Proceedings of the 9th World Congress on Momentum, Heat and Mass Transfer (MHMT 2024)
London, United Kingdom – April 11 – 13, 2024
Paper No. CSP 115
DOI: 10.11159/csp24.115

Changecharacteristics of Negative Drainage Pressure along the Drill Hole: Theoretical Analysis and Field Tests

Jun Liu
School of Safety Science and Engineering, Henan Polytechnic University, Jiaozuo, Henan, China
Liujun5027@163.com

Extended Abstract

Continuous fluid inflow along a the pipe network causes a change in the dynamic and laminar boundary variable mass flow state inside the pipe. The pressure and flow caused by a variable mass flow have been studies of interest in oil exploitation. Dikken [1] and Doan [2] investigated the severity of the pressure reduction in the process of a variable mass flow.Su [3]et al. found that the pressure drop of a variable mass flow primarily consists of four parts:friction pressure drop of the tube wall, acceleration, hole roughness, and mixed pressure drop. Schulkes [4] et al., revealed that pressure drop was related to the holediameter, density, velocity, and angle of injection and obtained empirical formulas for mixed pressure drop.Qu [5] et al. studied two-phase transition mass flow and established pressure drop model for multi-branch wells. Shi [6] et al, studied two-phase transition mass flow and established pressure drop model for multi-branch wells. Duan[7] et al, believed that the distribution of the negative pressure in an extraction borehole corresponds to a logarithmic relationship

In this paper, a proper understanding of the change characteristics of negative drainage pressure along athe drilling hole is essential, as gas drainage parameters are the key parameters influencing the efficiency of gas drainage. Based on the coupling of gas seepage from coal seams and the gas flow along the drilling hole, a theoretical model was established to calculate the gas pressure change law along the a drilling hole with different influencing factors. Subsequently then, a multi-branch method was applied to test the negative pressure at different drilling holes. Finally, a field test was conducted in the in Jiulishan coal mine to analyze the changed characteristics of the negative drainage pressure along athe drilling hole. The results show that, The gas flow, borehole diameter, borehole depth, and orifice negative pressureinfluence the variation in the negative pressure in a borehole. With an increase in the gas flow, the negative pressure loss is sharp and increases. The smaller the borehole diameter, the greater the loss of negative pressure. The longer the borehole, the more obvious the decrease in negative pressure. The variation characteristics of the negative suction pressure in different holes was same:in the range 0-20 m, the negative pressure basically remained unchanged; in the range 20-80 m, the negative pressure dropped faster; and in the range 80–100 m, the negative pressure dropped slowly.

Under a constant negative extraction pressure condition, the negative extraction pressure in a hole gradually decreases as the drilling depth deepens, and with an increase in the extraction pressure at the orifice, the loss of negative pressure at 100 m becomes a roughly increasing trend if human error and the precision error of instruments are excluded. It can be approximated that within the negative pressure and time range of the test in this study, the loss of negative pressure in a hole per 100 m basically does not change with a change in negative pressure.This study has important theoretical and practical significance for improving the gas drainage effect.

References

[1] Dikken B J. Pressure drop in horizontal wells and its effect on production performance. J. Pet. Technol.1990, 11:1426-1433.
[2] Doan Q.; Farouq Ali S M.; Georoge A E. Scaling criteria and model experiments for horizontal wells. In: The CIM/SPE Int Tech Meet,Calgary, June,1991, 27-28.
[3] Su, Z.; Gudmundsson J S. Pressure drop in perforated pipes: experiments and analysis. SPE28800. In: The SPE Asia Pacific Oil and Gas Conference. November.1994,563-574.
[4] Schulkes R.; Utvik O H.; Rinde T. Pressure drop in horizontal wells: multiphase flow with radial inflow. In: BHR Group Multiphase. 1997, 45-55.

[5] Qu, Z. Q.;Yang, Y.;Lu, H.; Sun, X. N.; Wang, B.; Yao, J.Productivity calculation of radial well distal fracturing andits application.J. Cent. South Univ. (Sci. Technol.).2014, 45 (07): 2289-2294.
[6] Shi,J. T.;Hou, C, H.; Wang, S.;Xiong, X. Y.;Wu, S. G.;Liu, C. The semi-analytical productivity equations for vertically fractured coalbed methane wells considering pressure propagation process, variable mass flow, and fracture conductivity decrease. J. Pet. Sci. Eng.2019, 178 : 528-543.
[7] Duan, H. J.; Wang, Y.; Xiao, Q.; Wang, J. L.; Peng, D. Gas extraction technology and application of near horizontal high directional drilling. Energy Rep.2022, 8(S4) : 1326-1333.