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SCIENTIFIC & RESEARCH PROJECTS

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Project Title:

Development of a New Graphical Tool for Calculation of Exergy Losses in Sub-Ambient Processes

Abstract:

This paper presents new graphical tools, which can quickly identify all thermal exergy losses occurring in process design particularly in condensers/evaporators of low-temperature processes. Although the Omega-H diagram is a powerful tool for getting insights about exergy loss in a heat exchanger network (HEN), the calculation of the enclosed area is not straightforward due to non-linearity of the curves. The Omega Composite Curves (OCCs) and Omega Grand Composite Curve (OGCC) developed in this research are new graphical tools that can be applied to any process, including sub-ambient processes. These curves are linear, and all enclosed areas have a rectangular shape. So, all thermal exergy losses can readily be calculated and also necessary modifications to enhance the efficiency of refrigeration systems, either in new design or retrofit study can graphically be suggested. To demonstrate the capability of the new graphical tools, two ammonia refrigeration cycles (one single-stage and one three-stage) have been designed to fulfil the cooling demand of a sub-ambient process and achieve minimum shaft work requirements. The exergy loss associated with each unit in the refrigeration cycle is directly calculated from the OGCC diagram. This is a convenient tool for calculation of exergy losses and can be used to compute the enclosed areas between the OGCC and the condenser/evaporator horizontal lines. The enclosed areas show that exergy loss for 3-stage compression is much less than that in the 1-stage cycle. Also, for the throttling valve, the exergy loss in the 3-stage refrigeration is considerably less than that in the 1-stage cycle. The new linear curves can easily be plotted and implemented to show the share of inefficiencies occurring in different unit operations.