SEMINAR - סמינר

הנך מוזמן/ת להרצאה סמינריונית של הפקולטה להנדסת מכונות, שתתקיים ביום ב׳ 27.12.2021
(כ״ג בטבת תשפ״ב), בשעה 14:30 סמינר יתקיים באודיטוריום 1, בנין ד. דן ובטי קאהן.

מרצה:

Evgeniy Boyko, Ph.D.

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על הנושא:

Flow rate–pressure drop relation for non-Newtonian fluids in narrow geometries

The seminar will be delivered in English

להלן תקציר ההרצאה:

Pressure-driven flows of non-Newtonian fluids in narrow geometries are ubiquitous in natural processes and technological applications. The complex rheological behavior of non-Newtonian fluids affects their hydrodynamic features, including the flow rate–pressure drop (FRPD) relation. Despite a large number of the measurements and simulations of the FRPD relation of various complex fluids in different geometries, the understanding of how non-Newtonian features such as shear thinning and viscoelasticity modify FRPD relation remains poorly understood. Furthermore, in some cases, numerical simulations not only fail to quantitatively capture the experiments, but even qualitatively contradict them. Thus, a quantitative comparison of any theoretical or simulation result with experiments is of fundamental and practical importance.

In the first part of my talk, I will present a theoretical approach to calculating the FRPD relation of shear-thinning fluids in narrow channels that can be used for comparison with experimental measurements. Using the Carreau model that reproduces the realistic rheological behavior of shear-thinning fluids over the whole range of shear rates, we derive three distinct asymptotic solutions, which allow us to approximate analytically the entire FRPD curve. I will show that our theory is in excellent quantitative agreement with experiments and rationalizes a transition in experimental data at high flow rates, which cannot be explained using a simple power-law model.

In the second part of my talk, I will discuss the FRPD relation of viscoelastic fluids in non-uniform geometries and the long-standing contradiction between experiments and simulations. While experiments show the increase in the flow resistance, defined as the ratio of the pressure drop to the flow rate, simulations predict its decrease. Aiming to understand the cause of this contradiction, I will present a theoretical framework for calculating the FRPD relation of Oldroyd-B (OB) fluids in arbitrarily shaped, narrow geometries. I will show that for the OB model, which is the most commonly used continuum model for viscoelastic fluids derivable from microscopic principles, our analytical predictions are in excellent agreement with simulations. However, our analytical results using the OB model still fail to rationalize the increase in the flow resistance observed experimentally. I will briefly discuss the shortcomings of the OB model, which may lead to this disagreement, and their resolution through incorporating additional microscopic features of polymers.

Bio: Evgeniy Boyko is a Gilbreth and Zuckerman Postdoctoral Research Fellow at the Schools of Mechanical and Chemical Engineering at Purdue University since October 2021. Before joining Purdue Engineering, Evgeniy was a Rothschild and Zuckerman Postdoctoral Research Fellow at Princeton University in 2020-2021. He earned his B.Sc. (2015) and Ph.D. (direct track) (2020) degrees from the Faculty of Mechanical Engineering at the Technion–Israel Institute of Technology. His research interests include theoretical research of non-Newtonian fluid mechanics and transport phenomena in complex fluids.

מארח: פרופ׳ אולג גנדלמן

בברכה,

פרופ״ח מתי סקס

מרכז הסמינרים