Pinch Technology Second Generation

Application examples

Example Case 12

Energy Saving Opportunities in Distillation

CHP and Heat Pumps versus Heat Integrated Distillation Sequencing

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Case 12 ï Example for saving opportunities in distillation processes

Case 12 is an example from industry with several alternatives for reducing the energy cost of the original process. A reactor outlet stream contains three components x, y and z that have to be separated by distillation. A simplified process flow diagram is shown in Fig.12.1. Total steam consumption is 21 t/h.

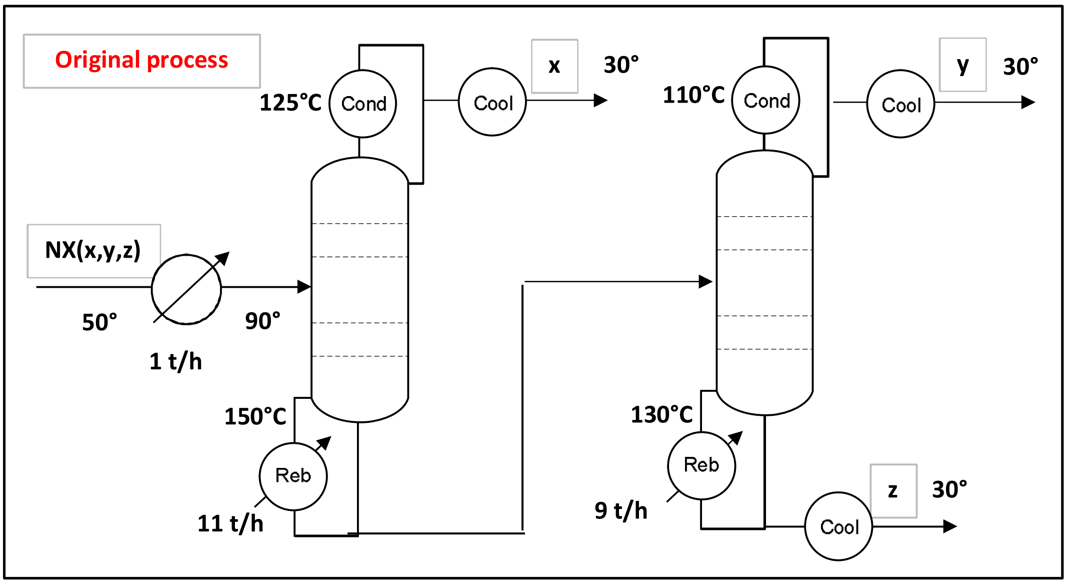


Fig.12.1

A pinch analysis produces Composite Curves as shown in Fig.12.2 and a Grand Composite as shown Fig.12.3. The total integration potential is 1 t/h of steam, namely the load on the feed preheater; this is roughly 5% of the total steam consumption. The heat could be recovered from an overhead condenser (preferably) or even from the distilled products. This measure has no impact on further assessments and has been withheld in further flow sheets by the notation “Hex” in the feed stream.

Fig.12.2

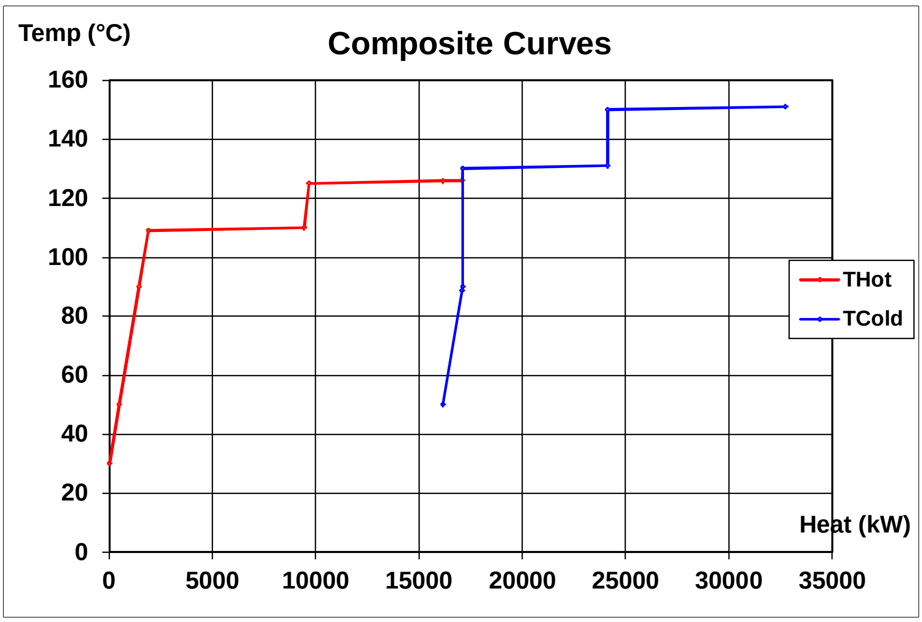
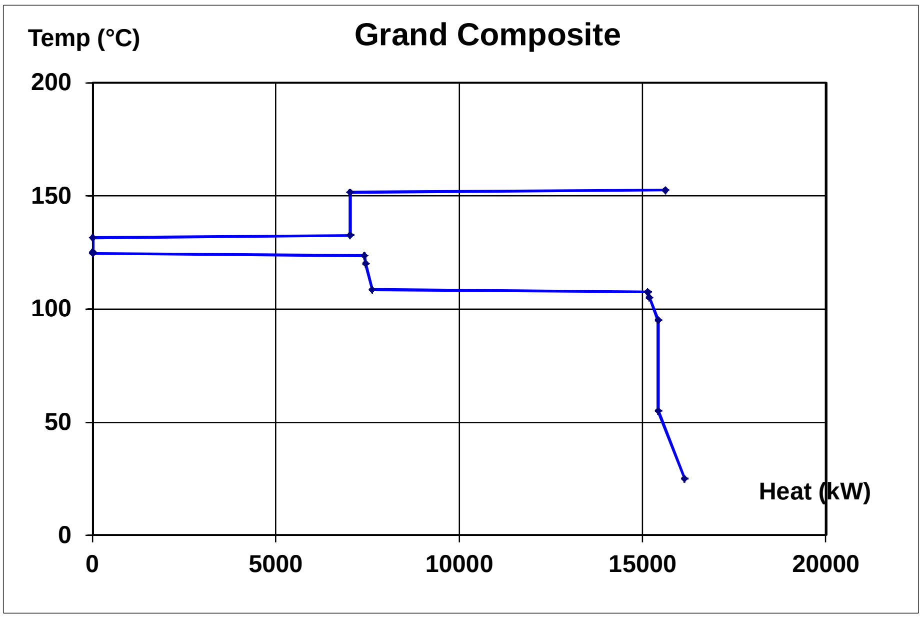


Fig.12.3



Potential alternatives for cost reduction are summarised in Table 12.1.

Table 12.1

Overview of cost reduction alternatives		
	Uttilities (excl. Cooling water)	
Original process	**Steam**	**21 t/h**
A : Heat integration	**Steam**	**20 t/h**
A + Install CHP	**Steam**	**20 t/h**
A + Install vapour recompressor (Heat pump)		
	Steam	**11 t/h**
	Power	**350 kW**
A + operating parameters adjusted & columns coupled		
	Steam	**11 t/h**
A + new distillation sequence		
	Steam	**7 t/h**

It is obvious that preheating the feed with waste heat is always a valuable option; also the use of steam from a CHP facility is applicable in all cases.

The shape of the Grand Composite would invite the utility expert to considering a vapour re-compressor, functioning as a heat pump. This would result into the process flow diagram of Fig. 12.4 with a significant reduction of the steam demand that would over-compensate the operating cost for the heat pump.

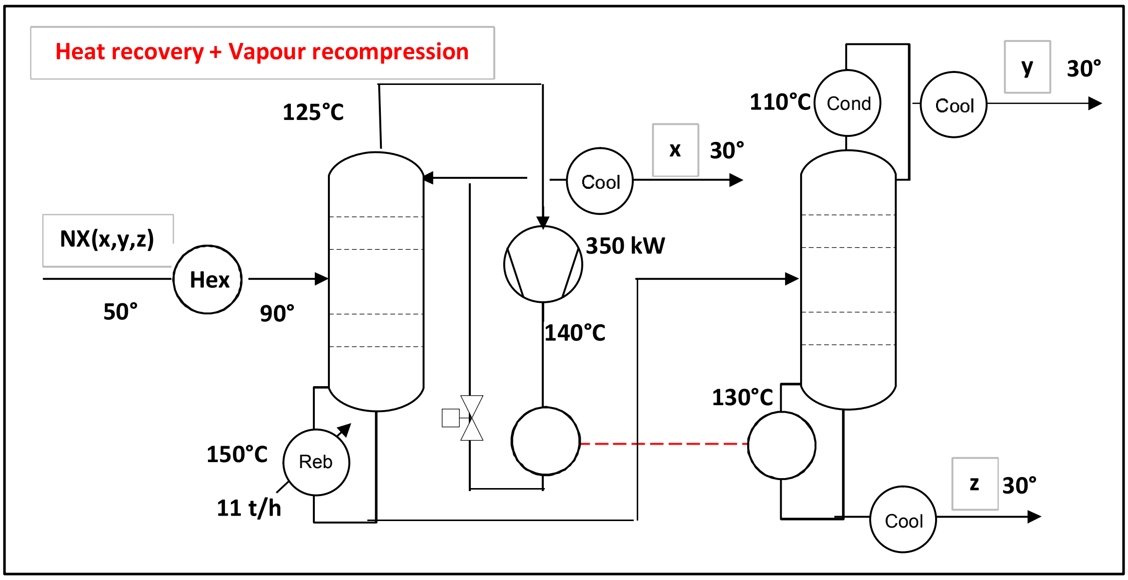


Fig.12.4

So far, the process was kept as such without changing operating parameters. Next to the heat pump alternative, the shape of the Composite Curves and the Grand Composite would call upon the process engineer to consider adjustment of the operating parameters e.g. raising the pressure (and temperature) level of the first column and/or lowering the pressure (and temperature) level of the second column, enabling direct thermal coupling of both columns as shown in Fig.12.5. This would enable the same steam savings as with the heat pump, but without the need for additional power and with much lower additional investment. The heat integration curves for this case are shown in Fig.12.6 and Fig.12.7.

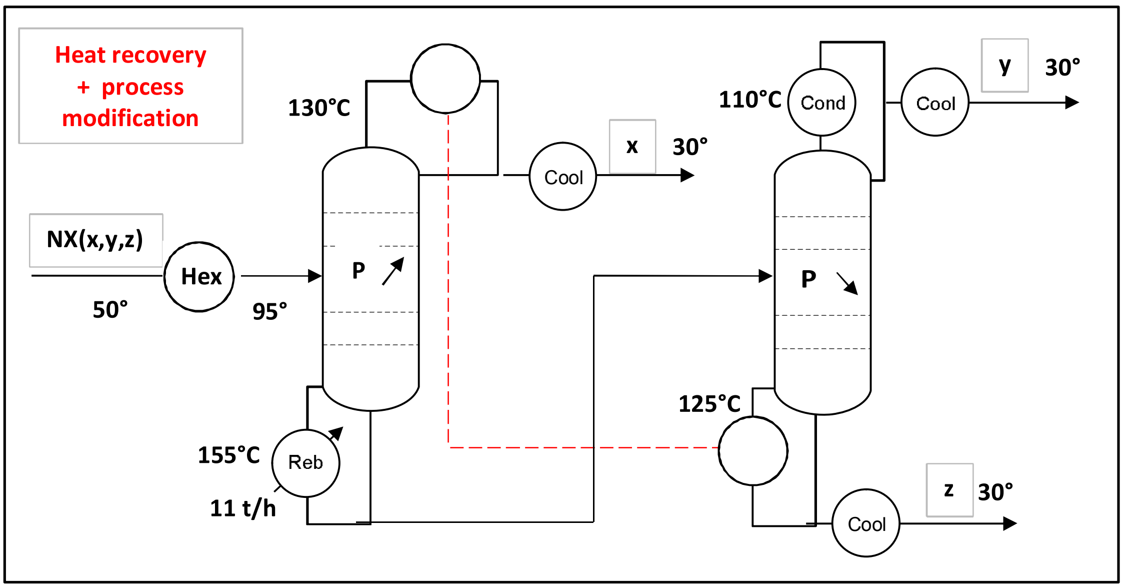


Fig.12.5

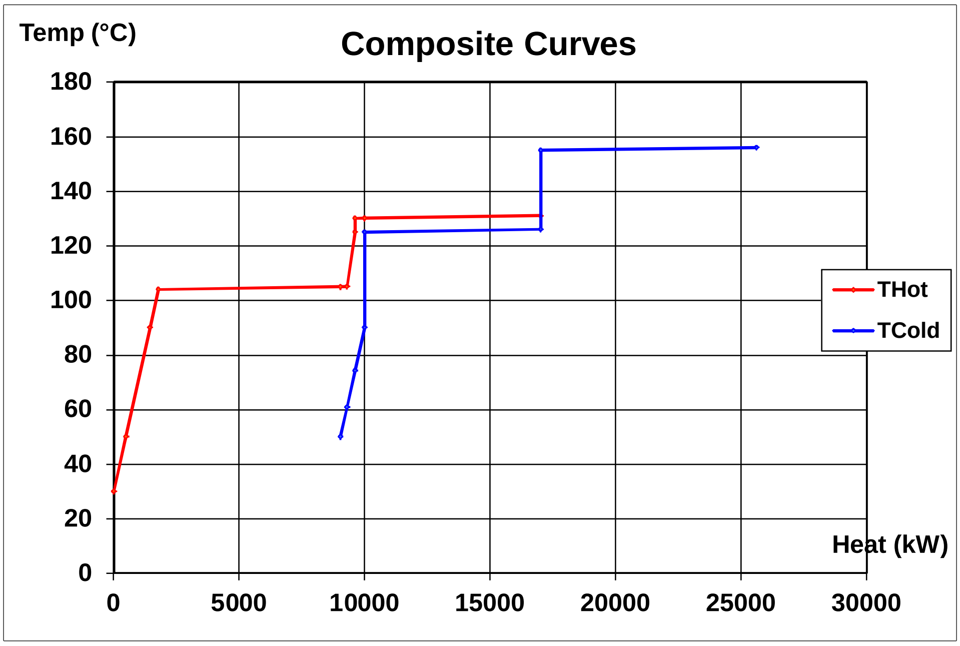


Fig.12.6

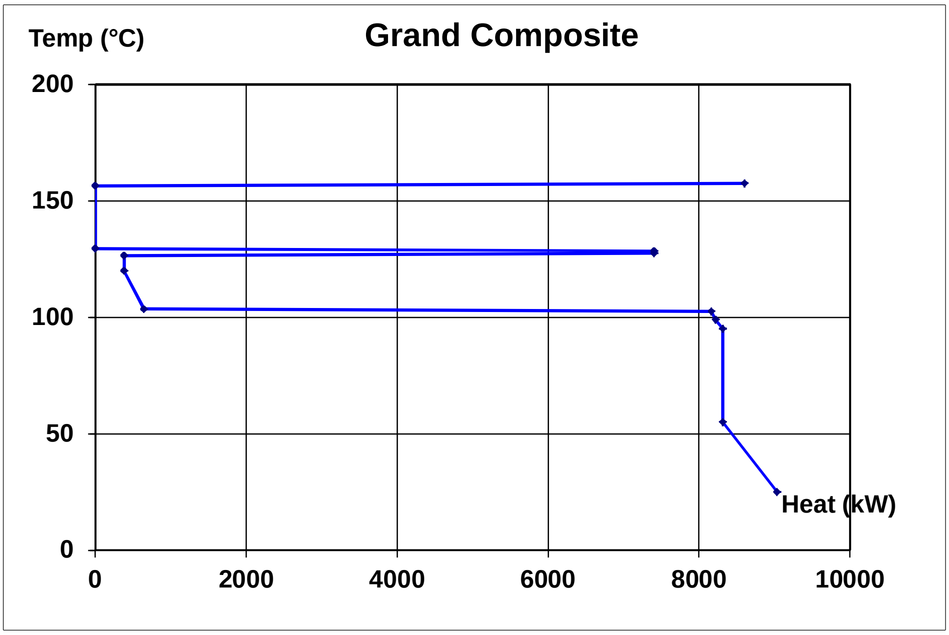


Fig.12.7

After questioning the operating parameters of the distillation train, also the distillation sequence as such should be scrutinised. With new insights in sequencing and based upon the principle of sloppy separation, the flow sheet of Fig.12.8 can be developed, saving another 30 % of the remaining steam demand. And, finally, depending upon relations between energy and capital cost, also a configuration with a divided wall column could be envisaged (Fig.12.9), with major savings on capital cost.

The above example shows that pinch analysis is very useful to identify saving potential and such potential can be evaluated very quickly. However, the process developer should be encouraged, before starting a design, to return to the process and question it in all its aspects. Even if the golden rules of pinch are respected, the process is not necessarily optimal. Steam from CHP should be used above the pinch and, so, using such steam to run the reboilers, which are above the pinch is not a violation. A heat pump should always be placed across the pinch and, so, putting in a heat pump as presented is not a violation; however, there is still a significant saving potential left and this shows that also that other golden rule should be respected: process optimisation comes before utilities.

Fig.12.8

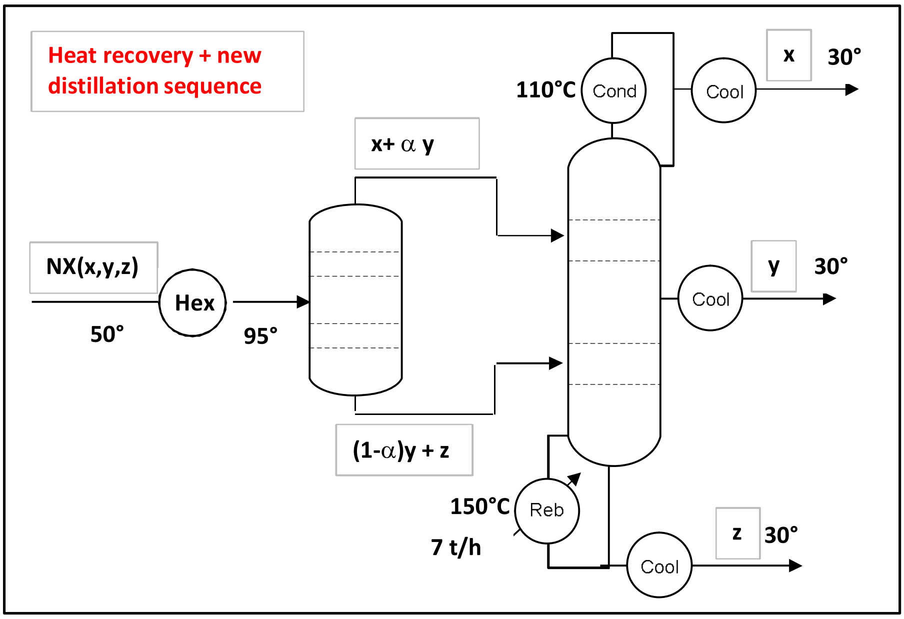


Fig.12.9