Numerical Investigations on Fluid Flow through Metal Screens

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Fine metal screens are used in fuel tanks of satellites and space launch vehicles to guarantee a contaminant and gaseous free supply of propellants in direction of the respective engine. For the preliminary design of the propellant system the screen characteristics in dependence on the flow rate through the screen is important to know. The main characteristic quantity of the screen in this connection is the occurring pressure drop together with the flow behaviour.

There are various experimental research made by Cady[1973], Armour et.al.[1968], Schubauer et.al.[1950]. Most of them investigated the pressure drop and developed correlations between screens properties and the pressure drop. The correlations deviate over a wide range caused by different definitions of the screen Reynolds number and due to different experimental set-ups and measurement systems.

Numerical investigations on metal screens cannot be found as often as experimental data. Most papers focus on plain woven screens with a wider mesh. Lu et.al.[1996] made simulations on four types of pores in plain woven screens. A high influence of the pore type on the flow behaviour and pressure drop can be shown. Green et.al.[2007] made calculations on screens, which are used in wind tunnels. The results show a transient behaviour at the screen Reynolds number 40 and higher. Shklyar et.al.[2009] made calculations on screens used in greenhouses and developed an analytical approach for the pressure drop and turbulence.

In this study numerical investigations were made on the metal screens of type “Twilled Dutch 165x800” and “Twilled Dutch 200x1400” over a wide range of screen Reynolds numbers (Re_{Screen} = 0,1 .. 1000) with liquid water, liquid nitrogen and isopropyl alcohol (IPA). For calculations the commercial solver ANSYS Fluent (Version 13.0) is used. To avoid a high mesh cell number only a periodic cut-out was used with periodic boundary conditions. The results were compared with experimental data of Cady[1973], Armour et.al.[1968], Sperling[1996] and Fischer[2012]. There is a good agreement with the measurements made by Fischer[2012]. Furthermore the streamlines, the local velocity and pressure field are investigated, which is difficult to show in experiments. Postulated effects like the transient behaviour at Re_{Screen} = 40 by Green et.al.[2007] will be shown.