INTRODUCTION

- Energy efficiency is a global priority, especially in production plants. Heat integration through pinch analysis is one of the most promising tools to reduce energy consumption in chemical processes.
- Those processes can be defined by different levels of data extraction: from only utility consumption until very detailed models.
- A detailed model of a chemical process is simulated, and the heat recovery identified using heat integration are compared with the identified using a simple model where the enthalpy of the process is given from the utility side.
- A heat exchanger network is proposed for this heat recovery and the material selection and corrosion assessment for it is performed.

MATERIALS & METHODS

- Software
  - Process simulation: Aspen V7.2, Dortmund Databank
  - Heat integration: OSMOSE

RESULTS

The detailed model simulated in Aspen was tested versus a simple model obtained in a previous work, which consider the data for enthalpy energy requirement from the utility point of view. Column integration, heat pumping and cogeneration were evaluated for each case. The total annual cost includes operational cost and annualized investment cost.

<table>
<thead>
<tr>
<th>Simple model</th>
<th>Detailed model</th>
<th>Detailed model + Process modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearly Operating Cost (k€/y)</td>
<td>Heat integration pump network</td>
<td>Heat integration pump network HP + Sn</td>
</tr>
<tr>
<td>HEN area (m²)</td>
<td>490 440 423 384</td>
<td>486 401 422 355</td>
</tr>
<tr>
<td>Min number of HeX</td>
<td>62 70 92 90</td>
<td>447 456 488 501</td>
</tr>
<tr>
<td>HEN cost bath (k€)</td>
<td>498 535 881 842</td>
<td>3977 925 1379 1311</td>
</tr>
<tr>
<td>EAC investment (k€/y)</td>
<td>51 54 90 86</td>
<td>405 94 140 134</td>
</tr>
<tr>
<td>Total annual cost (k€/y)</td>
<td>541 494 513 470</td>
<td>891 495 562 489</td>
</tr>
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Evaluation of Detailed model

The main advantage of using a detailed model versus a simple one, is having the possibility of envisioning beneficial process modifications. Column targeting and pressure increment are only possible for detailed model.

Figure a) compares the Grand Composite Curve of Detailed and Simple model. The curves shows consistency between models, and the differences are caused by the update of enthalpy needs and missing information in the Simple model.

Figures b) to d) shows the improvements over the Detailed model (Base case) by the use of column integration, pressure increment, heat pumping and cogeneration.

Finally, Figure e) shows the synergy between the previous techniques, with a final reduction of 92% of hot energy consumption, corresponding to 46% reduction in operating costs.

CONCLUSIONS

- Detailed model is preferred over simple one because it allows to envision beneficial process modifications to decrease unit’s energy consumption before heat integration. Process modification alone achieved 36% operating cost reduction without further investments, compared to Simple model.
- Process modification, heat pumping and cogeneration reduces operating costs in 83% compared to the current scenario.
- Proposed heat exchanger network allows 900 kW of heat recovery.
- The most economical suitable material for the heat exchangers proposed is 316L SS.

Heat Exchanger Network design

Heat Load Distribution was performed over the Base Case. The feasibility of the exchanges depends on the real plant layout and the exchange distances.

Material selection for heat exchangers

Corrosion resistance, service temperature, thermal and mechanical properties, machinability and price were the constraints applied for selection.

316L SS was selected over 304L SS owing its superior corrosion resistance and was then tested for the highest corrodent concentration in process.

Results of the potentiodynamic analysis shows the characteristic passivation zone of 316L SS. Resulting corrosion rates are lower than 20 mpy, which is considered as acceptable corrosion resistance.

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