OPTIMAL SEPARATION SEQUENCES BASED ON DISTILLATION: FROM CONVENTIONAL TO FULLY THERMALLY COUPLED SYSTEMS.

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Separation of a Mixture of 5 components using conventional distillation columns

The objective of this example is to serve as a comparison based when thermally coupled distillation is considered. Here is the optimal solution when only conventional columns (one feed, two products reboiler and condenser) are considered. The model considerably simplifies respect to the TCD model, but we exclude a large number of alternatives.

The optimal solution obtained in this example is presented in the Figure (1). Some statistics can be found in Table 1. The problem can be solved fast and reliably in about 6 s of CPU time.

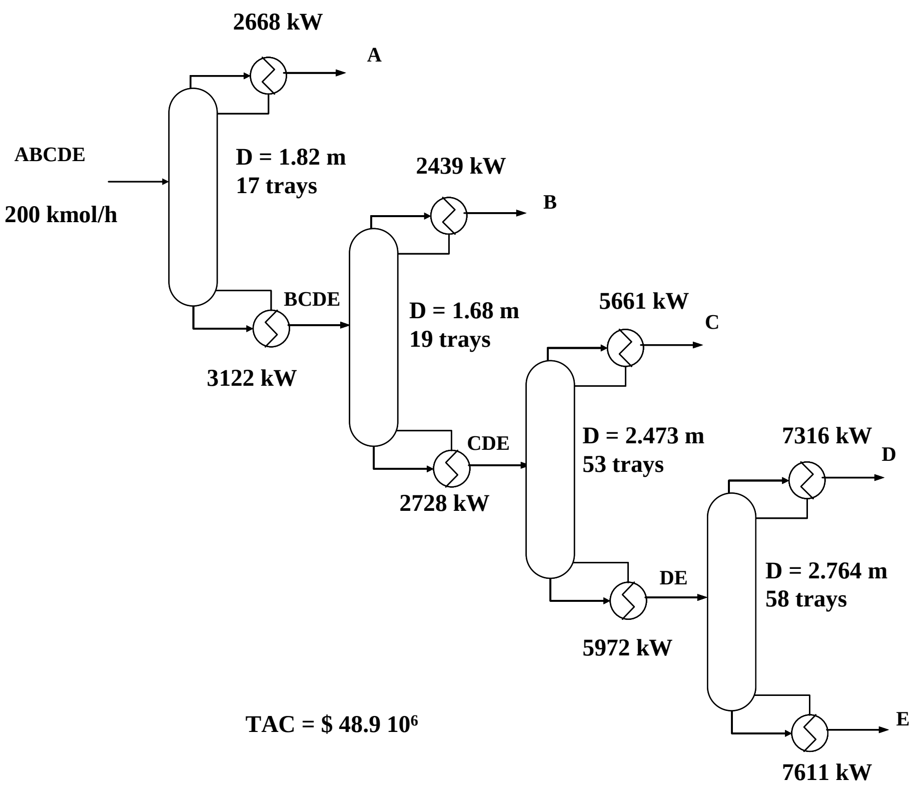

Figure 1.- Optimal solution obtained when only conventional columns are considered

Table 1 Statistics of the model

Number of equations	1129	Variables	
		Continuous	642
		Discrete	20
CPU time (s)	5.968		
Algorithm	Outer Approximation (DICOPT / GAMS)	Reference Equipment	PC Intel Pentium 4 2800 MHz; 2000 MB RAM.

Separation of a Mixture of 5 components using thermally coupled configurations (TCD)

Here we present the results of the second case. The separation of a 5 component mixture considering from conventional to fully thermally coupled distillation sequences going through all the intermediate alternatives.

Figure 2 shows the optimal configuration. Table 2 shows some model statistics.

The CPU time is considerably larger than with the model in which only conventional columns are taken into account. The reason is that, due to the non convex nature of the problem a direct Outer Approximation algorithm like DICOPT as implemented in GAMS produce a very poor local solution. It is necessary to use a two step strategy as commented in the model description and a solver that is no so sensitive to the non-convexities in this particular problem. We note, however, that the resulting model is very robust and reliable.

Comparing to the system using only conventional columns there is more than 20% saved in TAC.

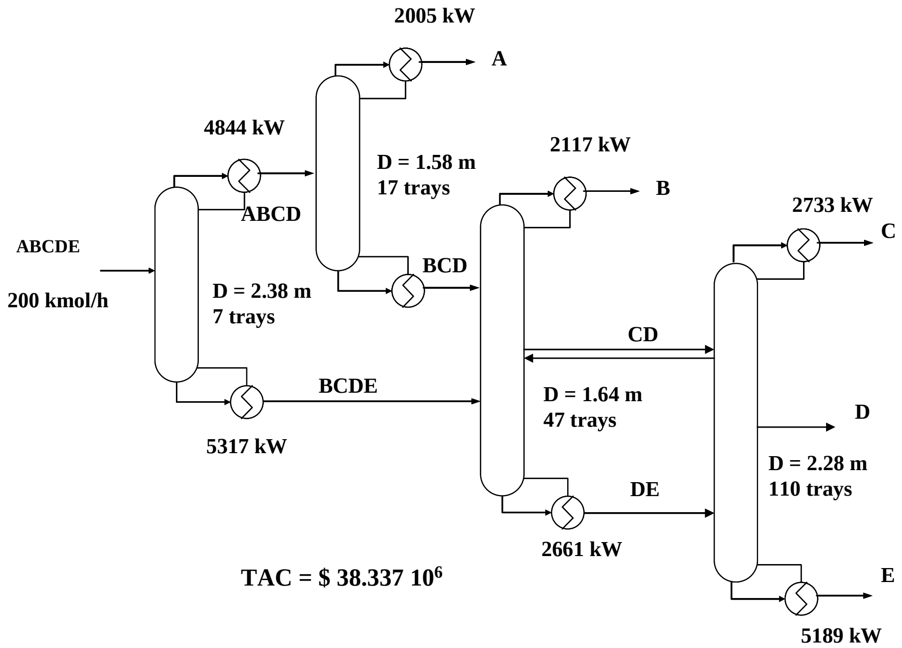

Figure 2. Optimal solution when complex configurations are considered

Table 2 Statistics of the model

Number of equations		Variables	
Sub-model 1	1296	Continuous	483
CPU time (s)	164	Discrete	35
Sub-model 2	1311	Continuous	498
CPU time (s)	6.03	Discrete	30
Algorithm	Branch and Bound (SBB / GAMS)	Reference Equipment	PC Intel Pentium 4 2800 MHz; 2000 MB RAM.

Sub-model 1= All internal heat exchangers fixed to false.

Sub-model 2= Optimization of heat exchangers in fixed structure of submodel 1.

(See model description)