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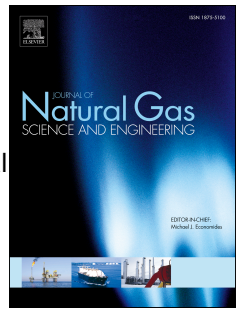

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Characteristic Analysis of A Non-Equilibrium Thermodynamic Two-Fluid Model for Natural Gas Liquid Pipe Flow

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Abstract: Natural Gas Liquid (NGL) primarily contains light hydrocarbon components, e.g., ethane, propane and iso-butane. Its unique phase behavior and rapid evaporation process typically causes a non-equilibrium thermodynamic two-phase flow in the transmission pipeline, in which the liquid and vapor phases have different temperatures at the same cross section of the pipe. To describe this two-phase flow, a one-dimensional two-fluid model considering the NGL compressibility and viscosity is built based on the general mass, momentum and energy conservation equations for each phase. To select its appropriate solution method, the mathematical characteristic of the model is studied using the eigenvalue analysis method. The results demonstrate that its mathematical characteristic is primarily dependent on the void fraction, densities and flow velocities of the liquid and vapor phases. The two-fluid model is hyperbolic and well-posed when the liquid flow velocity is equal to the vapor flow velocity, the two-phase flow reduces to a single phase flow, or the difference between