**Documentation for MYOHMIC and Ohmic Models**

**Overview**

This repository contains the implementation of two computational fluid dynamics (CFD) models: the Poisson-Boltzmann-Ohmic (MYOHMIC) model and the Ohmic model. These models are used to simulate the behavior of electrokinetic flows, particularly focusing on the effects of shear thinning and electroosmotic flow in non-Newtonian fluids such as Carreau fluids.

**Models Description**

**1. Poisson-Boltzmann-Ohmic (MYOHMIC) Model**

The MYOHMIC model integrates the Poisson-Boltzmann equation with the Ohmic model to capture the behavior of electrokinetic flows in channels, especially under the influence of electric fields. This model is particularly useful for studying non-Newtonian fluids, where the fluid's viscosity depends on the shear rate.

* **Electrokinetic Effects:** The MYOHMIC model accounts for electrokinetic effects by solving the Poisson-Boltzmann equation, which describes the distribution of electrical potential in the fluid. The model also includes the effects of free charge distribution near the channel walls, which are crucial for understanding electroosmotic flow.
* **Shear Thinning:** The model captures the shear-thinning behavior of non-Newtonian fluids, where viscosity decreases with increasing shear rate. This effect is particularly pronounced near the walls, leading to a significant reduction in viscosity in these regions.
* **Instability Suppression:** Due to the high shear rates near the walls, the MYOHMIC model predicts a substantial reduction in viscosity, which helps dampen velocity fluctuations and suppress flow instabilities. This is a key advantage of the MYOHMIC model, making it more stable under certain conditions compared to the Ohmic model.

**2. Ohmic Model**

The Ohmic model is a more traditional approach to modeling electrokinetic flows. It assumes that the electric potential distribution can be described using Ohm's law, with no consideration for the complex interactions captured by the Poisson-Boltzmann equation.

* **Boundary Conditions:** The Ohmic model typically employs slip boundary conditions, which allow for a velocity slip at the walls depending on the local electric field and fluid properties.
* **Fluid Behavior:** While the Ohmic model can be applied to both Newtonian and non-Newtonian fluids, it does not capture the detailed shear-thinning behavior as effectively as the MYOHMIC model. As a result, it may not predict the same level of velocity fluctuations or instabilities, particularly in fluids with significant shear-thinning properties.

**Why Use the MYOHMIC Model?**

The MYOHMIC model is chosen over the Ohmic model in situations where the detailed interaction between electrokinetic effects and non-Newtonian fluid behavior is critical. Specifically:

1. **Shear-Thinning Fluids:** In fluids like Carreau fluids, where viscosity decreases with increasing shear rate, the MYOHMIC model provides a more accurate representation of the flow, especially near the walls where shear rates are highest.
2. **Instability Management:** The MYOHMIC model's ability to reduce viscosity near the walls helps in dampening velocity fluctuations, effectively reducing instabilities in the flow. This makes it a preferred choice for simulations where stability is a concern.
3. **Electroosmotic Flow:** The MYOHMIC model provides a more detailed description of electroosmotic flow by incorporating the effects of free charge distribution and electric potential, which are essential for accurately predicting flow behavior in channels with electric fields.

**Implementation Details**

* **Solver Setup:** The code is implemented using [your chosen software, e.g., OpenFOAM], with custom modifications to solve the MYOHMIC and Ohmic models.
* **Boundary Conditions:** Detailed descriptions of the boundary conditions used in each model, including slip conditions and electric potential specifications.
* **Simulation Parameters:** Key parameters used in the simulations, such as fluid properties, channel dimensions, and electric field strength.

**Conclusion**

In summary, the MYOHMIC model is a robust tool for simulating electrokinetic flows in non-Newtonian fluids, particularly where shear thinning, and electroosmotic effects play a significant role. While the Ohmic model provides a simpler approach, the MYOHMIC model's ability to capture complex interactions and stabilize the flow makes it a valuable choice for advanced CFD simulations.

**Repository Structure**

* myOhmic\_model/: of90\src\libs\EDFModels\models\myOhmic.
* Ohmic\_model/: of90\src\libs\EDFModels\models\Ohmic.
* docs/: You need to understand how PB model and ohmic model are implemented in rheoTool(openFOAM) before reading this.
* Tutorials: I provided some examples to understand how slip velocity fails to predict the EKI in shear thinning fluids**.**