322a A Study of Integration Potentials in Different Reformer Strategies for Logistical Fuels Processing

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The theoretical energy efficiency of a fuel cell system is approximately three times higher than a combustion engine based generator, thus it would provide substantial savings if alternative means of power production could be developed. Recent efforts have been focused on reforming existing logistical fuels, e.g. diesel or JP-8 for use in fuel cell systems. This is particularly important for military applications, as it would allow for the US armed forces to move towards using one single logistical fuel. To meet these ends the Center for Microfibrous Materials Manufacturing (CM3) at Auburn University has developed a bench scale test bed for investigating running a portable radar system of a PEM fuel cell stack by producing high purity hydrogen from steam reforming (SR) of JP-8. In principle, a PEM fuel cell system consists of the fuel processing section and the fuel cell itself, with the former being the reformer and post-combustion cleanup steps. Such systems inherently possess tremendous integration potential, not just limited to recycling unused material, but also in terms of energy recovery. Process integration techniques can be employed to realize this potential by providing global process insights and identifying overall process performance targets. It is imperative to apply a holistic approach in order to guarantee a truly optimal solution to the problem, since optimizing each unit individually might lead to suboptimal designs as one bottleneck is replaced by another. Using commercial process simulation software an initial model of the steam reforming and reformate clean up system was developed based on data from the fuel processing test bed. Once the simulation model had been developed, a process integration study was performed to identify the potential energy recovery. By employing pinch analysis methods the global flow of energy in the system was mapped and analyzed. Similar models have been developed for alternative reformation strategies, such as partial oxidation (POX) and auto-thermal reforming (ATR). Partial oxidation refers to incomplete combustion of the hydrocarbon fuel, while auto-thermal reforming is a hybrid process consisting of part combustion and part steam reforming. Since the post-reformation steps, i.e. hydrogen cleanup, do not change significantly if the reforming process is changed, it is fairly simple to compare the overall efficiency of the three reforming techniques after performing a thermal pinch analysis to identify the minimum utility requirements. A comprehensive efficiency analysis of hydrogen production from logistical fuels also requires an evaluation of effects of changing the fuel itself. Therefore the simulation models described above have been modified to investigate the use of alternative logistical fuels such as diesel and kerosene. Changing the fuel changes the chemical make-up of the reformer effluent, thus the downstream processing is also affected. This contribution will illustrate the results of a process integration analysis of the different reforming strategies of the various logistical fuels, including preliminary thermal management and water conservation strategies.