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Research Article

Analyzing the Effects of Gravel Pack Completion on Flowpotential in Gas Condensate Well

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Abstract

Miocene or younger sands are major source of sand production, these type of formations are mostly unconsolidated or only partially consolidated with soft clay or silt, and these formations are structurally weak. These weak formations may not detain sand particle movement, and produce along with the hydrocarbon fluids at high rates. This undesirable sand production can cause many different problems at surface as well as at sub-surface. An effective way of dealing with this problem is the use of gravel pack technique. However, designing gravel pack treatment requires consideration of different influencing parameters. This research aims to study the performance of gravel pack along with the gravel pack height and permeability on the well flow. The approach taken in this study includes the well performance modeling using a commercial simulator. A filed data is collected for gas condensate well that is being produced from Lower Goru Massive Sand Formation. The collected field data is simulated to compare the performance of Gas Condensate well before and after gravel pack completion. With this, the analysis is carried out to determine the effect of gravel pack height & permeability on flow parameters (i.e; flow rates of fluids, sand control losses, frictional losses, sand control skin, gravel pack critical velocity). Lastly, an appropriate height and permeable gravel is recommended on the basis of simulation results.

Keywords: *sand production, gravel pack, sands, well performance modeling, commercial simulator.*

1. Introduction

Miocene or younger sands are major source of sand production, these type of formations are mostly unconsolidated or only partially consolidated with soft clay or silt, and these formations are structurally weak. These weak formations may not detain sand particle movement, and produce along with the hydrocarbon fluids at high rates. This undesirable sand production can cause many different problems at surface as well as at sub-surface.

In order to control sand production, different methods have been used; Gravel Pack (GP) technique is one of them, which has been used worldwide by the oil industry since many decays. This technique involves placement of gravels (As per size of produced sand) across a perforated interval, in the annulus of screen casing and in the perforation tunnels to prevent the sand production from unconsolidated formation.

Gravels act like an additional filter when they are placed outside the screens at some height, for the prevention of sand production from an unconsolidated formation, and developed an additional formation, which have some permeability.

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Due to extra formation of gravel in a cased hole, well flow behavior declines. This flow behavior can be improved by choosing an appropriate length /height of the gravel.

This research is based on a simulation study. A field data is collected for Gas condensate well that is being produced from Lower Goru Massive Sand Formation. The collected field data is simulated to compare the performance of Gas Condensate well before and after gravel pack completion and to analysis the effect of gravel pack height & permeability on flow parameters (i.e; flow rates of fluids, sand control losses, frictional losses, sand control skin, gravel pack critical velocity) by using Prosper. An appropriate height and permeable gravel is recommended on the basis of simulation results.

2. Model Description

A well model without gravel pack is initially developed by utilizing the parameters obtained from a gas condensate Lower Goru Massive Sand Formation. The data sources includes various well logging results for well and formation survey, well casing data, laboratory results of PVT, petrophysical data, and sand formation data. These different data are presented in tables given below.

Table 1 presents the reservoir properties. This data is used to generate IPR of the studied well model. Table 2 shows PVT data generated. Since, the reservoir is gas condensate reservoir so the PVT modelling is compositional rather than black-oil. The Peng-Robinson equation is used to develop compositional data. The phase diagram is shown in **Error! Reference source not found.**.

Table 1 Reservoir Properties

Reservoir properties	Values
Reservoir Pressure	6000 psig
Reservoir Temperature	274 F
Kx/Ky	1
Reservoir Permeability	25 md
Reservoir Porosity	25%
Thickness	100 ft
Area	340 acres
Shape Factor	31.6
Water Saturation	20%

Table 2 General PVT Data

Fluid properties	Value
Formation GOR	6944 scf/STB
Formation CGR	144 STB/MMSCF
Oil Gravity	51 API
Gas Gravity	0.8

The properties of well are given in table 3. With this, the wellbore profile is presented in figure 1.

Table 03 Well Properties

Well properties	Value
Measured Depth	12000 ft
Casing ID	8.3”
Tubing Depth	11800 ft
Tubing OD	3.992”

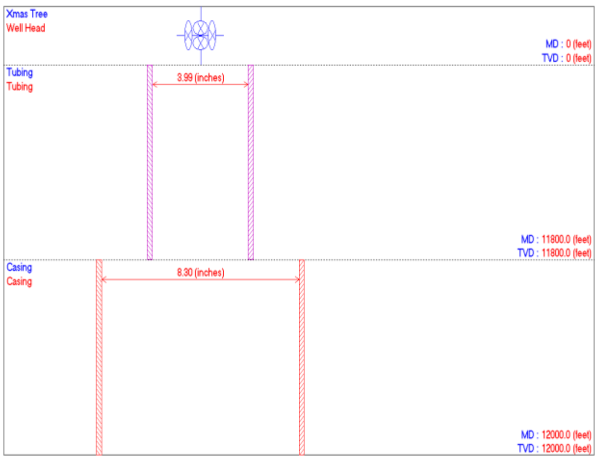

Figure 1 Well Profile

Table 4 Gravel Pack Data

Parameters	Values
Gravel Pack Permeability	15000 md
Gravel Pack Length	3.00 inches
Perforation Diameter	0.4 inches
Shot Density	12 1/ft

3. Results & Discussion

The well performance is initially determined at the completion without the gravel packing. The inflow performance of this case is shown in**Error! Reference source not found.**. From this figure, it is determined that the absolute open flow is 166.74 MMscf/day. Although the AOF is too high, yet it is not the representation of sand problem occurring in the field.

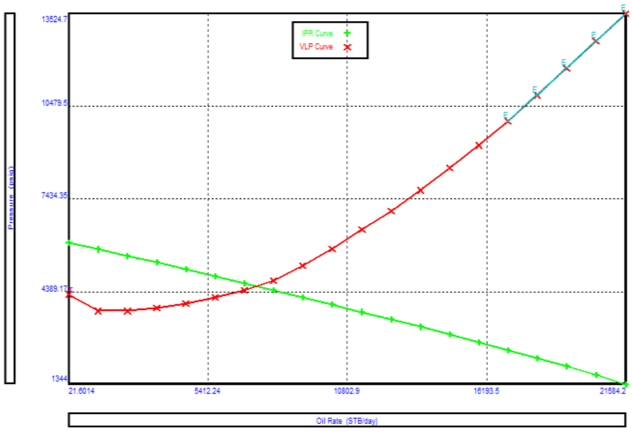

Figure 02 Oil IPR-VLP Intersection Curve

Table 05 Results Summary for Completion without Gravel Pack

Parameters	Values
Gas rates	50.8 MMscf/d
Oil rates	7325.3 STB/d
Solution node pressure	4573.17 psig
dP Friction	913.37
dP Gravity	1159.64
dP Total skin	481.70
Total Skin	5.00

The calculated AOF is comparatively lower than the completion without gravel packing i.e. 90.6 MMscf/d. This is due to the implementation of gravel pack unit inside the wellbore which results extra resistance to flow. However, this implementation is necessary to avoid sand invasion into the wellbore and upto the surface. The summary of obtained performance results is presented in table 06.

Table 07 Performance Results after Gravel Pack

Parameters	Values
Gas rates	45.5 MMscf/d
Oil rates	6551.9 STB/d
Solution node pressure	4380.33 psig
dP Friction	738.40
dP Gravity	1141.84
dP Total skin	781.26
Total Skin	7.92
dp Sand Control	348.16 psi

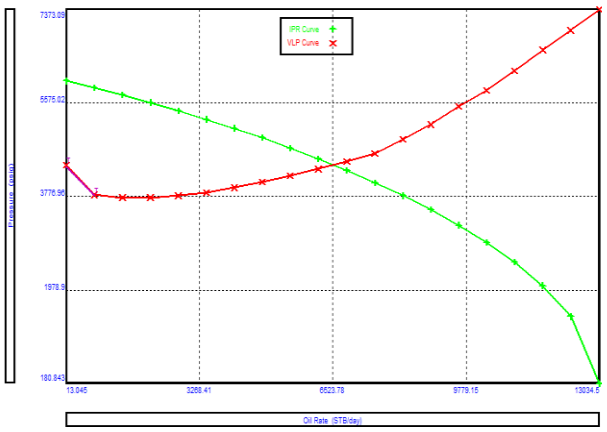

Figure 03 Oil IPR-VLP Intersection Curve after Gravel Pack

Sensitivity on Gravel Pack Length

In the last section, a gravel pack length which is a distance between screen OD to the sandface, is taken around 3 inches. In this section, analysis has been carried out to determine how the gravel pack length affects the well performance. An IPR plot is established to evaluate the impact of this length to the well performance. This plot is shown in 04.

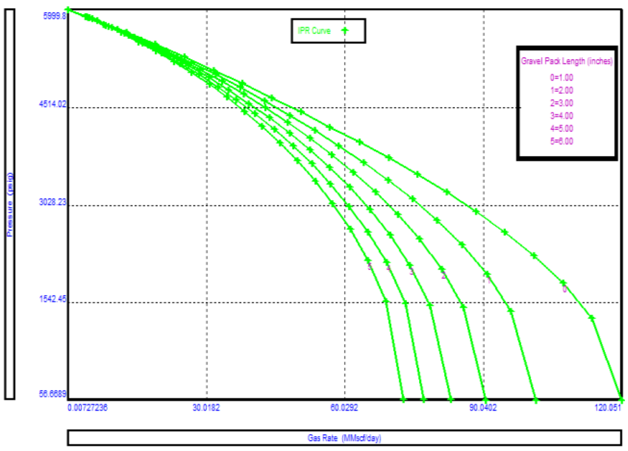

Figure 04 Gas IPR plot for Gravel Pack Length

Sensitivity on Gravel Pack Permeability

In this research, all these permeabilities are evaluated to determine the suitable values resulting an increased well performance. The gas IPR curve obtained after running the well simulation is shown in
Figure 5.

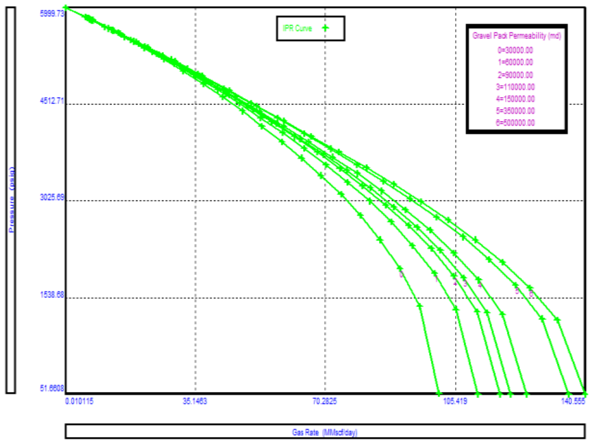

Figure 05 Gas IPR plot for different pack permeabilities

Conclusion

The production of sand is one of the major problem during the hydrocarbon production. It results in wellbore damage, plugging, erosion, and even harm the surface facilities. Therefore, its removal is one of the top priorities of any company. For controlling such problem, gravel pack method is widely accepted. This research discusses various factors related to gravel pack method. On the basis of the analysis, the following conclusions are drawn from this study:

1. Gravel pack completion is an effective method for dealing with sand problem.
2. The gravel pack causes the restrictive flow performance due to pressure losses as a result of the equipment. Yet it is best practice to utilize this method for sand control problem.
3. The gravel pack length and gravel pack permeabilities are the important factors influencing the well performance.
4. Decreasing gravel pack length results an increase in well production including AOF and operating rates.
5. Decreasing gravel pack lengths have low pressure drops due to skin and overall low skin factor.
6. Increasing the gravel pack permeability improves the well production including the parameters such as AOF and hydrocarbon operating rates.
7. The pressure drop is significantly lower at high values of gravel pack permeability.
8. The skin factor is small while increasing the gravel pack permeability.

Hence, keeping the gravel pack length and gravel pack permeability at optimum values, the sand control design can be optimized resulting in higher well productivity.

Recommendations

The future work in this domain includes:

1. Analysis of different types of sand control methods for better production results.
2. Different other gravel pack parameters including the type of packs, gravel selection, and gravel placement may be studied in the future.
3. The reservoir heterogeneity impact can be introduced while modeling the gravel pack completion scenario.

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