SELECTION OF COMPLETION AND WORKOVER FLUIDS

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ABSTRACT

As the use of special fluids to complete or workover wells has become accepted practice, the number of completion and workover products on the market has increased considerably. Because of this, the selection of the fluid which will provide the best performance at the most efficient cost is a critical question.

A review of the basic functions of a completion or workover fluid is presented. In addition, a discussion of the various types of completion and workover fluids is included. A decision chart is presented in order to systematize the selection process.

INTRODUCTION

In the past few years, the use of special fluids for completion and workover operations has become widespread. The main reason for using these fluids is to increase productivity by reducing damage to the pay zone. Indeed, throughout the emergence of completion- and workover-fluid technology, the major goal has been to minimize formation damage.

Reduction of the permeability of a producing zone can result from a variety of reasons. Among these are particle plugging, hydration of formation clays, movement of clays and fines, change of the wettability of the rock, precipitated solids due to incompatible fluids, and emulsion blocks. Perhaps the most critical of these causes are particle plugging, clay hydration, and movement of fines. Because of the plugging action of clay solids in drilling mud and the swelling of formation clays by the filtrate, the emphasis in completion and workover fluids has been away from clay solids and uninhibited muds toward solids free brines or brines weighted with acid soluble weighting agent. Polymers are used in place of clay to obtain a wide variety of fluid properties.

Naturally, with the increased use of completion and workover fluids there has been a corresponding rise in the number of service companies participating in the market. Because of the ever-increasing number of products offered to the industry, the operator is faced with the problem of knowing which product is best suited to his need. A good approach to selecting a fluid is to decide what functions the fluid is to perform, then select a base fluid and additives that will most effectively do the job.

BASIC FUNCTIONS OF COMPLETION AND WORKOVER FLUIDS

Density

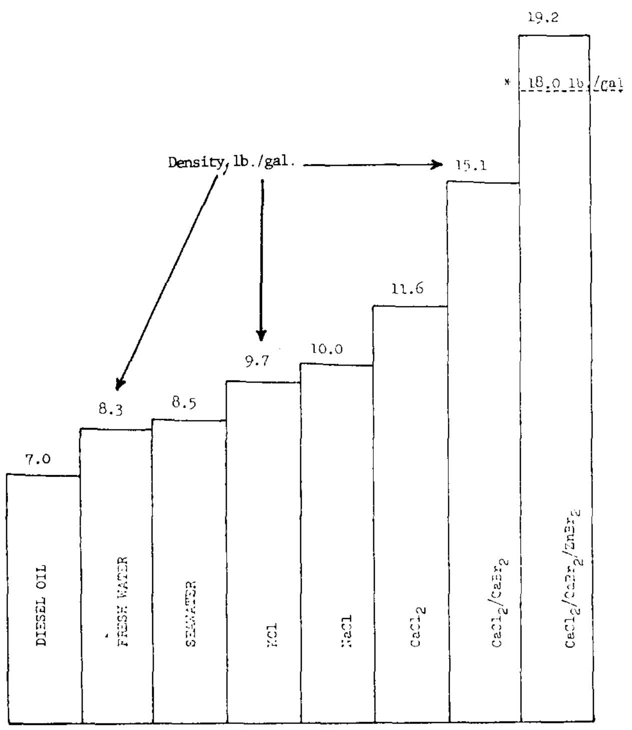
The first function of a completion or workover fluid is to control the well. The density should be no higher than necessary to control the formation pressure. Increased density can be obtained by using weighting materials such as barite, siderite, or calcite (Table 1) or by using soluble salts such as NaCl, $CaCl_2$, $CaBr_2$, or $ZnBr_2$ (Figure 1).

TABLE 1 -SOLIDS LADEN WORKOVER/COMPLETION FLUIDS

Weight Material	Density Range (lb./gal.)	Acid Solubility
$CaCO_3$	10-14	98%
$FeCO_3$	10-18	90%
$BaSO_4$	10-21	0%

Viscosity

In many cases the viscosity of the fluid must be increased for a specific operation such as sand washing, milling, etc. At present, the most popular viscosifier for completion and workover fluids is hydroxyethyl cellulose (HEC). It is a highly refined



* Recommended density of this fluid due to corrosion rate being higher than 1.7 mpy if exceeded.

FIGURE 1—SOLIDS FREE WORKOVER/COMPLETION FLUIDS

polymer with very little residue. Other materials used as viscosifiers include guar gums, asbestos, and clay (Table 2). Although these materials are applicable in certain instances, they do not meet the purity standards of HEC.

When choosing a viscosifier, be careful to determine the product composition and quality. Some questions to ask are: Is it a single component product or a blend? Does it contain filler? Does it contain guar?

Suspension Properties

In some cases solids must be suspended at low shear or static conditions. Again, several alternatives are presently available: clays, asbestos, and polymers. The most widely used suspension agent in completion and workover fluids is XC-Polymer.

Filtration Control

In most applications some measure of filtration control is desirable. The standard approach to filtration control in completion and workover fluids is the use of properly sized calcium carbonate particles for bridging in conjunction with colloidal materials such as starch or CMC. The calcium carbonate is acid soluble and can be removed. In some cases, oil-soluble resins are used as bridging agents.

Temperature Consideration

Virtually all water-soluble polymers, currently in use have one thing in common. The common denominator is thermal stability. In general, these polymers are not stable for more than a few hours at temperatures above 250°F.

TABLE 2—CHARACTERISTICS OF WATER SOLUBLE POLYMERS USED FOR VISCOSITY, SUSPENSION OR FILTRATION CONTROL

Polymer	Type	Viscosity Development	Filtration Control	Suspension Properties	Acid Solubility	Temp. Stab.	Brine Tolerance
HEC	NI	Excellent	Poor	Poor	Excellent	250°F	Excellent
HEMC	NI	Excellent	Poor	Poor	Good	"	Excellent
CMC	A	Good	Good	Fair	Poor	"	Poor
XC-Polymer	A	Fair	Poor	Excellent	Good	"	Fair
Drispac	A	Poor	Good	Poor	Poor	"	Poor
Starch	NI	Poor	Good	Poor	Poor	"	Good
Guar	NI	Excellent	Poor	Poor	Fair	"	Good
Polyacrylate	A	Poor	Good	Poor	Insol.	"	Poor
Asbestos	NI	Good	Fair	Excellent	Poor	400°F	Excellent

NI - Non Ionic

A - Anionic

Mixing

Mixing is frequently the most difficult procedure involved in the use of completion and workover fluids. In situations where blending facilities are inadequate, polymers and weighting materials are difficult to mix.

Corrosion

Embrittlement and corrosion are constant sources of concern during completion/workover/production operations. Corrosion inhibitors used in clear brines are of the film forming amine variety. A bactericide is usually added to inhibit bacteria growth. Solids laden fluids require alternate methods, such as pH control and addition of oxygen scavengers, in addition to bacterial control.

Compatibility

This is a broad subject area including the nature of the interaction of the completion or workover fluid with drilling mud, treating fluids such as cement slurries or acid, and formation fluids (water and oil). Compatibility with drilling mud to prevent severe gellation of the mud during displacement is necessary to ensure proper clean-out. When formation fluids come in contact with completion or workover fluids, the result can be formation of emulsions or precipitation of insoluble salts. Emulsion formation can be hindered or prevented with the use of non-emulsifying surfactants. Formation of precipitated salts can be prevented by matching the electrolyte composition of the completion or workover fluid with the formation water or by using a prepad volume of compatible brine in order to minimize contact between the two incompatible fluids.

Formation Protection

As mentioned before, the major reason for using completion and workover fluids is to prevent formation damage. The best fluids for this purpose are clear, solids-free brines. In instances when solids are desirable for bridging and filtration control or for weight-up due to economic factors, the added solids should be acid or oil soluble. All other additives should be water, oil, or acid soluble.

Cost

Evaluation of the cost of a completion or workover fluid is not simply the price per barrel. The effect of the fluid on the formation and how that effects productivity is of primary concern. Also, the need for additional stimulation treatment should be considered. Indeed, a clay-based mud may be cheaper than an acid-soluble fluid or a clear brine but the cost may be much higher.

The first decision in selecting a fluid is identification of the required properties. Figure 2 shows a breakdown of the properties or functions of completion and workover fluids. After the critical functions or properties of the fluid have been decided upon, the next step is the selection of the type of fluid to be used. Figure 3 shows a decision chart for various fluid types. The fluid decision is heavily dependent on the function or properties decision. For example, if economy is the overriding consideration on the function chart, then the choice on the fluid chart would be a clay-based mud. However, if formation protection is equally important, then the decision may branch to acid-soluble or oil-base fluids on the fluid chart. If formation protection is the main concern, which is often the case, then the decision may branch to clear brines on the fluid chart (Figure 3).

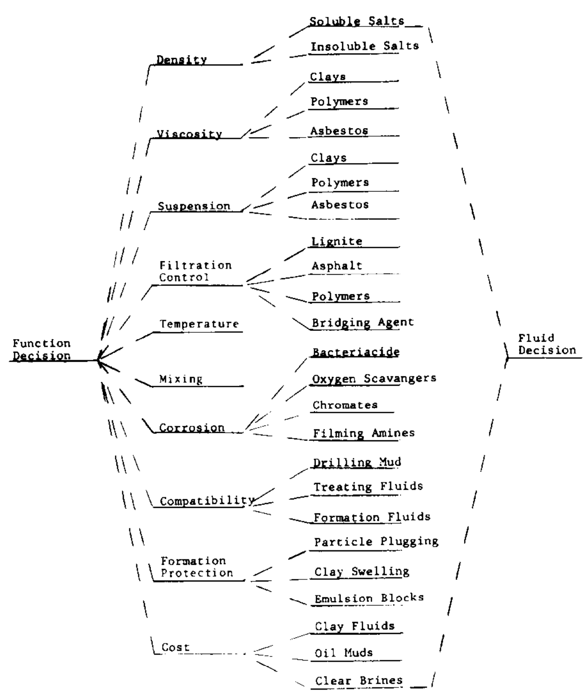


FIGURE 2—FLUID FUNCTION CHART

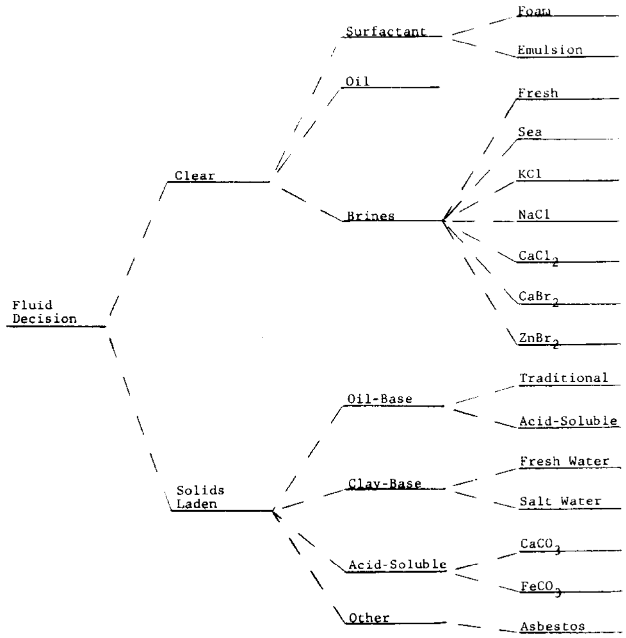


FIGURE 3—FLUID SELECTION CHART

The example is somewhat simplistic. However, the basic selection principle is illustrated. The properties or functions of the fluid dictate the type of fluid to be used: the reverse is not true. All too often a particular type of fluid is chosen and its properties do not match up well with the job requirements, resulting in poor performance.

CONCLUSION

If all the properties of functions of the completion or workover fluid are considered with respect to the particular job requirements, then the type of fluid selected should provide a more trouble-free operation and, most importantly, increased productivity.

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