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Application of Entropy Concept for Shear Stress Distribution in Laminar Pipe Flow

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In the river fluid mechanics, shear stress is calculated from frictional force caused by viscosity and fluctuating velocity. Traditional shear stress distribution equations have been widely used because of their simplicity. However, they have a critical limitation of requiring energy gradient which is generally difficult to estimate in practice. Especially, measuring velocity/velocity gradient on the boundary layer is difficult in practice. It requires point velocity throughout the entire cross section to calculate velocity gradient. This study proposes shear stress distribution equations for laminar flow based on entropy theory using mean velocity and entropy coefficient. The proposed equations are demonstrated and compared with measured shear stress distribution using Nikuradse's data. Results showed that the coefficient of determination is around 0.99 indicating that the proposed method well describes the true shear stress distribution. Therefore, it was proved that shear stress distribution can be easily and accurately estimated by using the proposed equations.
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