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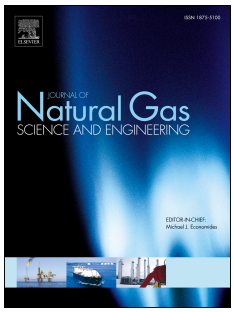

Experimental and theoretical analysis of a supercritical carbon dioxide jet on wellbore temperature and pressure

Yi Hu, Yong Kang, Xiaochuan Wang, Xiaohong Li, Man Huang, Mingxing Zhang

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

Yi Hu [a, b], Yong Kang [a, b,*], Xiaochuan Wang [a, b], Xiaohong Li [a, b], Man Huang [a, b], Mingxing Zhang [a, b]

[a] School of Power and Mechanical Engineering, Wuhan University, Wuhan, 430072, China

[b] Hubei Key Laboratory of Water Jet Theory and New Technology, Wuhan University, Wuhan, 430072, China

Abstract

Along with the fast development of society, the demand for energy continually increases. Shale gas, a type of unconventional natural gas trapped within shale formations, 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-CO_2) instead of water to fracture shale has been mentioned. This novel approach could enhance shale gas recovery with no harm to the environment. To investigate the use of a SC-CO_2 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-CO_2 jet has a similar structure as a water jet, while a SC-CO_2 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. Considering the application, the minimum jet pressure should be chosen to be more than 1.5 times the ambient pressure, and a suitable target distance for a SC-CO_2 jet is no more than 7.5 nozzle diameters. These results help optimize the parameters of the SC-CO_2 jet and promote the application of SC-CO_2 in shale gas exploitation.

Key words: Supercritical carbon dioxide jet, Shale gas exploitation, Enhance gas recovery, Impinging jet

Corresponding author Tel: +86 02768774906; fax: +86 02768774906. E-mail address: kangyong@whu.edu.cn(Yong Kang)