

工程热物理

亚临界及近临界压力区低质量流速垂直内螺纹管传热特性试验研究

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摘要:

在低质量流速条件下,对垂直上升内螺纹管内汽水两相流动沸腾传热特性进行了系统的试验研究。试验段采用了材料为SA-213T12的f32mm/6.3mm四头内螺纹管。试验参数范围为压力p=12~21MPa,质量流速G=232~773kg/(m2·s),内壁热流密度q=132~663kW/m2。试验得到了不同工况下垂直上升内螺纹管的壁温分布特性,分析了压力、内壁热负荷和质量流速变化对内螺纹管传热特性的影响,探讨了传热恶化的发生机制,并给出了能用于工程实际的传热试验关联式。试验结果表明:在亚临界及近临界压力区,垂直上升内螺纹管会发生第2类传热恶化——干涸(dryout),而在试验中未观测到第1类传热恶化——膜态沸腾(departure from nucleate boiling, DNB)。压力与内壁热负荷的增大,以及质量流速的减小,均会导致干涸提前发生和干涸后的壁温飞升值增大。与亚临界压力区相比,内螺纹管在近临界压力区的传热特性变差,管壁温度显著升高,发生传热恶化时的临界焓值减小。

关键词: 亚临界及近临界压力 低质量流速 内螺纹管 传热特性 壁温 干涸

Experimental Investigation on Heat Transfer Characteristics of Vertical Rifled Tube at Low Mass Flux Under Subcritical and Nearcritical Pressure

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Abstract:

Within the range of pressure from 12 to 21MPa, mass flux from 232 to 773 kg/(m2·s), and inner wall heat flux from 132 to 663 kW/m2, an in-depth experiment was conducted at low mass flux to investigate the flow boiling heat transfer characteristics of steam-water in vertical upward rifled tube. The rifled tube is f32 mm/6.3 mm SA-213T12 carbon steel. The tube wall temperature distribution was obtained in the experiment. The effects of pressure, inner wall heat flux and mass flux on heat transfer were analyzed, the heat transfer deterioration mechanism was discussed, and the corresponding empirical correlations were also presented. The experimental results show that dryout can occur in vertical upward rifled tube, but departure from nucleate boiling (DNB) has not been captured. With the increase of pressure and inner wall heat flux, and with the decrease of mass flux, dryout occurs ahead and the wall temperature in post-dryout region increases obviously. Compared with the heat transfer performance of rifled tube at subcritical pressure, that in nearcritical pressure region gets worse, the wall temperature significantly rises, and the critical enthalpy decreases.

Keywords: subcritical and nearcritical pressure low mass flux rifled tube heat transfer characteristics wall temperature dryout

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