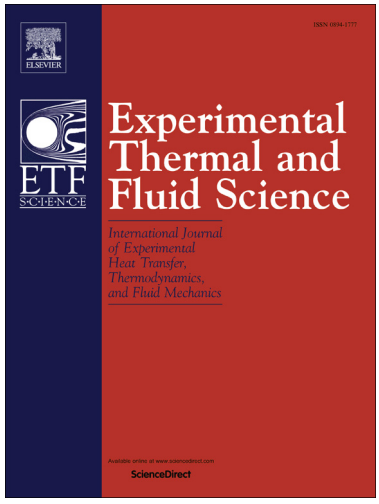

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Flow pattern of non-Newtonian fluids in reciprocating scraped surface heat exchangers

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Abstract

The flow pattern of a pseudoplastic fluid inside a scraped surface heat exchanger has been obtained by means of Particle Image Velocimetry. The scraping device consists of a rod with semicircular pieces mounted on it, which are in contact with the inner surface of the pipe. The whole moves axially and thus the pieces scrape the inner surface of the pipe, in order to avoid fouling formation and enhance heat transfer.

The aim of this work is to obtain the influence on the flow pattern of the significant parameters of the problem: the Reynolds number, the scraping velocity and the non-Newtonian behaviour of the fluid. In order to achieve this, a numerical model has been created. This model provides the velocity profile of non-Newtonian fluids in a concentric annulus, which has been used as start point for the study of the flow in the pipe with the insert device. Finally, PIV experiments have been carried out in the geometry under study, covering the representative ranges of the mentioned variables.

The results provide a deeper knowledge of the flow, allowing for a better understanding of the flow structures, as well as of the consequences they can have on linear pressure drop and heat transfer and on their study. Furthermore, the possibility of applying a suitable generalization method for the viscosity in this device has been analysed.

Keywords: non-Newtonian, *Power Law*, flow visualization, experimental, enhanced heat exchanger

Nomenclature

D, R	inner diameter and radius of the acrylic pipe (see Fig. 1) ,	[m]
d, R_s	diameter and radius of the insert device rod (see Fig. 1) ,	[m]
D_h	hydraulic diameter (see Fig. 1) ,	[m]
L	longitudinal position referenced to the centre of the scraper, being positive downstream of it ,	[mm]
N	number of pair of images in an experiment	
NN	number of finite volumes of the mesh	
m	flow consistency index (rheological property) ,	[$Pa\ s^n$]
Q	flow rate ,	[m^3/s]
P	distance from one scraper to the next one at the same angular position ,	[m]
p	pressure ,	[Pa]
r	radial position ,	[m]
s	standard deviation or Root Mean Square function (RMS)	
t	scraper length (see Fig. 1) ,	[mm]
T	temperature ,	[^{o}C]
u	fluid velocity ,	[m/s]
u_b	bulk velocity ,	[m/s]