CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

The observation made from the interpretation of the simulation results indicates that there is potential use of the in-situ gas lift technique from understanding different sets of variables that have an effect on its performance. Some scenarios can provide higher recovery factors than the base case well with conventional gas lift. In term of maximizing recovery factor, the in-situ gas lift technique can be used for oil wells with presence of certain thickness (or OGIP) of gas zone while the depth and the permeability of the in-situ gas zone may give different impacts on the recovery factors. Some attempts were also made to increase or reduce the perforation interval of the in-situ gas zone in some scenarios that cannot catch up the base case's recovery factor.

6.1 Conclusions

According to the simulation results, the summary of oil recovery factor for each scenario is shown in Table 6.1.

Table 6.1 Summary of Oil Recovery Factors using In-situ Gas Lift Technique

In-situ Gas Zone Scenario		15-ft Thickness			45-ft Thickness			90-ft Thickness		
Permeability (mD)	Depth (ft TVD)	OGIP (MMscf)	Oil Recovery Factor		OGIP (MMscf)	Oil Recovery Factor		OGIP (MMscf)	Oil Recovery Factor	
			Concurrent Perforation	Time-lapsed Perforation		Concurrent Perforation	Time-lapsed Perforation		Concurrent Perforation	Time-lapsed Perforation
10	5500	568	37.0%	39.0%	1704	40.5%	40.8%	3407	41.1%	41.3%
10	6500	722	37.3%	39.9%	2167	40.7%	41.2%	4334	41.3%	42.1%
10	7500	816	39.9%	40.6%	2447	41.3%	41.5%	4895	41.9%	43.0%
100	5500	568	36.3%	38.0%	1704	39.0%	40.8%	3407	40.4%	40.9%
100	6500	722	36.5%	39.0%	2167	40.1%	41.0%	4334	40.9%	41.8%
100	7500	816	37.3%	39.6%	2447	41.0%	41.3%	4895	41.5%	42.4%
1000	5500	568	36.0%	37.0%	1704	38.1%	39.2%	3407	39.6%	40.5%
1000	6500	722	36.3%	38.1%	2167	39.0%	40.7%	4334	40.5%	41.5%
1000	7500	816	36.6%	38.4%	2447	39.5%	40.8%	4895	41.2%	41.9%
Note: The recovery factors for natural flow and the base case are 32.1 % and 41.4%, respectively. The recovery factor for the base case is the sum of the natural flow and conventional gas lift.										

According to all simulation results, the following can be concluded:

(a) All scenarios with in-situ gas lift zone in both concurrent and time-lapsed perforation schedule can provide the recovery factor exceeding that of the natural flow (32.1%).

(b) In order to improve the recovery factor, the time-lapsed perforation schedule of the in-situ gas zone should be always used. Basically, in this study, the well is initially produced naturally for certain duration until the water cut reaches 50% and the in-situ gas zone is then perforated with 1-ft interval.

(c) In order to obtain comparable recovery factor with the base case, the thickness of the in-situ gas zone needs to be in a high range or 45 ft and 90 ft (OGIP between 1704 and 4895 MMscf) which actually means that larger OGIP will contribute to the success of the in-situ gas lift technique. Increasing in thickness or OGIP provides more gas rate to maintain sufficient GLR for longer period of time. It is also noted that the scenarios with 90-ft thickness (OGIP between 3407 – 4895 MMscf) of in-situ gas zone provide the highest recovery factor for a given depth and permeability of in-situ gas zone.

(d) In either concurrent or time-lapsed perforation schedule, the recovery factor increases with the depth of the in-situ gas zone. This increasing depth effect is similar to the effect of the depth of gas injection in conventional gas lift. Moreover, the deeper the in-situ gas zone, the higher reservoir pressure and temperature, resulting in higher expansion ratio of gas when migrating up the well which better helps lift the liquid column than shallower in-situ gas zones. As a result, it is also noted that for given thickness and permeability of in-situ gas zone, the scenarios with 7500-ft TVD (or deepest) of in-situ gas zone provide the highest recovery factor.For scenarios with an in-situ gas zone with low permeability (k = 10 mD) there is a need to increase the amount of gas produced into the well to increase or optimize GLR. For this study, an attempt to increase the perforation interval of the in-situ gas zone from 1 ft to 2 ft was made to improve the recovery factor successfully.

(e) For scenarios with an in-situ gas zone with high permeability (k = 1000 mD), there is a need to control the amount of gas produced into the well to prevent excessive GLR. For this study, an attempt to reduce the perforation interval of the in-situ gas zone from 1 ft (6 shots) to 0.33 ft (2 shots) was made to improve the recovery factor successfully.

(f) For scenarios with an in-situ gas zone with moderate permeability (k = 100 mD), increasing perforation interval of the in-situ gas zone from 1 ft to 1.5 ft will help improve recovery factor; however, increasing perforation interval of the in-situ gas zone from 1.5 ft to 2.0 ft, the recovery factor will decrease. On the other words, there appears to the optimal perforation interval of the in-situ gas lift zone with 100 mD which is 1.5 ft.

6.2 Recommendations

As a result, given similar fluid properties and arrangement of the oil and gas reservoirs in the well model, the recommendations for using the in-situ gas lift for monobore oil wells with commingled production in Pattani Basin are as follows:

(a) Any monobore oil well consisting of an in-situ gas zone(s) with 45 ft or 90 ft thickness can be completed using in-situ gas lift or without conventional gas lift and still obtain very comparable recovery factor with the base case. The completion using in-situ gas lift technique also gives significant savings due to the costs of the gas lift compressor and its surface facilities.

(b) The time-lapsed perforation schedule of the in-situ gas zone is recommended for any monobore oil well with an in-situ gas zone with "*kh*" between 150 mD-ft to 90,000 mD-ft which is the range used in this study.

(c) In order to improve the recovery factor of any monobore oil well with an in-situ gas zone with high permeability (k = 1000 mD), the perforation interval on in-situ gas zone should be reduced, i.e. from 1 ft (6 shots) to 0.33 ft (or 2 shots) whereas other monobore oil well with low permeability (k = 10 mD), the perforation interval of in-situ gas zone should be increased, i.e. from 1 ft to 2 ft in this study.

(d) In order to improve the recovery factor of any monobore oil well with an in-situ gas zone with moderate permeability (k = 100 mD), the perforation interval of the in-situ gas zone should be increased from 1 ft to 1.5 ft only.

(e) In order to gain better understanding of the use of in-situ gas lift technique in monobore oil wells with commingled production, other parameters that affect IPR or TPR, such as tubing size and other fluid properties are recommended to be further studied.

(f) It appears that the time-lapsed perforation schedule provides better results or higher recovery factors than the concurrent. However in this study only 50% water cut is used as the trigger for time-lapsed perforation of the in-situ gas zone. As a result, it is recommended that the timing of time-lapsed perforation schedule of the in-situ gas zone be further evaluated to optimize the recovery factor.

(g) In this study, some simulation attempts were made to reduce or increase the perforation interval of the in-situ gas zone with a good sign of improvement in recovery factors. However, not many simulation runs were made in this study for wider range of the perforation intervals of the in-situ gas zone. Therefore, it is recommended that the perforation interval of the in-situ gas zone be further evaluated to optimize the GLR or improve the recovery factors.