Simple Modeling of Flow Maldistribution in Plate-Fin Exchangers

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Abstract:

Detailed modelling of layer-pattern effects, pressure dependence and two-phase heat transfer in multi-stream plate-fin exchangers is now standard using proprietary HTFS software. What has received less attention is the effect on thermal performance of flow maldistribution across layers. It is generally assumed that inlet and outlet distributors can be designed to minimise flow variations. In complex exchangers with high pressure streams, such as those of modern oxygen plant main exchangers, this is not always possible. The constraints of header topology and fin type (strength) can lead to flow variations of greater than +/-10% which should not be ignored, particularly if the condition of partial draw-off or turbine streams are process critical. A simple technique has been developed for use with the HTFS MULE program which enables the actual performance of maldistributed exchangers to be determined with good accuracy. Each stream path through the exchanger is divided lengthways into several, usually 5, strips starting at the inlet distributor and ending at the outlet distributor. A flowrate is assigned to each strip based on the results of MULE distributor pressure drop calculations. MULE is then re-run 5 times to obtain the thermal performance of each set of strips. Improved overall performance values are then obtained from a mixed mean enthalpy calculation using a spreadsheet. The method is illustrated for a high pressure exchanger where the strip model shows that maldistribution across the layer leads to significant under-performance.