EXPERIMENTAL AND NUMERICAL HEAT TRANSFER STUDY OF SUPERCRITICAL WATER JETS PENETRATING SUBCRITICAL WATER

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Spallation drilling is a promising alternative drilling technology that could proof to be economically advantageous over rotary techniques for drilling deep wells needed e.g. for geothermal energy production. This drilling technique uses the properties of certain rock types to disintegrate into small disk-like fragments due to thermal stresses when heated up rapidly by a highly energetic jet.

In water-filled boreholes at depths of 2-3 kilometers water exceeds its supercritical pressure (221 bar) and hydrothermal flames can be applied to provide the required heat to spall the rock. One such potential spallation drilling head consists of a combustion chamber fed by water, fuel and an oxidant. Fuel and oxidant are preheated and form a supercritical, hydrothermal flame in the aqueous environment of the burning chamber. The water present in the combustion chamber is thus heated up to high, supercritical temperatures and ejected through a nozzle together with the combustion products. This supercritical water jet is directed towards the rock surface to induce fragmentation.

Crucial quantities in this process are heat fluxes of the supercritical water jet to the rock surface and heat losses to the aqueous surroundings typically at subcritical temperatures. To get a better insight of the heat transfer across the interface between the supercritical and subcritical water phase this work is aimed at investigating heat losses of subsonic, turbulent, supercritical water jets to a subcritical water bulk. Experiments are conducted in a high pressure vessel equipped with a preheating and injection system providing supercritical water jets at different temperatures, mass flows and nozzle diameters. Optical access at two opponent sides of the vessels allows for optical measurements of supercritical jet lengths, interfacial surface areas and also for the calculation of overall heat transfer coefficients. Experimentally determined results are compared to numerical simulations using an Euler/Euler two phase model.