macchietto
Collaborating academic: Prof. S. Richardson

CROF meeting
09/04/08

Objective

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



Roadmap:

Tube side model: process simulator

Shell side model: CFD

Interface tube side with shell side

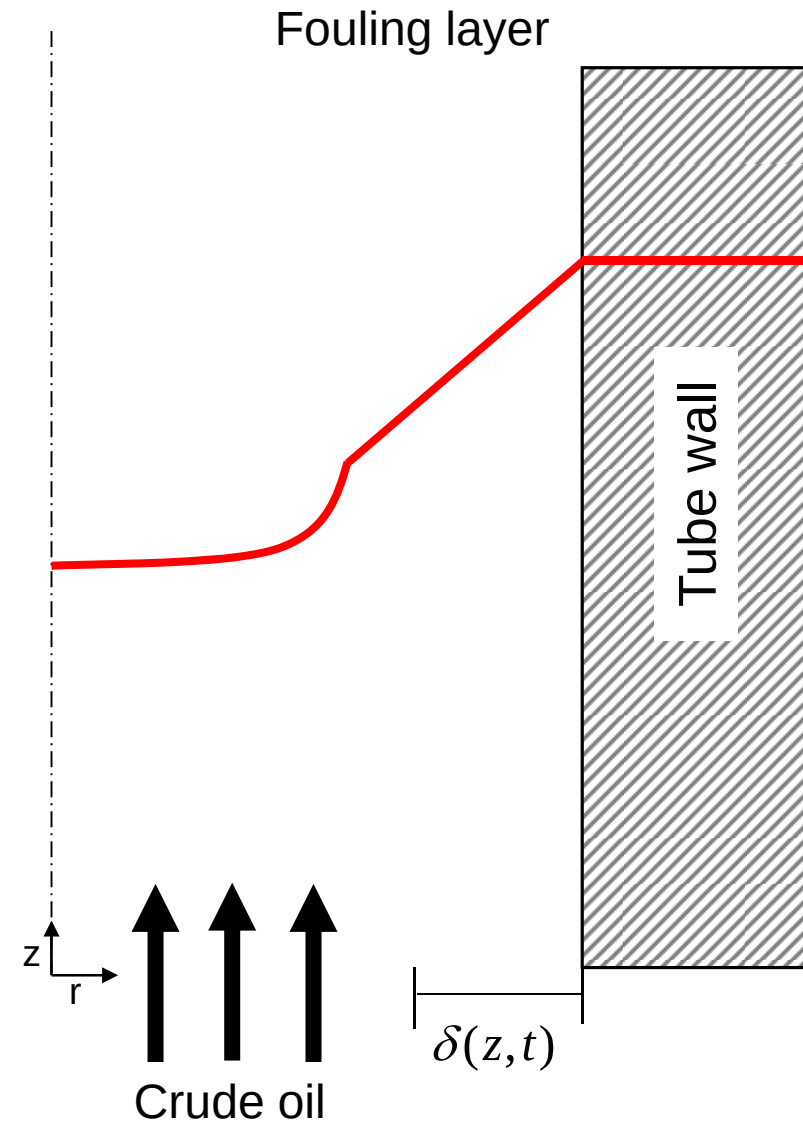
Overview

- Fouling in a **single** tube: a **2D** model
- Ageing model
- Simulation results on Sub-Project F test section
- Future work: from tube to full HEX model
- On site visit (collaboration with ExxonMobil)

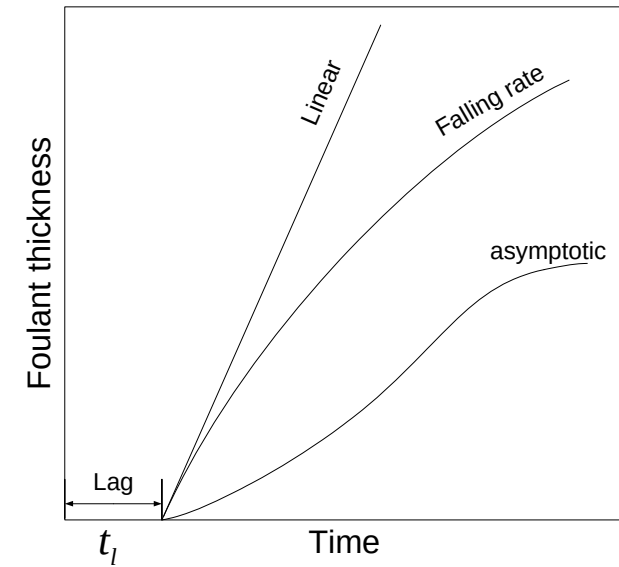
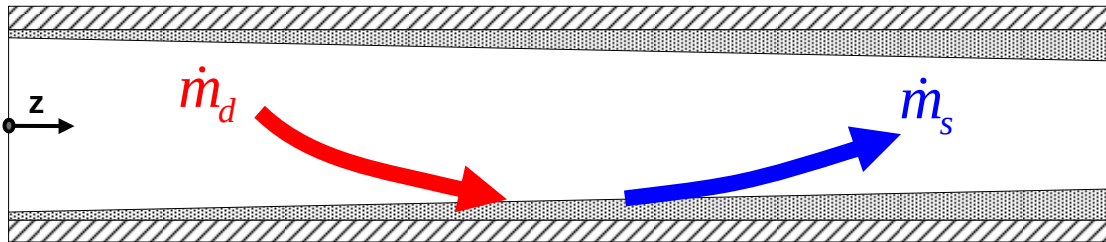
Fouling in a single tube: a 2D model

Single tube model:

- **2D** Distributed domain
- Constant wall T
- Moving boundary
- Fouling model: $R_f(T, v, t)$
- Fluid-dynamic interactions
- Deposit **ageing**



Fouling model: R_f dependency on T , v and time



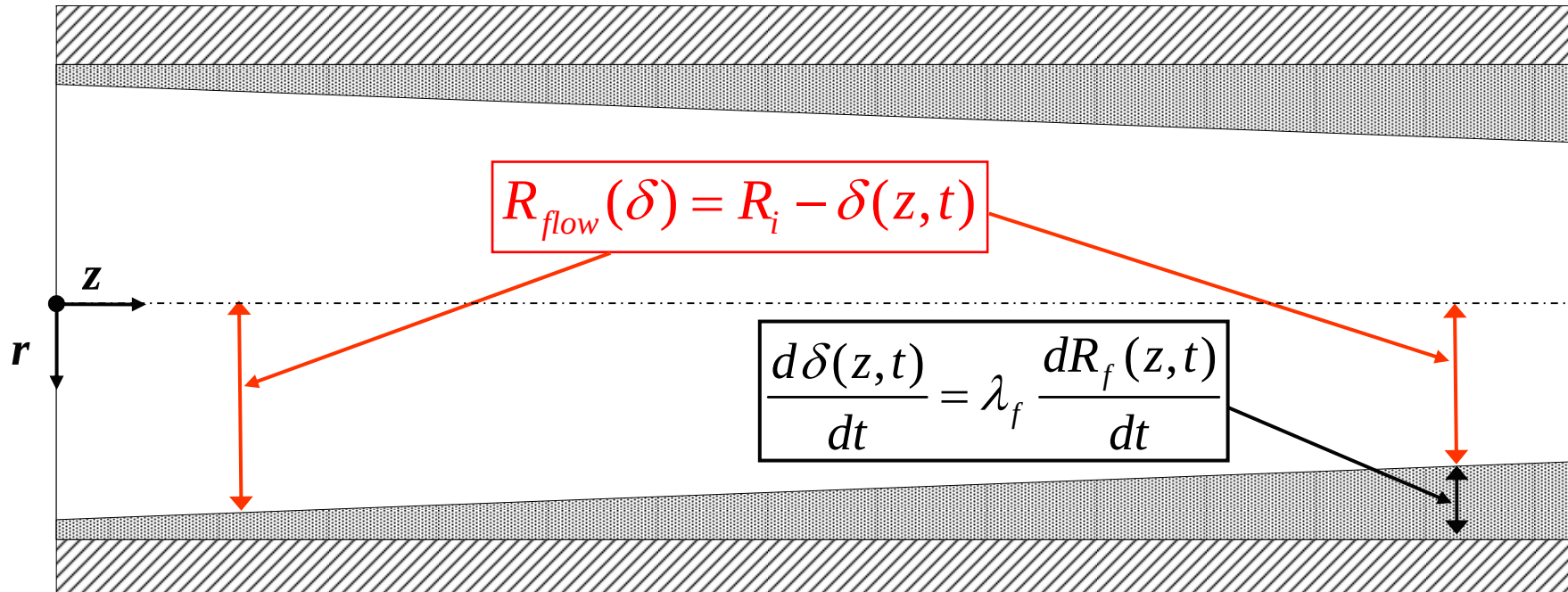
$$\frac{dR_f(z,t)}{dt} = \alpha \text{Re}^\beta(z,t) \exp\left(\frac{-E}{RT_f(z,t)}\right) - \dot{m}_s(z,t)$$

$v(z,t)$

$$\frac{d\delta(z,t)}{dt} = \lambda_f \frac{dR_f(z,t)}{dt}$$

Ebert and Panchal, 1995

Fluid-dynamic interactions with fouling layer



$$\frac{dP(z, t)}{dz} = C_f(z, t) \frac{z}{4} \frac{v^2(z, t)}{R_{flow}(\delta)}$$

Importance of deposit ageing



Time
→
Temperature



Wax-Gel:

- soft
- low thermal conductivity:

$$\lambda = 0.2 \text{ W m}^{-1}\text{K}^{-1}$$

Coke:

- hard
- higher thermal conductivity:

$$\lambda = 2 \text{ W m}^{-1}\text{K}^{-1}$$