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Sensitivity Analysis of the Heat Exchanger Design in Net Power Oxy-Combustion Cycle for Carbon Capture

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Abstract : The global warming and its impact on climate change is one of main challenges for current century. Global warming is mainly due to the emission of greenhouse gases (GHG) and carbon dioxide (CO₂) is known to be the major contributor to the GHG emission profile. Whilst the energy sector is the primary source for CO₂ emission, Carbon Capture and Storage (CCS) are believed to be the solution for controlling this emission. Oxyfuel combustion (Oxy-combustion) is one of the major technologies for capturing CO₂ from power plants. For gas turbines, several Oxy-combustion power cycles (Oxyturbine cycles) have been investigated by means of thermodynamic analysis. NetPower cycle is one of the leading oxyturbine power cycles with almost full carbon capture capability from a natural gas fired power plant. In this manuscript, sensitivity analysis of the heat exchanger design in NetPower cycle is completed by means of process modelling. The heat capacity variation and supercritical CO₂with gaseous admixtures are considered for multi-zone analysis with Aspen Plus software. It is found that the heat exchanger design has a major role to increase the efficiency of NetPower cycle. The pinch-point analysis is done to extract the composite and grand composite curve for the heat exchanger. In this paper, relationship between the cycle efficiency and the minimum approach temperature (ΔTmin) of the heat exchanger has also been evaluated. Increase in ΔTmin causes a decrease in the temperature of the recycle flue gases (RFG) and an overall decrease in the required power for the recycled gas compressor. The main challenge in the design of heat exchangers in power plants is a tradeoff between the capital and operational costs. To achieve lower ΔTmin, larger size of heat exchanger is required. This means a higher capital cost but leading to a better heat recovery and lower operational cost. To achieve this, ΔTmin is selected from the minimum point in the diagrams of capital and operational costs. This study provides an insight into the NetPower Oxy-combustion cycle’s performance analysis and operational condition based on its heat exchanger design.

Keywords : carbon capture and storage, oxy-combustion, netpower cycle, oxy turbine cycles, zero emission, heat exchanger design, supercritical carbon dioxide, oxy-fuel power plant, pinch point analysis
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