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# Effect of Sand Control Techniques on Oil Well Performance

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## Abstract

*This paper presents a comparative analysis of sand control, oil gravity and water cut influence on oil well production. The analysis has been performed for two types of crude oil (a light oil and a heavier oil). The data interpretation has been performed with the help of numerical simulators, using nodal analysis.*

**Key words:** *producing well system, sand control, gravel pack, oil gravity, water cut*

## Introduction

The completion phase of well operations begins when drilling is completed and ends with well commissioning. Typical completion operations include, but are not restricted to, perforating, placing gravel packs, acidizing, fracturing and setting production tubing and packers.

The goal of these operations is to obtain a well which has a productivity that is not limited by the completion itself. While this sounds easy to accomplish, completion techniques that restrict the productivity of the well are commonly used.

## Review

The issue of productivity is especially important in wells requiring sand control. Gravel packed wells are particularly sensitive to problems involving extremely poor productivity if improper completion techniques are used.

This work purpose is to provide information about completion (sand control) in order to maximize wells productivity. To achieve this, the factors that can have a negative effect on the on the fluids flow from a well should be illustrated. The nature of fluid flow towards a wellbore and a description of the potential restrictions to production are described herein. Improving or eliminating the zone of reduced permeability near the wellbore are critical for any well completion success. Wells requiring sand control are especially susceptible to damages near wellbore since the primary technique for controlling sand production, gravel packing, requires the introduction of additional fluids and gravel pack sand into the near wellbore area. Furthermore, once a gravel pack is in place, opportunities to clean-up the near wellbore area by flowing the well, acidizing or re-perforating are somewhat limited. Therefore, the best approach to a successful gravel pack completion is to ensure that minimal formation damage occurs from the moment the drill bit enters the pay zone until the well commissioning.

Hence, the decision to use a sand control technique is both an economic and operational decision that must be taken with limited data. The decision is complicated by the fact that the sand control techniques, such as gravel packing, are expensive and can restrict well productivity.

Numerous techniques are available for dealing with sand production from wells. These range from simple changes in operating practices to expensive completions such as sand consolidation and gravel packing. The sand control method selected depends on site specific conditions, operating practices and economic considerations. Some of the sand control techniques available are: a) Selective completion practices; b) Resin coated gravel; c) Slotted liner or screens without gravel packing; d) Slotted liner or screens with gravel packing; e) Gravel packing in an open hole.

Gravel packing relies on the bridging of formation sand against larger sand with the larger sand positively retained by a slotted liner or screen. The larger sand (referred to as gravel pack sand or simply, gravel) is sized to be about 5 to 6 times larger than the formation sand. Gravel packing creates a permeable downhole filter that will allow the production of the formation fluids but restrict the entry and production of formation sand. Schematics of an open hole and cased hole gravel pack are shown in Figure 1. Because the gravel is tightly packed between the formation and the screen, the bridges formed are stable preventing shifting and resorting of the formation sand.

Gravel packs are performed by running the slotted liner or screen in the hole and circulating the gravel into position using a carrier fluid. For optimum results, all the space between the screen and formation must be completely packed with high permeability gravel pack sand. Complete packing is relatively simple in open hole completions, but can be challenging in cased hole perforated completions. Although expensive, gravel packs have proven to be the most reliable sand control technique available and they are, therefore, the most common approach used.

Gravel packing can be applied in both open and cased hole completions, in well deviations from 0 to 110° and in zone length up to a few hundred meters. Systems are available for virtually any well temperature, pressure or environment. Gravel packed wells can be produced under high drawdown without concern of sand production. Although the gravel packing process can induce significant formation damage, adherence to proper practices as well as advanced installation techniques can limit formation damage to acceptable levels.

The scope of this work is to analyze the oil well behavior for:
a) open hole gravel pack (figure 2),
b) cased hole gravel pack (figure 3)
c) cased hole well without sand control (figure 4).

The well behavior was also analyzed in the above mentioned conditions for an oil with a density of 0.83 kg/$m^3$ and 0.90 kg/$m^3$.

## Well Data Example

| | | |
|---|---|---|
| Oil Grav.=0.83kg/$dm^3$;0.9 kg/$dm^3$ | Reservoir Temp. = 70° C | Casing = 5 $^{1/2}$ in / 2150 m |
| Water Cut = 10 %; 40 % | Avg. Resv. Perm. = 5 mD | Tubing = 2 $^{7/8}$ in / 1950 m |
| Water Sp Grav.= 1070 | Reservoir Thickness = 22 m | Top of Perforation = 2044 m |
| GOR = 388 $m^3_g/m^3_l$ | Perforation Interval = 22 m | Flow Line = 2 $^{7/8}$ in / 1500 m |
| Reservoir Pressure = 190 bar | Reservoir Radius = 210 m | Separator Pressure = 8 bar |

## Completion data

**Open Hole Gravel Pack**

Gravel Pack Perm. = 20 mD
Gravel Pack Length = 150 mm
Reservoir Thickness = 22 m
Wellbore Radius = 220 mm

**Cased Hole Gravel Pack**

Perforation Length = 120 mm
Perm. Ratio Kc/Kf = 0,7
Damaged Zone Perm. = 1 mD
Damaged Radius = 450 mm
Gravel Pack Length = 150 mm
Gravel Pack Perm. = 20 mD

**Cased Hole Well**

Perforation Length = 120 mm
Perm. Ratio Kc/Kf = 0,7
Damaged Zone Perm. = 1 mD
Damaged Radius = 450 mm

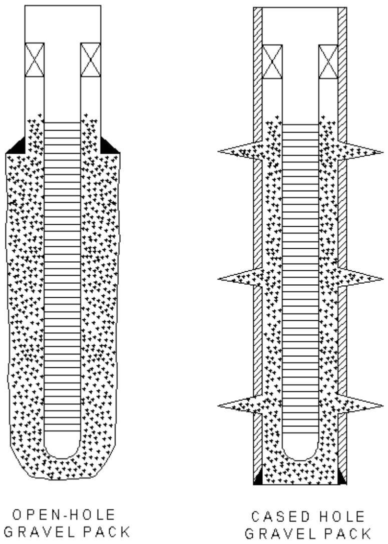


**Fig. 1.** Open Hole and Cased Hole Gravel Pack

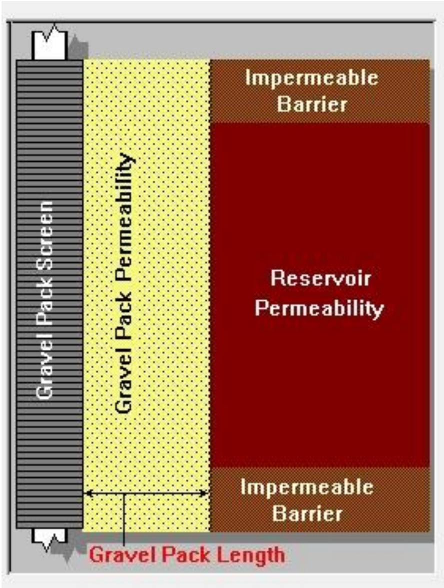


**Fig. 2.** Open Hole Gravel Pack

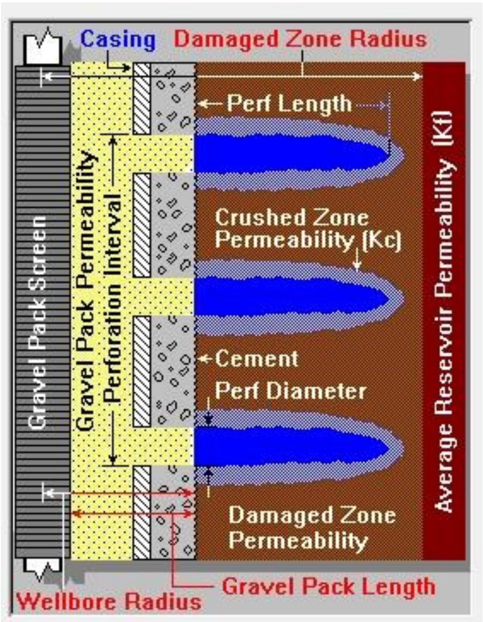


**Fig. 3.** Cased Hole Gravel Pack

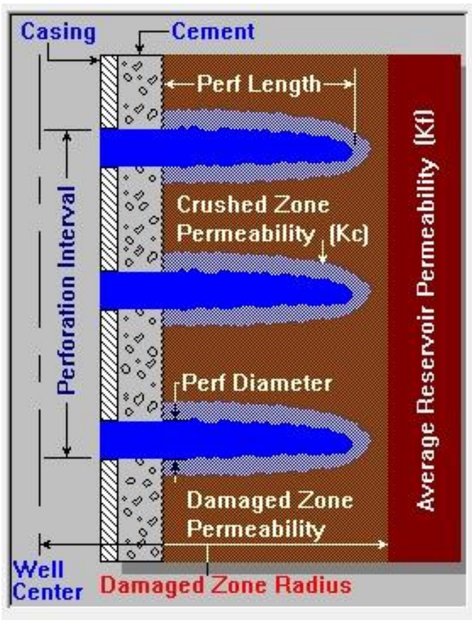


**Fig. 4.** Cased Hole Well with No Sand Control

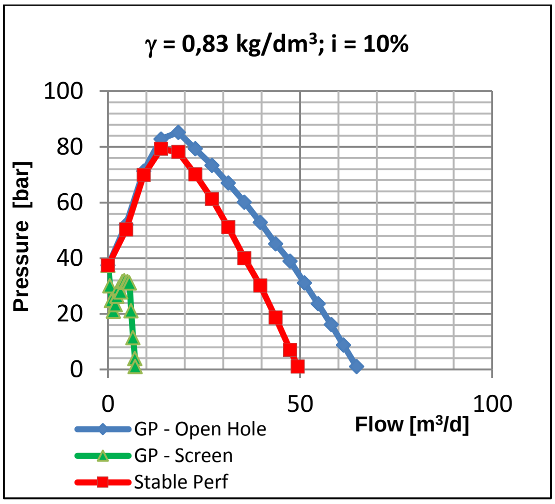


**Fig. 5.** Inflow curves for water cut = 10 % and oil gravity = 0.83 kg/dm$^3$

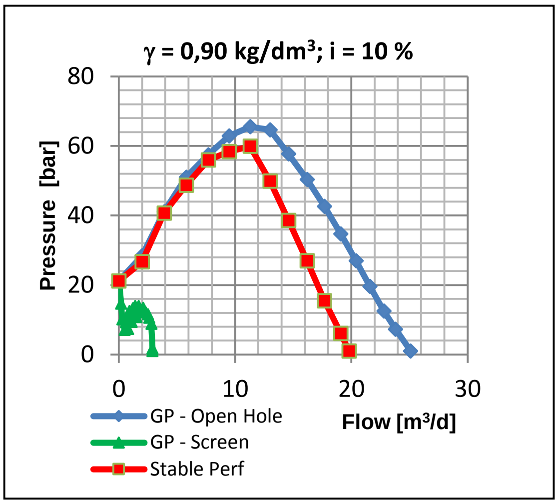


**Fig. 6.** Inflow curves for water cut = 10 % and oil gravity = 0.9 kg/dm$^3$

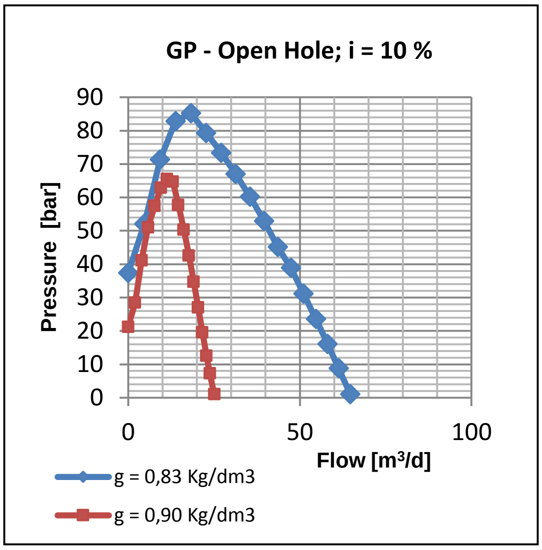


**Fig. 7.** Inflow curves for Open Hole Gravel Pack, water cut = 10% and oil gravity = 0.83/0.9 kg/dm$^3$

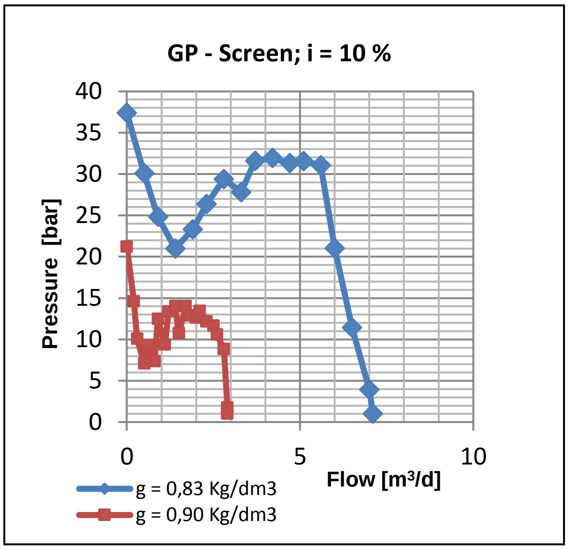


**Fig. 8.** Inflow curves for open hole Gravel Pack, water cut = 10 % and oil gravity = 0.83/0.9 kg/dm$^3$

## Conclusions

Analysing the production data presented in the article, it can be concluded that:

The well flow rate significantly depends on the well completion, high values being recorded for the open hole case and up to 6 times smaller values for gravel packed wells (figures 7, 8).

It is also noticed a significant influence of the reservoir water on the well flow in case of a heavier oil (oil gravity = 0.9 kg/dm$^3$) regardless the well completion types. In this case, the oil net production decline could be compensated by the flow increasing.

For gravel packed wells, the significant flow decreasing does not automatically assumes the extraction system inefficiency (there are wells that cannot be otherwise operated).

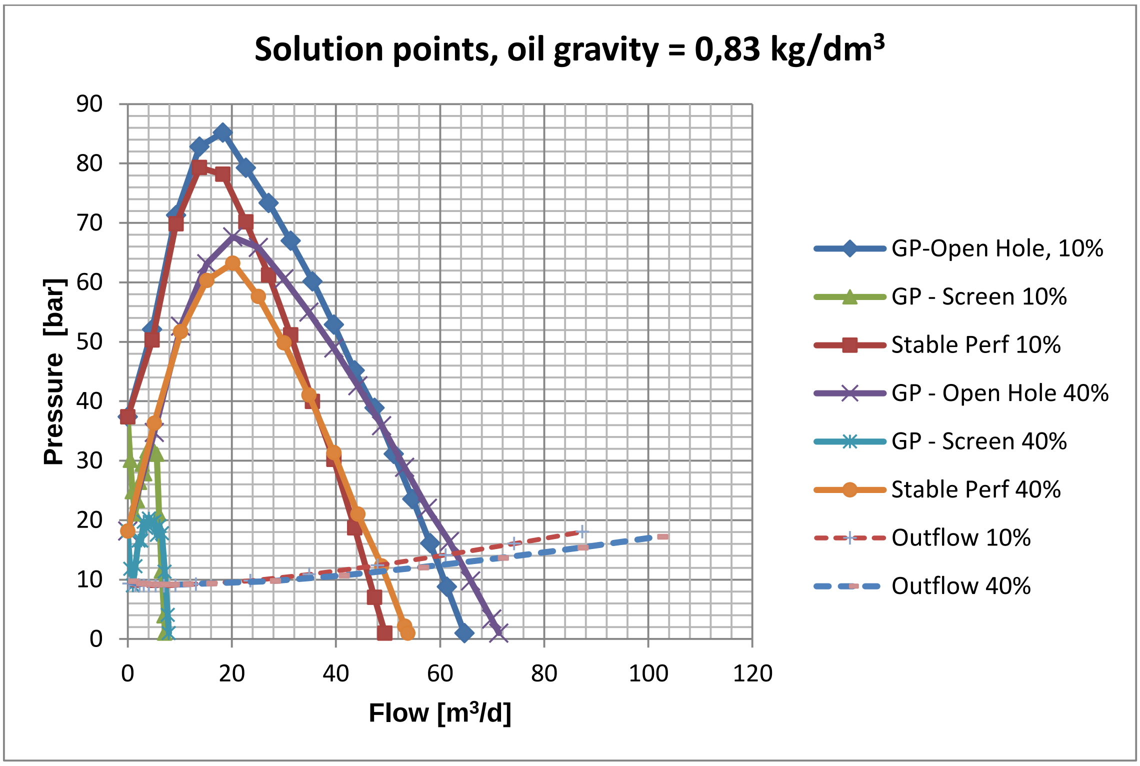


**Fig. 9.** Solution Points for cases a), b) and c) , water cut = 10 % and 40 % oil gravity = 0.83 kg/dm$^3$

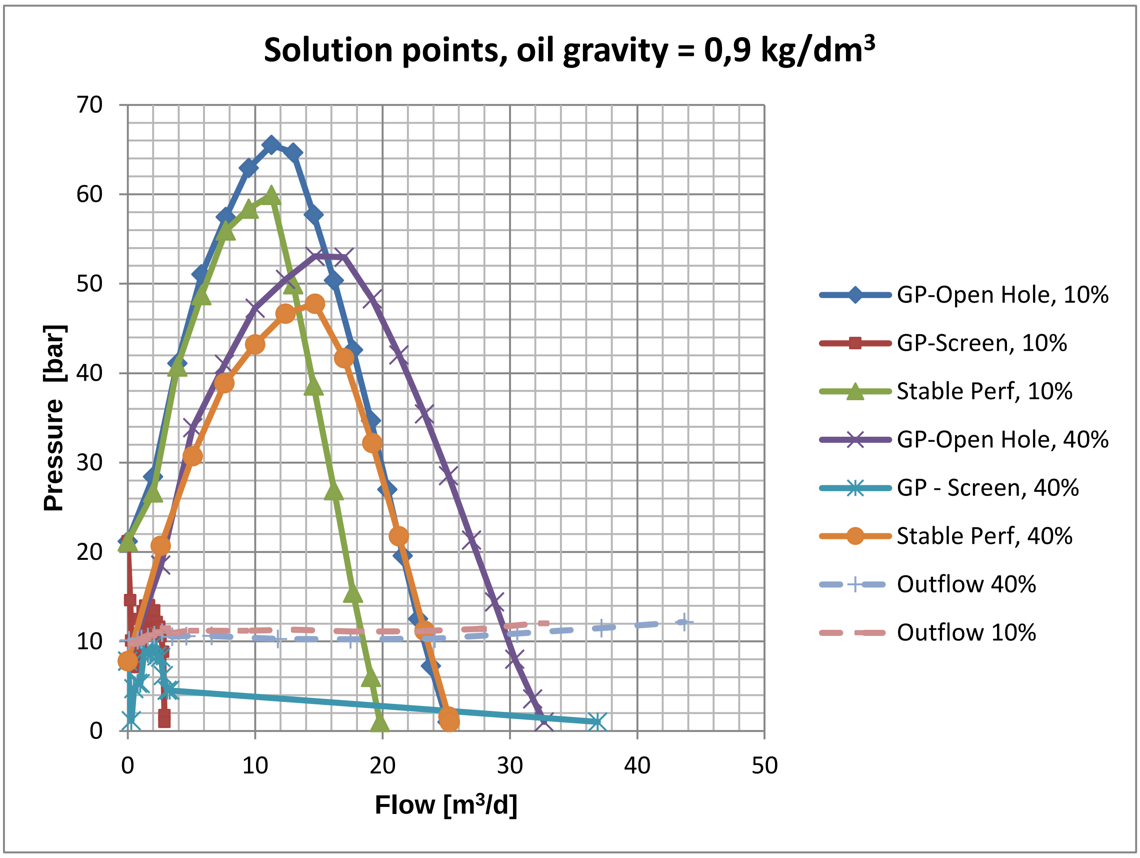


**Fig. 10.** Solution Points for cases a), b) and c) , water cut = 10 % and 40 % oil gravity = 0.9 kg/dm$^3$

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# Influența tehnologiilor de combatere a viiturilor de nisip asupra productivității unei sonde de țiței

## Rezumat

*În această lucrare este prezentată o analiză comparativă a efectului indus de modul de completare a unei sonde de producție. S-a analizat atât influenţa modului de completare în sistemul gravel packing asupra debitului sondei, cât şi influenţa creşterii procentului de apă de zăcământ; analiza a fost facută pentru două tipuri de ţiţei (un ţiţei uşor şi un ţiţei greu). Interpretarea datelor a fost realizată cu ajutorul simulatoarelor numerice, utilizând analiza nodală.*