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Experimental and theoretical analysis of a supercritical carbon dioxide jet on wellbore temperature and pressure

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Shale gas is considered to be one of the best clean alternative fuels with the most potential because of large reserves all over the world. However, hydraulic fracturing, a widely-used technology in shale gas exploitation, may cause serious environment issues. Therefore, the application of supercritical carbon dioxide (SC-CO₂) instead of water to fracture shale has been mentioned. To investigate the use of a SC-CO₂ jet on the wellbore pressure and temperature, a series of experiments based on impinging theory have been conducted in the present study. In the first experiment, a specially designed apparatus with four visual windows was used to intuitively observe the jet's structure and character with a high-speed video system recording the entire experimental process. In the second experiment, a high precision sensor was assembled in the vessel to measure the impinging pressure. The result shows that: (1) a SC-CO₂ jet has a similar structure as a water jet, while a SC-CO₂ jet dissipates slowly due to its low viscosity; (2) the impinging pressure increases with the increasing jet pressure, but the increasing rate is different because dissipation ratio decreases; (3) the ambient pressure affects the jet energy transfer rate though flow resistance and the ambient density. Under present experimental conditions, the critical pressure is 14.5 MPa; (4) a predictive equation is listed to calculate the impinging pressure based on the jet pressure and ambient pressure. These results help optimize the parameters of the SC-CO₂ jet and promote the application of SC-CO₂ in shale gas exploitation.

Biography

Yi Hu services as a researcher at Hubei Key Laboratory of Waterjet Theory and New Technology, Wuhan University, Wuhan 430072, China. His research interests focus on shale gas and coal bed methane exploitation by Supercritical Carbon Dioxide (SC-CO₂)

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