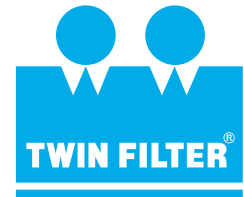


# THE RELATIONSHIP BETWEEN CLEAN FLUIDS & EFFECTIVE COMPLETIONS



by James L. Rike, Rike Service Inc.

## ABSTRACT

The preponderance of evidence shows that completion effectiveness, and especially well productivity, is directly related to the use of clean completion and workover fluids. Even small amounts of solids (500 ppm) in completion and workover fluids can be enough to bridge in perforation tunnels, in channels behind pipe, and in gravel packs and in propped fractures. This plugging is responsible for many wells producing at 10-85% of full potential; for multiple squeeze attempts so often necessary to successfully seal cement channels; and for sticking pipe during concentric tubing operations. It is a widely held myth among industry operations personnel that plugging material is easily removed with reactive materials such as HF acid in the case of clay solids or HCl acid in the case of carbonate solids. Tests and field experience indicate that significant increases in flow conductivity are obtained not only with clean fluids instead of muds and dirty fluids, but also when larger pressure differentials into the wellbore exist while perforating.

## PRODUCTIVITY LOSS DUE TO PLUGGED PERFORATIONS

A common argument in defense of solids-laden fluids assumes that a few unplugged perforation holes act as independent conduits and will usually have more flow capacity than there is from the formation into the well. However, the funneling of all formation fluids through very small amounts of horizontal formation into a few select perforation holes (Fig. 1) results in seriously diminished productivities. Several investigators have examined the potential effects of perforation density, depth, and geometry on the final productivity of a perforated casing well (Fig. 2).<sup>2,3,4,5</sup> This graph of their findings makes it apparent that about 4 shots per foot (0.305 m) must be productive with a penetration of about 8 in. (20.3 cm) or more for a perforated well to have a productivity equivalent to an open-hole completion. These investigations suggest a loss of productivity of about 15% if only 2 shots per foot (0.305 m) is productive in a given well. We can reasonably infer that a density of 1 shot per two feet (0.610 m) would provide a productivity of about 35% of an open-hole completion or 35% of a well shot 4 shots per foot (0.305 m) with all holes open and producing. When only a few holes become productive, actual productivity can probably be projected at 10-20% of equivalent open hole productivity.

## AMOUNTS OF PLUGGING SOLIDS

If we have 0.5% solids in a fluid, let's examine how many perforations could be lost. If we lose 50 bbl (7.9 m<sup>3</sup>) of workover fluid to the formation during a completion or workover, the total solids (at 0.5%) can be calculated:

$$\begin{aligned}
 \text{Solids volume} &= (\text{Solids Concentration}) \\
 &= (\text{Fluid Volume}) \dots \dots \dots (1) \\
 &= (0.005)(50)(5.6)(1728) \\
 &= 2419 \text{ cu. in. (39,640 cc)}
 \end{aligned}$$

The volume in a perforation hole can be approximated with a cylinder 10 in. (25.4 cm) long and 1/2 in. (1.27 cm) in diameter:

$$\begin{aligned}
 \text{Volume} &= \frac{\pi d^2 l}{4} \dots \dots \dots (2) \\
 &= \frac{(3.14)(0.5)^2 \times 10}{(4)} \\
 &= 1.96 \text{ cu. in. (32.1 cc)}
 \end{aligned}$$

There are therefore enough solids in the 50 bbl (7.9 m<sup>3</sup>) lost to totally plug 1,234 typical perforation holes. Note that if the workover or completion fluid were 10 times cleaner, there would still be enough solids in the 500 ppm workover or completion fluid to totally plug 123 holes.

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