



# **CHE 551 Advanced Topics In Chemical Engineering**

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**Energy Optimization Using Pinch Analysis**

**Lecture 2**

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# Pinch Analysis Theory

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- The concept of pinch analysis is to set **energy targets** prior to the design of the heat exchanger network.
- The **energy target** or the minimum energy consumption is the minimal quantity of energy that the process would need from external sources.

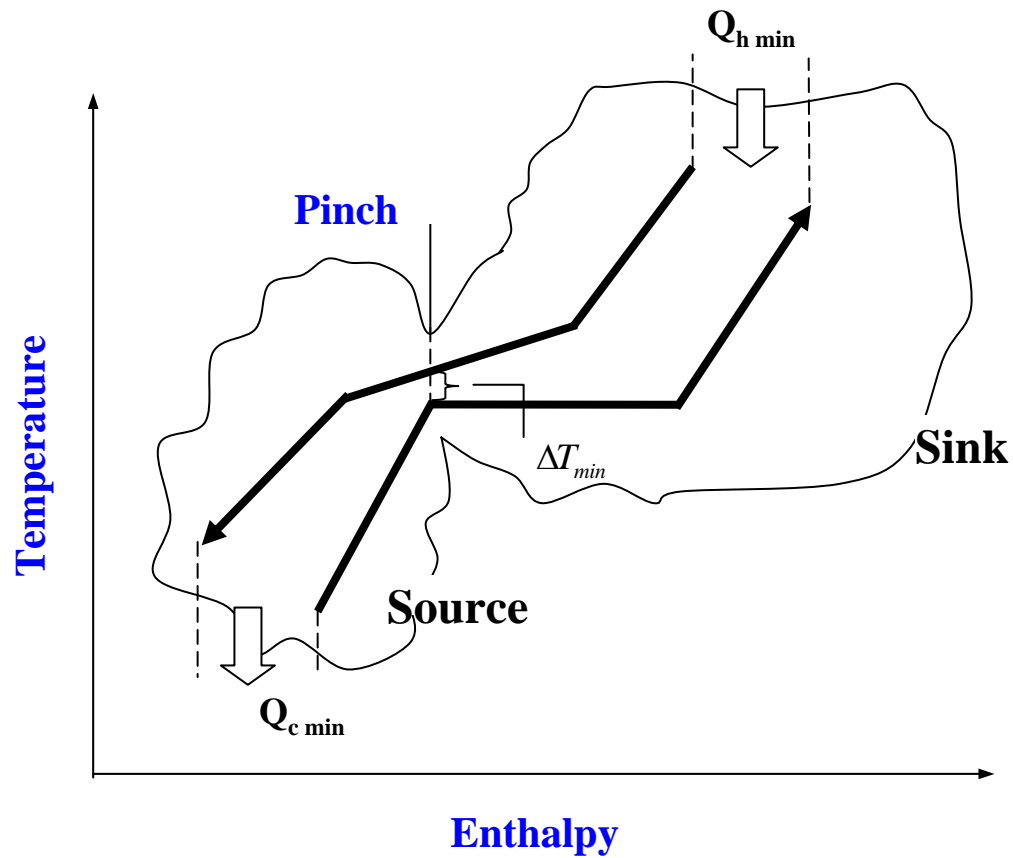


# Composite Curves

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- All hot streams and all cold streams from a heat and material balance are combined in terms of their heat contents in “ **composite curves**”.

# ENERGY TARGETS AND THE "PINCH" WITH THE COMPOSITE CURVES





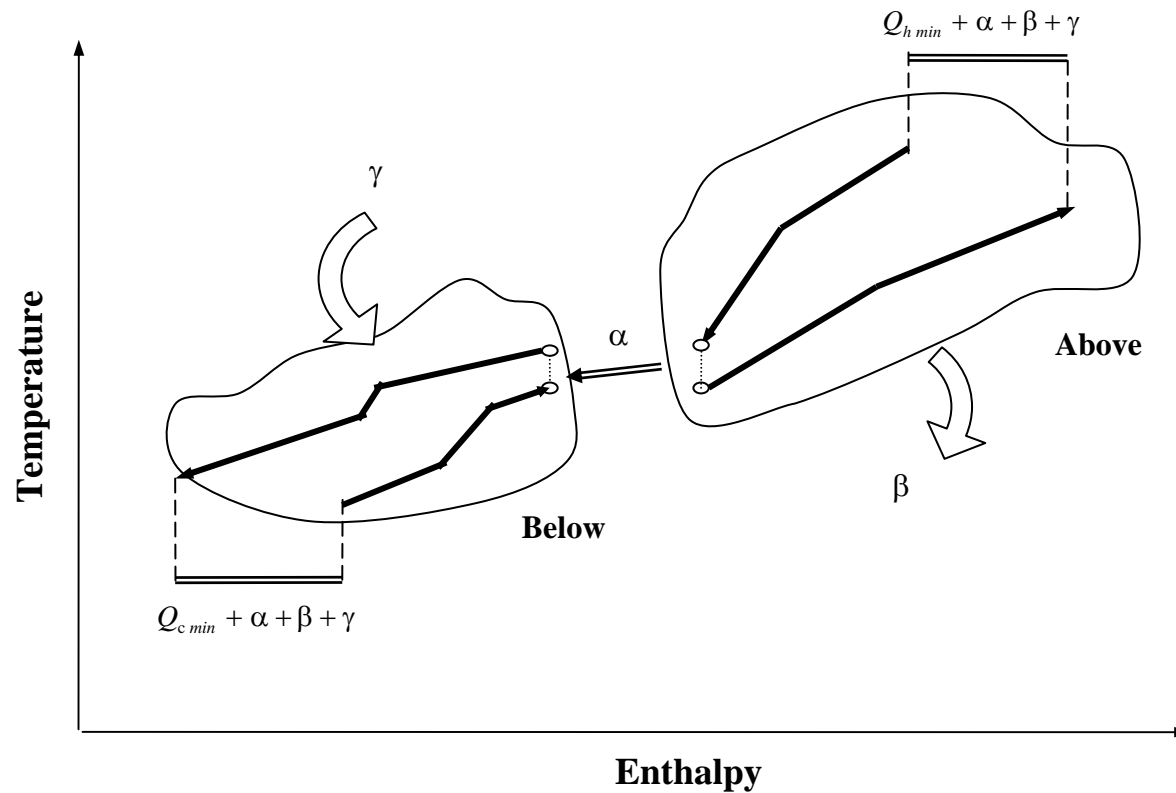
# Pinch Technology Rules

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The pinch technology technique provides three rules that must be obeyed in order to achieve the minimum energy targets for a process:

- No external cooling above the pinch.
- No external heating below the pinch.
- No heat transferred across the pinch.

# ENERGY TARGETS WITH EXTERNAL COOLING ABOVE THE PINCH, EXTERNAL HEATING BELOW THE PINCH AND HEAT FLOW ACROSS THE PINCH





# Conclusions from the composite curves

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- The design meets the energy targets only when the energy targets exhibit a **zero** heat flow across the pinch.
- Excess heat flow across the pinch tends to increase capital costs due to the extra heat transfer area required for both hot and cold utilities.



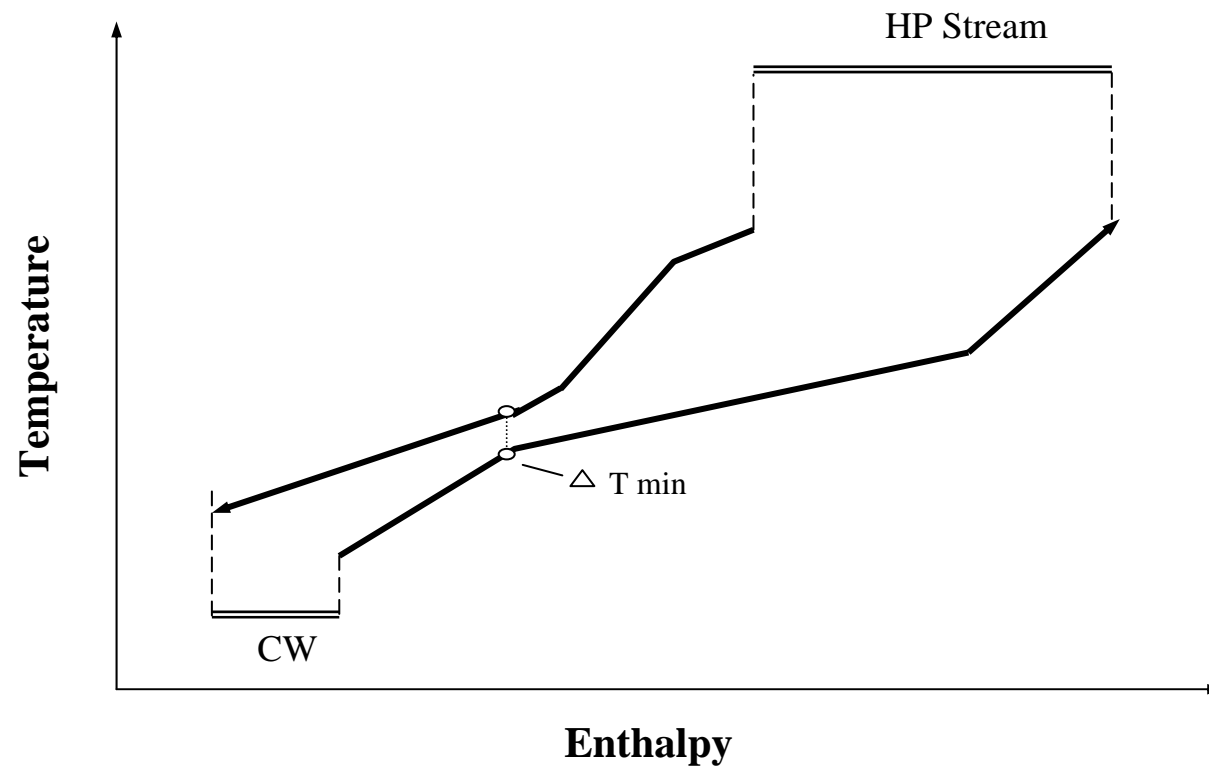
# Multiple Utilities Targeting

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- The composite curves provide the overall energy targets without any reference as to the quantity of energy that must be supplied by the various utility levels.
- Such information is particularly useful when a single hot and cold utility is available for the process.
- In many industrial applications, the energy requirement for a process can be supplied by several different utilities such as **cooling water, refrigeration and steam**.

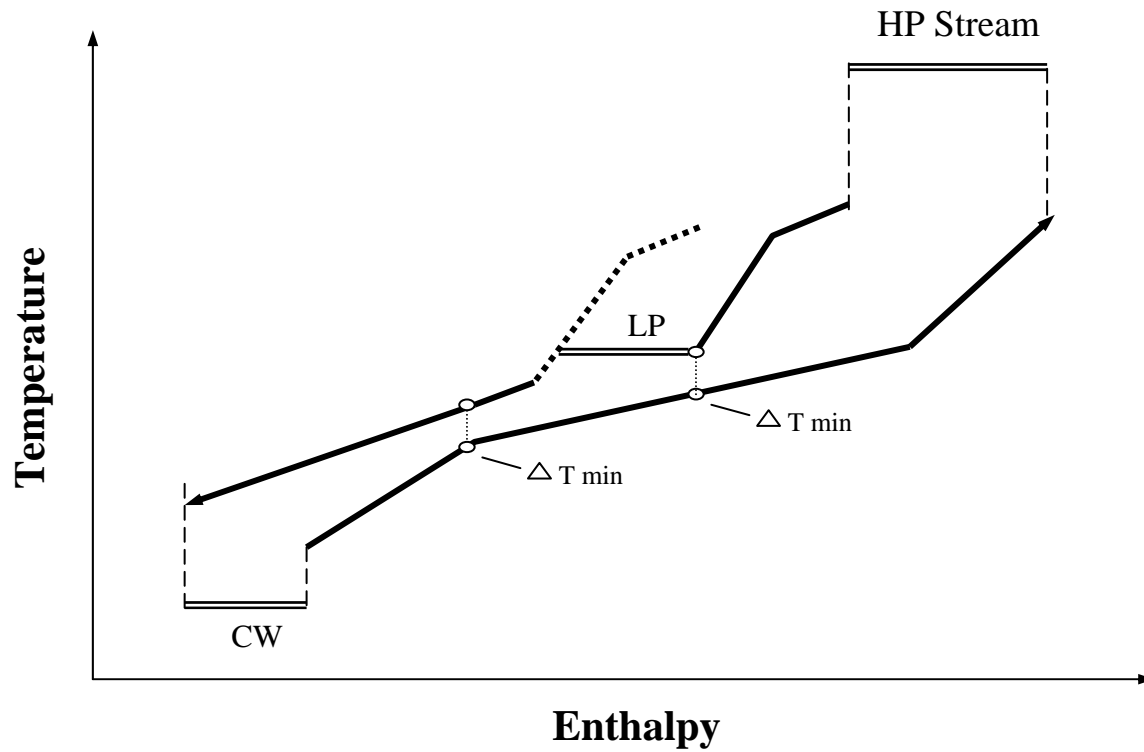
**The objective is to maximize the use of the less expensive utilities and minimize the use of the more expensive utilities.**

# COMPOSITE CURVES FOR MULTIPLE UTILITIES TARGETING



(a)

# COMPOSITE CURVES FOR MULTIPLE UTILITIES TARGETING



(b)