TBC-BRINADD

A DIVISION OF TEXAS UNITED CHEMICAL COMPANY, LLC

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Bridgesal-Ultra™ System

DESCRIPTION

The **Bridgesal-Ultra** System is composed of two basic products, **Bridgesal-Ultra** and **Bridgesal-Ultra SF**. These new products are improvements of the popular **Bridgesal-Plus** completion and workover fluids. Incorporating an increased concentration of bridging particles below 10 microns in combination with broad particle distributions of 120 and 325 mesh, the **Bridgesal-Ultra** products are able to provide improved filtrate control with a significant reduction in polymer levels.

Recognized throughout the world as the premier fluid loss control system, the new **Bridgesal-Ultra** and **Bridgesal-Ultra SF** can be used for:

- Lost circulation pills
- Perforating fluid loss pills
- Pre/post gravel pack fluid loss pills
- Sealing annular leaks in casing

Normally, the **Bridgesal-Ultra** products are mixed in saturated sodium chloride brine, but they can also be used with potassium chloride, calcium chloride, and sodium bromide as long as the base brine is saturated with respect to sodium chloride. **Bridgesal-Ultra** and **Bridgesal-Ultra SF** fluid densities range from 10.5 lb/gal to 13.5 lb/gal depending on the base brine and concentration of bridging solids utilized. **Bridgesal-Ultra** products are packaged in 50 lb or 25 kg sacks.

FEATURES

- Blended salt products contained in the **Bridgesal-Ultra SF** and **Bridgesal-Ultra** products provide optimized broad particle distributions for reduction in polymer concentrations, and improved sealing characteristics over a wide range of reservoir permeabilities
- **Bridgesal-Ultra** products when combined with **Plug-Sal®**, **Plug-Sal X** and **Plug-Sal XC**, generate a series of overlapping particle distributions which provide formulating flexibility to meet formation requirements in lost circulation applications
- **Bridgesal-Ultra SF** particle sizing allows not only the sealing of a permeable formation, but also permits removal through a 6 or higher gauge production or tell-tale screen
- Incorporates a patented derivatized starch/biopolymer combination for outstanding rheological and suspension properties to prevent settling at bottom hole temperatures up to 275°F with the addition of **pH Buffer**
- This polymer combination creates a unique synergistic effect creating an optimum viscosity profile giving **Bridgesal-Ultra** long-term suspension stability
- Upper temperature limit is extended to 325°F by including **Thermasal™-A** and **Thermasal-B** with **Polytex AHT** in system compositions
- Improved bridging/filtration control results in thin, ultra-low permeability filter cakes
- Compatible with **Ultra Breake M™**, the patented internal breaker system for filter cake removal

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Bridgesal-Ultra™ System Products

PRODUCT	COMPONENTS	FUNCTIONS
Bridgesal-Ultra SF	Xanthan gum biopolymer, derivatized starch, sized NaCl blend (44 microns)	One-sack lost circulation treatment
Bridgesal-Ultra	Xanthan gum biopolymer, derivatized starch, sized NaCl blend (120 microns)	One-sack lost circulation treatment
FL-7 Plus™	Derivatized starch	Fluid loss control additive
Plug-Sal® **Plug-Sal X** **Plug-Sal XC**	Medium to coarse NaCl	Bridging/lost circulation additives
pH Buffer	Magnesia compound	Buffer to maintain alkaline pH
Thermasal™-A **Thermasal-B**	Anhydrous salt and magnesia compound	Two component thermal stabilizing system
Polytex AHT	Polymer blend	High temperature fluid loss control additive

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Bridgesal-Ultra™ SF COMPOSITIONS MIXED IN SATURATED SODIUM CHLORIDE BRINE

Formation Permeabilities up to 2000 mD

COMPOSITION	TEMPERATURE, °F		
	150	200	250
Saturated NaCl Brine, bbl	0.90	0.88	0.87
Bridgesal-Ultra SF, lb/bbl	50.0	50.0	60.0
FL-7 Plus™, lb/bbl	-	3.0	3.0
pH Buffer, lb/bbl	3.0	5.0	5.0
Ultrasal™ 10E, lb/bbl	30.0	40.0	30.0
Final Density, lb/gal	10.8	10.8	11.0

In-Screen Pill up to 250°F (6 or 8 Gauge)

Saturated NaCl Brine, bbl	0.83
Bridgesal-Ultra SF, lb/bbl	60.0
pH Buffer, lb/bbl	2.0
Ultrasal 10E, lb/bbl	20.0
Plug-Sal®, lb/bbl	50.0
Final Density, lb/gal	11.4

- If the bottom hole temperature is above 250°F, contact a TBC-Brinadd representative for the appropriate recommendation.

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Bridgesal-Ultra™ SF COMPOSITIONS MIXED IN CALCIUM CHLORIDE BRINE

Formation Permeabilities up to 2000 mD and 250°F

$CaCl_2$ Brine Density, lb/gal	9.0	10.0	10.7
$CaCl_2$ Brine, bbl	0.85	0.90	0.95
Evaporated NaCl, lb/bbl	100.0	40.0	20.0
Bridgesal-Ultra SF, lb/bbl	50.0	50.0	50.0
pH Buffer, lb/bbl	5.0	5.0	5.0
Final Density, lb/gal	10.75	10.9	11.4

In-Screen Pill up to 250°F (6 or 8 Gauge)

$CaCl_2$ Brine Density, lb/gal	9.0	10.0	10.7
$CaCl_2$ Brine, bbl	0.72	0.78	0.80
Evaporated NaCl, lb/bbl	100.0	40.0	40.0
Bridgesal-Ultra SF, lb/bbl	60.0	60.0	60.0
pH Buffer, lb/bbl	5.0	5.0	5.0
Plug-Sal®, lb/bbl	60.0	60.0	60.0
Final Density, lb/gal	11.4	11.6	12.2

- If the bottom hole temperature is above 250°F, contact a TBC-Brinadd representative for the appropriate recommendation.

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Bridgesal-Ultra™ COMPOSITIONS FOR BRIDGING COARSE SAND OR GRAVEL

Media	Formulation
40/60 Sand	50-60 lb/bbl **Bridgesal-Ultra** 40-50 lb/bbl **Plug-Sal®**
20/40 Sand	50-65 lb/bbl **Bridgesal-Ultra** 50-75 lb/bbl **Plug-Sal**
16/30 Gravel	50-65 lb/bbl **Bridgesal-Ultra** 45-50 lb/bbl **Plug-Sal** 40-55 lb/bbl **Plug-Sal X**
12/20 Gravel	50-60 lb/bbl **Bridgesal-Ultra** 40-50 lb/bbl **Plug-Sal** 50-60 lb/bbl **Plug-Sal X**
8/20 Gravel	50-65 lb/bbl **Bridgesal-Ultra** 50-60 lb/bbl **Plug-Sal** 40-70 lb/bbl **Plug-Sal X**

Note: Formulations contain the bridging solids concentrations necessary to seal the designated media up to 150°F. Contact a TBC-Brinadd representative for the proper recommendation above this temperature.

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Bridgesal-Ultra™ System

MIXING PROCEDURE:

Before adding **Bridgesal-Ultra** or **Bridgesal-Ultra SF**, the base brine must be saturated with respect to sodium chloride to prevent the bridging salt from being dissolved. Refer to the sodium chloride saturation tables referenced below.

SODIUM CHLORIDE BASE BRINE	TABLE B: NaCl and fresh water
POTASSIUM CHLORIDE BASE BRINE	TABLE F and G: NaCl and KCl brine
CALCIUM CHLORIDE BASE BRINE	TABLE I and J: NaCl and $CaCl_2$ brine
SODIUM BROMIDE BASE BRINE	TABLE M: NaBr and NaCl brine

THE FOLLOWING INSTRUCTIONS ARE FOR MIXING ONLY; PLEASE CONTACT A TBC-BRINADD REPRESENTATIVE FOR THE PROPER RECOMMENDATION.

1. Start with the desired amount of base brine in the slugging pit or mixing tank.
2. Add the prescribed amount of evaporated sodium chloride (for saturation) through a hopper at 1-2 minutes per sack; agitate until the desired density is reached.
3. Add recommended defoaming agent as needed. Normally 1/2 can (2.5 gal) of **Defoam 2** for every 20 bbl of pill is sufficient.
4. Add prescribed amount of **Bridgesal-Ultra** or **Bridgesal-Ultra SF** through a hopper at 3-4 minutes per sack.
5. If necessary, add recommended concentration of **FL-7 Plus™** through a hopper at 8-10 minutes per sack.
6. Add 2-5 lb/bbl of **pH Buffer** through a hopper at 3-4 minutes per sack.
7. Allow the pill to agitate for 30-45 minutes prior to pumping downhole.
8. For moderate lost circulation or post gravel pack in-screen pills, add the prescribed amount of **Plug-Sal®** through a hopper at 1-2 minutes per sack.
9. For severe lost circulation, add the prescribed amount of **Plug-Sal** and **Plug-Sal X** through a hopper at 1-2 minutes per sack.

10. Allow the pill to agitate for 10 -15 minutes prior to pumping downhole.

    - **If a hopper is not available, add all products at maximum agitation while circulating through a pump.**

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Hysal™ System

DESCRIPTION

The **Hysal** System utilizes either sized sodium chloride or calcium carbonate bridging particles for lost circulation pill applications requiring fluid densities above 12.5 lb/gal. The **Hysal** System is composed of four basic products, **Hysal SF, Hysal HD** and **Hysal HT** with sodium chloride bridging solids, and **Hysal C** with calcium carbonate.

The **Hysal** System can be used for:

- Lost circulation pills
- Perforating fluid loss pills
- Pre/post gravel pack fluid loss pills

Hysal products may be formulated in calcium chloride, calcium bromide and/or zinc bromide mixtures. **Hysal** is packaged in 50 lb or 25 kg sacks.

FEATURES

- Applicable across a broad range of fluid densities
- Provides effective bridging and temporary plugging of productive formations and flows easily through wire-wrapped production or tell-tale screens during displacement
- Can be used to seal inside a completion screen to prevent losses with the addition of larger bridging particles
- Incorporates a unique combination of derivatized starch, buffer, and bridging solids which provides excellent filtration control up to 250°F

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Hysal™ System Products

PRODUCT	COMPONENTS	FUNCTIONS
Hysal SF	Derivatized starch, low reactivity alkaline buffer, sized NaCl (44 microns)	One-sack lost circulation treatment
Hysal HD	Derivatized starch, high reactivity alkaline buffer, sized NaCl (44 microns)	One-sack lost circulation treatment
Hysal HT	Derivatized starch, sized NaCl (44 microns)	Lost circulation treatment for higher temperatures
Hysal C	Derivatized starch, low reactivity alkaline buffer, sized $CaCO_3$ (65 microns)	One-sack lost circulation treatment
Hysal Activator	Glycol mixture	Polar additive
Alka Buff™-Hi	High reactivity alkaline buffer	Stabilizer for zinc bromide brines
pH Buffer	Low reactivity alkaline buffer	Stabilizer for calcium bromide brines
Thermasal™-B	High reactivity alkaline buffer	Stabilizer for higher temperatures
Plug-Sal® **Plug-Sal X** **Plug-Sal XC**	Medium to coarse NaCl	Bridging/lost circulation additives
Sluggit® **Sluggit CM** **Sluggit Plus**	Medium to coarse $CaCO_3$	Bridging/lost circulation additives

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Hysal™ System

MIXING PROCEDURE:

Hysal C, Hysal HD, Hysal HT and **Hysal SF** are fluid loss control additives that are designed for use in high-density brines (12.5 - 18.5 lb/gal).

THE FOLLOWING INSTRUCTIONS ARE FOR MIXING ONLY; PLEASE CONTACT A TBC-BRINADD REPRESENTATIVE FOR THE PROPER RECOMMENDATION.

12.5-16.0 lb/gal

1. Add 0.5 gal/bbl of **Hysal Activator** to the prescribed amount of base brine.
2. Add 100 lb/bbl of **Hysal C, Hysal SF** or **Hysal HT** at 3-5 minutes per sack through a hopper.
3. Add recommended concentration of **Thermasal™-B** at 5 minutes per sack through a hopper.
4. Allow the slurry to mix, circulating through a choke to generate temperature, for approximately four hours.
5. Add recommended concentration of **Ultrasal™** products for base brine and bottom hole temperature solubility at 5 minutes per sack through a hopper.
6. For moderate lost circulation or post gravel pack in-screen pills, add the prescribed amount of **Plug-Sal®** through a hopper at 1-2 minutes per sack.
7. For severe lost circulation, add the prescribed amount of **Plug-Sal** and **Plug-Sal X** through a hopper at 1-2 minutes per sack.

16.0-17.5 lb/gal

1. Add 0.5 gal/bbl of **Hysal Activator** to the prescribed amount of base brine.
2. Add 100 lb/bbl of **Hysal HD** or **Hysal HT** at 3-5 minutes per sack through a hopper.
3. Add recommended concentration of **Thermasal-B**, or **Alka Buff™ Hi** at 5 minutes per sack through a hopper.

4. Allow the slurry to mix, circulating through a choke to generate temperature, for approximately four hours.

5. Add recommended concentration of **Ultrasal™** products for base brine and bottom hole temperature solubility at 5 minutes per sack through a hopper.

6. For moderate lost circulation or post gravel pack in-screen pills, add the prescribed amount of **Plug-Sal®** through a hopper at 1-2 minutes per sack.

7. For severe lost circulation, add the prescribed amount of **Plug-Sal** and **Plug-Sal X** through a hopper at 1-2 minutes per sack.

17.5-18.5 lb/gal

NOTE*: Formulations from 17.5 lb/gal to 18.5 lb/gal should be verified by laboratory testing*.

- **If a hopper is not available, add all products at maximum agitation while circulating through a pump.**

- **If the BHT is above 200°F or 14.5 lb/gal, a TBC-BRINADD representative should be contacted for an appropriate recommendation.**

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GENERAL GUIDELINES FOR APPLICATION OF TBC-BRINADD WATER-SOLUBLE BRIDGING PARTICLE SYSTEMS

1. If you have any questions concerning a particular application, please call your TBC-Brinadd representative for the proper recommendation.

2. Always saturate the base brine prior to adding **Bridgesal-Ultra™** or **Bridgesal-Ultra SF**. This is done by adding the prescribed amounts of evaporated sodium chloride and/or **Ultrasal™ 10E**.

3. Saturated brine spacers should be used preceding and following **Bridgesal-Ultra** or **Bridgesal-Ultra SF** pills to prevent the dissolving of sodium chloride bridging particles during placement.

4. Should it be necessary to use **Plug-Sal®** or **Plug-Sal X** to seal formations or gravel pack sand with larger pore sizes, the pill in the casing should be displaced with **Bridgesal-Ultra SF, Hysal™ SF, Hysal HD** or **Hysal HT** prior to placement of a gravel pack assembly.

5. When bridging the inside of a gravel pack screen, add the following products to **Bridgesal-Ultra/Bridgesal-Ultra SF** or **Hysal SF/Hysal HD/Hysal HT**.

   A. 6 or 8 Gauge: **Plug-Sal**
   B. 12 Gauge: **Plug-Sal and Plug-Sal X**

6. If a **Bridgesal-Ultra/Bridgesal-Ultra SF** pill is placed across a production zone above a less dense low salinity/unsaturated brine in the rat hole, the heavier pill will migrate downward displacing the less dense, low salinity solution upward. As the unsaturated brine reaches the perforations it will dissolve the sodium chloride bridging particles allowing water to be lost to the formation.

7. Use **pH Buffer** with all calcium chloride brines.

8. If a pill does not adequately stop your fluid loss problem or prematurely breaks down, please contact your TBC-Brinadd representative.

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Bridgecarb-Ultra™ System

DESCRIPTION

The **Bridgecarb-Ultra** System utilizes sized calcium carbonate particles for pill applications requiring fluid densities below 10.5 lb/gal or where a calcium carbonate system is preferred. The **Bridgecarb-Ultra** System is composed of two basic products, **Bridgecarb-Ultra** and **Bridgecarb-Ultra Fine**. Incorporating an increased concentration of bridging particles below 10 microns in combination with broad particle distributions, the **Bridgecarb-Ultra** products are able to provide improved filtrate control with a significant reduction in polymer levels.

The new **Bridgecarb-Ultra** and **Bridgecarb-Ultra Fine** can be used for:

- Lost circulation pills
- Perforating fluid loss pills
- Pre/post gravel pack fluid loss pills
- Sealing annular leaks in casing

The **Bridgecarb-Ultra** products may be mixed in potassium chloride, sodium chloride, calcium chloride, and sodium bromide brines. **Bridgecarb-Ultra** and **Bridgecarb-Ultra Fine** fluid densities range from 9.0 lb/gal to 13.5 lb/gal depending on the base brine and concentration of bridging solids utilized. **Bridgecarb-Ultra** products are packaged in 50 lb or 25 kg sacks.

FEATURES

- Applicable across a broad range of fluid densities
- Blended calcium carbonate products contained in the **Bridgecarb-Ultra** and **Bridgecarb-Ultra Fine** products provide optimized broad particle distributions for reduction in polymer concentrations, and improved sealing characteristics over a wide range of reservoir permeabilities
- **Bridgecarb-Ultra** products when combined with **Sluggit®, Sluggit CM and Sluggit Plus,** generate a series of overlapping particle distributions which provide formulating flexibility to meet formation requirements in lost circulation applications
- Incorporates a proprietary derivatized starch/biopolymer combination for outstanding rheological and suspension properties to prevent settling at bottom hole temperatures up to 250°F
- This polymer combination creates a unique synergistic effect creating an optimum viscosity profile giving **Bridgecarb-Ultra** long-term suspension stability
- Improved bridging/filtration control results in thin, ultra-low permeability filter cakes
- Compatible with **Ultra Breake M™**, the patented internal breaker system for filter cake removal

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Bridgecarb-Ultra™ System Products

PRODUCT	COMPONENTS	FUNCTIONS
Bridgecarb-Ultra Fine	Xanthan gum biopolymer, derivatized starch, magnesia compound, sized calcium carbonate (63 microns)	One-sack lost circulation treatment
Bridgecarb-Ultra	Xanthan gum biopolymer, derivatized starch, magnesia compound, sized calcium carbonate (106 microns)	One-sack lost circulation treatment
FL-7 Plus™	Derivatized starch	Fluid loss control additive
Sluggit® **Sluggit CM** **Sluggit Plus**	Medium to coarse calcium carbonate	Bridging/lost circulation additives
pH Buffer	Magnesia compound	Buffer to maintain alkaline pH
Defoam 2	Water miscible glycol mixture	Defoamer
Ultra Breake M™	Magnesium peroxide	Internal filter cake breaker

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Bridgecarb-Ultra™ System

MIXING PROCEDURE:

Refer to the brine tables prior to mixing the **Bridgecarb-Ultra** or **Bridgecarb-Ultra Fine** Systems.

SODIUM CHLORIDE BASE BRINE	TABLE B: NaCl and fresh water
POTASSIUM CHLORIDE BASE BRINE	TABLE F: KCl and fresh water
CALCIUM CHLORIDE BASE BRINE	TABLE I: $CaCl_2$ and fresh water
SODIUM BROMIDE BASE BRINE	TABLE O: NaBr and fresh water

THE FOLLOWING INSTRUCTIONS ARE FOR MIXING ONLY; PLEASE CONTACT A TBC-BRINADD REPRESENTATIVE FOR THE PROPER RECOMMENDATION.

1. Start with the desired amount of base brine in the slugging pit or mixing tank.
2. Add recommended defoaming agent as needed. Normally 1/2 can (2.5 gal) of **Defoam 2** for every 20 bbl of pill is sufficient.
3. Add prescribed amount of **Bridgecarb-Ultra** or **Bridgecarb-Ultra Fine** through a hopper at 3-4 minutes per sack.
4. If necessary, add recommended concentration of **FL-7 Plus**™ through a hopper at 8-10 minutes per sack.
5. Allow the pill to agitate for 30-45 minutes prior to pumping downhole.
6. For moderate lost circulation or post gravel pack in-screen pills, add the prescribed amount of **Sluggit®** through a hopper at 1-2 minutes per sack.
7. For severe lost circulation, add the prescribed amount of **Sluggit**, **Sluggit CM** and **Sluggit Plus** through a hopper at 1-2 minutes per sack.
8. Allow the pill to agitate for 10-15 minutes prior to pumping downhole.

- **If a hopper is not available, add all products at maximum agitation while circulating through a pump.**

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PBS Plug™ System

DESCRIPTION

PBS Plug is a surface-mixed, pumpable plugging material, formulated to provide a rigid crosslinked gel structure. **PBS Plug 500** and **PBS Plug 2000** contain sized particles of borate–containing minerals and special polymers which provide formulating flexibility to meet various formation requirements in lost circulation applications. **PBS Plug Activator** a salt/magnesia compound, serves as a crosslink catalyst when mixed with **PBS Plug**. Also, calcium chloride may be used as a secondary accelerator in cold-water applications, or to increase rigidity of the plug. The polymers in the base product add viscosity and filtration control and are crosslinked by the borate anion in the sparingly water-soluble borate. The catalysts initiate the crosslink reaction by raising the pH and salinity of the fresh water mixture. This reaction is accelerated by the normally higher temperature in the wellbore. **PBS Plug Retarder** and **PBS Plug Activator-E** are used to delay the set, increase the available pumping time, and broaden the window of possible applications. **PBS Plug Activator-E** is especially useful for mixes where the base water is above 100° F. **PBS Plug** products are packaged in 25 kg sacks.

APPLICATIONS

PBS Plug is a unique system whose main application is the control of lost circulation. The combination of **PBS Plug** and **PBS Plug Activator** satisfies the requirements for the majority of extreme lost circulation situations where anything from induced fractures to total losses are experienced. The final consistency of the **PBS Plug** also allows it to be easily drilled after the chemical setting reaction has been completed. Calcium chloride may also be added as a secondary accelerator to modify the **PBS Plug** shear strength for the following applications:

- Lost circulation pill
- Open hole cement retainer
- Pre-cement pad
- Profile modification
- Formation consolidating gel

The base density for 100 lb/bbl of **PBS Plug** is 10.1 lb/gal but weights up to 17.0 lb/gal can be achieved with the addition of barite or other inert weighting material.

ADVANTAGES

PBS Plug offers the following advantages:

- Provides excellent fluid loss control
- Seals high permeability and fractured formations
- Does not shrink
- Exhibits high shear strength
- Bonds tightly to the formation
- Can be spotted through mud motors and bit nozzles
- Utilizes standard mixing equipment

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PBS Plug™ System Products

PRODUCT	COMPONENTS	FUNCTIONS
PBS Plug 500	Blend of polymers and 500 micron borate mineral	Viscosity, filtration control, bridging
PBS Plug 2000	Blend of polymers and 2000 micron borate mineral	Viscosity, filtration control, bridging
PBS Plug Activator	Blend of salt and magnesia compound	Primary crosslink catalyst
PBS Plug Activator-E	Blend of encapsulated salt and magnesia compound	Delayed crosslink catalyst
PBS Plug Retarder	Magnesium salt	Crosslink retarder, thinner
Calcium Chloride	94-97% $CaCl_2$	Secondary crosslink catalyst

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PBS Plug™ System

MIXING PROCEDURE:

THE FOLLOWING INSTRUCTIONS ARE FOR MIXING ONLY; PLEASE CONTACT A TBC-BRINADD REPRESENTATIVE FOR THE PROPER RECOMMENDATION.

1. Ensure all lines and tanks are washed and clean of any acid or caustic soda.

2. Add the calculated volume of fresh water and verify a neutral pH.

3. If recommended, add the **PBS Plug Retarder** through a hopper and be sure it dissolves before additional products are added to the mixture.

4. Add the recommended amount of **PBS Plug 500** or **PBS Plug 2000** through a hopper at approximately 3 minutes per sack.

5. Allow the **PBS Plug** slurry to mix for a minimum of 30 minutes.

6. If applicable, add weighting material (barite) through a hopper at 1-2 minutes per sack.

7. Immediately prior to pumping, add the **PBS Plug Activator**.

NOTE: DO NOT ADD THIS PRODUCT UNTIL IT IS KNOWN THE PILL WILL BE NEEDED.

8. If required, add calcium chloride pellets through a hopper at 1-2 minutes per sack.

CAUTION: THIS PILL BEGINS TO SET IMMEDIATELY; IT SHOULD BE HANDLED SIMILARLY TO CEMENT SLURRIES.

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TABLE A

PROPERTIES OF SODIUM CHLORIDE SOLUTIONS

Density, 70°F		Specific Gravity	NaCl wt %	Sodium wt %	Chloride wt %
lb/gal	lb/cu ft				
8.4	62.95	1.008	1.04	0.41	0.63
8.5	63.70	1.020	2.66	1.05	1.62
8.6	64.45	1.032	4.44	1.75	2.69
8.7	65.20	1.044	6.01	2.36	3.65
8.8	65.95	1.056	7.53	2.96	4.57
8.9	66.70	1.068	9.22	3.62	5.59
9.0	67.45	1.080	10.74	4.22	6.52
9.1	68.20	1.092	12.36	4.86	7.50
9.2	68.95	1.104	13.91	5.47	8.44
9.3	69.70	1.116	15.54	6.11	9.43
9.4	70.45	1.128	17.05	6.70	10.35
9.5	71.20	1.140	18.51	7.28	11.23
9.6	71.95	1.152	19.96	7.85	12.11
9.7	72.70	1.164	21.53	8.46	13.07
9.8	73.45	1.176	22.99	9.04	13.95
9.9	74.20	1.188	24.36	9.58	14.78
10.0	74.95	1.200	25.69	10.10	15.59

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TABLE B

PREPARATION OF SODIUM CHLORIDE SOLUTIONS FROM DRY SODIUM CHLORIDE AND FRESH WATER

Density, 70°F lb/gal	COMPOSITION FOR ONE BARREL	
	NaCl 99% lb	Water bbl
8.4	3.7	0.998
8.5	9.6	0.993
8.6	16.2	0.986
8.7	22.2	0.981
8.8	28.1	0.976
8.9	34.8	0.969
9.0	41.0	0.962
9.1	47.7	0.955
9.2	54.3	0.948
9.3	61.3	0.940
9.4	68.0	0.933
9.5	74.6	0.926
9.6	81.3	0.919
9.7	88.6	0.910
9.8	95.6	0.902
9.9	102.3	0.895
10.0	109.0	0.890

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TABLE C

DENSITY INCREASE OF FIELD WATER

Final desired weight, lb/gal	Weight of Field Water – lb/gal																
	8.33	8.5	8.6	8.7	8.8	8.9	9.0	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	9.9	10.0
					Per Cent 10.0 lb/gal Sodium Chloride Brine Required												
8.33	0																
8.5	10	0															
8.6	16	7	0														
8.7	22	14	7	0													
8.8	28	20	14	8	0												
8.9	34	27	21	15	8	0											
9.0	40	34	28	23	16	9	0										
9.1	46	40	36	31	25	18	10	0									
9.2	52	47	43	38	33	27	20	11	0								
9.3	58	54	50	46	41	36	30	22	12	0							
9.4	64	60	57	54	50	45	40	33	25	14	0						
9.5	70	67	64	61	58	54	50	44	37	28	16	0					
9.6	76	74	71	69	66	63	60	55	50	43	33	20	0				
9.7	82	80	78	77	75	73	70	66	62	57	50	40	25	0			
9.8	88	87	85	84	83	82	80	78	75	72	67	60	50	33	0		
9.9	94	93	93	92	92	91	90	89	88	86	84	80	75	67	50	0	
10.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

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TABLE D

SODIUM CHLORIDE SOLUBILITY IN 10.0 lb/gal NaCl BRINE AT VARIOUS TEMPERATURES

Temperature, °F	Sodium Chloride Solubility, lb/bbl
72	0
200	10
250	14
300	18
350	26
400	38

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TABLE E

PROPERTIES OF POTASSIUM CHLORIDE SOLUTIONS

Density, 70 °F		Specific Gravity	KCl wt %	Potassium wt %	Chloride wt %
lb/gal	lb/cu ft				
8.4	62.95	1.008	1.21	0.63	0.57
8.5	63.70	1.020	3.22	1.69	1.53
8.6	64.45	1.032	5.21	2.73	2.48
8.7	65.20	1.044	7.04	3.69	3.35
8.8	65.95	1.056	8.95	4.69	4.25
8.9	66.70	1.068	10.86	5.70	5.16
9.0	67.45	1.080	12.49	6.55	5.94
9.1	68.20	1.092	14.43	7.57	6.86
9.2	68.95	1.104	16.06	8.43	7.64
9.3	69.70	1.116	17.59	9.23	8.36
9.4	70.45	1.128	19.26	10.10	9.16
9.5	71.20	1.140	20.87	10.94	9.92
9.6	71.95	1.152	22.47	11.78	10.68
9.7	72.70	1.164	23.96	12.57	11.39

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TABLE F

PREPARATION OF POTASSIUM CHLORIDE SOLUTIONS FROM DRY POTASSIUM CHLORIDE AND FRESH WATER

Density, 70°F lb/gal	COMPOSITION FOR ONE BARREL	
	KCl 99% lb	Water bbl
8.4	4.3	0.995
8.5	11.6	0.986
8.6	19.0	0.977
8.7	26.0	0.970
8.8	33.4	0.960
8.9	41.0	0.950
9.0	47.7	0.943
9.1	55.7	0.932
9.2	62.7	0.924
9.3	69.4	0.917
9.4	76.8	0.908
9.5	84.1	0.898
9.6	91.5	0.890
9.7	98.6	0.882

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TABLE G

SODIUM CHLORIDE REQUIRED TO SATURATE POTASSIUM CHLORIDE BRINES FOR ONE BARREL OF A SATURATED SOLUTION

KCl Brine		KCl Brine bbl	NaCl lb/bbl
Density lb/gal	KCl wt %		
8.4	1.21	0.89	107
8.5	3.22	0.89	105
8.6	5.21	0.89	103
8.7	7.04	0.89	101
8.8	8.95	0.89	99
8.9	10.86	0.90	95
9.0	12.49	0.90	86

CAUTION: KCl brines with densities greater than 9.0 lb/gal cannot be saturated with respect to NaCl without precipitating KCl.

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TABLE H

PROPERTIES OF CALCIUM CHLORIDE SOLUTIONS

Density, 70°F		Specific Gravity	$CaCl_2$ wt %	Calcium wt %	Chloride wt %
lb/gal	lb/cu ft				
8.4	62.94	1.008	1.03	0.37	0.66
8.5	63.69	1.020	2.04	0.74	1.31
8.6	64.44	1.032	3.35	1.21	2.14
8.7	65.19	1.044	5.07	1.83	3.24
8.8	65.94	1.056	6.00	2.17	3.83
8.9	66.69	1.068	7.55	2.73	4.82
9.0	67.44	1.080	8.86	3.20	5.66
9.1	68.19	1.092	10.20	3.68	6.51
9.2	68.94	1.104	11.53	4.16	7.36
9.3	69.69	1.116	12.80	4.62	8.18
9.4	70.44	1.128	14.05	5.08	8.98
9.5	71.19	1.140	15.35	5.54	9.81
9.6	71.94	1.152	16.62	6.00	10.62
9.7	72.69	1.164	17.81	6.43	11.38
9.8	73.44	1.176	18.99	6.86	12.13
9.9	74.18	1.188	20.20	7.30	12.91
10.0	74.93	1.200	21.39	7.73	13.67
10.1	75.68	1.212	22.54	8.14	14.40
10.2	76.43	1.224	23.64	8.54	15.10
10.3	77.18	1.236	24.81	8.96	15.85
10.4	77.93	1.248	25.93	9.37	16.57
10.5	78.68	1.261	26.97	9.74	17.23
10.6	79.43	1.273	27.97	10.10	17.87
10.7	80.18	1.285	28.84	10.41	18.42
10.8	80.93	1.297	29.67	10.72	18.96
10.9	81.68	1.309	30.97	11.19	19.79
11.0	82.43	1.321	32.25	11.65	20.60
11.1	83.18	1.333	33.19	11.99	21.21
11.2	83.93	1.345	34.10	12.32	21.79
11.3	84.68	1.357	35.14	12.69	22.45
11.4	85.42	1.369	36.15	13.06	23.09
11.5	86.17	1.381	37.03	13.37	23.66
11.6	86.92	1.393	37.89	13.68	24.21

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TABLE I

PREPARATION OF CALCIUM CHLORIDE SOLUTIONS FROM DRY CALCIUM CHLORIDE AND FRESH WATER

Density lb/gal	COMPOSITION FOR ONE BARREL	
	$CaCl_2$ 94 - 97% lb	Water bbl
8.4	3.8	0.998
8.5	7.6	0.996
8.6	12.6	0.992
8.7	19.3	0.988
8.8	23.1	0.986
8.9	29.4	0.984
9.0	34.9	0.977
9.1	40.6	0.973
9.2	46.4	0.969
9.3	52.1	0.965
9.4	57.8	0.961
9.5	63.8	0.956
9.6	69.8	0.952
9.7	75.6	0.947
9.8	81.4	0.943
9.9	87.5	0.937
10.0	93.6	0.932
10.1	99.6	0.927
10.2	105.5	0.923
10.3	111.8	0.917
10.4	118.0	0.912
10.5	123.9	0.906
10.6	129.7	0.901
10.7	135.0	0.896
10.8	140.2	0.892
10.9	147.7	0.886
11.0	155.2	0.880
11.1	161.2	0.873
11.2	167.1	0.866
11.3	173.7	0.859
11.4	180.3	0.853
11.5	186.3	0.847
11.6	192.3	0.842

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TABLE J

SODIUM CHLORIDE REQUIRED TO SATURATE CALCIUM CHLORIDE BRINES FOR ONE BARREL OF A SATURATED SOLUTION

$CaCl_2$		$CaCl_2$ Brine bbl	77°F	175°F
Density lb/gal	$CaCl_2$ wt %		NaCl lb	NaCl lb
8.4	1.03	0.89	106	120
8.5	2.04	0.90	103	116
8.6	3.35	0.90	99	112
8.7	5.07	0.90	95	108
8.8	6.00	0.91	90	104
8.9	7.55	0.91	85	100
9.0	8.86	0.91	81	95
9.1	10.20	0.92	76	90
9.2	11.53	0.92	72	85
9.3	12.80	0.93	67	80
9.4	14.05	0.93	63	75
9.5	15.35	0.93	58	70
9.6	16.62	0.94	53	66
9.7	17.81	0.94	49	62
9.8	18.99	0.95	44	58
9.9	20.20	0.95	40	54
10.0	21.39	0.96	35	50
10.1	22.54	0.96	31	45
10.2	23.64	0.97	26	40
10.3	24.81	0.97	22	35
10.4	25.93	0.98	17	30
10.5	26.97	0.99	13	25
10.6	27.97	0.99	10	22
10.7	28.84	1.00	6	18
GREATER THAN 10.7	-	-	6	18

CAUTION: This data is based on theoretical calculations. The NaCl solubility values may vary as much as 10.0 lb/bbl with different sources of calcium chloride salt.

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TABLE K

DILUTION CHART FOR CALCIUM CHLORIDE BRINE

Final $CaCl_2$ Weight, lb/gal	Original $CaCl_2$ Weight, lb/gal													
	11.6		11.5		11.4		11.3		11.2		11.1		11.0	
	$CaCl_2$ bbl	**H_20 bbl**	**$CaCl_2$ bbl**	**H_20 bbl**	**$CaCl_2$ bbl**	**H_20 bbl**	**$CaCl_2$ bbl**	**H_20 bbl**	**$CaCl_2$ bbl**	**H_20 bbl**	**$CaCl_2$ bbl**	**H_20 bbl**	**$CaCl_2$ bbl**	**H_20 bbl**
10.1	54	46	56	44	58	42	59	41	62	38	64	36	66	34
10.2	57	43	59	41	61	39	63	37	65	35	67	33	70	30
10.3	60	40	62	38	64	36	66	34	69	31	71	29	74	26
10.4	63	37	65	35	68	32	70	30	72	28	75	25	77	23
10.5	66	34	68	32	71	29	73	27	76	24	73	27	81	19
10.6	69	31	72	28	74	26	76	24	79	21	82	18	85	15
10.7	72	28	75	25	77	23	80	20	83	17	85	15	89	11
10.8	75	25	78	22	81	19	83	17	86	14	89	11	92	8
10.9	78	22	81	19	84	16	87	13	90	10	93	7	96	4
11.0	81	19	84	16	87	13	90	10	93	7	96	4	100	0
11.1	85	15	88	12	90	10	93	7	97	3	100	0		
11.2	88	12	91	9	94	6	97	3	100	0				
11.3	91	9	94	6	97	3	100	0						
11.4	94	6	97	3	100	0								
11.5	97	3	100	0										
11.6	100	0							Based on 100 bbl					

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TABLE L

PROPERTIES OF SODIUM BROMIDE AND SODIUM CHLORIDE BLENDS

Density, 70°F		Specific Gravity	NaBr wt %	NaCl wt %	Sodium wt %	Bromide wt %	Chloride wt %
lb/gal	lb/cu ft						
10.0	74.95	1.200	0.00	25.69	10.10	0.00	15.59
10.1	75.70	1.212	2.21	24.42	10.09	1.71	14.82
10.2	76.44	1.224	4.37	23.17	10.09	3.39	14.06
10.3	77.19	1.236	6.49	21.95	10.08	5.04	13.32
10.4	77.94	1.248	8.57	20.75	10.07	6.65	12.59
10.5	78.69	1.261	10.61	19.58	10.07	8.24	11.88
10.6	79.44	1.273	12.61	18.42	10.06	9.79	11.18
10.7	80.19	1.285	14.58	17.29	10.06	11.32	10.49
10.8	80.94	1.297	16.51	16.18	10.05	12.82	9.82
10.9	81.69	1.309	18.40	15.09	10.04	14.29	9.15
11.0	82.44	1.321	20.26	14.01	10.04	15.73	8.50
11.1	83.19	1.333	22.08	12.96	10.03	17.15	7.87
11.2	83.94	1.345	23.87	11.93	10.03	18.54	7.24
11.3	84.69	1.357	25.63	10.91	10.02	19.91	6.62
11.4	85.44	1.369	27.36	9.92	10.01	21.25	6.02
11.5	86.19	1.381	29.06	8.94	10.01	22.57	5.42
11.6	86.94	1.393	30.73	7.97	10.00	23.87	4.84
11.7	87.69	1.405	32.38	7.03	10.00	25.14	4.26
11.8	88.44	1.417	33.99	6.10	9.99	26.39	3.70
11.9	89.19	1.429	35.58	5.18	9.99	27.63	3.14
12.0	89.94	1.441	37.14	4.28	9.98	28.84	2.60
12.1	90.68	1.453	38.67	3.40	9.98	30.03	2.06
12.2	91.43	1.465	40.18	2.53	9.97	31.20	1.53
12.3	92.18	1.477	41.67	1.67	9.97	32.35	1.01
12.4	92.93	1.489	43.13	0.83	9.96	33.49	0.50
12.5	93.68	1.501	44.56	0.00	9.96	34.60	0.00

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TABLE M

PREPARATION OF 12.5 lb/gal NaBr AND 10.0 lb/gal NaCl BLENDS

Density, 70°F lb/gal	COMPOSITION FOR ONE BARREL	
	12.5 lb/gal NaBr bbl	10.0 lb/gal NaCl bbl
10.0	0.000	1.000
10.1	0.040	0.960
10.2	0.080	0.920
10.3	0.120	0.880
10.4	0.160	0.840
10.5	0.200	0.800
10.6	0.240	0.760
10.7	0.280	0.720
10.8	0.320	0.680
10.9	0.360	0.640
11.0	0.400	0.600
11.1	0.440	0.560
11.2	0.480	0.520
11.3	0.520	0.480
11.4	0.560	0.440
11.5	0.600	0.400
11.6	0.640	0.360
11.7	0.680	0.320
11.8	0.720	0.280
11.9	0.760	0.240
12.0	0.800	0.200
12.1	0.840	0.160
12.2	0.880	0.120
12.3	0.920	0.080
12.4	0.960	0.040
12.5	1.000	0.000

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TABLE N

PROPERTIES OF SODIUM BROMIDE AND FRESH WATER BLENDS

Density, 70°F		Specific Gravity	NaBr wt %	Sodium wt %	Bromide wt %
lb/gal	lb/cu ft				
9.0	67.45	1.080	9.73	2.17	7.55
9.1	68.20	1.092	11.01	2.46	8.55
9.2	68.95	1.104	12.28	2.74	9.53
9.3	69.70	1.116	13.53	3.02	10.51
9.4	70.45	1.128	14.79	3.31	11.49
9.5	71.20	1.140	16.00	3.58	12.42
9.6	71.95	1.152	17.20	3.84	13.36
9.7	72.70	1.164	18.38	4.11	14.27
9.8	73.45	1.176	19.56	4.37	15.19
9.9	74.20	1.188	20.69	4.62	16.07
10.0	74.95	1.200	21.83	4.88	16.95
10.1	75.70	1.212	22.94	5.13	17.81
10.2	76.44	1.224	24.02	5.37	18.65
10.3	77.19	1.236	25.09	5.61	19.48
10.4	77.94	1.248	26.16	5.85	20.31
10.5	78.69	1.261	27.19	6.08	21.11
10.6	79.44	1.273	28.22	6.31	21.91
10.7	80.19	1.285	29.20	6.53	22.68
10.8	80.94	1.297	30.19	6.75	23.45
10.9	81.69	1.309	31.17	6.97	24.20
11.0	82.44	1.321	32.12	7.18	24.94
11.1	83.19	1.333	33.06	7.39	25.67
11.2	83.94	1.345	33.96	7.59	26.37
11.3	84.69	1.357	35.69	7.98	27.71
11.4	85.44	1.369	35.76	7.99	27.77
11.5	86.19	1.381	36.63	8.19	28.44
11.6	86.94	1.393	37.49	8.38	29.11
11.7	87.69	1.405	38.33	8.57	29.77
11.8	88.44	1.417	39.16	8.75	30.41
11.9	89.19	1.429	39.98	8.94	31.04
12.0	89.94	1.441	40.78	9.11	31.67
12.1	90.68	1.453	41.57	9.29	32.28
12.2	91.43	1.465	42.33	9.46	32.87
12.3	92.18	1.477	43.09	9.63	33.46
12.4	92.93	1.489	43.84	9.80	34.04
12.5	93.68	1.501	44.56	9.96	34.60

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TABLE O

PREPARATION OF 12.5 lb/gal NaBr AND FRESH WATER BLENDS

Density, 70°F	COMPOSITION FOR ONE BARREL	
	12.5 lb/gal NaBr bbl	Water bbl
9.0	0.157	0.845
9.1	0.180	0.822
9.2	0.203	0.800
9.3	0.226	0.777
9.4	0.250	0.754
9.5	0.273	0.731
9.6	0.296	0.708
9.7	0.320	0.684
9.8	0.344	0.660
9.9	0.368	0.637
10.0	0.392	0.613
10.1	0.416	0.588
10.2	0.440	0.564
10.3	0.464	0.540
10.4	0.488	0.516
10.5	0.512	0.492
10.6	0.537	0.467
10.7	0.561	0.443
10.8	0.585	0.418
10.9	0.610	0.393
11.0	0.634	0.369
11.1	0.659	0.344
11.2	0.683	0.320
11.3	0.707	0.295
11.4	0.732	0.270
11.5	0.756	0.246
11.6	0.781	0.221
11.7	0.805	0.196
11.8	0.830	0.172
11.9	0.854	0.147
12.0	0.879	0.122
12.1	0.903	0.098
12.2	0.927	0.073
12.3	0.951	0.049
12.4	0.976	0.024
12.5	1.000	0.000

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FORMULA A

MASS BALANCE

Calculations provide initial liquid fractions and concentrations of inert weighting materials (in pounds per final barrel) to achieve a final barrel of a predetermined density.

$$[(350 - X) \bullet (W_1 \div 8.33)] + (sg \bullet X) = 350 \bullet (W_2 \div 8.33)$$

Where: W_1 = initial weight (lb/gal)
W_2 = desired weight (lb/gal)
sg = specific gravity of weighting agent
X = volume gain (ml/350 ml lab bbl)

Solve for X, then:

a) (350 – X) ÷ 350 = initial liquid fraction
b) sg • X = required concentration of weighting material in lb/bbl

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FORMULA B

INITIAL LIQUID FRACTION

$$1 - (X \div Y \div 350) = Z$$

Where: X = lb/bbl of weighting materials
Y = specific gravity of material
Z = initial liquid volume fraction

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FORMULA C

COMBINING TWO FLUIDS OF KNOWN VOLUMES AND DENSITIES

$$(V_1 \bullet D_1) + (V_2 \bullet D_2) = X$$

Then,

$$X \div V_{(1+2)} = D_{(1+2)}$$

Where:
- V_1 = volume of 1st fluid
- V_2 = volume of 2nd fluid
- D_1 = density of 1st fluid
- D_2 = density of 2nd fluid
- $V_{(1+2)}$ = combined volume of both fluids
- $D_{(1+2)}$ = combined density of both fluids

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FORMULA D

FLUID DENSITY CUT-BACK

$$(W_1 - W_2) \div (W_1 - C) = X$$

Where:
- W_1 = initial density (lb/gal)
- W_2 = desired density (lb/gal)
- C = cut-back fluid density (lb/gal)
- X = fraction of cut-back fluid needed

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FORMULA E

FLUID DENSITY WEIGHT-UP

$$(W_2 - W_1) \div (H - W_1) = X$$

Where:
- W_1 = initial density (lb/gal)
- W_2 = desired density (lb/gal)
- H = high density fluid (lb/gal)
- X = fraction of cut-back fluid needed

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FORMULA F

STANDARD WEIGHT-UP FORMULA

$$[(350 \bullet sg) \bullet (W_2 - W_1)] \div [(8.33 \bullet sg) - W_2)] = X$$

And,

1 bbl volume increase = 350 • sg = lb of material

Where:
- sg = specific gravity of weighting agent
- W_1 = initial density (lb/gal)
- W_2 = desired density (lb/gal)
- X = lb of weighting material per existing bbl

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FORMULA G

FANN 35 – VISCOSITIES & SHEAR RATES

Shear Rate (sec^{-1}) = 1.703 • rpm

Viscosity (cP) = (511 • Rdg) ÷ (1.703 • rpm)

Where: Rdg = Fann 35 reading

rpm = Fann 35 speed

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FORMULA H

ANNULAR SHEAR RATES

$$ASR = (2.4 \bullet AV) \div (I.D. - O.D.)$$

Where:

ASR	=	annular shear rate (sec^{-1})
AV	=	annular velocity (ft/min)
I.D.	=	inside diameter of casing or open-hole (in.)
O.D.	=	outside diameter of drillpipe, collars, etc. (in.)

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FORMULA I

VOLUME IN RECTANGULAR TANK

$$(L \bullet W \bullet H) \div 5.61 = \text{volume (bbl)}$$

Where:
- L = Length (ft)
- W = Width (ft)
- H = Height (ft)

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FORMULA J

HOLE VOLUME

$I.D.^2 \div 1029 = \text{volume in bbl/ft}$

Where: I.D. = inside diameter (in.)

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FORMULA K

ANNULAR VOLUME

$$(I.D.^2 - O.D.^2) \div 1029 = \text{volume (bbl/ft)}$$

Where: I.D. = inside diameter of casing or open-hole (in.)
O.D. = outside diameter of drillpipe, collars, etc. (in.)

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FORMULA L

ESTIMATING QUANTITY OF SOLIDS FROM OPEN HOLE

$$(sg \bullet 62.43) \bullet [(O.H. \div 12 \div 2)^2 \bullet 3.1416 \bullet L)] = X$$

Where:
- sg = specific gravity of drill solids
- O.H. = diameter of open hole (in.)
- L = length of drilled interval (ft)
- X = estimated total pounds of solids removed

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SPECIFIC GRAVITY OF WEIGHTING AGENTS

Sodium Chloride	2.17
Calcium Carbonate	2.7
Barite	4.25
Iron Oxide	5.0
Oil Soluble Resin	1.07