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## Subcooled flow boiling heat transfer of water in a circular channel with a twisted tape insert under high and non-uniform heat fluxes

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### Abstract

In order to investigate the water cooling technology for the divertor in the International Thermonuclear Experimental Reactor (ITER), heat transfer tests of subcooled water flow boiling in a circular channel with a twisted tape (TT) insert under high and non-uniform fluxes have been performed at Xi'an Jiaotong University. The vertically upward channel was off-center in a nickel rectangular block and the twist ratio of the twisted tape is 2. Experimental parameters covered the pressure range of 3-5 MPa, mass flux range of 3000-8000 kg·m<sup>-2</sup>·s<sup>-1</sup>, the inlet fluid temperature of 40-220 °C and the average heat flux on the inner wall surface of 2-5 MW·m<sup>-2</sup>. The influences of parameters on heat transfer coefficients have been discussed in detail. A wide set of empirical heat transfer correlations from forced convection to fully developed boiling (FDB) have been assessed with the experimental results, and most of the correlations could not fit the experimental data well. A new correlation for the FDB region and a modified Liu and Winterton correlation for the entire subcooled boiling region were proposed to predict the heat transfer coefficients in swirl flow under high and non-uniform heat fluxes. The average deviations (*ADs*) of the two correlation were 0.46% and 3.65%, respectively, and the root mean square deviations (*RSMDs*) of them were 4.85% and 13%, respectively.

**Keywords:** Subcooled flow boiling, Heat transfer, Twisted tape, non-uniform heat fluxes, ITER

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### Nomenclature

$A$	area [m <sup>2</sup> ]	$z$	axial distance [m]
$AD$	average deviation [%]		
$A_f$	flow area [m <sup>2</sup> ]		<i>Greek Letters</i>

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