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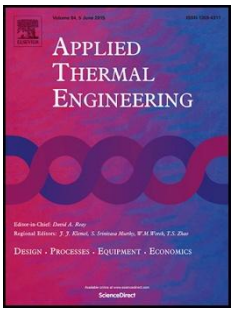

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Experimental Investigation of Transcritical Methane Flow in Rocket Engine Cooling Channel

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Highlights:

- Experimental tests on transcritical methane heat transfer are performed;
- Test conditions are relevant to rocket engine cooling channels;
- Surface roughness has prevented the heat transfer deterioration;
- A Nusselt number correlation for asymmetrically-heated channel has been derived.

Abstract

A test article has been specifically designed in order to investigate the methane behaviour inside rocket engine cooling channels. The test article is composed of a suitable copper-alloy block warmed up by cartridge heaters and of a single channel with rectangular cross section, which is fed with transcritical methane flow. Steady-state conditions and channel dimensions are representative of a typical rocket engine cooling channel. Several tests have been conducted with mass flow rate ranging from 10 to 25 g/s, exit pressure from 60 to 150 bar, and inlet temperature of about 130−140 K. The maximum provided heat flux at channel bottom is 20 MW/m^2. Measurements of channel inlet and exit temperature and pressure, mass flow rate, and wall temperature at different channel locations have provided data useful to evaluate heat transfer and pressure loss. In particular, the channel surface roughness induced by the manufacturing process has been estimated and a peculiar Nusselt number correlation has been obtained. This correlation is suitable to describe the thermal behaviour of the rectangular cooling channel including both methane flow and wall.

Keywords: Liquid rocket engine, Regenerative cooling, Transcritical methane, Heated channel, Nusselt number correlation, Channel roughness

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