UTILITY PLACEMENT
HEAT AND POWER
INTEGRATION
We now introduce the GRAND COMPOSITE CURVE, which will be useful to analyze the placement of utilities.

Start at the pinch.
GRAND COMPOSITE CURVE

These are called “pockets” Process-to Process integration takes place here.
UTILITY PLACEMENT

We now resort to a generic grand composite curve to show how utilities are placed.
UTILITY PLACEMENT

Hot Oil placement and extreme return temperatures

Oil minimum return temperature

Water maximum return temperature

Cooling water

Hot oil from furnace

Process

$T$ vs $\Delta H$
UTILITY PLACEMENT

Theoretical Flame Temperature

Furnace

T

Ambient Temperature

Stack Loss

Fuel heat value

ΔH

T_{\text{stack}}

Air

Fuel

Process Stream

Theoretical Flame Temperature

T_{\text{stack}}
An increase in flame temperature reduces stack loss.
COMBINED HEAT AND POWER

Integration of a Heat Engine Across the Pinch.

$$Q_{H,min} + Q_{HE}$$

TOTAL ENERGY INTAKE

Note that in this case there is no gain. The heat engine can be arranged separately and the utility usage will not change.

$Q_{C,min} + (Q_{HE} - W)$
COMBINED HEAT AND POWER

Integration of a Heat Engine Across the Pinch.

Note that in this case there is a gain.

\[ Q_{H,\text{min}} - (Q_{HE} - W) \]

**TOTAL ENERGY INTAKE**

\[ Q_{H,\text{min}} + W \]

(smaller)

Discussion of energy intake and heat engine integration.
In this case there is a gain of \((Q_{\text{cond}} - Q_{\text{reb}})\) in the cooling utility.
Placement of Heat Pumps

\[ Q_{H,\text{min}} - (Q_{HP} + W) \]

\[ Q_{HP} + W \]

\[ Q_{C,\text{min}} - Q_{HP} \]

**TOTAL ENERGY INTAKE**

\[ Q_{H,\text{min}} - Q_{HP} \]
We assumed that $Q_{H,min} = Q_{HP} + Q_{LP}$
COMBINED HEAT AND POWER

Gas Turbine Placement

TOTAL ENERGY INTAKE

\[ Q_{H,\text{min}} + W + Q_{\text{LOSS}} \]

\[ Q_{H,\text{min}} - (Q_F - W - Q_{\text{LOSS}}) \]

\[ Q_{S} \]

\[ Q_{\text{LOSS}} \]

\[ Q_{C,\text{min}} \]

\[ T_0 \]

\[ T_{EX} \]