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传递现象

滴状冷凝强化含不凝气的蒸气冷凝传热机制

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摘要 为了深入考察滴状冷凝强化混合蒸气冷凝传热传质过程的作用机制，在竖直表面上设计了完全滴状（DWC）、没有液滴向下脱落运动的条形分割滴膜共存（DFC）和膜状（FWC）3种冷凝形态的实验表面。对纯蒸气及含不凝气蒸气的冷凝传热过程进行了分析和实验研究，结果表明纯蒸气滴状冷凝与滴膜共存冷凝传热特性相近；而对含不凝气的冷凝，滴膜共存表面与膜状冷凝表面的传热特性相近；不凝气摩尔分数分别为0.9%、4.8%时，滴状冷凝较其他两种形态下的冷凝传热系数提高了30%～80%。其主要原因是由于混合蒸气冷凝传热阻力主要由气相边界层控制，滴膜共存冷凝并没有使气相的扩散传质过程得到强化，而完全滴状冷凝与设计的滴膜共存冷凝的区别在于后者仅存在小液滴的合并运动而没有大液滴向下脱落和对表面冲刷过程。根据二者实验结果的分析，认为滴状冷凝的大液滴脱落运动是影响气相传质的主要因素，大液滴脱落过程对气相边界层的扰动和剪切作用强化了气液界面传热传质特性。

关键词 滴状冷凝 滴膜共存 不凝气 强化传热 界面效应

分类号

Mechanism of dropwise condensation heat transfer enhancement in presence of non-condensable gas

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Abstract

In order to get a better understanding of the mechanism of heat transfer enhancement in dropwise condensation in the presence of non-condensable gas（NCG）, dropwise condensation（DWC）, filmwise condensation（FWC）and coexisting dropwise-filmwise condensation（DFC） heat transfer processes with and without NCG were designed on a vertical surface and investigated.The experimental results indicated that the heat transfer coefficient of dropwise condensation was of the same order of magnitude as that of coexisting dropwise-filmwise condensation without non-condensable gas.But, in the presence of non-condensable gas, the heat transfer coefficient of coexisting dropwise-filmwise condensation without droplets falling movement was of the same order of magnitude as that of filmwise condensation, and no heat transfer enhancement was found.Compared with the other condensation modes in the presence of non-condensable gas, heat transfer coefficient for dropwise condensation was enhanced by 30%—80% for air mole concentration of 0.9% and 4.8%.As the dominant resistance of the condensation with non-condensable gas resided in the gas phase, the enhancement mechanism was different from the condensation without non-condensable gas; it was mainly due to the falling behavior of condensate droplets making a considerable contribution to the overall heat and mass transfer performance.

Key words dropwise condensation dropwise-filmwise coexisting non-condensable gas heat transfer enhancement interfacial effects

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