Sensitivity Study of Fracture Parameters and Horizontal Well Length for Optimum Production Strategy in Tight Gas Reservoirs

Reza Kazmi[1], Jawad Sarmad[1], and Misha Qazi[1]

[1]Final Year Students, Petroleum & Gas Engineering Department, UET Lahore

Extended Abstract

The development of unconventional resources has been one of the industry's major focus for a decade or so to fulfil the rising world energy demand. Reservoirs with very less permeability that do not produce economic flow rates of gas without stimulation are classified as tight gas reservoirs. Production from such reservoirs is made possible by specialized techniques such as fracturing vertical wells, drilling horizontal wells or multistage fracturing. Different production enhancement strategies are available considering the economic and technical aspects of the project.

The aim of this study is to enhance the production of tight gas reservoir by either fracturing a vertical well or drilling it horizontally. For fracturing a well, the fracture half-length, fracture permeability and reservoir permeability are the most important parameters that affect the performance of a hydraulically fractured well. Whereas in a horizontal well the horizontal well length will be of significant importance for production optimization. Effects of varying fracture half-length and fracture permeability on production have been analysed and an optimum value of both is chosen as final selection. Moreover, the role of reservoir permeability for the selection of optimum fracture half-length and fracture permeability have also been emphasized. For horizontal wells, the length of the horizontal well section has been varied to check the production performance. Consequently, the production of tight gas reservoir under study has been optimized by a comprehensive sensitivity analysis. The study has been concluded by presenting a comparison between the production from a vertically fractured well and horizontal well in different reservoirs.

A single phase black oil model is created in PIPESIM. To observe the performance of an unstimulated vertical well, a base case is first developed using pseudo steady state equation for inflow performance relationship (IPR) and Gray (modified) model for outflow performance relationship (OPR).Hydraulic fracture model is then utilized for analysing the stimulation effects. A sensitivity analysis is carried out for fracture half-length (L_f) and fracture permeability (k_f). System analysis is performed to analyse the effect of fracture half-length and fracture permeability simultaneously on gas production rate, first fracture half-length as sensitivity variable and then fracture permeability. Also, the effect of fracture half- length and fracture permeability is analysed for different reservoir permeabilities. A horizontal completion model is then created to observe the effects of different horizontal well lengths on gas production rate.

The base case unstimulated well gives the production rate of about 0.7mmscf/d. Post fracture analysis shows that even with the minimum fracture half-length i.e300 ft and the fracture permeability of 20000 md gives around 3 mmscf/d production rate which is 4 times that of the

original production rate. Furthermore, it has also been observed that increasing the half-length and fracture permeability the production rate does increase but not proportionally. Consequently it has been inferred that at higher values of L_f and k_f the increase in production rate is not so prominent and an investment on such an extensive fracture treatment might not turn out to be economically feasible. It also signifies the importance of optimum values of fracture parameters for a successful fracture job. For this purpose, system analysis has been employed and optimum values of both the parameters are selected. For the given reservoir (k=0.1 md), it has been noticed that varying fracture half-length has relatively more effect on production rate as compared to fracture permeability. This is because fracture half-length controls the productivity of low permeability reservoirs more as compared to fracture conductivity. On the contrary, for the moderate permeability reservoirs, fracture permeability plays a more vital role. Sensitivity study for horizontal well length was then carried out for different horizontal well lengths. Production continued to increase with increasing well length from 200ft to 600ft and was observed to be stable (no increase) afterwards. Therefore 600ft length was finally selected in horizontal well which gave approximately 1mmscf/day.

- Production at optimum values of fracture permeability (20000 md) and fracture half-length (500 ft)came out to be approximately 3 mmscf/day.
- Production from horizontal well with well length of 600 ft and greater was 1 mmscf/day.
- Considering the above two values in our current case, fracturing a vertical well will be preferred as it gives us a better production rate.
- In tight gas reservoirs fracture half-length has a much greater effect on production rate as compared to fracture permeability. For moderate permeability reservoirs, fracture permeability has a more important role to play.
- Horizontal well length’s affect is observed to be more prominent at moderate and high reservoir permeabilities.