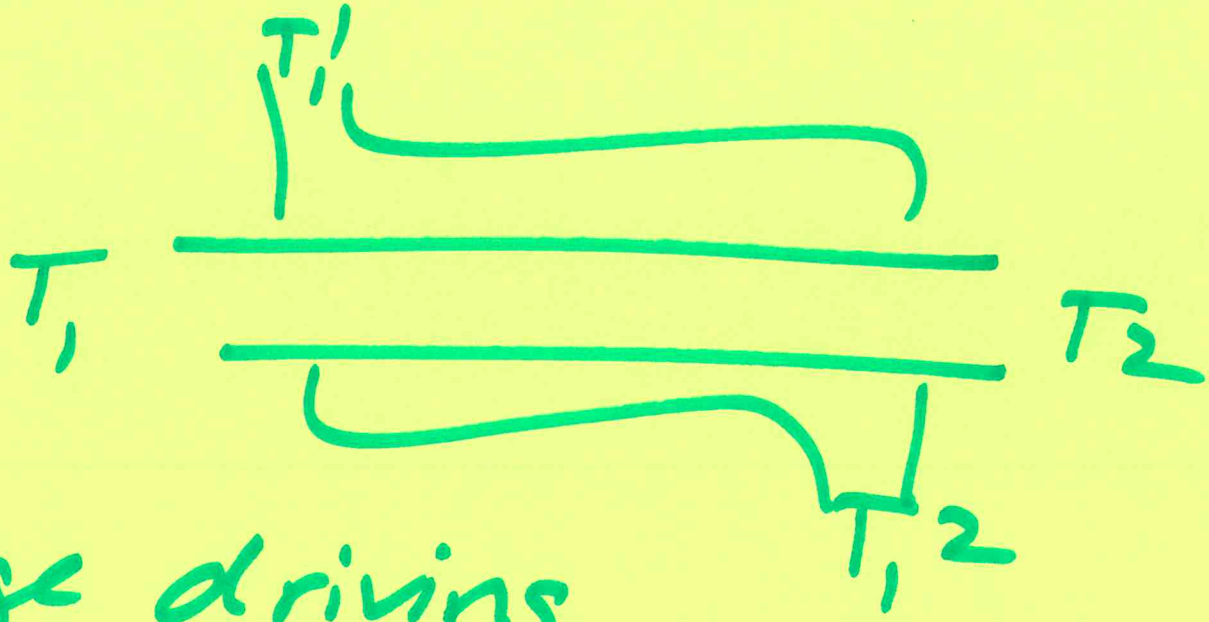
Applied Heat Xfr:

So FAR Heat Exchangers



average driving force for heat xfr =

$$\Delta T_{lm} = \frac{\Delta T_L - \Delta T_R}{\ln \Delta T_L / \Delta T_R}$$

1. $Q = U A (\Delta T_{lm} F_T)$

($F_T = 1$ double pipe or 1-1 Shell + Tube)

2. Shell + Tube HE:

1-2, 2-4 } read from graph

3. H.E. Effectiveness – know inlet temp + (mC_p) + UA $\Rightarrow Q$

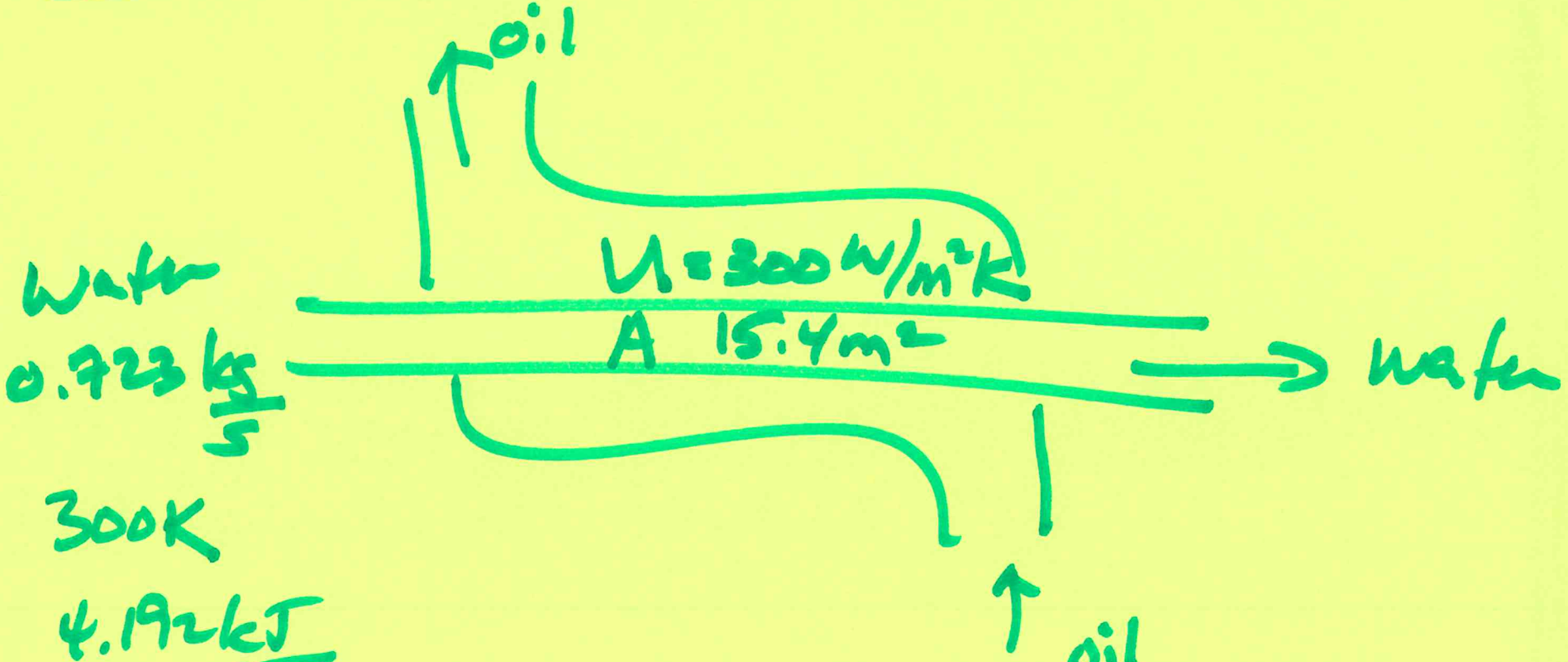
4. Fouling

Heat Exchanger Effectiveness

- common circumstance
  (only inlet temperatures known
- complex calculation

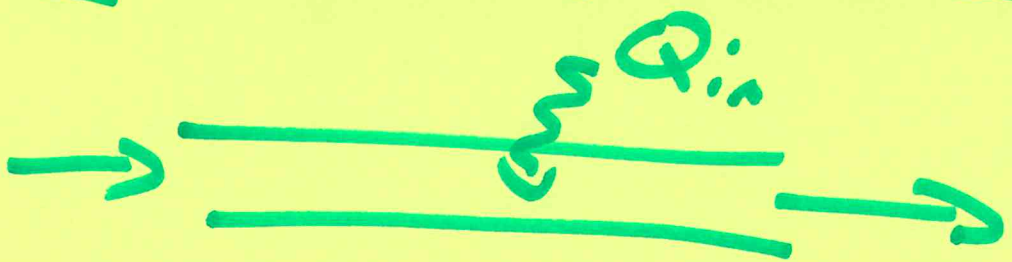
⇒ put together an easy way to address.

EXAMPLE



What is Q ?

MACRO ENERGY BAL INSIDE



$\dot{m} = 0.723 \text{ kg/s}$

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$$\Delta E_p + \Delta E_k + \Delta H = Q_{in} + W_{s,in}$$

$$Q_{in} = \Delta H$$

$$= \sum_{outs} \dot{m}\hat{H} - \sum_{in} \dot{m}\hat{H}$$

$$Q_{in} = \dot{m}(\hat{H}_{out} - \hat{H}_{in})$$

$$Q_{in} = \dot{m} C_p (T_{out} - T_{ref})$$

MACRO E-BAL OUTSIDE

$$\Delta E_p + \Delta E_k + \Delta H = Q_{in} + W_{s,in}$$

$$-Q_{in} = \tilde{Q}_{in} = \Delta H = \sum_{outs} \dot{m}\hat{H} - \sum_{in} \dot{m}'\hat{H}$$

$$= -\dot{m}'(\hat{H}_{out} - \hat{H}_{in})$$

$$-Q_{in} = \dot{m}' C_p (T_{out} - T_{in})$$

(FROM OVERALL MACRO E-B)

2 Eqns
3 Unknowns → Q_{in}, $T_{out,w}$, $T_{out,oil}$

3RD EQN ?

$$Q_{in} = \dot{m} c_p \Delta T_{lm}$$

★ YES ★

BACK TO OUR H.E. :

(1) Is it a HE eff p/m ?
inlet temps known ✓

(2) $(\dot{m}C_p)_{water} = (0.723)(4.192) = 3.03 \frac{kW}{K}$

$(\dot{m}'C_p')_{oil} = (3.2\frac{kg}{s})(1.89\frac{kJ}{kgK}) = 6.05\frac{kW}{K}$

~~for~~ $(\dot{m}C_p)_m =$ WATER ✓

$Q = \varepsilon (\dot{m}C_p)_{min} (385 - 302)K$

$\varepsilon = ?$

(9)

$$\frac{\dot{m}c_{p_{WATER}}}{\dot{m}c_{p_{OIL}}} = \frac{3.02}{6.05} = 0.5$$

$$NTU = \frac{UA}{(\dot{m}c_p)_{min}} = \frac{\left(300 \frac{W}{m^2 K}\right)(15.4\ m^2)}{\left(3.02 \times 10^3 \frac{W}{K}\right)}$$

$$= 1.5$$