18/06/2014

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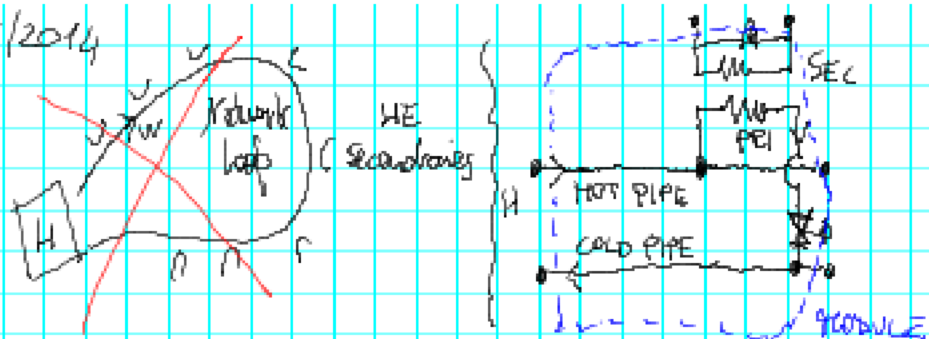
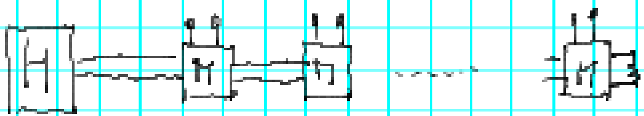


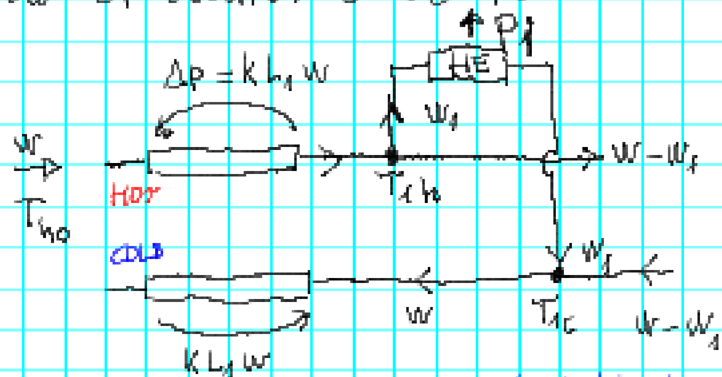


Many different configurations exist

Note: unreviewed material

2 Typical model & control structure

(1) Heater: Flow and outlet T control are here ideal



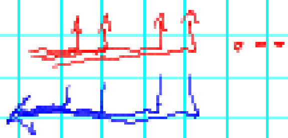
k friction-related coefficient

L_i piping lengths

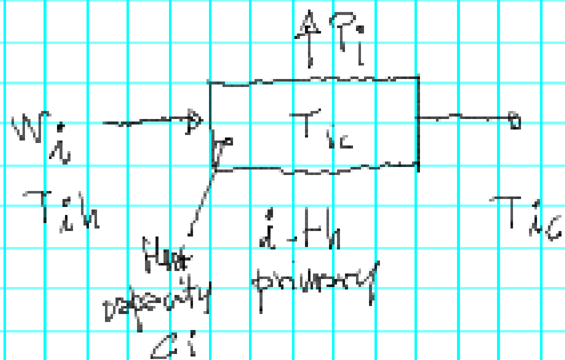
$w_i \ll w$

statically

$w_1 c (T_{1h} - T_{1c}) = P_1$



If we want a dynamic model, we associate each primary side of a HE to one (or more) capacity, thus



$$C_i \dot{T}_{ic} = W_i c \left(T_{ih} - T_{ic}\right) - P_i$$

4 Control at the user level

We want a certain P_i (required by the utilisers)

We have limits on the return temperature

and on the taken flow rate

Why:

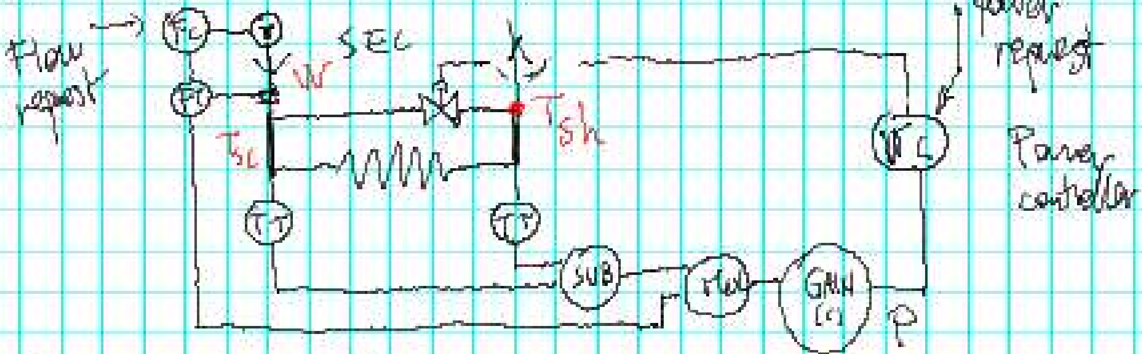
The hot (and also cold) side temperatures do not depend on the loads of the upstream users (but the available flows do)

So, a too low cold T may be a problem for the central heater

while a too high w_i can be a problem for downstream users

⇒ CONFLICTING NEEDS

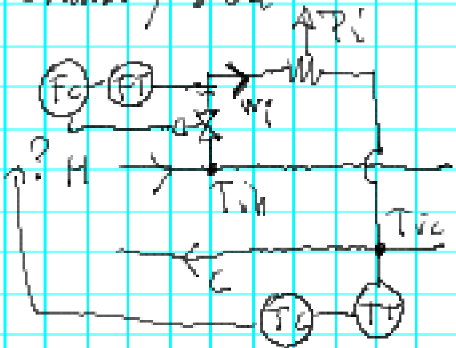
Typical layout (one of many...)



Alternatively, treat the secondary exchanger side as a local heater and just control w and T_{sh}

Or, intermediately, control w and $T_{sh} - T_{sc}$

Primary side



Two needs (not exceeding boundaries on w_i and T_{ic})

One manipulated variable

Reasoning: suppose T_{ih} impressed, and P_i as well (sec control)

$$\Rightarrow (T_{ih} - T_{ic})\, c\, w_i = P_i \qquad T_{ih} - T_{ic} = \frac{P_i}{c w_i}$$

$$T_{ic} = T_{ih} - \frac{P_i}{c w_i} \quad \text{, so } w_i \uparrow \Rightarrow T_{ic} \uparrow$$

$\nearrow W_i \uparrow \Rightarrow T_{ic} \uparrow$

) have a lower limit on T_{ic} and an upper one on W_i

$\Rightarrow$ • as long as T_{ic} is high enough, take the minimum W_i compatible with the sizing of the HE

• if we approach the lower bound for T_{ic}, increase W_i

$\Rightarrow$ (1) two controllers, higher valve opening, represt wins (other tracks)

(2) (simpler) : just control W_i, schedule the set point based on T_{ic}

As for controllers, PI ones suffice

Heater side control

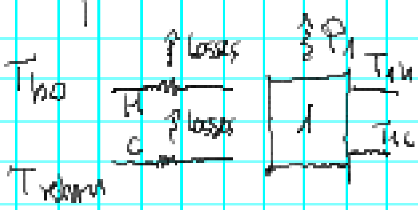
W control → PI loop acting on pump(s)

Only issue: be cautious with response speed requirements as the network fluid has a huge inertia

outlet T control → PI loop (possibly with TDO activation) on the fuel valve, or equivalent.

Only relevant problem: generating the temperature set point

Principles and modus operandi



PIPING
SECTION
H⇒1

$\text{losses} = f(\text{local } T, \text{terrain } T)$

hot Temps ⇒ hot pipe losses and W_1

cold Temps ⇒ cold pipe losses, W_i and P_i

1) Summing up,

$\left.\begin{array}{l} T_{ho} \\ w \\ w_i \\ P_i \end{array}\right\} \rightarrow T_{return}, T_{ih}, T_{ic} \Rightarrow$ worst-case (lowest) T_{return} under the hypothesis that the last T_{ih} is high enough

$\Rightarrow$ losses

Set the set point for T_{ho} to the lowest value fulfilling the worst case analysis (plus a few degrees) $\Rightarrow$ min loss

① Of course one can have different T_{ho} set points for different situations (e.g., loads may not be the same for day & night, or working days vs holidays, and so on).

⇒ Relevant research/engineering issue: exploiting heat storages.
