Effect of Lubricating Oil on Cooling Heat Transfer of Supercritical Carbon Dioxide Inside a Small Size Internal Grooved Tube

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The effect of a PAG-type lubricating oil on the heat transfer characteristics of supercritical carbon dioxide inside a small size grooved tube were experimentally investigated. The oil concentration was changed from 0% to 5% to measure the heat transfer coefficient and pressure drop. The mean inner diameter of the grooved tube is 2 mm, with a lead angle of 6.3º and average area enlargement ratio of 2.0. Experiments were conducted using supercritical carbon dioxide at pressures from 8 MPa to 10 MPa and mass fluxes from 400 kg/m^{2}s to 1200 kg/m^{2}s. With an oil concentration of 1% the heat transfer coefficient decreased 30-50% from the value for the oil free condition, and a 50-70% decrease was found when the oil concentration increased to 5%. However, there was no difference in the heat transfer coefficient between 3% and 5%, showing a saturation phenomenon with increasing oil concentration. Compared to a smooth tube, the heat transfer coefficient almost doubled at different oil concentration conditions, which was considered to be the effect of the area enlargement ratio. Pressure drop was found to increase 1.3 and 2 times with an oil concentration increase from 0% to 1% and 3%, respectively. Compared to a smooth tube, the increase of pressure drop for 0% and 1% is about 2 times, however, when the oil concentration increased to 3%, the increase in pressure drop was about 30%.