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HOW COMPOSITE CURVES AND PINCH ANALYSIS CAN BE USED TO IMPROVE THE ENERGY EFFICIENCY OF THE PLANT?

Answering the key questions about how composite curves are built and what useful information can be perceived from them

Composite curves are a synonym for the application of pinch technology and improvement of the unit's energy efficiency. Learning how to read them can be of great value in estimating the energy efficiency level of the current plant design.

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What are composite curves?

Composite curves are T/H diagrams (temperature/heat diagrams) used to visualize cold and hot streams and potential heat transfer between them. It is a graphical technique used for visualizing the heat cascade.

What is the theoretical background for building composite curves?

A helpful method of visualization is the temperature-heat content diagram based on the following equations:

$$Q = \int_{T_S}^{T_T} Cp\, dT = Cp(T_T - T_S) = \Delta H$$

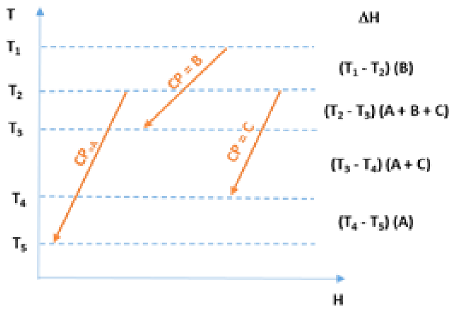
Where:
H – the heat content H of a stream, frequently called its enthalpy, kW;
Cp – heat capacity flowrate, kW/K = mass flow w (kg/s) x specific heat cp (kJ/kgK);
TS – supply temperature, °C
TT – target temperature, °C
With CP assumed constant, for a stream requiring heating ("cold" stream) from a "supply temperature" (TS) to a "target temperature" (TT), the total heat added will be equal to the stream enthalpy change.
The slope of the line representing the stream is:

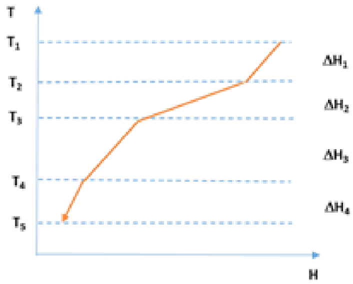
$$\frac{dT}{dQ} = \frac{1}{C_P}$$

This is the theoretical basis for developing composite curves.

How composite curves are built in practice?

Let's take a look at the example of 3 hot streams A, B, and C without going into any details of the process. Just to understand how to build one composite curve from different heat streams..





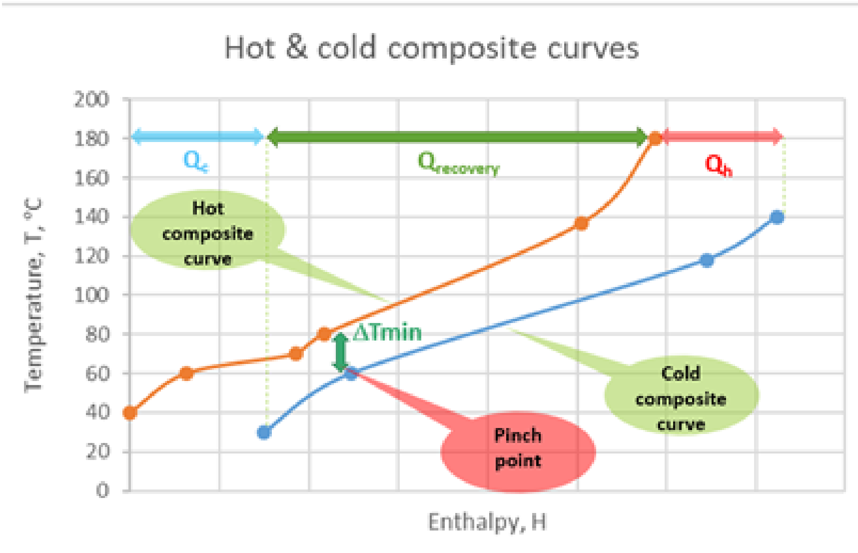
In the graph above, the three hot streams are plotted separately, with their supply and target temperatures defining a series of "interval" temperatures T1–T5. Between T1 and T2, only stream B exists, and so the heat available in this interval is given by B x (T1 – T2).

Between T2 and T3 all three streams exist and so the heat available in this interval is (A + B) x (T2 – T3) and so on...

A series of values of ΔH for each interval is obtained in this way and the result re-plotted against the interval temperatures as shown in the picture on the right.

Great! So, what can be found out from composite curves?

The figure below is showing a typical pair of composite curves:



The most important information that can be perceived from this pair of composite curves:

- The overlap between the composite curves represents the maximum amount of heat recovery possible within the process.
- The “overshoot” at the bottom of the hot composite represents the minimum amount of external cooling required.
- The “overshoot” at the top of the cold composite represents the minimum amount of external heating required.
- The position where two composite curves are the closest to each other represents the pinch point that will define the requirements of how to improve energy efficiency.

What does the reading of composite curve parameters mean in the real world, for a particular plant or a section?

Simply said, we can say that composite curves show the potential – energy target – what is possible to achieve: maximum heat recovery possible, the minimum required heating and minimum required cooling. If you compare these numbers with the numbers of the current state of the plant, you will have information on how efficient the plant is in the terms of heater exchangers network and how much the plant can be improved to get the numbers that are closer to the optimal, as given in the analysis.

A short-cut analysis of a plant or a section can be done in 30 minutes. Of course, this is just to get a quick general information. To reach the solution, a deeper analysis is needed that results in a reliable solution and correct decision – more time and effort is needed that includes the knowledge of the process, a modeling tool and detailed calculation.
To learn more about pinch analysis through a short mini-course and to be informed about the interactive course where you can build your solution with the support from the experienced mentor, subscribe with your email at the link:
http://www.simulatelive.com/downloads/improving-energy-efficiency-with-pinch-method-how-to-build-your-case-from-data-to-solution

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