Numerical investigation of three-layer polymer coextrusion channels based on Carreau and Cross models

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INTRODUCTION

The coextrusion is a complex process which involves flow of several polymer melts. Every aspect of the process, including design of channels has effect on an end product. Moreover, there are several viscosity models that can be used to describe the flow.

AIM

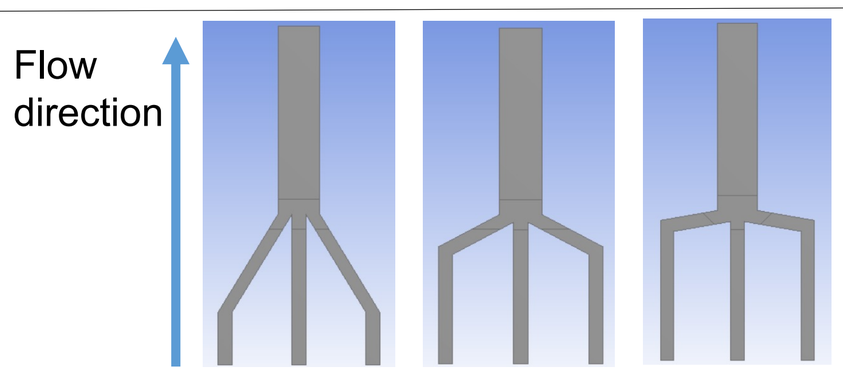
The project aims at understanding impacts that design modifications have on polymer melt flow's behavior.

OBJECTIVES

Main objectives of the project are to discuss the influence of a convergence angle value on pressure distribution all over the flow, to illustrate that both Carreau and Cross models are able to describe the flow, to show that inclination of a channel is a method to increase pressure.

METHODOLOGY

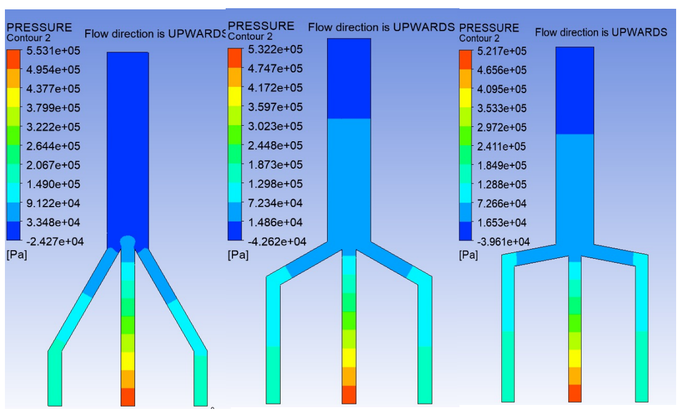
The investigation is done with the help of ANSYS POLYFLOW software. Three-layer polymer flow is analyzed. For this analysis, LLDPE and HDPE are considered. The effect of convergence angles is investigated by observing velocity and pressure contour maps. The behavior of flows at the regions with fillets instead of corners is discussed. Models are compared based on velocity and pressure.



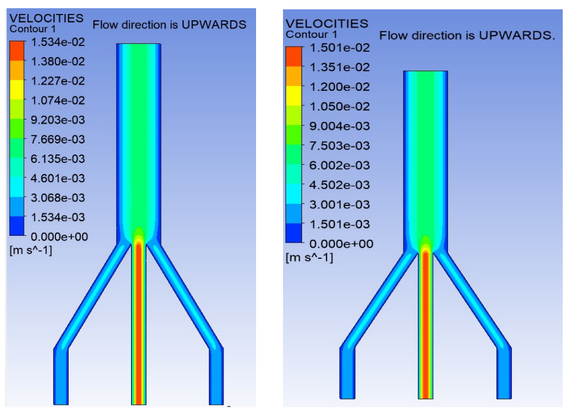
	Density (ρ), kg/m^3	Zero-shear viscosity (η_0), Pa*s	Time parameter (λ), s	Power-law index (n)
LLDPE	940	1300	0.0316	0.57
HDPE	975	1500	0.08	0.5

Dimensions are as follows: D at an inlet is 3,5 mm, D at the exit is 10,5 mm. Overall length of the model is 90 mm. Length between an inlet and merger point is 40 mm. LLDPE enters through middle channel at 36 cm^3/s, while two side channels are filled with HDPE at 6,808 cm^3/s. Viscosity parameters are shown in the table above.

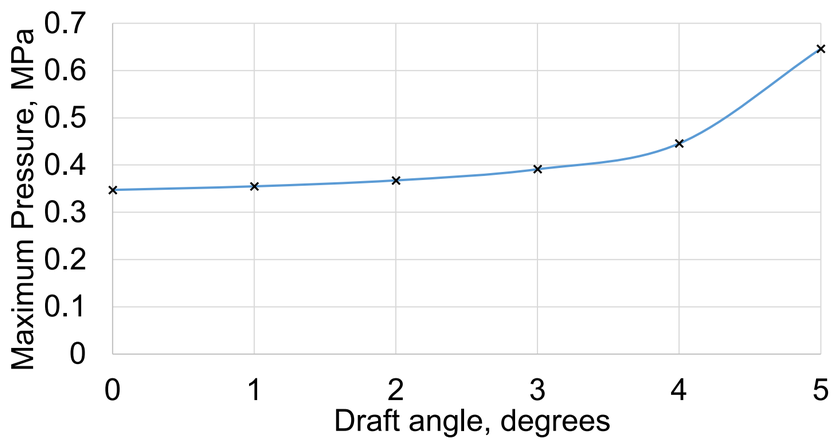
RESULTS



Figures above show that the main influence of convergence angle values are on pressure distribution. Higher convergence angle is specified, higher pressure is derived.



Figures above show velocity contour maps for analyses with Carreau and with Cross models. The deviation in values is quite small, , flow pattern is similar.



The graph above shows an increase rate of pressure for different configurations of a model with changed inclination (draft) angle. The larger the inclination is, the higher pressure is obtained.

CONSLUSIONS & RECOMMENDATRIONS

Coextrusion polymer flow behavior is indeed influenced by design parameters. Both inclination and convergence angles affect the pressure distribution and have directly proportional relationship with it. Moreover, according to this study, both Carreau and Cross viscosity models can be fairly used to investigate polymer flows. The limitations of the work include consideration of only velocity and pressure contour maps and insufficient computational power to conduct more accurate simulations.

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