TAKING CARE OF YOUR REDBED PROBLEMS

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ABSTRACT

This paper summarizes the evolution of a polymer drilling fluid that was developed for drilling through the sticky redbeds of West Texas and Eastern New Mexico. The polymer is not a new chemical; however, it has not been used previously for drilling through the swelling redbeds found throughout most of the Permian Basin. Advantages and disadvantages as well as problems encountered while using the polymer drilling fluid are pointed out and discussed. Data obtained from actual field drilling operations are used to compare the polymer drilling fluid with various conventional drilling fluids usually employed. Results presented emphasize the importance of the polymer drilling fluid in effectively eliminating the severe problem of drilling through the redbeds at a cost lower than or comparable to that of conventional drilling fluids normally used.

INTRODUCTION

Some operators in the Permian Basin have recently found that a polymer drilling fluid made with Nalco ASP-725 cationic liquid polymer effectively eliminated the serious problem of drilling through the swelling redbeds found throughout most of West Texas and Eastern New Mexico in about the same cost range or less than that of conventional drilling fluids normally used.[1] ASP-725 is not a new chemical; however, it has not been used previously for drilling through the sticky redbeds found in most of the Permian Basin. ASP-725 is a cationic polymer (positive charge) which reacts with the anionic redbed clay (negative charge) to inhibit the clay's tendency to allow water invasion and swelling. Reducing the charge on the redbed clays to reduce the tendency of hydration and migration will cause the active drilling solids to be flocculated for rapid removal to the surface. This property alone solves a major problem for drilling sensitive formations such as the redbeds, that is maintaining low solids in the fluid. An attractive benefit of maintaining a low amount of solids, aside from reduced probability of becoming stuck, is an increase in penetration rate. Also, the cationic nature of ASP-725 will reduce the tendency of the clays on the borehole wall to slough and heave.

The redbeds of West Texas and Eastern New Mexico have a history of causing serious drilling problems. The most common problems encountered are:

1. Solids build-up in the drilling fluid
2. Slower penetration rate
3. Hole instability - sloughing and heaving
4. Bottomhole fill
5. Torque build-up on the drill pipe
6. Drag on the drill pipe
7. Stuck pipe - both drill pipe and casing

Usually, the redbeds in most wells are drilled with brine water, either prepared or native. As the redbeds began to slough and heave off into the hole and be circulated through the pits, native viscosity is allowed to build to 30-35 sec/qt. Sometimes oil is added (5-10 percent) as a lubricant. While drilling the redbeds, it is imperative to control the solids. This is done either by solids control equipment or by dilution. As more redbeds are circulated and the viscosity increases, additional water is usually added to the mud system. Failure to control the solids can result in stuck pipe, and stuck pipe usually results in an expensive fishing job. Problems increase in that sloughing and heaving causes a very irregular and enlarged hole which makes logging and/or coring difficult if not impossible and cementing extremely costly.

Before discussing the successful drilling of the Permian Basin redbeds with Nalco ASP-725, it might be helpful to review the basic concepts of the nature of the problems encountered in drilling troublesome shales and clays.

SHALES AND CLAYS

Sedimentary deposits of erosional products are the source of the troublesome clays that are normally encountered throughout the petroleum industry.[2] Shales are sedimentary deposits that have been laid down over geologic time in marine basins. The shales are usually composed of quartz, feldspar, calcite, and various types and amounts of clays. Some are hydratable clays, and some are migrating clays. Hydratable clays absorb water readily and swell freely resulting in sloughing, heaving, and wellbore instability. Hydratable clays can also break loose from the formation and become migrating fines. Migrating clays are not strongly attached to the formation and are easily dispersed by drilling fluids, cementing fluids, and treating fluids. When a well is put on production, the migrating clays accumulate in or near the wellbore as the produced fluid moves into the wellbore. Refer to Fig. 1[3] for the effect of water salinity, clay content, clay swelling, and particle movement on the variation of permeability.

According to Steiger[4], the most common water-sensitive clays, in order of greatest to least sensitivity, are listed and discussed below.

1. Montomorillonite clay

   A. Swelling clays are disordered microcrystals of layered aluminosilicates with defect structures.[4] Each clay layer unit consists of an octahedral aluminate layer sandwiched between two tetrahedral silicate layers.[4] The silicate surfaces of the microcrystals have net negative charges because of isomorphous substitution in the octahedral and tetrahedral layers.[4] Refer to Fig. 2[3] for a schematic of clay crystal structures.

   B. For montmorillonite, the substitution is predominantly iron or magnesium for aluminum in the octahedral or middle layer, which produces a negative charge at the surface.[4] The charges are balanced by positive ions, usually sodium and calcium absorbed to the surface.[5]

      In montmorillonites, where the balancing cations are usually sodium and calcium ions, the adjoining clay layers are not held together; water moves in between the layers, interacts with the surface and the cations, and causes expansion.[4] However, note that montmorillonites saturated with potassium exhibit only very limited expansion.[6] Refer to Fig. 2[3] for a schematic of montmorillonite clay crystal structure.

2. Mixed-layered and/or interlayed montmorillonite and illite clays

3. Illite clay

   A. Illite has an octahedral layer similar in composition to monmorillonite, but it also has significant substitution of aluminum for silicon in the tetrahedral or outside layers, which produces strong negative charges at the clay surface.[4] The negative charges are balanced by positive ions, usually potassium, absorbed to the surface.[4]

   In illites, where the balancing cations are usually almost all potassium ions, the adjoining clay layer units are held tightly together by the potassium so that water cannot move in, interact with the surface, and cause expansion.[4] However, incomplete saturation with potassium and the substitution of sodium or calcium ions allows water penetration between the clay layers or at frayed edges of interlayers and expansion of some illites.[4] Moveover, illites also can contain up to 5 percent interstratified montmorillonite, which has a greater tendency to hydrate and to swell.[4] Refer to Fig. 2[3] for a schematic of illite clay crystal structure.

4. Chlorite and kaolinite clays are also commonly found in shales; however, they exhibit no appreciable swelling tendencies. Chlorite and kaolinite are migrating clays. They are not strongly cemented to the formation, are easily dispersed by drilling and completion fluids, and are easily moved toward the wellbore as migrating fines. Refer to Fig. 2[3] for a schematic of chlorite and kaolinite clay crystal structures.

HYDRATION AND MIGRATION OF SHALES AND CLAYS

Clay hydration causes significant changes in the mechanical properties of a shale, and hydration of the wellbore surface is a function of the hydration character and depth of the shale.[4] Shallow, wet gumbo shale exhibits the worst surface swelling and some plastic flow and needs to be opened periodically with short wiper trips to keep the hole near gauge.[4] Hydration and swelling of confined or compacted shale generates internal stresses that can lead to spalling, vertical fracturing, and reduction of compressive strength.[7] This causes wellbore instability and hole enlargement problems.[4] Hydration of unconfined shales in water can cause disintegration of the shale matrix and allow the separated microcrystals to disperse into the liquid phase.[4] An excessive amount of these finely divided particles can have an adverse effect on the rheological properties of a drilling fluid.[4] Drill cuttings of extremely hydratable shales can soften in water and can stick together to form mud rings in the annulus or can stick to the bit, stabilizers, and drill collars.[4]

SHALE AND CLAY CLASSIFICATION

Problem shales can be classified in a general way to describe their relative tendencies to swell and to disperse. The swelling and dispersion characteristics of a particular shale are functions of the amounts and types of clay present. Several shale classification schemes have been proposed in the past.[8,9,10] All of them served well; however, a more comprehensive sorting system that fits the vast majority of shales encountered in ordinary drilling practice was presented by O'brien and Chenevert in 1973.

The system proposed by O'brien and Chenevert[11] divides shales into five general classes based on total clay content and observed drilling characteristics such as hardness, dispersion, sloughing and caving tendencies. O'brien and Chenevert's classification system for problem shales is shown in Table 1.[11] A brief explanation of each class listed in Table 1 is given on the table for easy reference.

Steiger[4] found that many shales fit one class in terms of clay content description and fit another class in terms of observed drilling characteristics. Steiger[4] concluded that this procedure gives a qualitative ordering of the shales; however, for the following reasons the system needed to be expanded further to include the quantitative ordering of the shales.

1. Clay content analysis is only qualitative, and significant variations between different analytical laboratories and procedures have been observed.[4]
2. Observed drilling characteristics are quite subjective and produce considerable variation between different observers.[4]

Steiger[4] concluded that the quantitative ordering of shales is based on the following:

1. A quantitative ordering of a shale's hydration characteristics is obtained from measurement of the shale's specific surface area.[4]
2. The swelling pressure or hydration tendency of a clay has been shown to be a function of the surface area of the clay, and to a smaller extent, a function of the cation exchange capacity of the clay.[12,13] Thus, the surface area of the shale is a good indicator of its hydration characteristics or of the amount of expandable clay layers present.[4]
3. A shale's surface area can be compared with nonswelling sand grains of pure quartz that have a diameter of 200 microns and a specific surface area of 0.011 m^2/g, and with highly swelling sodium montmorillonite clay that has a specific surface area of 810 m^2/g.[4] The shale's surface area is determined by a modification of a liquid adsorption technique used to determine the surface area of clays.[14]

Steiger's classification system for problem shales is shown in Table 2.[4] Several typical problem shales are listed in Table 2 for the purpose of explaining Steiger's classification system. A brief explanation of each column in Table 2 is given on the table for easy reference.

NALCO ASP-725

Nalco ASP-725 is a cationic liquid polymer designed for use as a viscosifier and clay stabilizer in clear or low solids drilling fluids.[15] ASP-725 is highly soluble in fresh water, hard water, or brine. It is a single component system requiring no activators or other additives for yielding. By design, ASP-725 requires a very minimum of mixing to yeild. This eliminates costly high shear devices and other expensive mixing equipment. Due to the ease of mixing, ASP-725 yields quickly to give almost instantaneous control of drilling fluids.

In clear water or low solids drilling, ASP-725 is designed to impart sufficient viscosity to the drilling fluid for excellent hole cleaning. More importantly, ASP-725 is designed to stabilize clays to help prevent hydration and migration. This property imparts borehole stability by preventing sloughing and/or heaving from sensitive shales and clays and gives very straight and good gauge holes.

ASP-725 is an excellent total flocculant. Refer to Fig. 3[16] for a description of the mechanism of flocculation. This property alone helps maintain a very low solids content for high rates of penetration. ASP-725 encapsulates the cuttings, helping to maintain their integrity; therefore, reducing the amount of drilling solids in the drilling fluid. The encapsulation of the cuttings gives clear representative samples allowing for formation evaluation which is a very desirable property. ASP-725 reduces the amount of bottomhole fill and the tendency of "booting off" when drilling in sticky shales. ASP-725 has excellent friction reduction characteristics. This combined with total flocculant properties to help insure a low solids content causes a significant reduction in pump pressure and pipe torque and, therefore, a much more efficient drilling operation.

Feeding of ASP-725 is ordinarily done very slowly through a conventional mud hopper. Initial dosage level is normally 20 gal/1,000 bbl, added very slowly through the mud hopper. Since ASP-725 is depleted from the mud system, maintenance amounts have to be added. Maintenance amounts are usually 5 gal/ 8 hr tower, added very slowly through the mud hopper. Typical properties of a brine water, ASP-725 mud system are summarized in Table 3. The general description of ASP-725 is given in Table 4.[15] Handling, storage, specifications, and shipping are given on the table for easy reference.

The use of cationic polymers, such as ASP-725, prohibits the use of drilling clays such as bentonite and attapulgite. The viscosity of ASP-725 mud systems can be increased by the use of HEC (hydroxyethel cellulose), and the effect on the penetration rate would be negligible. However, it would add to the mud bill significantly.

Permanent methods of stabilizing clays generally involve use of multisited cationic chemicals.[17,18,19] Polymers with cationic functional groups which are absorbed on clay platelets have proved to be one of the most permanent means of stabilizing clays.[2] Examples are partially hydrolyzed polyacrylamides, flaxmeal, and Halliburton Services' CLA-STA™.[2] ASP-725 polymer is also a multisited chemical with cationic functional groups. Polymers, such as those just pointed out, are easily mixed with treating and/or drilling fluids and are effective clay inhibitors over a wide range of conditions.

ASP-725 cationic polymer acts by exchanging a cationic site (positive charge) on the polymer for a cation (negative charge) within the clay lattice. The positive charged sites on the ASP-725 polymer neutralize the negative charges within the clay lattice. The repelling force is eliminated, and the clay assumes a compact form. ASP-725 polymer is advantageous in that it offers multiple sites of attachment. Permanent protection is achieved because ASP-725 polymer is attached at numerous sites; therefore, release of the absorbed ASP-725 polymer requires simultaneous release of numerous polymer sites and substitution of additional clay cations at each site. Simultaneous release and attachment of all sites is highly improbable; thus, permanent protection against clay swelling is achieved.

FIELD RESULTS

As previously pointed out, the redbeds of West Texas and Eastern New Mexico have a history of causing serious drilling problems. The major problems encountered are solids build-up, hole instability, and stuck pipe (very common). These problems are due to the sensitivity of the redbeds to drilling fluids. The redbeds typically extend from approximately 200 ft to 2,000 ft below the surface and are interspersed with stringers of salt and anhydrite.

Nalco ASP-725 cationic liquid polymer was introduced late in 1981 in the Permian Basin. ASP-725 was found to be very successful in combating problems encountered when drilling the redbeds. Table 5 shows a comparison of wells drilled in the same area using ASP-725 mud and a typical salt gel mud. All wells were drilled using produced brine as the base fluid. The pit system used on all wells consisted of a settling pit, a reserve pit, and a working pit as seen in Fig. 4. The drilling fluid was circulated through the reserve pit on all wells. The total circulating volume on all wells was 800-1,000 bbl. A flow rate of approximately 7.0 bbl/min was used throughout the drilling operation on all wells.

On all wells drilled using produced brine and salt gel (attapulgite) as the drilling fluid, the penetration rate was slower and the mud cost was higher than on all wells drilled using produced brine and ASP-725 as the drilling fluid. The most obvious cause of the reduction in penetration rate is high solids content in the drilling fluid. This translates directly into an increase in rig time which in the long run, translates into increased drilling cost. The increased drilling time is important from another aspect also, that is, hole instability due to prolonged exposure to the drilling fluid. When drilling sensitive formations such as the redbeds, the shorter the open hole time, the fewer chances of bridging, sloughing, heaving, etc., and the fewer chances of stuck pipe.

On all wells drilled using produced brine and salt gel (attapulgite) as the drilling fluid, the only means of solids control was by circulation through the pits and by dilution. In remote areas where water is scarce, the purchase and transportation of water becomes a substantial figure. At the same time, the fluid properties of the mud are becoming uncontrollable. If the solids cannot be controlled, the mud will have to be disposed of and a fresh mud prepared.

On all wells drilled using produced brine and ASP-725 as the drilling fluid, no drag was experienced when coming out of the hole to change bits nor when going back into the hole. This means there were no tight spots due to cake formation or bridges from sloughing. No problems were encountered when casing was run. However, some slight fill (10-30 ft) was found in some holes. This is probably due to the clear fluid's (ASP-725 drilling fluid) inability (low viscosity) to totally suspend and carry the cuttings out completely.

Prior to drilling the surface pipe cement plug on all wells drilled using produced brine and ASP-725 as the drilling fluid, 20 gal of ASP-725 was added through the mud hopper over two hole circulations. Four sacks of shredded paper were added per 8 hr tower for seepage control. Maintenance amounts of ASP-725 were added at the rate of 4-6 gal/8 hr tower through the mud hopper. It is interesting to note that throughout the drilling operations, clear fluid was seen existing in the reserve pit into the working pit on all wells drilled using produced brine and ASP-725 as the drilling fluid.

The only negative aspect of the field test of ASP-725 was the enlargement of one hole. A caliper log was not run on the well; however, enlargement of the hole was reflected by the amount of cement used on the long string. Approximately 200 sacks of cement more than normally used was required to cement the long string, and very little cement was circulated. However, this should not be attributed to the ASP-725. There are two probable causes of the hole enlargement. They are:

1. Erosion of the borehole caused by turbulent annular flow.
2. Enlargement of the borehole in salt sections due to dissolution of the salt.

The erosion could be reduced by raising the viscosity of the drilling fluid and reducing the annular velocity. The dissolution of the salt sections could be lessened by increasing the concentration of the produced brine which was used as the base fluid of the drilling mud. Due to the manner in which the produced brine is purchased, it would be difficult to control the concentration of the brine. It is evident from mud reports that all shipments of produced brine were not saturated.

The viscosity of ASP-725 mud systems can be increased by the use of HEC (hydroxyethel cellulose), and the effect on penetration rate would be negligible. However, it would add to the mud bill significantly.

As previously stated, Nalco ASP-725 has been very successful in reducing problems encountered while drilling the redbeds of West Texas and Eastern New Mexico. Table 5 shows a comparison of wells drilled in the same approximate area using ASP-725 mud and a typical salt gel mud. All wells were drilled using produced brine as the base fluid. Wells drilled with the ASP-725 mud system had a rotating time of approximately 30 hr less than wells drilled with the salt gel mud system. This reduced rotating time alone represents a savings of approximately $6,000 to the operator if the wells were drilled on a day rate. Other factors related to the use of the ASP-725 are reduced water usage. Water usage on ASP-725 mud systems was approximately $1,000 per well less than water usage on the salt gel mud systems. The mud cost per foot was found to average approximately 31 percent more when using the salt gel mud system than when using the ASP-725 mud system. The most dramatic property demonstrated (aside from reducing the chance of becoming stuck) was the penetration rate of the ASP-725 mud system. The average rate of penetration for the ASP-725 mud systems was found to be approximately 30 percent greater than that for the salt gel mud systems.

CONCLUSIONS

The use of Nalco ASP-725 will not eliminate all of the problems associated with drilling fluids in drilling troublesome shales and clays; however, ASP-725 has been found to be successful in minimizing many of the problems. Also, the use of ASP-725 has been found effective in reducing the overall cost of drilling operations.

Results presented in this paper emphasize the importance of Nalco ASP-725 in effectively eliminating the severe problem of drilling through the redbeds of West Texas and Eastern New Mexico at a cost lower than or comparable to that of conventional drilling fluids normally used. Use of ASP-725 mud systems reduced the mud cost per foot by 30.8 percent, increased the rate of penetration by 30.0 percent, and decreased the drilling rig time by 22.4 percent; all of which translates directly into a substantial savings over conventional salt gel mud systems.

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TABLE 1
CLASSIFICATION OF PROBLEM SHALES

Class	Characteristics	Clay Content
1	Soft, high dispersion	High in montmorillonite, some illite
2	Soft, fairly high dispersion	Fairly high in montmorillonite, high illite
3	Medium-hard, moderate dispersion, sloughing tendencies	High in interlayered clays, high in illite, chlorite
4	Hard, little dispersion, sloughing tendencies	Moderate illite, moderate chlorite
5	Very Hard, brittle, no significant dispersion, caving tendencies	High in illite, moderate chlorite

Class 1 - Soft shales having a high montmorillonite content, with some illite included. Large swelling and dispersion effects are encountered. Most shales designated as "gumbo" shales, especially those with high adhesive and cohesive tendencies, fall into this class.

Class 2 - Soft shales with both high montmorillonite and high illite fractions. The total clay content in such shales is extremely high and swelling is pronounced. Dispersion is somewhat less than for Class 1, owing to the presence of chlorite fractions. Drilling personnel often refer to shales from Classes 1 and 2 as soft, mud-making shales. Classes 3, 4 and 5 generally include those shales that are referred to as hard shales.

Class 3 - Medium-hard shales which are noted for their sloughing tendencies. These materials exhibit a large degree of swelling, but only a medium level of dispersion. Both illitic and interlayered clay fractions constitute a significant percentage of the shale's weight. Appreciable amounts of chlorite are present, but discrete montmorillonite usually does not occur.

Class 4 - Hard shale prone to sloughing. Illite and chlorite normally compose the entire clay fraction, and this fraction is only about 20 percent of the total weight of the shale. This variety shows little dispersion in water. Although the clay content is low (confined to illite and chlorite alone) and the resulting over-all swelling is low, almost any amount of hydration is sufficient to make the formation unstable. Differential swelling pressures, which result when a small amount of clay is surrounded by a completely nonswelling quartz and feldspar matrix, are often blamed for such instabilities. Classes 3 and 4 include the majority of shales that are involved in the most serious hole problems.

Class 5 - Very hard, brittle shales, some of which have matrices with numerous microfractures. Very little or no dispersion occurs upon water contact. The overall illite content is fairly high, and there is some chlorite present. Formations of this type are recognized as having caving and heaving tendencies. Swelling is limited but may be accelerated by the invasion of water long microfractures. Typically, large fragments of such formations are pushed into the wellbore to relieve the pressure.

After O'brien and Chenevert; J. Pet. Tech. (Sept., 1973) 25, No. 9, 1089-1100; Trans. AIME (1973) 255, I-1089--I-1100.

TABLE 2
CLASSIFICATION OF TYPICAL PROBLEM SHALES

(1) Surface Area (m2/g)	(2) Shale	(3) Class	Clay Content (Weight Percent) (4) Montmorillonite	(5) Interlayered	(6) Illite	(7) Chlorite	(8) Kaolinite
412	Q	1(1)	25.2	11.6	38.4	0.7	2.4
369	D	1(1)	45.1	--	11.1	0.9	3.5
337	A	1(1)	34.6	--	43.4	3.9	4.2
295	F	1(2)	17.8	11.9	31.9	4.0	3.6
249	P	1(2)	18.9	11.4	35.4	1.2	---
228	I	1(2)	21.1	9.4	27.4	4.5	3.8
215	E	1(2)	16.5	13.6	25.7	10.8	7.0
215	S	1(3)	9.6	20.9	31.2	1.0	---
203	T	2(2)	23.3	--	22.4	5.6	6.8
168	J	2(3)	8.6	22.6	33.6	2.0	---
153	B	3(5)	--	--	33.1	20.4	34.7
151	H	3(3)	--	21.2	55.8	2.7	---
134	M	3(3)	9.2	11.2	35.0	5.5	4.4
127	G	3(3)	--	18.3	38.7	4.4	14.5
121	R	3(3)	--	14.9	22.7	4.1	33.1
78	K	4(3)	--	22.3	33.7	8.8	7.7
70	C	4(5)	--	--	45.8	21.1	13.2

Column 1 - Listing of the measurement of each shale's specific surface area. A quantitative ordering of a shale's hydration characteristics is obtained from measurement of the shale's specific surface area. The swelling pressure or hydration tendency of a clay has been shown to be a function of the surface area of the clay, and to a smaller extent, a function of the cation exchange capacity of the clay. Thus, the surface area of a shale is a good indicator of its hydration characteristics or of the amount of expandable clay layers present. A shale's surface area can be compared with nonswelling sand grains of pure quartz that have a diameter of 200 microns and a specific surface area of 0.011 m^2/g, and with highly swelling sodium montmorillonite clay that has a specific surface area of 810 m^2/g. The shale's surface area is determined by a modification of a liquid absorption technique used to determine surface areas of clays.

Column 2 - Alphabetical listing of each shale for identification purposes only.

Column 3 - A system proposed by O'brien and Chenevert in 1973 and presented in Table 1 is very useful in dividing shales in five general classes based on total clay content and observed drilling characteristics such as hardness, dispersion, sloughing, and caving tendencies. It has been found that many shales fit one class in terms of clay content and fit another class in terms of observed drilling characteristics.

Each shale in Column 3 is given two numbers to describe its class. The first number is based on observed drilling characteristics, and the second number is based on total clay content. This procedure gives a qualitative ordering of the shales.

Columns 4-8 - Listing of the clay content of each shale on a weight percentage basis for comparative purposes only.

After Steiger; J. Pet. Tech. (Aug., 1982) 34, No. 8, 1661-1670.

TABLE 3
COMPARSION OF MUD PROPERTIES OF NALCO ASP-725 MUD AND CONVENTIONAL SALT GEL MUD

	ASP-725 Mud	Salt Gel Mud
Mud Weight (Lb/Gal)	10.0	10.1
Funnel Viscosity (Sec/Qt)	29.0	32.0
Water Loss (cc)	28.0	28.0
pH (Dim)	7.4	9.3
Chloride Content (ppm)	126,000.0	126,000.0
Calcium Content (ppm)	3,030.0	3,030.0
Solids (% by Vol)	4.3	13.5

TABLE 4
NALCO ASP-725

GENERAL DESCRIPTION

Color	White
Odor	Sweet
Specific Gravity	1.07 @ 60° F
Density	8.9 Lb/Gal
Pour Point	-40° F
Flash Point	200° F
Viscosity	700-1100 cp @ 75° F
pH (20% Solution)	5.5
Nature of charge	Cationic
Percent Active	30%

HANDLING

Special precautions are not necessary for handling NALCO ASP-725, but contact with the skin and eyes should be avoided. Do not take NALCO ASP-725 internally.

Upon prolonged standing, some polymer separation will take place. Prior to use, some form of agitation will be required. In the case of drums, use either an air lance or drum mixer. In the case of five gallon metal cans, shake well. During cold weather operations, longer, more vigorous stirring may be necessary.

All equipment should be rinsed with diesel or kerosene thoroughly after use. DO NOT USE WATER.

STORAGE

NALCO ASP-725 is stable at normal outdoor temperature for one year. However, it should be stored indoors if possible. Recovery of NALCO ASP-725 after standing or freeze-thaw is complete with agitation. As with any chemical stored in a closed drum, exposure to high temperatures should be avoided.

SPECIFICATIONS

NALCO ASP-725 has been tested for materials compatibility and can be used with Copper, Aluminum, Brass, Mild Steel, 304 SS, 316 SS, Plasite 10-6000, Plasite 10-7122, Plasite, PVC, Teflon, Vinyl, Plexiglass, and Polyurethane. NALCO ASP-725 should not be used with Rubber, P. E., Neoprene, Hypalon, Viton, Buna-N, Polypropylene, and Ethylene Propylene.

SHIPPING

NALCO ASP-725 is available in 55 gal nonreturnable, steel drums and 5 gal metal cans, FOB Sugar Land, Texas.

After NALCO Chemical Co.; NALCO ASP-725 Drilling Fluid Additive Product Bulletin (Oct., 1981).

TABLE 5
COMPARSION OF NALCO ASP-725 MUD AND CONVENTIONAL SALT GEL MUD ON DRILLING TIME, PENETRATION RATE, AND MUD COST

Company (1)	Lease & Well No. (2)	County (3)	Drilling Fluid Type (4)	Well T.D. (Ft) (5)	Rotating Footage (Ft) (6)	Rotating Time (Hr) (7)	Drilling Rate (Ft/Hr) $\frac{(6)}{(7)} = (8)$	Drilling Fluid Cost ($) (9)	Drilling Fluid Cost ($/Ft) $\frac{(9)}{(5)} = (10)$
A	13-4	Andrews	ASP-725	4,997	4,649	114.25	40.69	5,170.36	1.03
A	13-7	Andrews	ASP-725	4,850	4,491	98.25	45.71	4,275.07	0.88
A	14-1	Andrews	ASP-725	4,860	4,525	103.50	43.72	2,791.69	0.57
Total	--	--	--	14,707	13,665	316.00	--	12,237.12	--
Avg.	--	--	--	4,902	4,555	105.33	43.24	4,079.04	0.83
A	7-1	Andrews	Salt Gel	4,850	4,497	151.50	29.68	3,259.32	0.67
A	7-2	Andrews	Salt Gel	4,850	4,491	142.50	31.52	7,649.81	1.58
A	7N-3	Andrews	Salt Gel	4,900	4,562	115.50	39.50	5,038.30	1.03
A	7N-4	Andrews	Salt Gel	4,880	4,541	116.50	38.98	6,406.56	1.31
A	13-3	Andrews	Salt Gel	4,850	4,493	153.00	29.37	6,857.93	1.41
Total	--	--	--	24,330	22,584	679.00	--	29,211.92	--
Avg.	--	--	--	4,866	4,517	135.80	33.26	5,842.38	1.20
A	3 wells	Andrews	ASP-725	4,902	4,555	105.33	43.24	4,079.04	0.83
A	5 wells	Andrews	Salt Gel	4,866	4,517	135.80	33.26	5,842.38	1.20

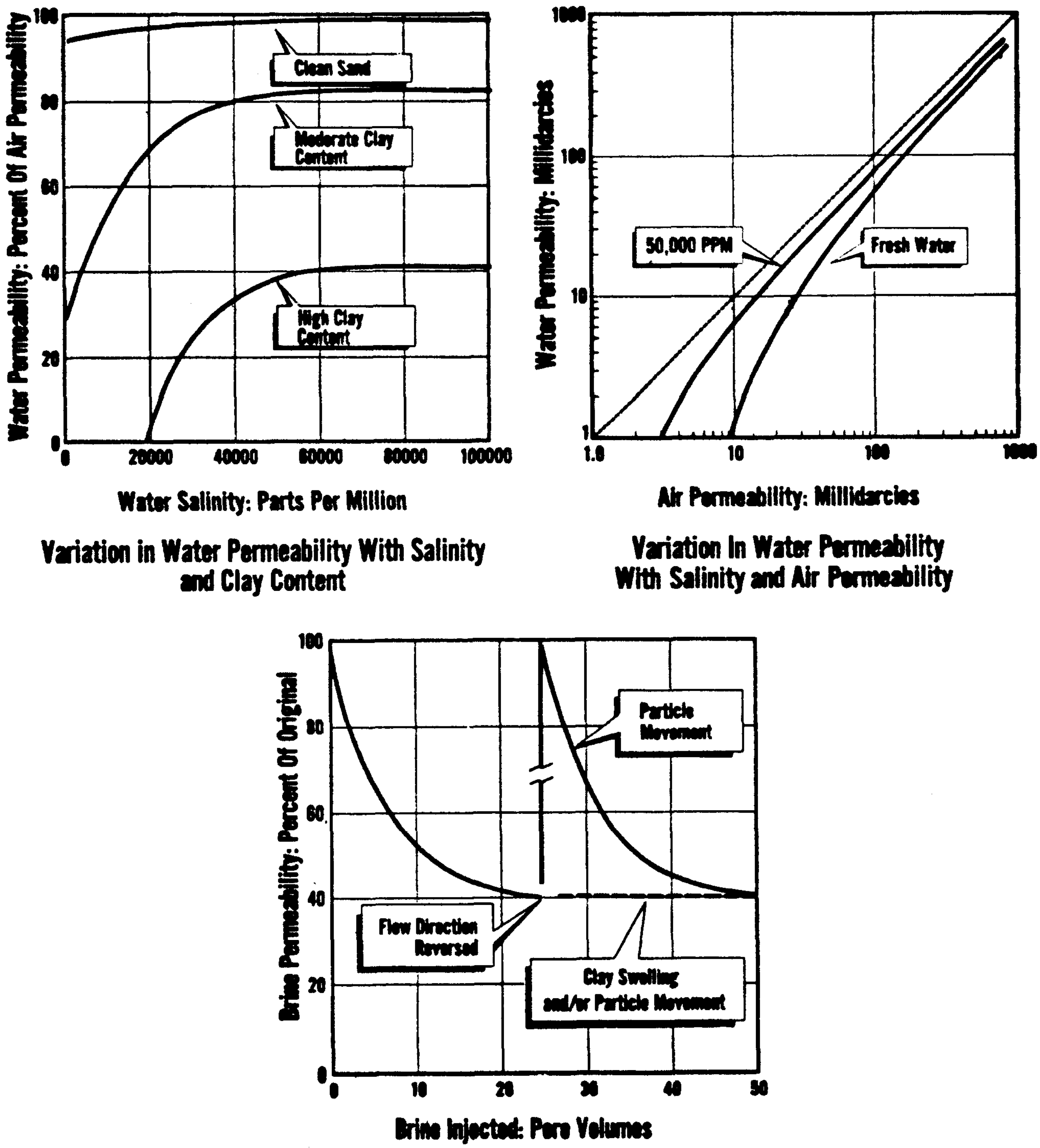

FIGURE 1 — THE EFFECT OF WATER SALINITY, CLAY CONTENT, CLAY SWELLING, AND PARTICLE MOVEMENT ON THE VARIATION OF PERMEABILITY

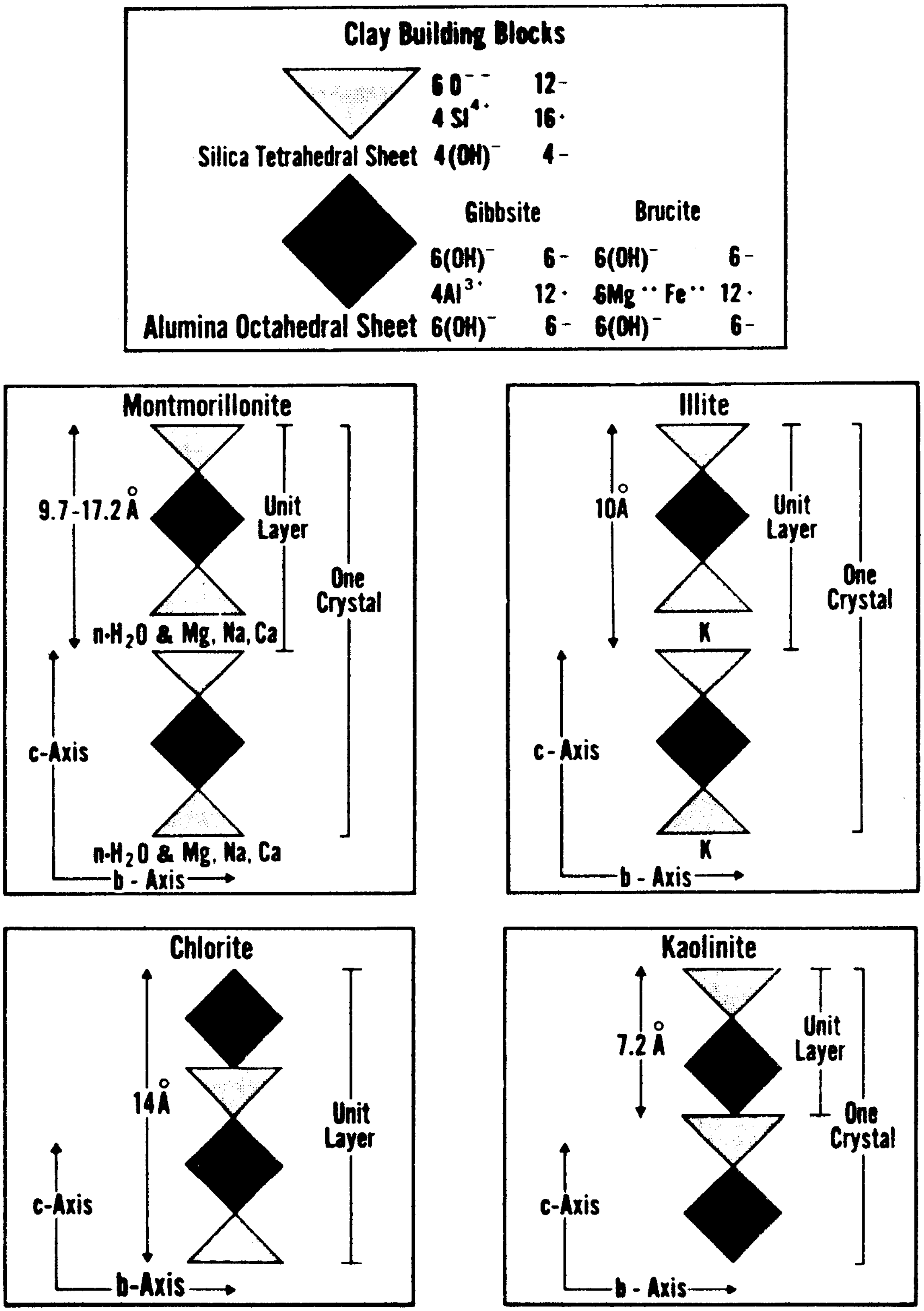

FIGURE 2 — SCHEMATIC OF CLAY CRYSTAL STRUCTURES

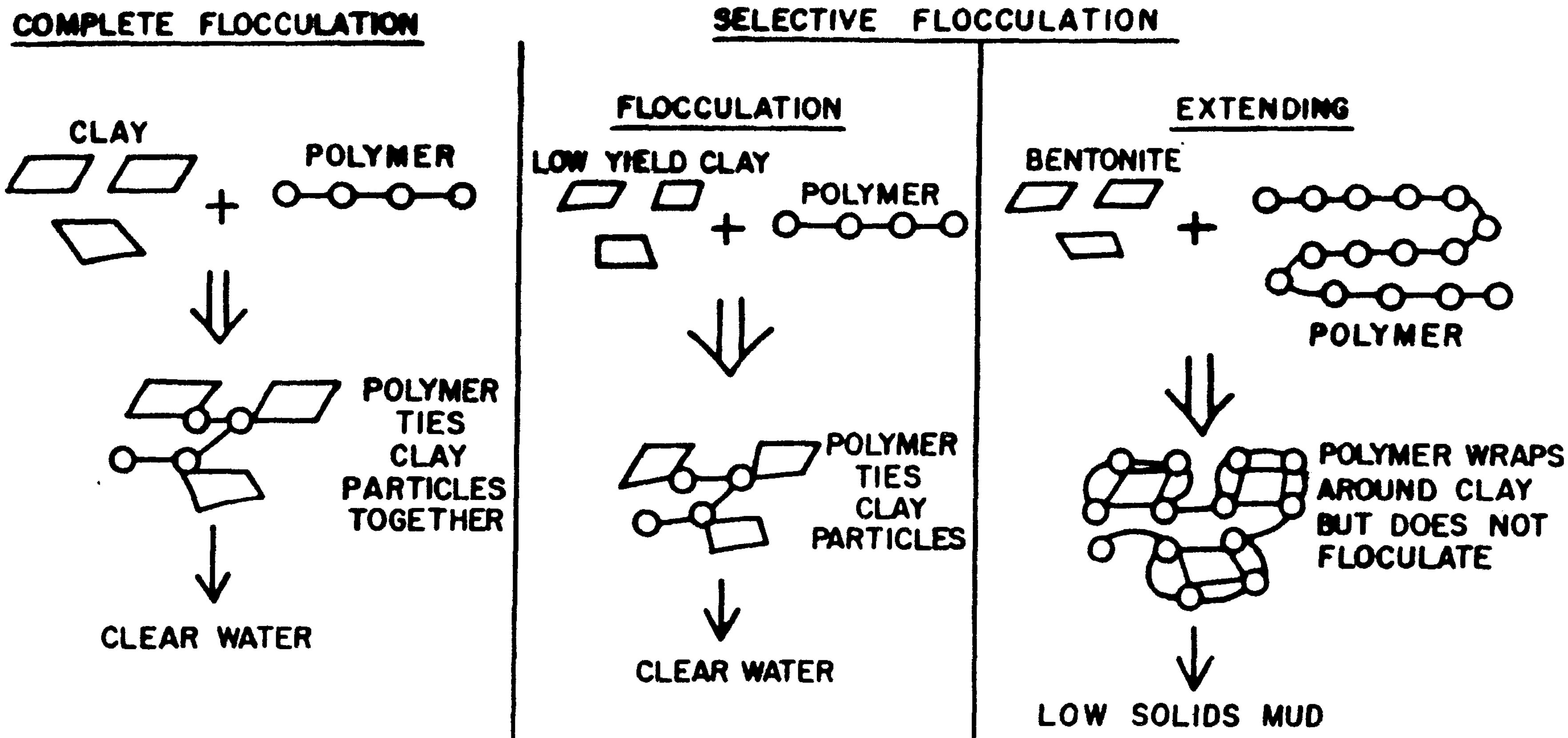

FIGURE 3 — MECHANISM OF FLOCCULATION

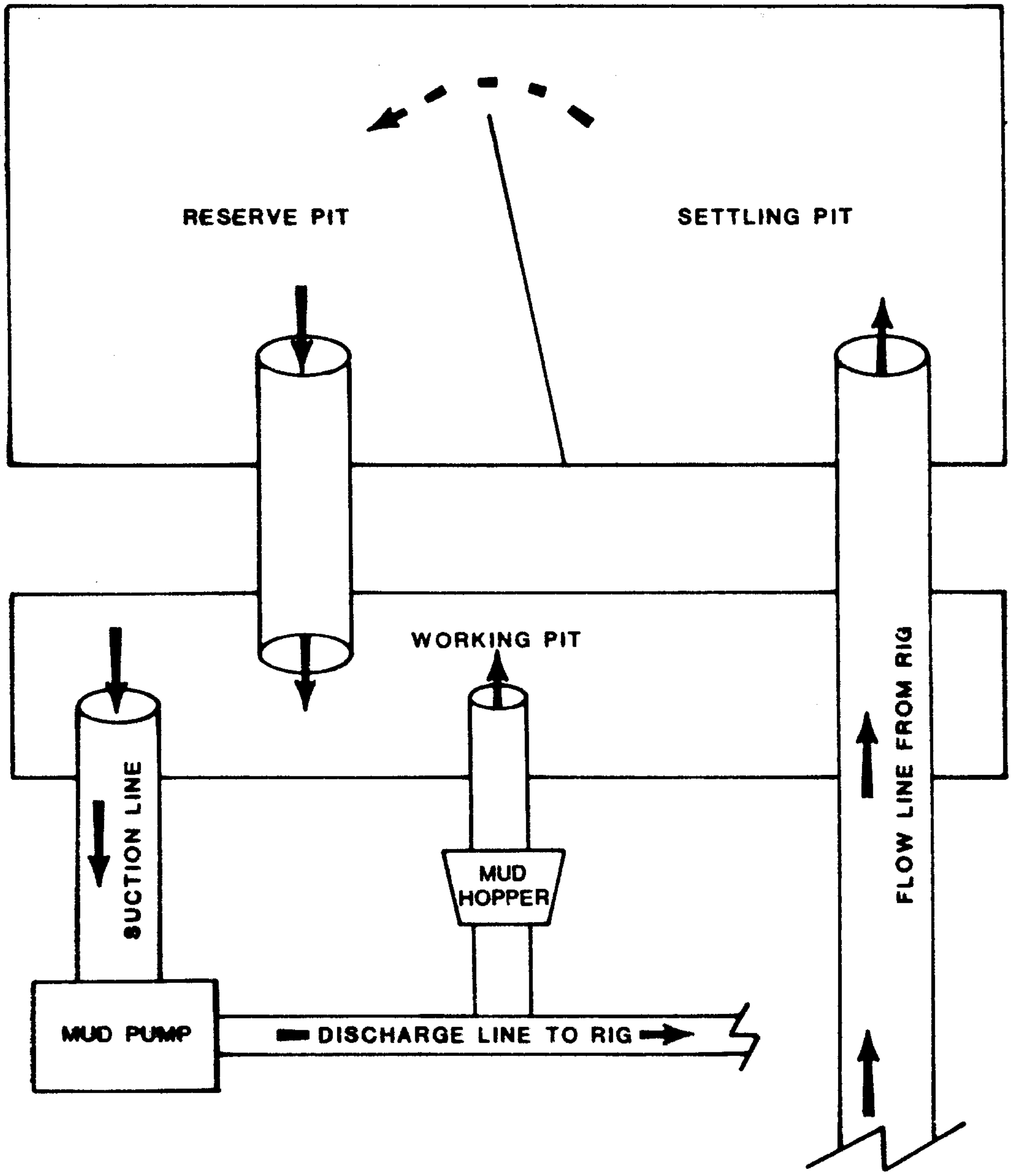

FIGURE 4 — SCHEMATIC OF PIT SYSTEM