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SCIENTIFIC & RESEARCH PROJECTS

Project No.: 07 **Year:** 2020

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Project Title:

Development of a New Graphical Tool for Calculation of Exergy Losses to Design and Optimization of 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 losses in a Heat Exchanger Network, the calculation of the enclosed area is not straightforward due to the non-linearity of the curve. The Omega Composite Curves and Omega Grand Composite Curve 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 condensers/evaporators in the refrigeration cycle is directly calculated from the diagrams. Combining the new tools with mathematical programming, a new systematic procedure for the design and optimisation of sub ambient processes is presented. A case study of a natural gas liquefaction process was used to demonstrate the application of the proposed procedure resulted in 24.9% lower shaft work consumption. This improvement was obtained by changing the composition of the mixed refrigerant. Also, in the third case study, the exergy loss within the refrigeration cycle of an industrial ammonia plant decreased by 15.31% by applying the suggested procedure to optimise the refrigeration levels.