

CO₂ expanding process for CO₂ transcritical cycle

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Abstract

Developing CO₂ expander to replace the throttling valve in CO₂ transcritical cycle is a good way to improve the efficiency of the cycle. In this paper, the CO₂ phase change equilibrium was analyzed, and finds the CO₂ isentropic expanding process is a stable or metastable process.

During the CO₂ isentropic expanding process, the working fluid may undergo three types of phase change process according to the inlet parameters of the fluid. One process begins from the supercritical region, the supercritical fluid expands and changes to super cold liquid, then expands and changes to liquid-gas two phase fluid; the second process begins from the supercritical region, expands and passes the critical point to liquid-gas two phase fluid region directly; the third process begins from the supercritical region, the supercritical fluid expands and changes to super heat liquid, then expands and changes to liquid-gas two phase fluid. By thermodynamic analysis of the expanding process, the chilling capacity and the expanding work were calculated at different inlet expanding pressure assuming the evaporating temperature is 5°C, the outlet temperature of gas cooler is 40°C, the isentropic efficiency of the compressor is 70% and the isentropic efficiency of the expander is 60%. Because the first phase change process occupies the highest COP of the cycle, we chose the first phase change process as the design process of developing expander. This process is also a quick decompressing process, during which the bubbles grow in the super heat liquid. The bubble grow model in quick decompressing process was given and analyzed.