maximum, and the maximum value is 852.47MPa, which is less than the yield limit of the material.

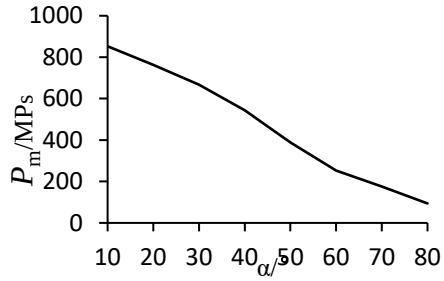

Figure 12. Maximum equivalent stress of fluid-solid coupling analysis at different opening angles

5. CONCLUSION

(1) For a certain type of subsurface safety valve, through the fluid simulation, we have obtained the valve body fluid pressure distribution cloud diagram at different valve opening angles, and the variation of the maximum fluid pressure at the inflow side of the valve plate.

(2) By corresponding post-processing of the fluid analysis results, we have obtained the relationship between the resistance of the well fluid to the valve plate and the opening angle of the valve plate; the relationship between the fluid resistance torque around the pinhole of the valve plate and the opening angle of the valve plate. All these provide certain guidance for the ground pressure control system when the subsurface safety valve plate opens.

(3) By establishing the fluid-solid coupling model under different opening angles and adopting one-way fluid-solid coupling analysis, we have obtained the stress cloud diagram of the solid model under the effect of fluid load when the valve plate of the subsurface safety valve is opened at different angles, as well as the relationship between the maximum stress and opening angle.

ACKNOWLEDGEMENTS

The projects supported National Key R & D project (2016YFC0303703) and Hubei Province Natural Science Foundation(2016CFC740) are gratefully acknowledged.

REFERENCES

[1] Corvaro F, Nardini G, Paroncini M, Vitali R. (2015). Pi v and numerical analysis of natural convective heat trans fer and fluid flow in a square cavity with twovertical obs tacles. International Journal of Heat and Technology 33(2): 51-56. https://doi:10.18280/ijht.330208

[2] Diaz JJDC, Nieto PJG, Mere JO, Garcia AB. (2007). Computer simulation of the laminar nozzle flow of a non-Newtonian fluid in a rubber extrusion process by the finite volume method and experimental comparison. Journal of Crystalline Solids 353(8-10): 981-983. https://doi.org/10.1016/j.jnoncrysol.2006.12.067

[3] Frigaard I, Vinay G, Wachs A. (2007). Compressible displacement of waxy crude oils in long pipeline startup flows, Journal of Non-Newtonian Fluid Mechanics 147(1): 45-64. https://DOI:10.1016/j.jnnfm.2007.07.002

[4] Zander V, Nitsche W. (2013). Control of secondary flow structures on a highly loaded compressor cascade,P.I. Mech. Eng. A-J. Pow. Energ 227(6): 674–682. https://DOI: 10.1177/0957650913495538

[5] Dossena V, Franchina N, Savini M, Marinoni F, Cecchi F, Bassi F. (2017). Reynolds number effects on the performance of safety valves operating with incompressible flows. Journal of Loss Prevention in the Process Industries(49): 525-535. https://doi.org/10.1016/j.jlp.2017.05.020

[6] Amarasinghe WS, Jayarathna CK, Ahangama BS, Moldestad BME, Tokheim LA. (2017). Experimental study and CFD modelling of minimum fluidization velocity for geldart A, B and D particles. International Journal of Modeling & Optimization, 7(3): 152-156. https://doi.org/10.7763/IJMO.2017.V7.575

[7] Li MQ, Yang K, Zhou SZ, Zhang S. (2017). Dynamic equilibrium response analysis for self-balancing subsurface safety valve. Chinese Hydraulics and Pneumatics (6): 70-74. https://doi:10.11832/j.issn.1000-4858.2017.06.014

[8] Pendyala R, Wong YS, Ilyas SU. (2015). CFD simulations of natural convection heat transfer in enclosures with varying aspect ratios. Chemical Engineering Transactions 45(9): 1348. http://doi:10.3303/CET1545133

[9] Pendyala R, Jia LC, Ilyas SU. (2015). CFD analysis of heat transfer performance in a car radiator with nanofluids as coolants. Chemical Engineering Transactions 45: 1261-1266. http://doi:10.3303/CET1545211

[10] Žižka M, Šulc R, Ditl P. (2017). Heat transfer between gas and liquid in a bubble column. Chemical Engineering Transactions 57(211): 1261-1266. http://doi:10.3303/CET1757211

[11] Snider DM. (2001). An incompressible three dimensional multiphase particle-in-cell model for dense particle flows. Journal of computational physics 170(2): 523-549. https://doi.org/10.1006/jcph.2001.6747

[12] Gbadebo SA, Cumpsty NA, Hynes TP. (2007). Control of three-dimensional separations in axial compressors by tailored boundary layer suction, ASME.J. Turbomach, 130(1): 011004-011004-8. https://DOI: 10.1115/1.2749294

[13] Chen F, Chen H. (2013). A BrokenP1-Nonconforming Finite Element Method for Incompressible Miscible Displacement Problem in Porous Media, ISRN Applied Mathematics 2013: 1-7. https://DOI: 10.1155/2013/498383

[14] Li Y. (2015). Research on calculation of pin mechanics about hydraulic support. Coal Mine Machinery 36(10): 19-21. http://doi:10.13436/j.mkjx.201510008

[15] Li YS, Dong SX. (2017). Finite element aanalysis on flow field and stress field of SSSV flapper open/close. Drilling and Production Technology 40(1): 61-64. http://doi:10.3969/J.ISSN.1006-768X.2017.01.17