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A COMPUTATIONAL STUDY TO INVESTIGATE THE ONSET OF HEAT TRANSFER DETERIORATION FOR A TRANS-CRITICAL METHANE FLOW IN A ROCKET ENGINE COOLANT CHANNEL

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ABSTRACT In recent times, there has been a growing interest in using liquid Methane as a rocket engine fuel to crop its advantages of being denser compared to liquid Hydrogen at the same time exhibiting better combustion characteristics compared to Kerosene. Since a typical coolant channel of rocket engine is exposed to very high pressures, a peculiar behaviour can be noted in the case of methane, it is referred to as trans-critical fluid flow where in Methane enters the coolant channel at supercritical pressure and sub-critical temperature. As it passes through the channel, temperature increases and exceeds the critical value. At this pseudo critical temperature 'liquid like' methane changes to 'gas like' with drastic property variations which can greatly influence the heat transfer. The literature review related to heat transfer at supercritical pressure indicates that drastic variations in the properties near critical point can make the flow field complex and results in unusual heat transfer behavior. Both heat transfer enhancement and heat transfer deterioration is reported in the literature near critical point. A systematic study has been carried out in the current work to investigate onset of heat transfer deterioration in rocket engine coolant channels which involves asymmetric heating through numerical analysis. The study indicates that heat transfer deterioration can be expected as heat flux is increased and interestingly localized flow acceleration owing to sharp fall in density appears to have a prime influence in the heat transfer deterioration. An attempt has been made to look at some possible methods to offset the heat transfer deterioration and the study reveals that providing higher surface roughness could be a simple possible means to overcome the heat transfer deterioration.