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MULTI-OBJECTIVE OPTIMIZATION OF INDUSTRIAL PROCESSES

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Abstract: Natural gas and sulfuric acid are two of the most widely consumed products around the world. The increased demand for energy leads to fast growth of natural gas. The natural gas processing goes through many stages. Many of these stages have been considered for multi-objective optimization (like liquefaction), while the area of dehydration stage still needs more study. Regarding sulfuric acid importance, in addition to its various uses, it is a part of the production process of many industrial goods such as fertilizers. The production process of sulfuric acid and natural gas generate several gas emissions that are released to atmosphere and are negatively affecting the environment. In addition, during the production, the plant units are losing huge amount of energy. In order to solve these environmental and thermodynamic problems, both processes need to be multi-objectively optimized with respect to the specified objectives. For natural gas production, the considered bi-objective case is the simultaneous minimization of total process physical exergy (EXRGT) and photochemical ozone creation potential (POCP). ProMax® 4.0 was used to simulate the process coupled with excel-based NSGA-II algorithm to carry out optimization. Many decision variables were considered like solvent and gas flow rates, pressure and temperature of inlet streams. Limitations for the final product water content, solvent flow rate were taken into account. It was found that there exists a potential for improving the process and that the pressure of the inlet wet gas stream has the strongest impact on the multi-optimization results. For the sulfuric acid production plant, Aspen Plus was used for simulation and excel-based NSGA-II algorithm was used for optimization. Minimization of acidification potential (AP) and the physical exergy of the process units (EXRGP). Decision variables like columns and reactors operating pressure and raw materials flow rates (air and sulfur) were considered in addition to several constrains regarding the purity of the acid, gas lines water content, etc. Results showed that there is a multi-optimization potential for this process with respect to the thermodynamic and environmental point of view and that process is mainly influenced by the steam flow rate that is used for gas cooling purposes. Both studies provide a better understanding for dehydration and sulfuric acid processes, so that it will help in improving all the related plants all around the world.