CHAPTER-8

RESULTS AND DISCUSSIONS

8.1 CASE 1: ONLY WELLBORE WITH NO HYDRAULIC FRACTURES:

In this case the gas will flow directly from matrix into horizontal wellbore; the matrix blocks which are in contact with the wellbore will act as a source for wellbore. So, the sink term is applied to the matrix blocks which are in contact with the wellbore.

Figure 8.1 gives the information about the flow rate variation with respect to time.

On X-axis- Time interval. Here, 1 time step = 40 Days.

On Y-axis- Gas Flow rate – (Mscf/Day)

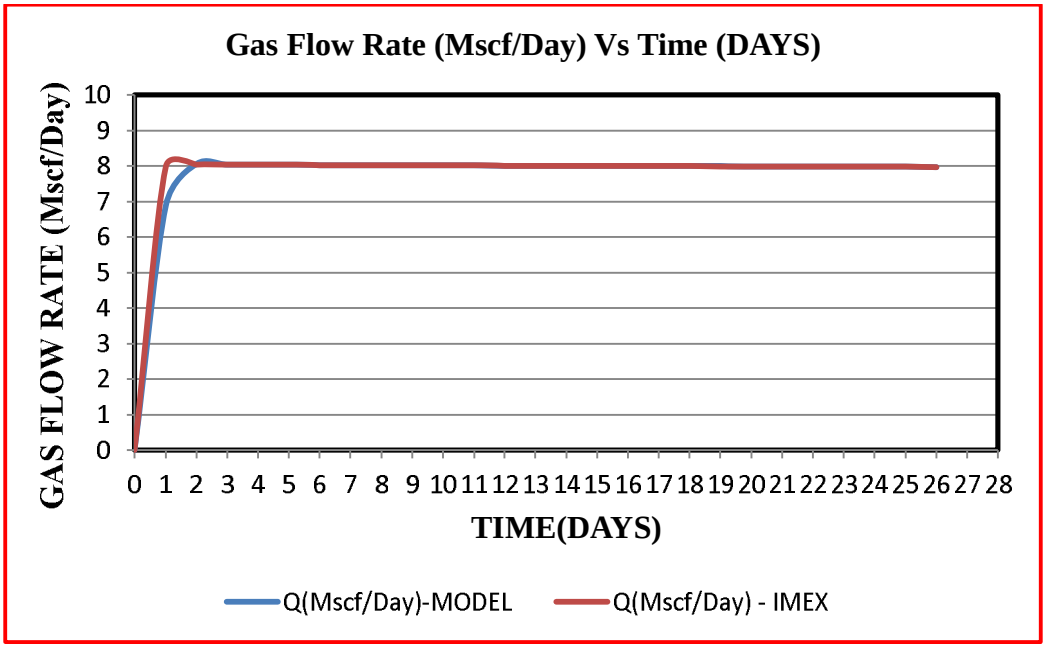

Figure 8.1: Variation of Gas Flow Rate (Mscf/Day) Vs Time (DAYS).

As the permeability of shale reservoirs is very low, for getting good rate of gas production the reservoir has to undergo hydraulic fracturing which increases the permeability of the reservoir. In this case, the gas in the reservoir will flow into the reservoir only through the permeability of the reservoir, At the initial stage when the reservoir is put under production the free gas in the fractures will be produced first, then once the pressure around the matrix drops

then due to pressure difference the adsorbed gas will start desorbing from the surface of the matrix. If the permeability of the fractures is higher, then the rate of production will be higher. Since, in this case the hydraulic fractures are not considered, the pressure drop will be low and hence the gas production will last for longer periods with low gas production per day.

8.2 CASE 2: WELLBORE WITH SINGLE HYDRAULIC FRACTURE:

In this case the gas will flow into the wellbore only from the hydraulic fracture and there will be no flow from the matrix to the wellbore.

Figure 8.2 gives the information about the flow rate variation with respect to time.

On X-axis- Time interval. Here, 1 time step = 40 Days.

On Y-axis- Gas Flow rate – (Mscf/Day)

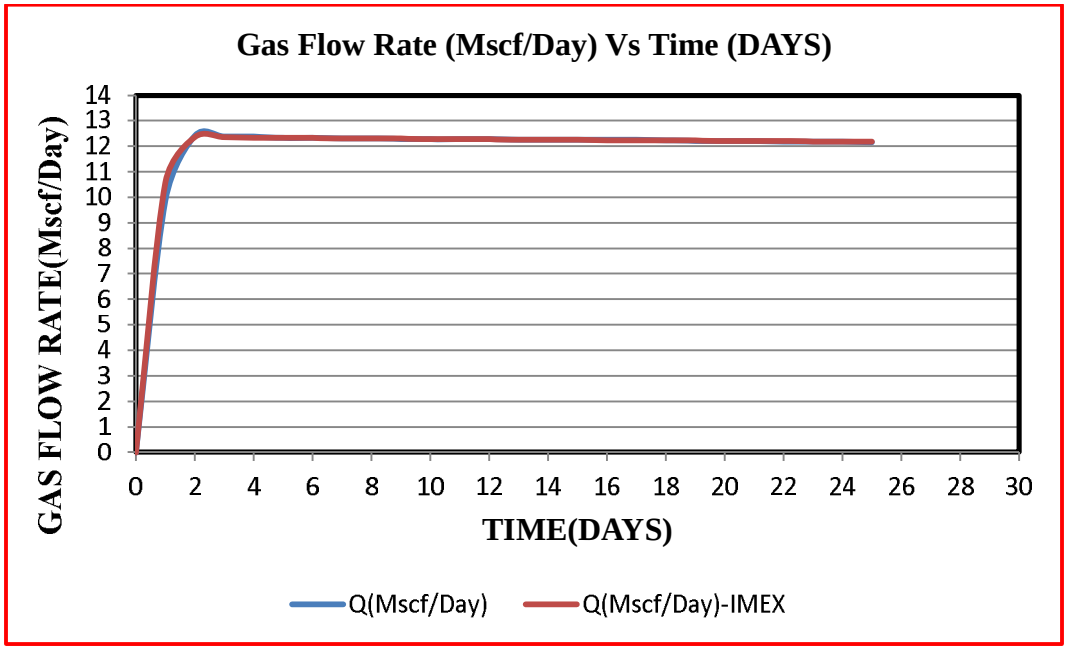

Figure 8.2: Variation of Gas Flow Rate (Mscf/Day) Vs Time (DAYS).

In this case there is only one hydraulic fracture for the entire reservoir. Since the permeability of the hydraulic fracture is higher than the permeability of the reservoir there will be higher pressure difference between the hydraulic fracture pressure and the reservoir pressure due to which the gas production at initial periods is higher when compared to the initial

production periods in no hydraulic fracture case. Here, as the production rates are higher this case will be economical when compared with case 1.

8.3 CASE 3: WELLBORE WITH TWO HYDRAULIC FRACTURES:

In this case the gas will flow into the wellbore from the two hydraulic fractures and there will be no flow from the matrix to the wellbore.

Figure 8.3 gives the information about the flow rate variation with respect to time.

On X-axis- Time interval. Here, 1 time step = 40 Days.

On Y-axis- Gas Flow rate – (Mscf/Day).

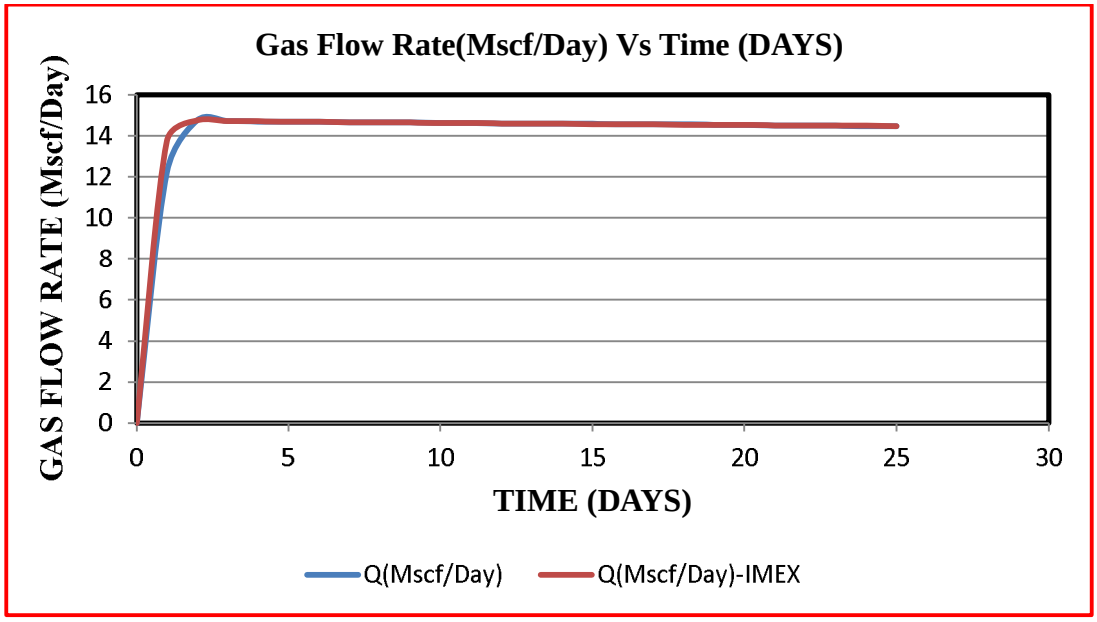

Figure 8.3: Variation of Gas Flow Rate (Mscf/Day) Vs Time (DAYS).

In this case, two hydraulic fractures were created for the entire reservoir. Since the permeability of the hydraulic fracture is higher than the permeability of the reservoir there will be higher pressure difference between the hydraulic fracture pressure and the reservoir pressure due to which the gas production at initial periods is higher when compared to the initial production periods in previous cases. As the number of hydraulic fractures is more, the pressure variation in the reservoir will also be at faster rate due to which the production rates at initial rates will be higher than in the previous cases.

8.4 CASE 4: WELLBORE WITH THREE HYDRAULIC FRACTURES:

In this case, the gas will flow into the wellbore from the three hydraulic fractures and there will be no flow from the matrix to the wellbore.

Figure 8.4 gives the information about the flow rate variation with respect to time.

On X-axis- Time interval. Here, 1 time step = 40 Days.

On Y-axis- Gas Flow rate – (Mscf/Day).

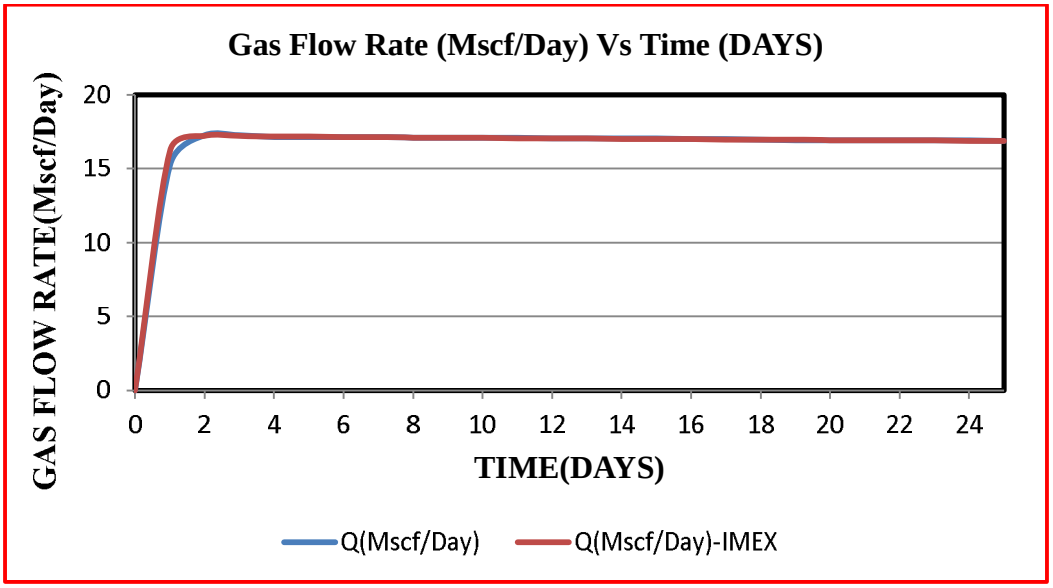

Figure 8.4: Variation of Gas Flow Rate (Mscf/Day) Vs Time (DAYS).

In this case, three hydraulic fractures were created for the entire reservoir. Since the permeability of the hydraulic fracture is higher than the permeability of the reservoir, there will be higher pressure difference between the hydraulic fracture pressure and the reservoir pressure due to which the gas production at initial periods is higher when compared to the initial production periods in previous cases. As the number of hydraulic fractures is more, the pressure variation in the reservoir will also be at faster rate due to which the production rates at initial rates will be higher than in the previous cases.

8.5 CASE 5: WELLBORE WITH FOUR HYDRAULIC FRACTURES:

In this case, the gas will flow into the wellbore from the four hydraulic fractures and there will be no flow from the matrix to the wellbore.

Figure 8.5 gives the information about the flow rate variation with respect to time.

On X-axis- Time interval. Here, 1 time step = 40 Days.

On Y-axis- Gas Flow rate – (Mscf/Day).

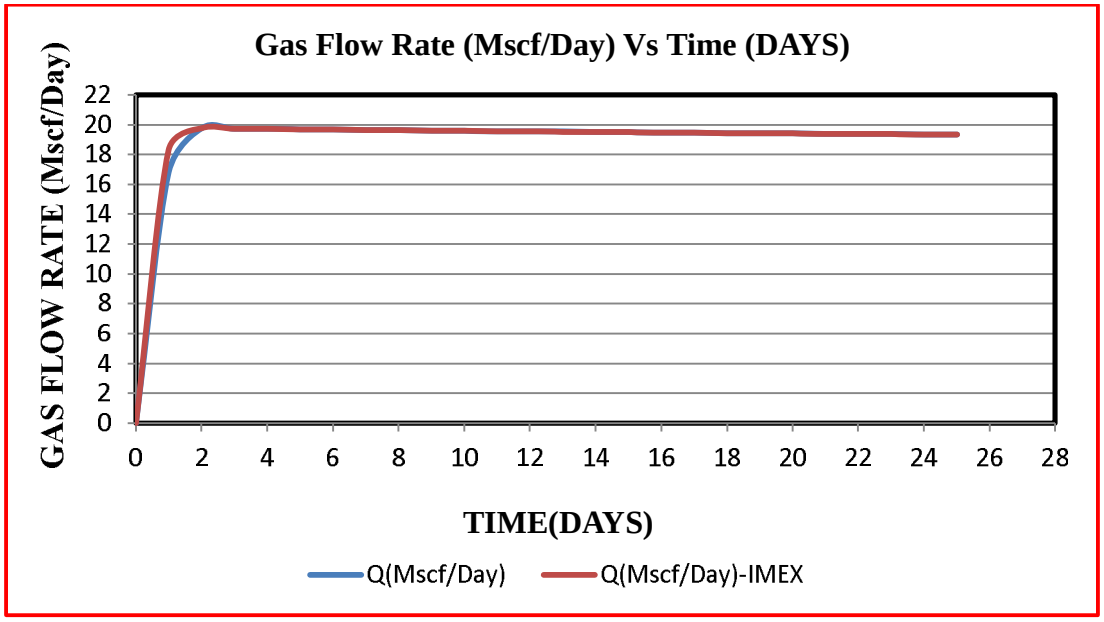

Figure 8.5: Variation of Gas Flow Rate (Mscf/Day) Vs Time (DAYS).

In this case, four hydraulic fractures were created for the entire reservoir. Since the permeability of the hydraulic fracture is higher than the permeability of the reservoir there will be higher pressure difference between the hydraulic fracture pressure and the reservoir pressure due to which the gas production at initial periods is higher when compared to the initial production periods in previous cases. As the number of hydraulic fractures is more, the pressure variation in the reservoir will also be at faster rate due to which the production rates at initial rates will be higher than in the previous cases.

8.6 CASE 6: WELLBORE WITH FIVE HYDRAULIC FRACTURES:

In this case, the gas will flow into the wellbore from the four hydraulic fractures and there will be no flow from the matrix to the wellbore.

Figure 8.6 gives the information about the flow rate variation with respect to time.

On X-axis- Time interval. Here, 1 time step = 40 Days.

On Y-axis- Gas Flow rate – (Mscf/Day).

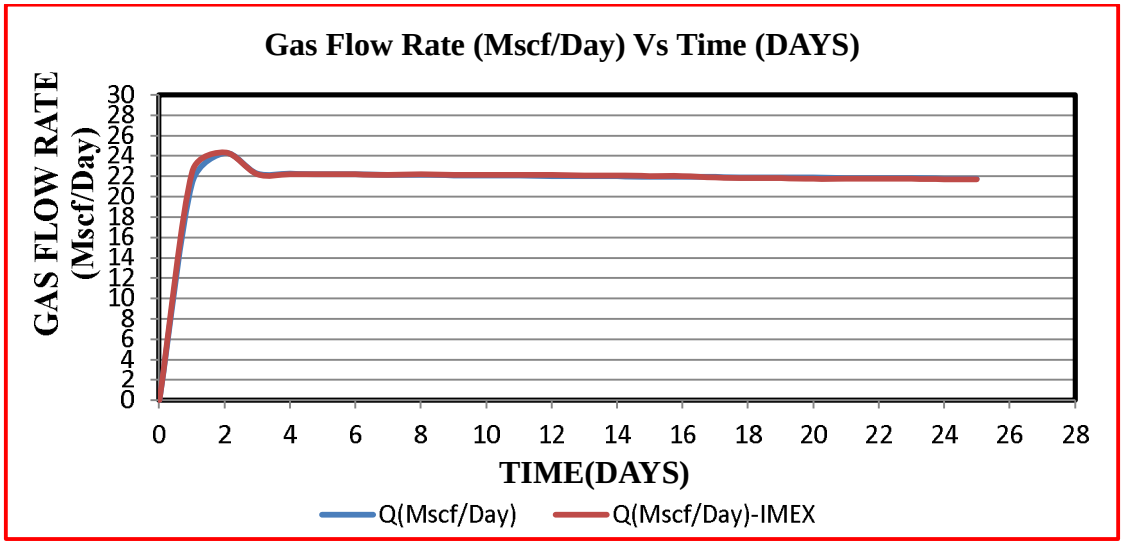

Figure 8.6: Variation of Gas Flow Rate (Mscf/Day) Vs Time (DAYS).

In this case, five hydraulic fractures were created for the entire reservoir. Since the permeability of the hydraulic fracture is higher than the permeability of the reservoir there will be higher pressure difference between the hydraulic fracture pressure and the reservoir pressure due to which the gas production at initial periods is higher when compared to the initial production periods in previous cases. As the number of hydraulic fractures is more, the pressure variation in the reservoir will also be at faster rate due to which the production rates at initial rates will be higher than in the previous cases.

Figure 8.7 gives the production rates at different time periods with increasing the number of hydraulic fractures

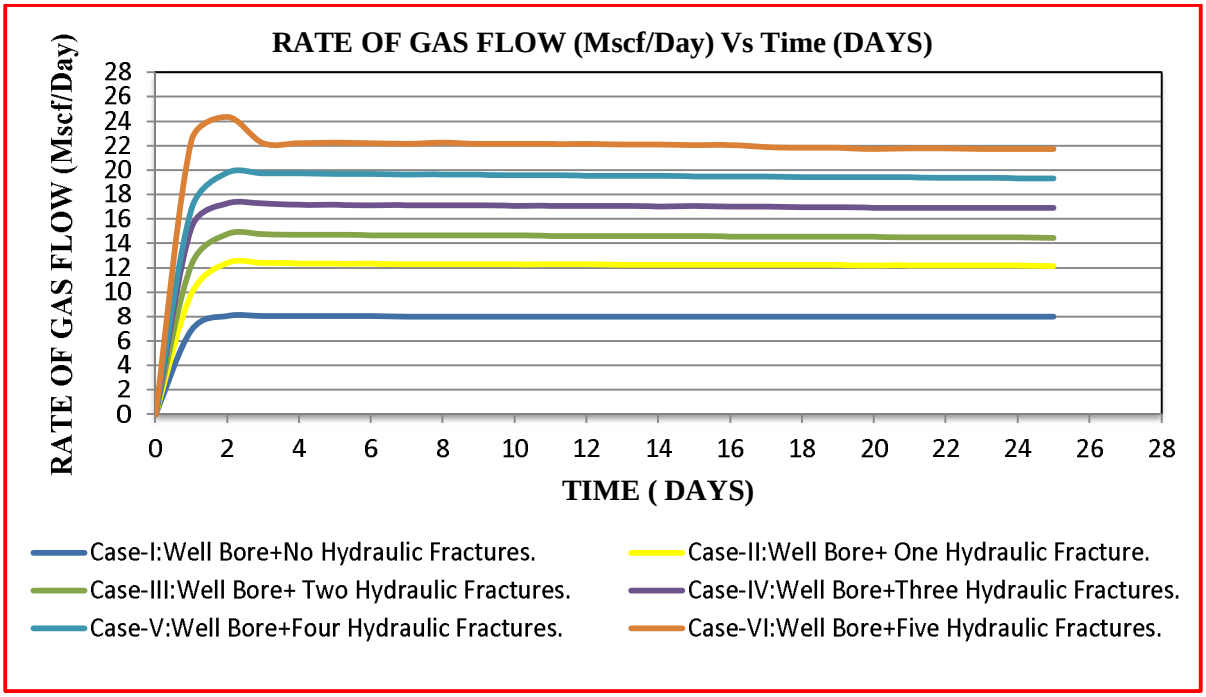

Figure 8.7: The graph of cumulative production versus time at different fracture stages.

The pressure variations at different time periods during the production of gas from shale reservoirs at different number of hydraulic fractures are given in Figure 8.7.

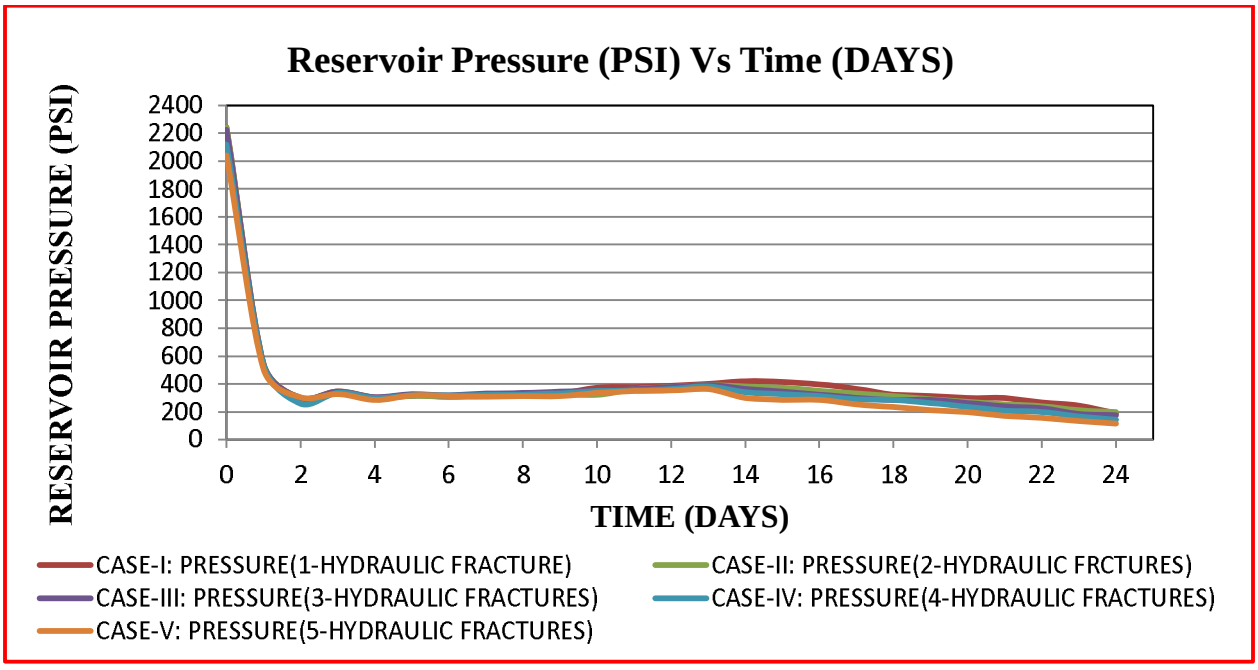

Figure 8.8: The pressure variations in reservoir versus time at different fracture stages.