11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

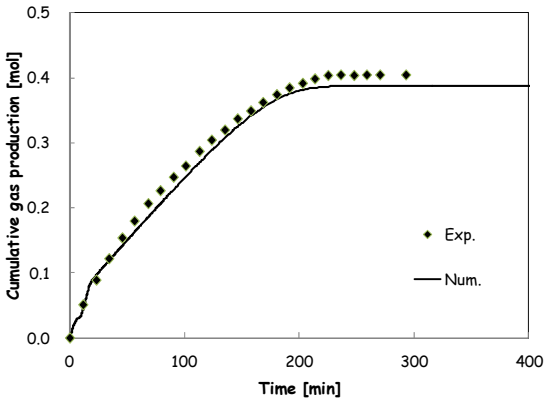
Development of THM coupled numerical simulator for methane hydrate bearing sediment

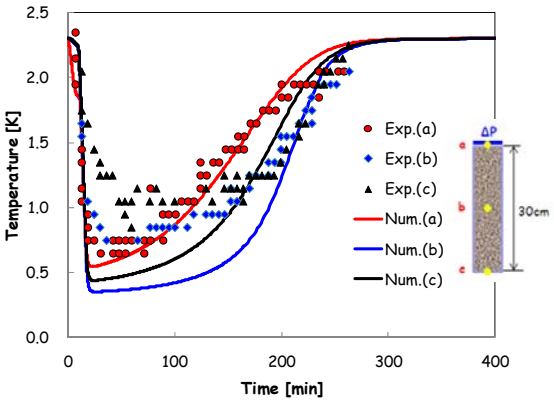
Shin, Hosung [1]

[1] University of Ulsan, Ulsan, 680-749, Republic of Korea, shingeo@ulsan.ac.kr

Key Words: *Methane hydrate bearing sediment, THM coupling, numerical simulation, production*

Methane gas hydrates found in the oceanic and permafrost environments are crystalline solids composed of CH4 gas and water. Vast quantities of methane are trapped within natural methane hydrate bearing sediment under high pressure and low-temperature conditions. This paper presents general governing equations for coupled THM(Thermo-Hydro-Mechanical) processes of methane hydrate bearing sediment. Coupled partial differential equations are derived from four mass balances equations (solid, water, methane air, and methane hydrate), energy balance equation, and force equilibrium equation: main variables=displacement, methane gas pressure, fluid pressure, temperature, and hydrate saturation. Also, elasto-plastic mechanical constitutive model for hydrate bearing sediment is formulated based on the effective stress. Numerical simulations involving coupled THM processes are conducted to discuss numerical stability and applicability of developed numerical simulator: Masuda's experiment (1999), gas production in Ulleung site in Korea by depressurization. Numerical results demonstrated that developed simulator can predict very complex behaviour of coupled THM phenomena of hydrate bearing sediment in the production process by depressurization.





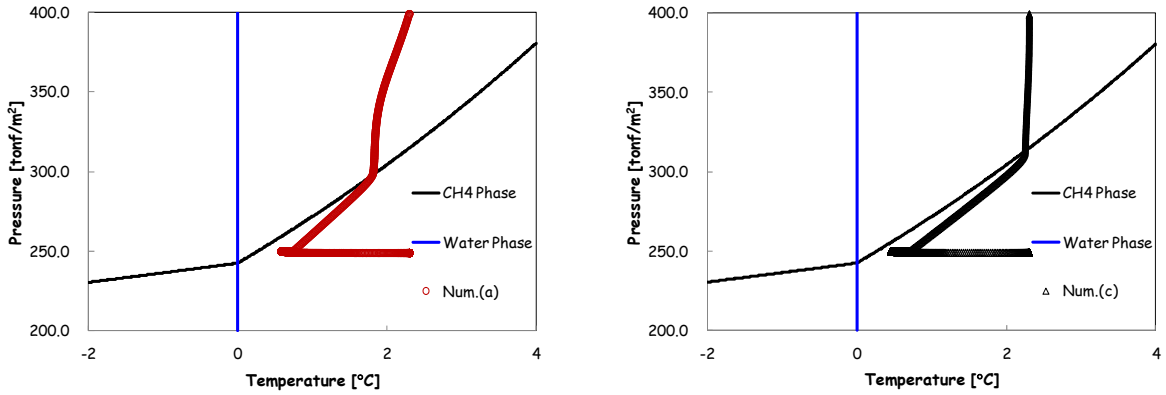


Figure. Numerical verification of experimental data from Masuda et al. (1999). a) Cumulative CH4 gas production, b) temperature variations at different sections, c) evolution in pressure-temperature phase diagram.

REFERENCES

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