

Standard Handbook of Petroleum and Natural Gas Engineering

Third Edition

William C. Lyons, Ph.D., P.E.

Gary J. Plisga, B.S.

Michael D. Lorenz, B.S.



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There are other types of completions, perhaps more specialized than these listed so far. They include underbalance completions, completions for heavy oil and steam injection, and completions for coal bed methane. If interested in these or others, please see the references.

4.9.6 Perforating

4.9.6.1 General

Perforating is primarily a cased hole completion process. It is the process by which holes are put into the casing and cement around the casing, so that the reservoir's production can flow into the well, and to the surface. The effectiveness of the perforating process can have a big impact on overall well productivity. It is therefore important to understand the factors that have the largest impact on the success of perforating operations.

4.9.6.2 Perforations

As mentioned, the objective of perforating is to be able to provide for flow from the reservoir into the wellbore. Figure 4.9.13 is an idealized schematic of a perforation.

Achieving holes like this through the casing and into the formation can provide for a very effective completion.

There are three parts to a perforating system and its explosive chain. They are the detonator, the detonating cord and the shaped charge. The explosive shaped charge develops intense pressure and penetrates the gun body, wellbore fluid, casing, cement and into the formation.

The perforating operation is one of the potentially most hazardous, due to the high explosives used. This requires strict attention to the care and handling of explosives, ensuring personnel are properly trained.

4.9.6.3 Perforating Basics

Components of the shaped charge are the case, the liner, the main explosive and the primer (Figure 4.9.14).

An explosive detonating wave travels down the detonating cord, initiating the primer and detonating the main explosive. The exploding charge generates on the order of millions of psi, effectively causing the perforating jet to force its way through the gun case, annular fluid, casing, cement, and into the formation. It is the shape of the liner that focuses the explosion.

4.9.6.4 Types of Perforating Charges

There are two basic types of perforating charges. They can be characterized as big hole (BH) charges and deep penetrating (DP) charges. For perforations that will be filled with sand or proppant, BH charges are most appropriate. For completions in which there will not be sand control, DP charges will generally deliver the best performance (Figure 4.9.15).

In general, the shape of the liner primarily determines whether hole size or penetration depth is optimized.

In addition to this, charges can also be categorized by the type of explosive used (Figure 4.9.16).

Normally, RDX is used as the standard explosive in perforating guns. It is the most economical and is rated for use at bottom hole temperatures up to about 200 degrees F. However, as bottom hole temperatures increase, different explosives are recommended (Figure 4.9.17).

Finally, the amount of explosive used in each charge can vary, depending on the application and the size of the perforating gun. Generally speaking, perforating larger size casing will require higher explosive performance, implying larger amounts of explosives in each charge.

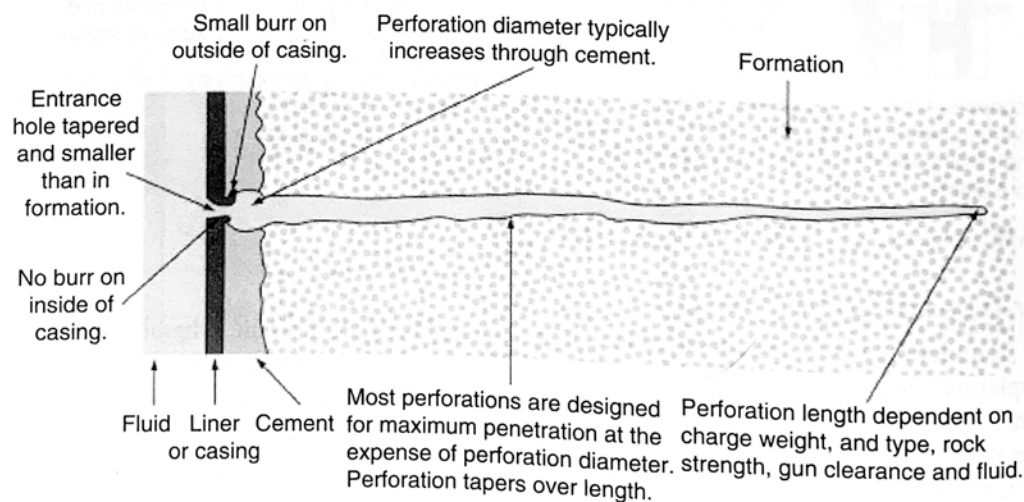


FIGURE 4.9.13 Typical perforation geometry [1, Figure 2.37, p. 501].

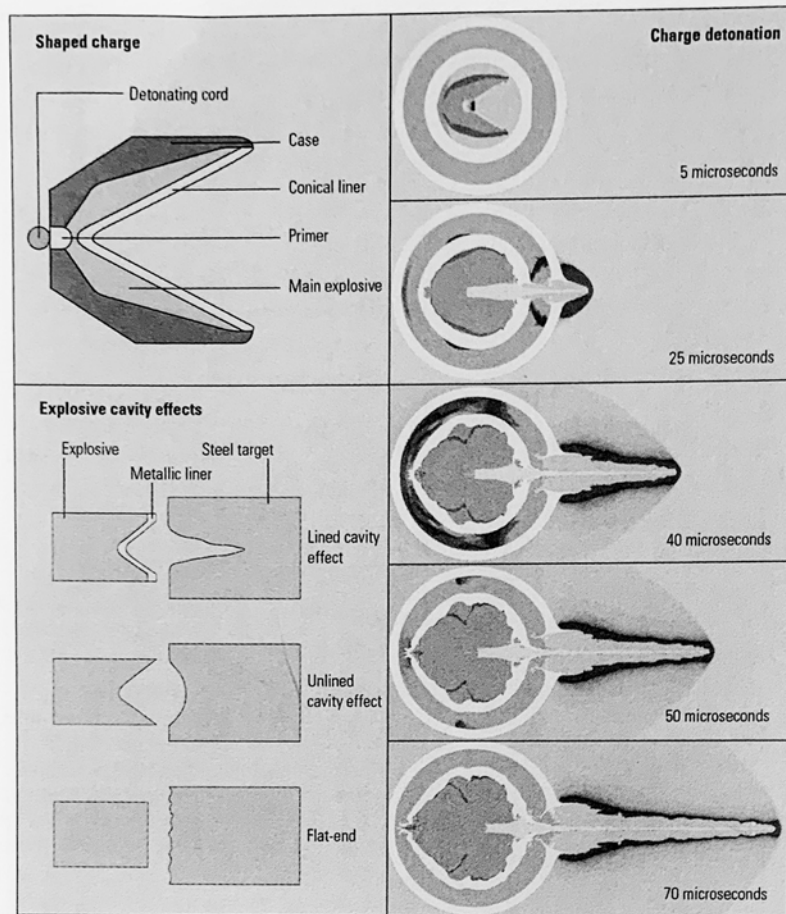


FIGURE 4.9.14 Perforating basics [4, p. 54]. Illustration copyright *Oilfield Review*, used with permission of Schlumberger.

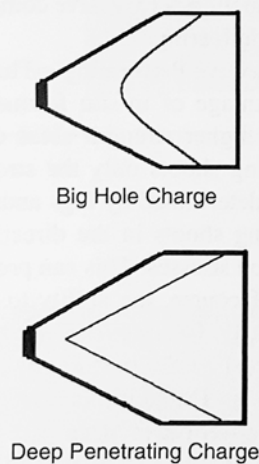


FIGURE 4.9.15 Types of shaped charges.

4.9.6.5 Perforating Guns

Perforating guns are generally also of two types—capsule and hollow carrier. The most likely conveyance method for capsule guns is via electric line. Hollow carrier guns can be conveyed with either electric line or with tubing/workstring (Figure 4.9.18).

Please note that with either gun, wellbore fluids and pressures are not allowed direct contact with the explosives.

Perforating guns can also be characterized by how the individual charges are oriented within the gun. This determines where the holes will be in the casing, and how many there will be per foot (Figure 4.9.19).

4.9.6.6 Perforating Conveyance Methods

There are multiple ways of performing perforating operations. For an introduction to some of the decision factors involved, see Figure 4.9.20.

4.9.7 Sand Control

4.9.7.1 General

A substantial number of oil and gas wells produce solid formation material, along with the oil and gas. Producing solids with oil and gas, especially at high rates, is not conducive to a safe and long-lived production well. The produced solids can very easily and in some cases, very quickly excessively erode the completion equipment, both downhole and at the surface, leading to leaks, and possible hydrocarbon spills and loss of containment. This possible