Optimal waste stream discharge temperature selection for dryer operations using thermo-economic assessment

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The application of traditional pinch analysis to processes involving waste streams require the discharge temperatures of the waste streams to be estimated prior to performing the pinch analysis. In this situation the waste stream discharge temperatures are often not fixed and are termed soft data. Where the waste streams are hot it maybe desirable to recover the heat. Heat recovery from liquid streams is also valuable to drive the discharge temperature to below resource consent temperature limits (T_{limit}) set by environmental regulators. Furthermore, there is often a significant range of acceptable discharge temperatures below any T_{limit}.Since the selection of the waste stream discharge temperatures affects the pinch results, there is value in understanding this affect so waste stream temperatures that minimise the total cost can be identified and used in process integration analysis and design. To select the most advantageous waste stream temperatures, the plus-minus principle previously developed (Klemeš et al.,2011) has been applied in a software tool and the soft temperatures have been varied until utility targets are minimised. The best waste stream temperatures have been obtained by a thermo-economic assessment similar to the traditional selection of ΔT_{min}. A ΔT_{min}temperature contribution (ΔT_{cont}) based on the state of the stream has also been applied within the software tool to allow for more explicit calculation of the basic energy and heat exchanger area targets.

A typical drying process that has liquid and gas waste streams has been analysed and the impact of selecting various combinations of discharge waste temperatures on heat recovery, utility targets, area targets, capital cost and total cost is reported. Network area targets for vertical heat transfer and capital cost are calculated using the method in Smith (2005). The two waste streams are the evaporator water condensate and the dryer exhaust air. Both streams are hot with significant potential for heat recovery, however the economics of heat exchange usually favours the recovery of heat from liquid streams over gaseous streams. Results show that optimum selection of the waste stream temperatures requires a multi-variable optimisation of the waste temperatures together with the ΔT_{cont}. When the temperature of the exhaust air is held constant, there is a corresponding water condensate outlet temperaturethat minimises the utility targets. Critical temperature combinations exist for each exhaust air temperature value and results inan additional pinch point.

References

Klemeš, J., Friedler, F., Bulatov, I., & Varbanov, P. (2011). *Sustainability in the process industry: integration and optimization*. McGraw-Hill, New York, USA.
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