Effect of Inlet Conditions on Convective Heat Transfer in Submerged Axisymmetric s-CO2 Impinging Jet for Next Generation Turbines

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ABSTRACT

The supercritical carbon dioxide, s-CO2, power cycle has emerged as a promising system for clean and high-efficiency power production [1]. Especially, directly heating system using oxy-fuel combustion technology called NET power cycle which suggested by Allam et al [2] is preparing for demonstration as a next generation new concept development system [3]. This system utilizes CO2 as the working fluid in a high temperature and pressure in about 1150°C and 300 bar. Especially, considering the operating temperature range, it is important that this system also overcome the thermal problem in terms of the stability and the sustainability. This system operates in high turbine inlet temperature, cooling technology, like gas turbines must be applied. However, it difficult to adapt conventional cooling data directly because the conditions of working fluid, CO2, in which this system operates is in a supercritical state. There are significantly lack of the design data.

The heat transfer characteristics of supercritical carbon dioxide, s-CO2, submerged impinging jet with various wall heat flux is investigated. Submerged unconfined fully developed round jet are considered. The jet diameter, d, is 25 mm and height to diameter, h/d, is 2. Jet Reynolds number is set to 24,000. Simulation range of the inlet temperature and pressure which normalized by critical value are in between 0.99 to 1.5. As a result, the heat transfer coefficient of the impinging jet of s-CO2 varies greatly depending on the surface heat flux and inlet conditions. As increasing the heat flux, heat transfer coefficient shifts to the higher value at same other conditions. Consequently, area averaged heat transfer coefficient has peak characteristics with various inlet conditions.

Keywords: Supercritical CO2, impinging jet, Allam cycle

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