SIMULATION OF HYDRAULIC FRACTURING WITH PROPANE-BASED FLUID USING A FRACTURE PROPAGATION MODEL COUPLED WITH MULTIPHASE FLOW SIMULATION IN THE COOPER BASIN, SOUTH AUSTRALIA

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Abstract

In many unconventional reservoirs, gas wells do not perform to their potential when water-based fracturing fluids are used for treatments. The sub-optimal fracture productivity can be attributed to many factors, such as: 1) Effective fracture length loss. 2) Low load fluid recovery. 3) Flowback time. 4) Water availability. Therefore, the development of unconventional reservoirs has prompted the industry to reconsider "Waterless" fracturing treatments as viable alternatives to water-based fracturing fluids. Results from the study will provide insight on the performance of different fracturing fluids with various reservoir conditions.

LPG Fracturing Fluid

- Hurst (1972) introduced a new stimulation technique using liquid gas (e.g. propane and butane). It is a fracturing treatment using an absolutely water-free fluid system.
- Leblanc et al (2011) presented a successful case for the application of a LPG-based fracturing fluid in the McCully gas field, in Canada. In addition, laboratory tests of LPG fracturing fluid have also been conducted in Canada (Taylor et al, 2010).
- There, however, are many gaps in knowledge of using LPG-based fracturing fluids, as research about this is very limited.

Methodology

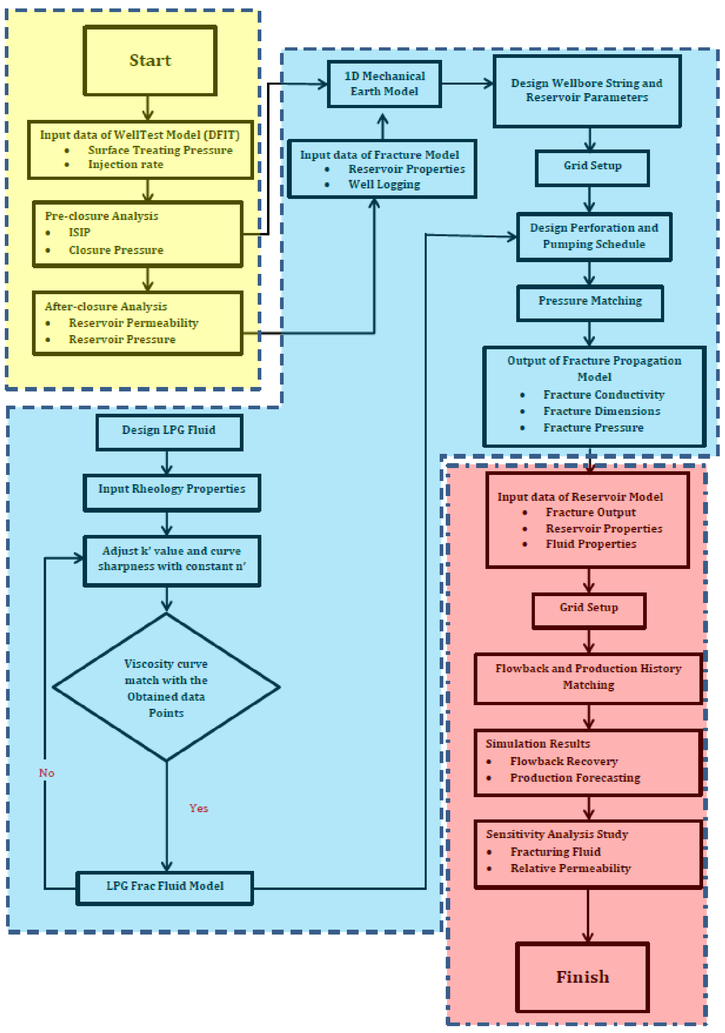


Figure 1. Workflow of the model development. Yellow indicated the IHS model process, blue indicates the GOHFER process, and red indicates the Eclipse Process.

Permeability Jail

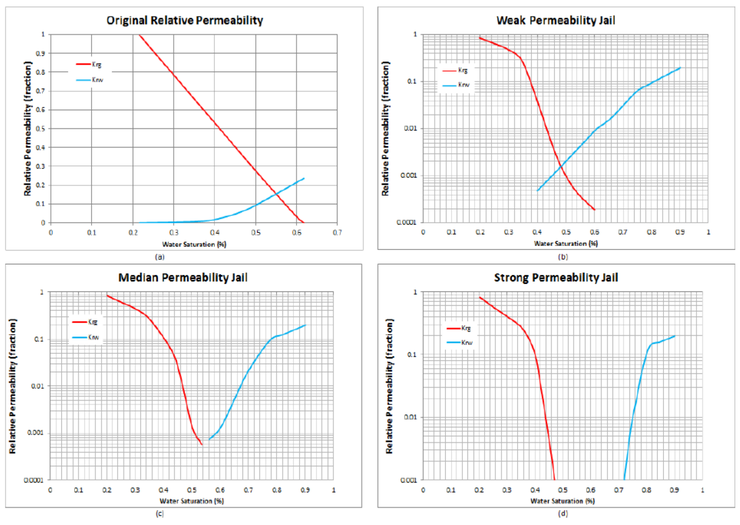
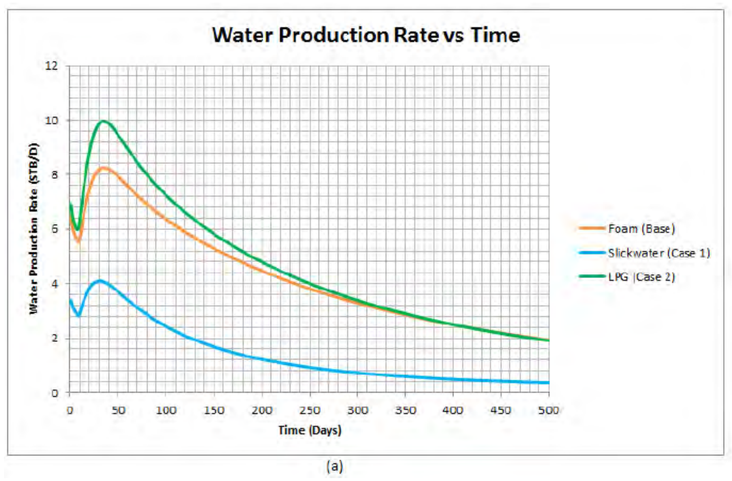


Figure 2. Sensitivity study of different relative permeability (rel-perm) curves. a) Normal tight gas rel-perm curve, b-d) Weak to strong rel-perm jail curves. Adapt from Shaoul et al., 2011).

Results



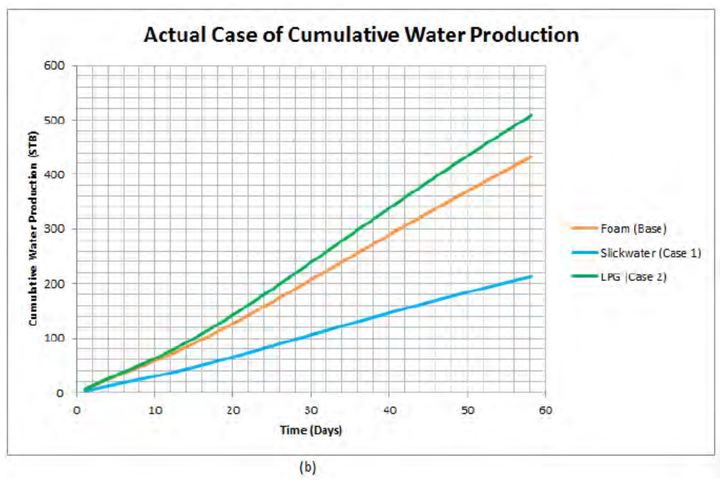


Figure 3. Effect of different fluid types on original reservoir condition. a) Water production rate versus time. b) Cumulative water production versus time.

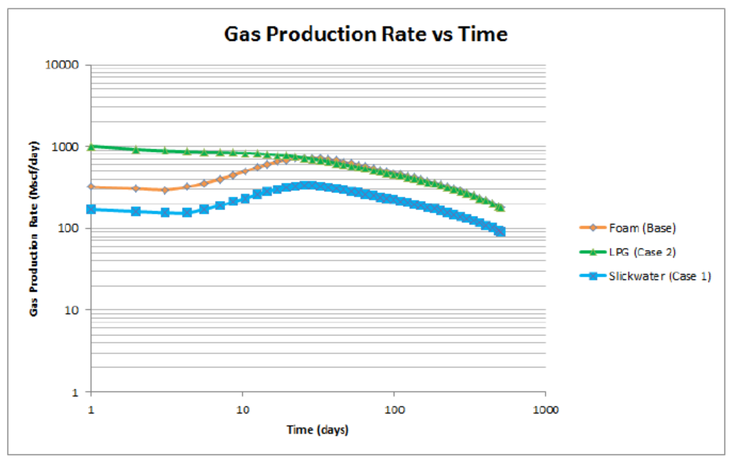


Figure 4. Effect of different fluid types on gas production (original reservoir).

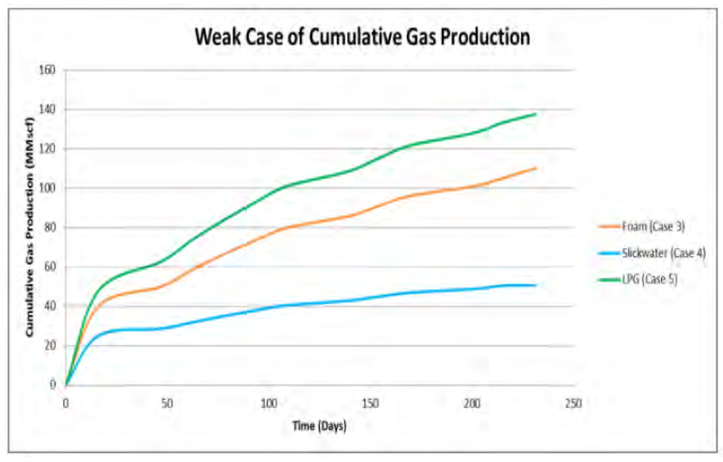


Figure 5. Effect of different fluid types on gas production (weak case).

Table 1. Summary of sensitivity analysis results.

Properties	Fraccing Fluid Type	Rel-Perm Type	Gas Cumulative at 230 days (MMscf)
Base Case	N2 Foam	Original Reservoir	167.5
Case 1	Slickwater	Original Reservoir	80.7
Case 2	LPG	Original Reservoir	170.9
Case 3	N2 Foam	Weak Perm Jail	110.2
Case 4	Slickwater	Weak Perm Jail	50.7
Case 5	LPG	Weak Perm Jail	137.7
Case 6	N2 Foam	Median Perm Jail	78.5
Case 7	Slickwater	Median Perm Jail	50.6
Case 8	LPG	Median Perm Jail	106.9
Case 9	N2 Foam	Strong Perm Jail	73.5
Case 10	Slickwater	Strong Perm Jail	38.2
Case 11	LPG	Strong Perm Jail	83.2

References

HURST, R.E., 1972—Gas Frac - A New Stimulation Technique Using Liquid Gases. SPE Rocky Mountain Regional Meeting, Denver, Colorado, 10–12 April, SPE-3837.

LEBLANC, D.P., MARTEL, T., GRAVES, D.G., Tudor, E. AND Lestz, R., 2011—Application of Propane (LPG) Based Hydraulic Fracturing in the McCully Gas Field, New Brunswick, Canada. North American Unconventional Gas Conference, Woodlands, Texas, 14–16 June, SPE-144093.

SHAOUL, J.R., VAN ZELM, L.F. AND DE PATER, C.J., 2011— Damage mechanisms in unconventional gas well stimulation--a new look at an old problem. SPE Production & Operations, 26 (04), 388–400.

TAYLOR, R.S., FYTEN, G., ROMANSON, R., MCINTOSH, G., LITUN,R., MUNN, D., BENNION, B., PLWOWAR, M. AND HOCH,O., 2010—Montney fracturing-fluid considerations. Journal of Canadian Petroleum Technology, 49 (12), 28–36.

Conclusions

- The permeability jail has negative impact on the gas production. With more severe liquid sensitive formation (from original to strong rel-perm), the cumulative gas production of all the frac fluid would decrease to 47%.
- In between 50% N_2 foam with LPG, LPG has slightly better flowback rate at the beginning stage (up to 50 days). The total flowback recovery was significantly enhanced to 76% within 60 days by using gelled LPG fracture stimulation.
- In a normal relative permeability reservoir, there is potential for 53% of effective fracture half-length loss by slickwater.
- There is potential for 53% of incremental gain comparing with slickwater for all the cases. However, in the cases of 50% N_2 foam, the results show that there is no significant benefit on the post frac production in normal relative permeability behaviour. Thus, higher quality foam is recommended in the low pressure normal water sensitivity formation.