REVIEW ON OPEN HOLE AND CASED HOLE WELL COMPLETION SYSTEMS IN OIL AND GAS WELLS

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ABSTRACT

Well completion is the process of making a well ready for production (or injection) after drilling operations. This principally involves preparing the bottom of the hole to the required specifications, running in the production tubing and its associated downhole tools as well as perforating and stimulating as required. Sometimes, the process of running in and cementing the casing is also included. After a well has been drilled, should the drilling fluids be removed, the well would eventually close in upon itself. Casing ensures that this will not happen while also protecting the wellstream from outside incumbents, like water or sand.

INTRODUCTION

There are several keys to designing a successful completion system and selecting components that are fit for purpose for both the downhole environment and application. Consideration must be given to the various modes under which the completion must operate and the effects any changes in temperature or differential pressure will have on the tubing string and packer. Ultimately, the system must be both efficient and cost-effective to achieve production and financial goals. A key factor in the completion design is the production rate.

Other factors that must be considered as part of the completion design:

- Packers
- Elastomers
- Flow control equipment
- Equipment metallurgy
- Equipment standards and grades such as ISO and API
- Understanding the impact of force and length changes to the tubing string
- Operational mode of the well (production, shut-in, injecting, treating)
The purposes of a well completion are to

- Connect the reservoir to the surface so that fluids can be produced from or injected into the reservoir
- Provide a conduit for well stimulation treatments
- Isolate the producing reservoir from other zones
- Protect the integrity of the reservoir, especially in unconsolidated formations
- Provide a conduit to measure the changes in flow rate and pressure needed to run a well test

LOWER COMPLETION

This refers to the portion of the well across the production or injection zone. The well designer has many tools and options available to design the lower completion (Downhole Completion) according to the conditions of the reservoir. Typically, the lower completion is set across the productive zone using a liner hanger system, which anchors the lower completion to the production casing string. The broad categories of lower completion are listed below.

BAREFOOT COMPLETION

This type is the most basic, but can be a good choice for hard rock, multi-laterals and underbalance drilling. It involves leaving the productive reservoir section without any tubulars. This effectively removes control of flow of fluids from the formation; it is not suitable for weaker formations which might require sand control, nor for formations requiring selective isolation of oil, gas and water intervals. However, advances in interventions such as coiled tubing and tractors means that barefoot wells can be successfully produced.

OPEN HOLE

This designation refers to a range of completions where no casing or liner is cemented in place across the production zone. In competent formations, the zone might be left entirely bare, but some sort of sand-control and/or flow-control means are usually incorporated.

OPEN HOLE COMPLETION

Openhole completions have seen significant uptake in recent years, and there are many configurations, often developed to address specific reservoir challenges. There have been many recent developments that have boosted the success of openhole completions, and they also tend to be popular in horizontal wells, where cemented installations are more expensive and technically more difficult. The common options for openhole completions are:
**PRE-HOLED LINER**

Also often called **pre-drilled liner**. The liner is prepared with multiple small drilled holes, then set across the production zone to provide wellbore stability and an intervention conduit. Pre-holed liner is often combined with openhole packers, such as swelling elastomers, mechanical packers or external casing packers, to provide zonal segregation and isolation.

**SLOTTED LINER**

Slotted liners can be selected as an alternative to pre-holed liner, sometimes as a personal preference or from established practice on a field. It can also be selected to provide a low cost control of sand/solids production.

**OPENHOLE SAND CONTROL**

This is selected where the liner is required to mechanically hold back the movement of formation sand. There are many variants of openhole sand control, the three popular choices being stand-alone screens, openhole gravel packs (also known as external gravel packs, where a sized sand 'gravel' is placed as an annulus around the sand control screen) and expandable screens. Screen designs are mainly wire-wrap or premium; wire-wrap screens use spiral-welded corrosion-resistant wire wrapped around a drilled basepipe to provide a consistent small helical gap (such as 0.012-inch (0.30 mm), termed 12 gauge).
HORIZONTAL OPEN HOLE COMPLETIONS

This is the most common open hole completion used today. It is basically the same described on the vertical open hole completion but on a horizontal well it enlarges significantly the contact with the reservoir, increasing the production or injection rates of your well.

LINER COMPLETIONS

In this case the casing is set above the primary zone. An un-cemented screen and liner assembly is installed across the pay section. This technique minimizes formation damage and gives the ability to control sand. It also makes cleanout easy. Perforating expense is also low to non-existent.

PERFORATED LINER

Casing is set above the producing zone, the zone is drilled and the liner casing is cemented in place. The liner is then perforated for production. This time additional expense in perforating the casing is incurred, also log interpretation is critical and it may be difficult to obtain good quality cement jobs.

PERFORATED CASING

Production casing is cemented through the zone and the pay section is selectively perforated. Gas and water are easily controlled as is sand. The formation can be selectively stimulated and the well can be deepened. This selection is adaptable to other completion configurations and logs are available to assist casing decisions. Much better primary casing. It can however cause damage to zones and needs good log interpretation. The perforating cost can be very high.

CASED HOLE COMPLETION

This involves running casing or a liner down through the production zone, and cementing it in place. Connection between the well bore and the formation is made by perforating. Because perforation intervals can be precisely positioned, this type of completion affords good control of fluid flow, although it relies on the quality of the cement to prevent fluid flow behind the liner. As such it is the most common form of completion...
Figure: 3 (a) a casing-tubing dual completion and (b) a completion with dual packers and dual tubing strings.

Figure: 4 Wellbore diagram of a conventional triple completion.

CONVENTIONAL COMPLETIONS

*Casing flow:* means that the producing fluid flow has only one path to the surface through the casing.

*Casing and tubing flow:* means that there is tubing within the casing that allows fluid to reach the surface. This tubing can be used as a kill string for chemical injection. The tubing may have a “no-go” nipple at the end as a means of pressure testing.

*Pumping flow:* the tubing and pump are run to a depth beneath the working fluid. The pump and rod string are installed concentrically within the tubing. A tubing anchor prevents tubing movement while pumping.

*Tubing flow:* a tubing string and a production packer are installed. The packer means that all the flow goes through the tubing. Within the tubing you can mount a combination of tools that will help to control fluid flow through the tubing.

*Gas lift well:* gas is fed into valves installed in mandrels in the tubing strip. The hydrostatic head is lowered and the fluid is gas lifted to the surface.

*Single-well alternate completions:* in this instance there is a well with two zones. In order to produce from both the zones are isolated with packers. Blast joints may be used on the tubing within the region of the perforations. These are thick walled subs that can withstand the fluid abrasion from the producing zone. This arrangement can also work if you have to produce from a higher zone given the depletion of a lower zone. The tubing may also have flow control mechanism.

*Single-well concentric kill string:* within the well a small diameter concentric kill string is used to circulate kill fluids when needed.
Single-well 2-tubing completion: in this instance 2 tubing strings are inserted down 1 well. They are connected at the lower end by a circulating head. Chemicals can be circulated down one tube and production can continue up the other.

CONCLUSION

Selecting a well completion mode is an important part of well completion engineering. A well completion mode should reduce formation damage; decrease the resistance to oil and gas flow into the well; isolate the oil and gas reservoirs and aquifers in order to avoid gas and water channeling and interlayer interference; control sand production; prepare the well for later stages; resist corrosion and creeping; and provide good economic benefits. The most common well completion modes include perforation completion, open hole completion, and slotted liner completion. Gravel pack completion and other sand control completions are also discussed. The "intelligent well completion system" is a computerized automatic control system for controlling oil and gas production that optimizes the process of well completion management. Because of the high cost of downhole completion devices, the intelligent well completion system is only suitable for certain well types. Monobore well completion is also covered.

REFERENCES