



Fouling in a Crude Oil Preheat Train

A New Attack on an Old Problem

Geoffrey F. Hewitt

Department of Chemical Engineering
Imperial College London

Simon J. Pugh

IHS ESDU, London

The fouling problem



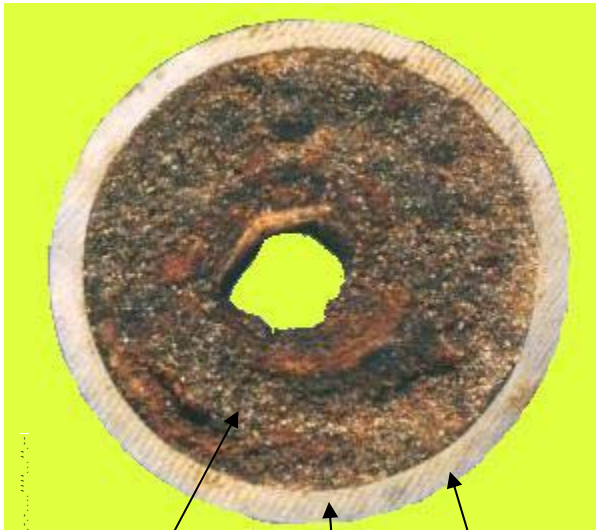
Heat exchangers are clean on installation as exemplified by this heat exchanger tube bundle but - - -

-- - after a period they may develop fouling layers on their surfaces which have a large effect on their efficiency



Conventional Design for Fouling

Tube side fouling



$$\dot{Q} = UA\Delta T$$

Where:

$\dot{Q}$ is the heat transfer rate (W)

A is the heat exchanger surface area (m²)

ΔT is the mean temperature difference between the hot and cold streams (K)

U is the overall heat transfer coefficient (W/m²K)

$$\frac{1}{U} = \frac{1}{\alpha_s} + \frac{1}{\alpha_t} + R_s + R_t + R_w$$

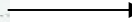
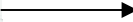
Where:

α_s and α_t are the shell side and tube side heat transfer coefficients (W/m²K)

R_s and R_t are the shell and tube side fouling resistances (m²K/W)

R_w is the wall resistance (m²K/W) (usually small)

The fouling factor trap



Plant 1:
 R_f larger than
design value

Plant 2: R_f from Plant 1
used in design. But actual
 R_f now even bigger!

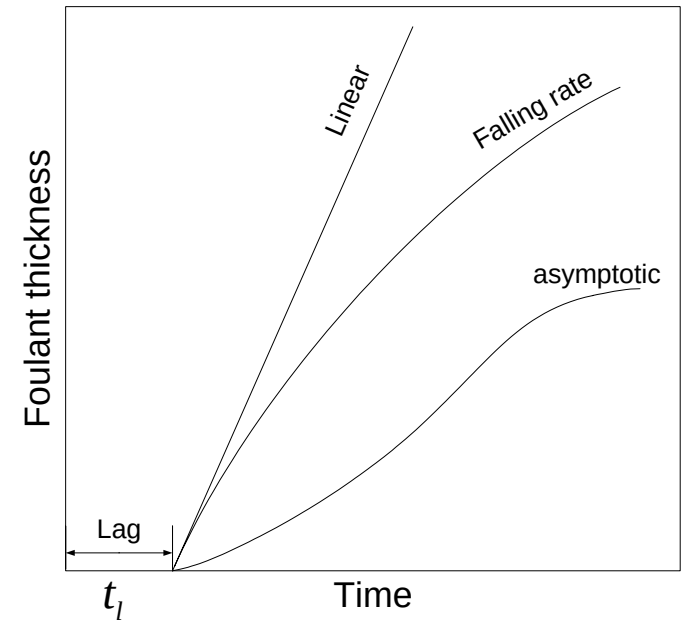
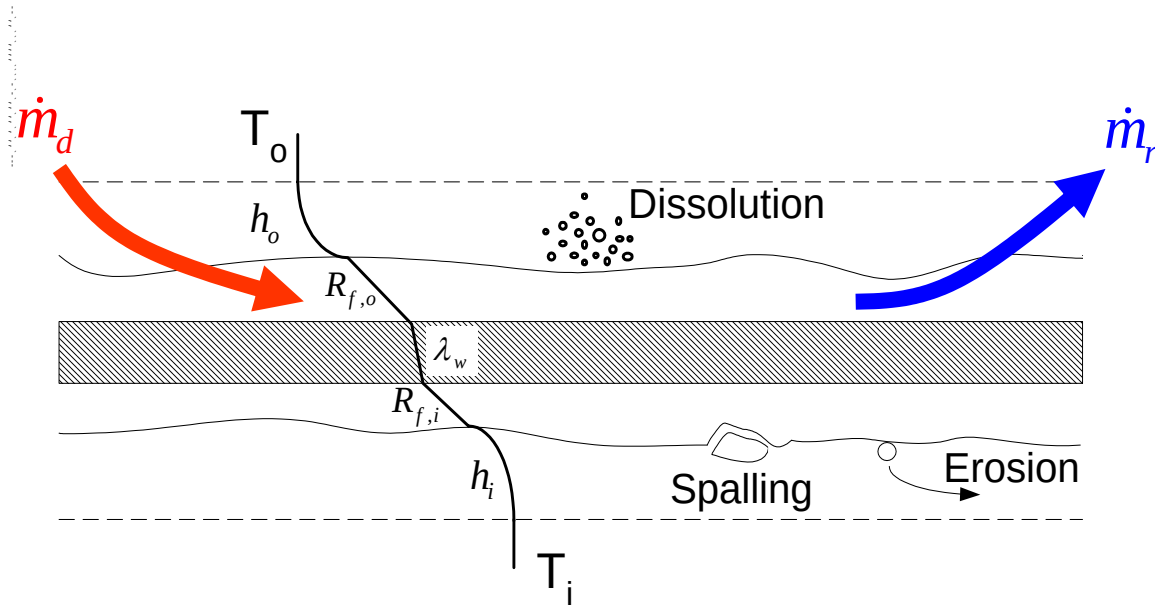
Plant 3: R_f from Plant 2
used in design. But actual
 R_f even bigger still !

Solution: Increase
velocity to decrease R_f



Plant 4: Smaller than
Plant 1.

Fouling on thermal surfaces

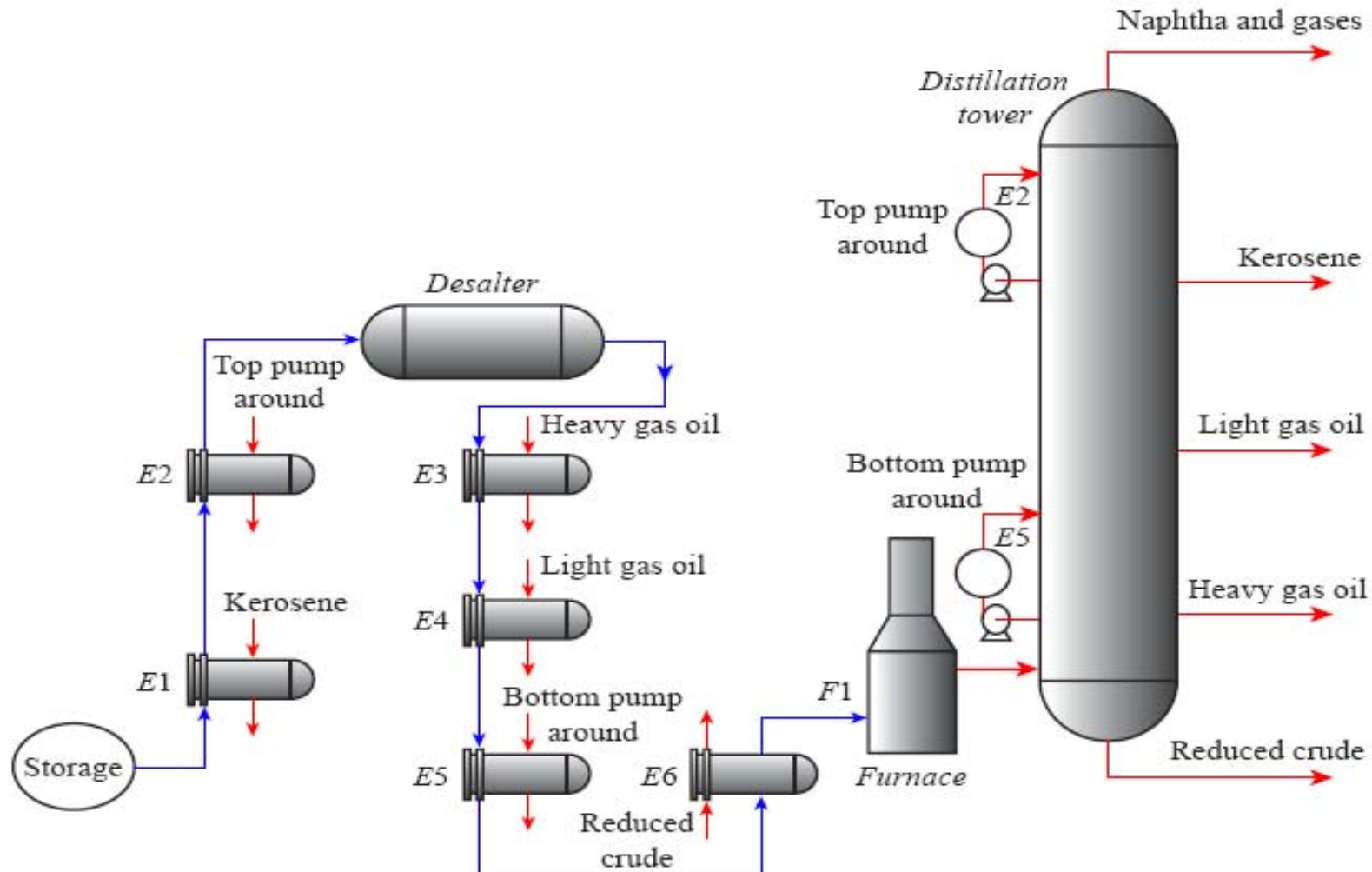


$$\frac{dR_f}{dt} = \alpha Re^\beta \exp\left(\frac{-E}{RT_f}\right) - \gamma\tau$$

$$\frac{dm_f}{dt} = \dot{m}_d - \dot{m}_r$$

(Ebert and Panchal, 1995)

Crude Oil Distillation Unit



Costs of fouling in such units > \$1 billion per annum in USA alone

Implications of fouling in crude oil preheat train

