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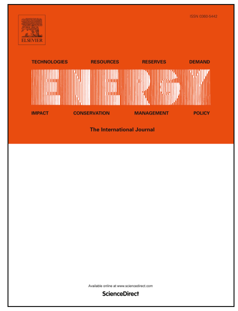

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Analysis of a recompression supercritical carbon dioxide power cycle with an integrated turbine design/optimization algorithm

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Abstract

A cycle simulation code with integrated turbine design/optimization algorithm has been developed and utilized for the analysis/optimization of $\approx 10MW_e$ recompression supercritical carbon dioxide Brayton cycle. Integrated turbine design and optimization code computes the turbine design engaging the meanline design calculations as a function of received inlet conditions from the main cycle simulation code. Moreover embedded turbine code optimizes the turbine geometric by minimized the losses with in the turbine using response surface optimization methodology and returns turbine geometry and performance parameters to main code. In order to capture the swift variation in thermophysical properties of SCO_2 in the supercritical region, cycle design point code and embedded turbine codes are linked with NIST REFPROP program. Integrated turbine design/optimization code was validated using 3D Reynolds-Averaged-Navier-Stokes calculations. Response surface methodology was tested by comparing the 3D computation results for the turbine baseline and optimized designs. Finally recompression supercritical carbon dioxide Brayton cycle was analyzed under various conditions of cycle's minimum temperature, minimum pressure, and pressure ratio and split mass fraction. On the basis of the results it is recommended to use proposed model for more realistic and accurate modeling cycle design point analysis.

Keywords: supercritical carbon dioxide cycle simulation, radial turbine design, optimization, recompression Brayton cycle

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