THE USE OF 100 MESH SAND FOR IMPROVING ACID EFFICIENCY

W. C. DAVID FRY, C. L. BONEY, J. W. ATCHLEY, and F. T. WHITSETT
Dowell Division of Dow Chemical Company

INTRODUCTION

Hydrochloric acid has been used for more than 40 years to improve production in oil and gas wells. Many techniques have been used to improve results of hydrochloric-acid treatments. One of the most important advances has been recognition that fracturing occurred during the majority of acidizing treatments. This enables the use of fracturing principles to increase live acid penetration. Unfortunately, actual results did not correlate with predicted results. This prompted the use of many techniques to improve results. Some of these are listed below.

1. Acid retardation
2. Increased acid concentration
3. Increased injection rates
4. Increased fracture width to decrease area-to- volume ratio
5. Improved matrix leakoff control
6. Increased pad volumes
7. Improved computer programs

All of these approaches had the purpose of increasing live acid penetration, and thus improving conductivity to the wellbore. Although each action helped either separately or when used in various combination, still a large gap remained between predicted and actual results. The problem has been that the work was based on the assumption that leak off was due to matrix permeability.

THEORY

A significant breakthrough was achieved by considering basic rock mechanics. Fracturing a limestone or dolomite reservoir and a sandstone reservoir is similar, but only until acid is introduced into the fracture. Natural or induced flow channels become enlarged by acid reaction; flow at right angles away from the main fracture is intensified. At this point, matrix sealants or conventional fluid loss additives are only partially effective and penetration by the main fracture into the reservoir will cease.

The use of 100-mesh sand in a highly viscous non-reactive fluid spaced between volumes of acid has shown to be very beneficial when severe leakoff away from the fracture face is encountered.

During an actual treatment, the pad fluid enters the formation; the fluid pad follows the path of least resistance. The path followed usually consists of fractures created by previous acid treatments or natural hairline fractures that are opened by fracturing. As the pad with the 100 mesh sand enters these fractures, the sand packs off the secondary fracture and reduces its flow capacity. The loss of fluid into multiple fractures is significantly decreased into a matrix, and flow down the main fracture is achieved. At this time acid is introduced into the formation and etching down one main fracture is obtained, until the acid is spent or leaked off. Then more new secondary fractures are created, and the series of pad and acid injection is repreated to get further penetration.

Since the use of 100-mesh sand and pads, a matrix leakoff is considered the major factor in leakoff of treating fluids. The use of a liquid resin fluid loss agent has proven effective at concentrations from 5 to 10 gallons per 1000 gallons of acid.

Now that the fluid loss in a frac-acid treatment has been controlled, low rates can be used for deep treating fluids in the zone.

Since the first introduction of 100-mesh sand, people have been leery of "fracturing" their wells in

the Levelland and Brownfield areas (Texas). In this area, frac jobs (large and high rate) had been disastrous due to fracturing into water zones. Studies of these jobs and conventional low-rate acid jobs, show that if pressures were kept low enough fracture growth could be controlled in the desirable zones. The top surface treating pressure is usually from 1600 psi to 2400 psi depending upon the static bottom-hole pressure.

The rates used to achieve these low pressures are generally from 2 to 4 BPM. A normal treatment will start off at 4 BPM until the 100-mesh sand starts reducing the leakoff to a point where new penetration is being achieved. As the leakoff is reduced and fracturing increases, the pressure will rise to or near the maximum. This occurs when rates are decreased to keep pressures low enough to maintain zone treatment. As acid is introduced into the fracture, leakoff is increased and pressure may be decreased and rate can be increased.

After the acid is in the formation, a gelled overflush is used to push the live acid toward the end of the fracture. This creates an etched fracture from the wellbore to where the acid is either spent or leaked off.

Sound concentration is a factor of the following.

1. Normal area experience
2. Age of the well
3. Amount and size of previous well treatments
4. Rates and pressures during treatment

In consideration of these factors, sand is usually run from 1 to 2 pounds per gallon. However, in many cases 4 pounds per gallon is not unusual in the older wells. A gelled water spacer is normally run between stages of sand to replenish fluid that has leaked to the formation.

The gelled water consists of 30 to 50 pounds guar gum or low residue gel system. If low rates, high sand concentrations, or both are expected, the higher gel concentration system is needed for sand transport to prevent the sand from settling out of the frac fluid before it reaches the secondary fractures.

Twenty-percent hydrochloric acid has been used in the majority of the treatments because of its success in conventional acid treatments. This will give good etch width and fair penetration. A non-emulsifying agent is normally run at 2 gallons per 1000 gallons acid to ensure good clean-up.

Most of the subject wells have "stringer" pays and each of these has a different frac gradient. To effectively treat these, the well treatment must be divided into stages and treated separately. To achieve this, approximately 400 pounds of benzoic acid flakes plug is used to divert out zone between stages. Like the sand, actual amounts of plugging material should be determined by treating rates and pressures.

EXAMPLE TREATMENT FOR OLD WELL

Well Data:

Formation—San Andres
TD—5000 feet
Casing—5-1/2 @ 4850 feet
Open Hole—150 feet
Net Height—50 feet
Permeability—5 md (fracture system considered)
matrix equals 0.5 md

Porosity—12 percent

Previous Treatments:

1-12-73 5000 gallons 15 percent HCL NE-FE
7-8-75 7500 gallons 20 percent HCL NE-FE

Treatment Procedure:

1. Pump 1000 gallons of 50 pound gelled water pad.
2. Pump 2000 gallons of 50 pound gelled water pad with 1 pound gallon 100 mesh sand.
3. Pump 1000 gallons of 50 pound gelled water pad.
4. Pump 2000 gallons of 50 pound water with 3 pounds/gallon 100 mesh sand.
5. Pump 3000 gallons of 20 percent HCL NE-Fe.
6. Overflush with 1000 gallons of 40 pound gelled water. Drop 400 pounds benzoic acid flakes in the last 250 gallons.
7. Repeat steps 1 through 6.
8. Repeat steps 1 through 5.
9. Overflush with 1000 gallons of 40 pound gelled water.

Treatment design on new wells will differ somewhat since the hairline fractures near the wellbore have not been opened up enough to accept the 100 mesh sand. To accomplish this, 1000 gallons of acid is usually run ahead of each stage.

EXAMPLE TREATMENT FOR A NEW WELL

Well Data:

Formation—San Andres
TD—4900 feet
Casing—5-1/2 @ 4730 feet
Open Hole—170 feet
New Height—63 feet
Permeability—3.5 md (fracture system considered)
matrix equals 0.7 md

Porosity—9 percent

Treatment Procedure:

1. Pump 1000 gallons of 20 percent HCL NE-FE.
2. Pump 1000 gallons of 30 pound gelled water pad.
3. Pump 1500 gallons of 30 pound gelled water with 1 pound/gallon 100 mesh sand.
4. Pump 500 gallons of 30 pounds gelled water pad.
5. Pump 2000 gallons of 30 pound gelled water with 2 pounds/gallon 100 mesh sand.
6. Pump 500 gallons of 30 pound gelled water
7. Overflush with 1000 gallons of 30 pounds gelled water. Drop 200 pounds benzoic acid flakes plug.
8. Repeat steps 1 through 7.
9. Repeat steps 1 through 6.
10. Overflush with 1000 gallons of 30 pound gelled water.

RESULTS

In the past year and a half, several hundred wells in the Levelland and Brownfield areas of Texas have been treated with 100 mesh sand. The results have shown sustained production increases in the bulk of the wells treated. Examples of unit results are shown below.

REPRESENTATIVE OF UNIT RESULTS:

Example No. 1

Location—West Hockley County
Formation—San Andres
Frac Fluid—15,000 gallons
Acid—6000 gallons 20 percent HCL NE-FE
100 mesh—4000 pounds
Rate—2-4 BPM
19 wells were treated

Production (total)

Before	340 BOPD plus 521 BWPD
Initial	604 BOPD plus 2524 BWPD
90 Days	662 BOPD plus 1665 BWPD

Example No. 2

Location—East Hockley County
Formation—San Andres
Frac Fluid—6000 gallons
Acid—5000 gallons 15 percent HCL
100 mesh—4000 pounds
Rate—2-4 BPM
31 wells were treated

Production (total)

Before	260 BOPD plus 2122 BWPD
Initial	345 BOPD plus 2419 BWPD
90 Days	421 BOPD plus 2381 BWPD

Example No. 3

Location—West Hockley County
Formation—San Andres
Frac Fluid—8000 gallons
Acid—7250
100 Mesh—8000 pounds
Rate—3-4 BPM
6 wells were treated

Production (total)

Before	128 BOPD plus 25 BWPD
60 Days	200 BOPD plus 40 BWPD

CONCLUSION

It has been proven in the field that the use of inert pads with 100-mesh sand improves acid efficiency by controlling leakoff. This allows deeper penetration of live acid, giving longer etched fractures. Table 1 summarizes these treatments.

BIBLIOGRAPHY

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2. Thompson, J.C.: *The Theory, Methods of Application and Results of the Use of 100 Mesh Sand in Stimulating Permian Basin Formations.*

TABLE 1—WELL RESULTS

FORMATION	COUNTY	TREATMENTS			BEFORE		INITIAL		30 DAY		60 DAY		90 DAY		180 DAY	
		20% HCL (GAL)	100 MESH (LBS)	GELLED WATER (GAL)	OIL	WTR	OIL	WTR	OIL	WTR	OIL	WTR	OIL	WTR	OIL	WTR
San Andres	Hockley	6000	9000	15000	9	74	23	68	24	83	34	71	26	76	24	69
San Andres	Cochran	6000	12000	15000	13	63	24	77	18	83	27	79	27	76	29	108
San Andres	Hockley	6000	10000	15000	16	94	29	307	37	488	36	220				
San Andres	Hockley	6000	12000	15000	26	22	44	180	60	156	72	164	52	164		
San Andres	Hockley	6000	20000	15000	6	54	22	58	22	73	20	56	21	66		
San Andres	Cochran	10000	12000	20000	3	63	17	72	14	67	19	69	13	70		
San Andres	Terry	6000	9000	15000	5	58	16	68	16	68	10	74	9	79	10	77
San Andres	Hockley	6000	9000	15000	9	31	19	81	22	73	20	56	21	66	21	60
San Andres	Hockley	6000	9000	15000	10	62	20	51	20	51	17	43	15	60	23	39
San Andres	Hockley	6000	9000	15000	12	74	7	81	26	71	21	72	21	71	17	74
San Andres	Hockley	6000	9000	15000	7	53	10	80	10	80	13	73	14	68	10	88
San Andres	Hockley	6000	9000	15000	8	79	9	91	15	85	13	86	10	79	10	74
Kingdom ABO	Terry	80000	32000	32000	60	TR	200	20	200	20	200	20	170	5	100	TR
Clearfork	Hale	15000*	13500	20000	35	100			65	240						

*15% HCL