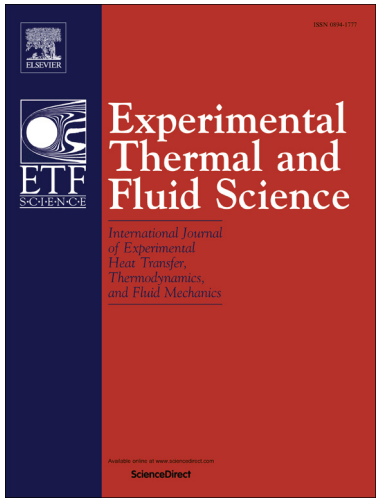

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Experimental investigation on the mechanism of pressure oscillation for steam jet in stable condensation region

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Abstract

The pressure oscillations for steam jet in stable condensation region are investigated experimentally. Steam at pressure 0.2 -0.6 MPa is injected into subcooled water at one atmosphere pressure with steam mass flux ranging from 298-865 kg/(m^2s), with water subcooling from 70-40 K. The steam plume shapes have been recorded and are compared with the pressure oscillation. The pressure oscillation for steam jet in stable condensation region is caused by the oscillation of steam plume length. When the steam plume length is the longest, the pressure oscillation has negative peak value and vice versa. Based on the experimental data and the change of steam plume shapes, a new phenomenological model of pressure oscillation is developed. The model also provides a method to obtain the steam plume length using the pressure oscillation. The prediction errors of the peak pressure oscillation are within ±30% of experimental values.

Keywords: Pressure oscillation, Steam jet, Direct contact condensation, Stable condensation, Plume length

Nomenclature

d_e	exit diameter of nozzle, mm	Δp	amplitude of pressure oscillation, kPa
G_e	steam mass flux, kg/(m^2s)	r	radial distance, mm
H	submerged depth of nozzle, mm	T_w	water temperature, K
l	steam plume length, mm	V	volume of steam plume, m^3
p_s	steam inlet pressure, kPa	x	axial distance, mm
p_∞	ambient pressure, kPa	τ	time, s

1. Introduction

Direct contact condensation has been widely used in nuclear power plants, chemical industry and other fields for its high heat transfer efficiency. For example, in nuclear power plant pressure relief system, when the pressure of nuclear reactor pressure vessel is higher than the safe value, the steam with high pressure and temperature is injected into subcooled water pool. The steam will be condensed rapidly due to the high heat transfer efficiency. However, in the process of steam-water direct contact