Fracture Design and Stimulation – Monitoring

Well Construction & Operations technical workshop

In support of the EPA Hydraulic Fracturing Study

March 10-11, 2011,

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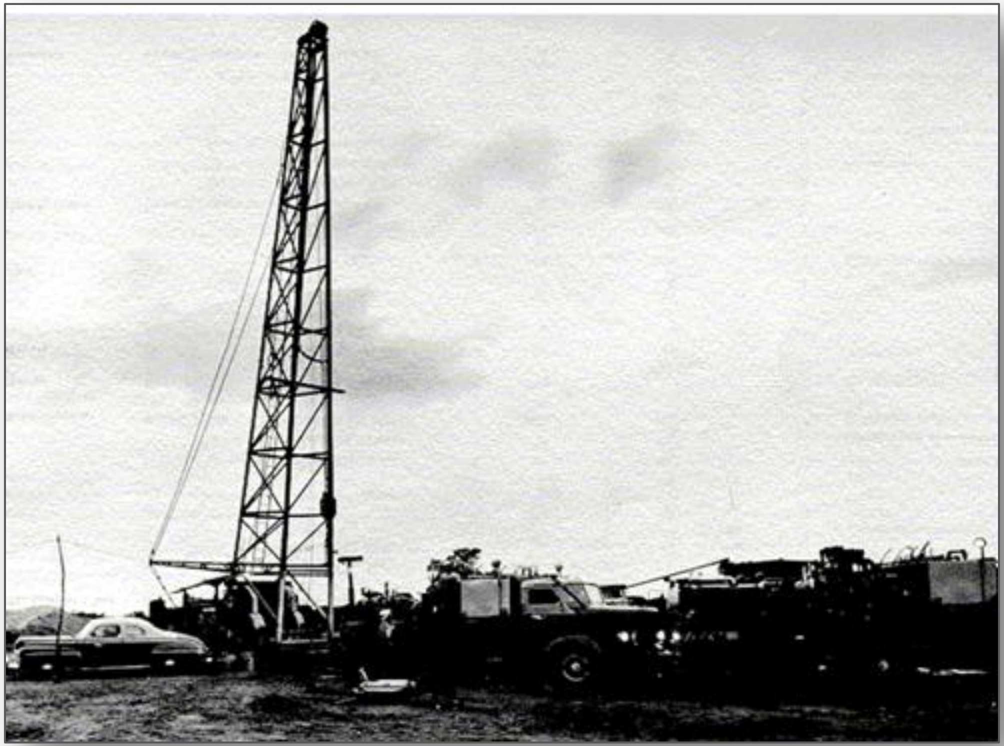
Agenda

- Well Construction
- Before the Treatment
- Well Site Rig-up
- Monitoring the Treatment
- After the Frac



July ,1947 - Stanolind Oil and Gas 1st Job: Klepper No. 1

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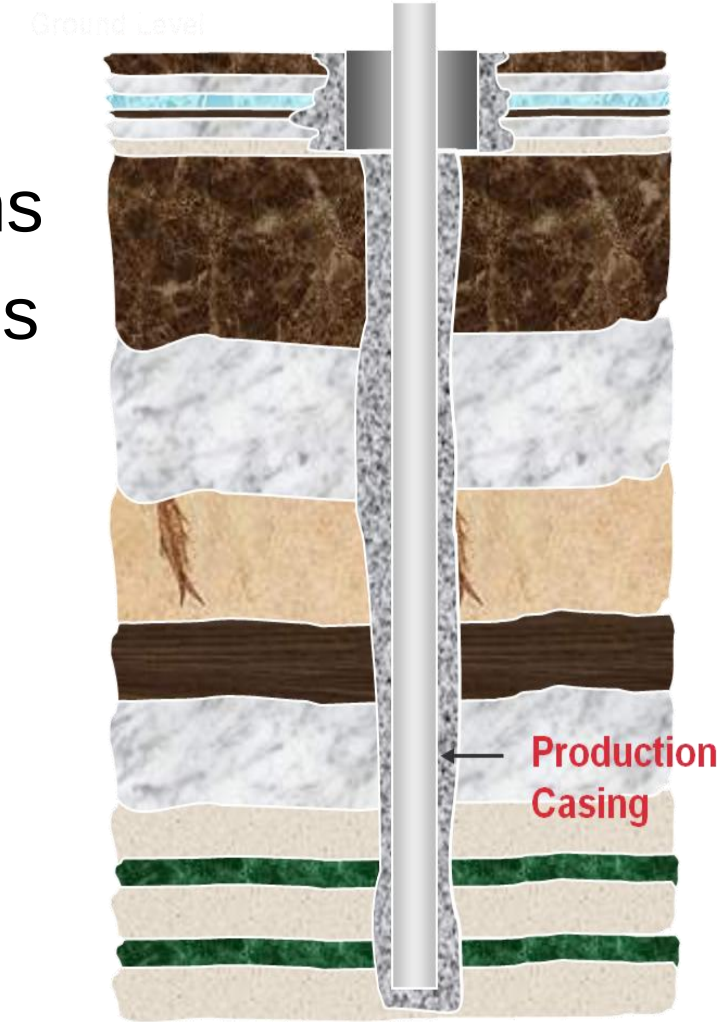
Well Construction

- Protect shallow formations
- Protect producing formations
- Withstand treating pressures



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Before the Treatment

- Treating rate and pressure
- Equipment and materials

Company:
Lease: SilverStim
Formation: CW 230 °
Location:

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Stage	Fluid Schedule	Volume (gal)	Proppant Type.	Prop Conc. (ppg)	Prop Total (lbs)	Slurry Vol. (gals)	Rate (bpm)	Stage Time (h:min:sec)	Exposure Time (h:min:sec)	CL-37 (gpt)	CL-23 1:3.5 (gpt)	BA-40L (gpt)	GasPerm 1100 (gpt)	Clayfix 3 (gpt)	VICON NF (gpt)	CAT-3 (gpt)	CAT-4 (gpt)	FR-66 (gpt)	WG-18 Variable (ppt)
1	FR Water Pad	50000				50000	50	0:23:49	1:18:43				1.50	1.25	3.00			1.00	
2	SilverStim Pad	6000				6000	50	0:02:51	0:54:55	0.50	0.30	0.50	1.50	1.25	3.00	0.25			28.00
3	SilverStim 24 visc	7000	Ottawa 30/50	1	7000	7317	50	0:03:29	0:52:03	0.50	0.30	0.50	1.50	1.25	3.00	0.25			28.00
4	SilverStim 24 visc	33000	Ottawa 30/50	2	66000	35986	50	0:17:08	0:48:34	0.50	0.30	0.50	1.50	1.25	3.00	0.25			28.00
5	SilverStim 24 visc	22000	Ottawa 30/50	3	66000	24986	50	0:11:54	0:31:26	0.50	0.30	0.55	1.50	1.25	3.00	0.25	0.10		28.00
6	SilverStim 24 visc	13000	Ottawa 30/50	3	39000	14765	50	0:07:02	0:19:32	0.50	0.30	0.70	1.50	1.25	3.00	0.50	0.10		28.00
7	SilverStim 24 visc	10000	Ottawa 30/50	4	40000	11810	50	0:05:37	0:12:30	0.50	0.30	0.80	1.50	1.25	3.00	0.50	0.25		28.00
8	SilverStim 24 visc	8000	Ottawa 30/50	4	32000	9448	50	0:04:30	0:06:53	0.50	0.30	0.90	1.50	1.25	3.00	0.50	0.50		28.00
9	Flush	5000				5000	50	0:02:23	0:02:23				1.50	1.25					
								0:00:00											

Total Pump Time: 1:18

					CL-37	CL-23	BA-40L	GasPerm 1100	Clayfix 3	VICON NF	CAT-3	CAT-4	FR-66	WG-18
TOTAL FLUID: 154000 gal	Total Proppant:	250000	165312	Final Design Used	50	30	59	231	193	447	33	10	50	2772
Pad+SLF+Flush: 154000 gal	Average Rate:	50.0 bpm												
Pad+SLF: 149000 gal	Treatment Down:	Casing												
Percent Pad: 37.6%	Abs. Min. HHP:	6,130 HHP		Loaded	67	42	79	294	246	564	46	18	68	3470

MAX PRESSURE: 5000 psi S.G.: 0.9

			T Perf	B Perf
Anticipated Surface Pres:	4743 psi			
Perforations:	48	Perf Zone #1	6,846	6858 NioA
Dia. in:	0.73	Perf Zone #2	6,977	6989 NioB
Calc. Perf Fric (psi):	11	Perf Zone #3		
Est. Well Bore Fric (psi):	1,500	Perf Zone #4		

WELL-BORE PATH

4 1/2" 11.6#	6846 ft
	ft
	ft

MAXIMUM CHEMICAL ADDITIVE

	CL-37	CL-23	BA-40L	GasPerm 1100	Clayfix 3	VICON NF	CAT-3	CAT-4	FR-66	WG-18
Pump Rates (gal/min) 50.0 bpm	1.05	0.63	1.89	3.15	2.63	6.30	1.05	1.05	2.10	58.82
Bucket Test Time for 1 gal (min:sec)	0.57	1.35	0.32	0.19	0.23	0.10	0.57	0.57	0.29	0.01

Gelled Fluid = 99000 Linear Gel = SLF = 93000 FR Water = 50000

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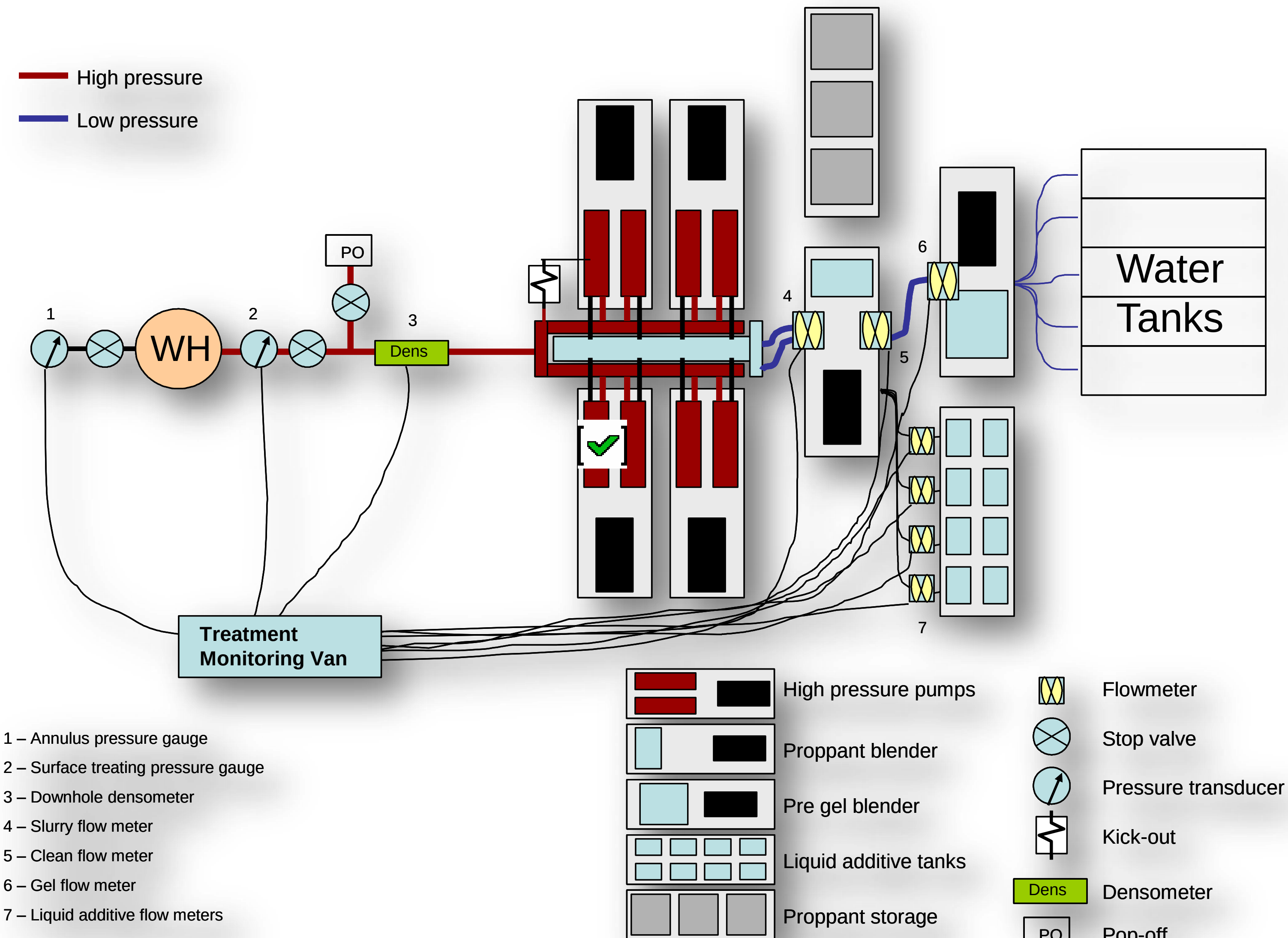
Well Site Rig-up

- Safety meetings

Well Site Rig-up

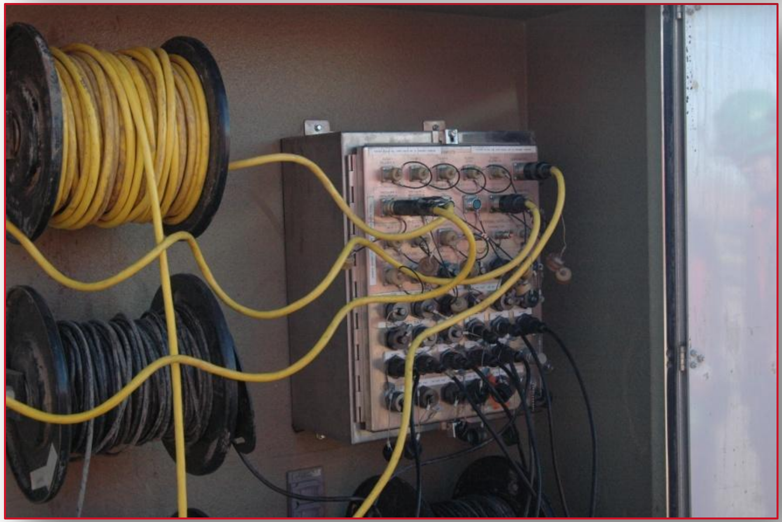
- Safety meetings
- High pressure and low pressure
- Pressure testing
- Protection systems tested
- Flowmeter calibration
- Data acquisition computers

Simplified Location Schematic



1 – Annulus pressure gauge
2 – Surface treating pressure gauge
3 – Downhole densometer
4 – Slurry flow meter
5 – Clean flow meter
6 – Gel flow meter
7 – Liquid additive flow meters

Monitoring Equipment

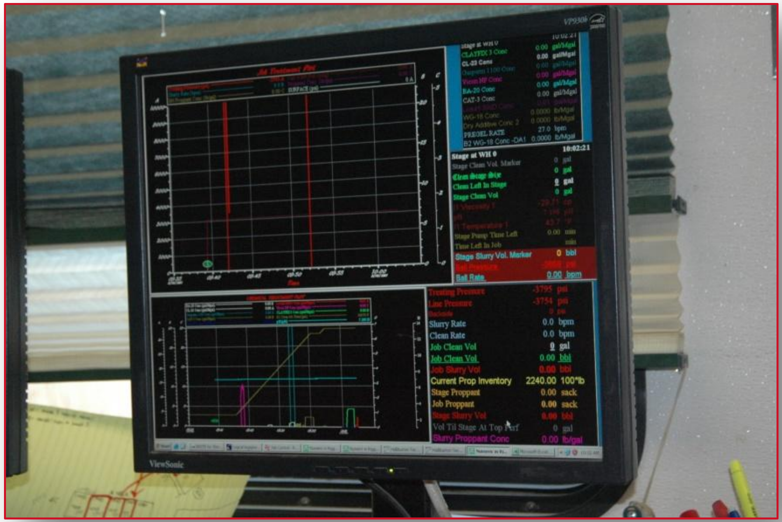


Blender Photos

Pressure Control and QC

Monitoring the Treatment

- Rate is brought up slowly
- Several people involved
- Treatment parameters
  - Rate, pressure, density
- Material parameters



$$WHTP = BHTP + P_{pipe} + P_{perf} - P_{hyd}$$

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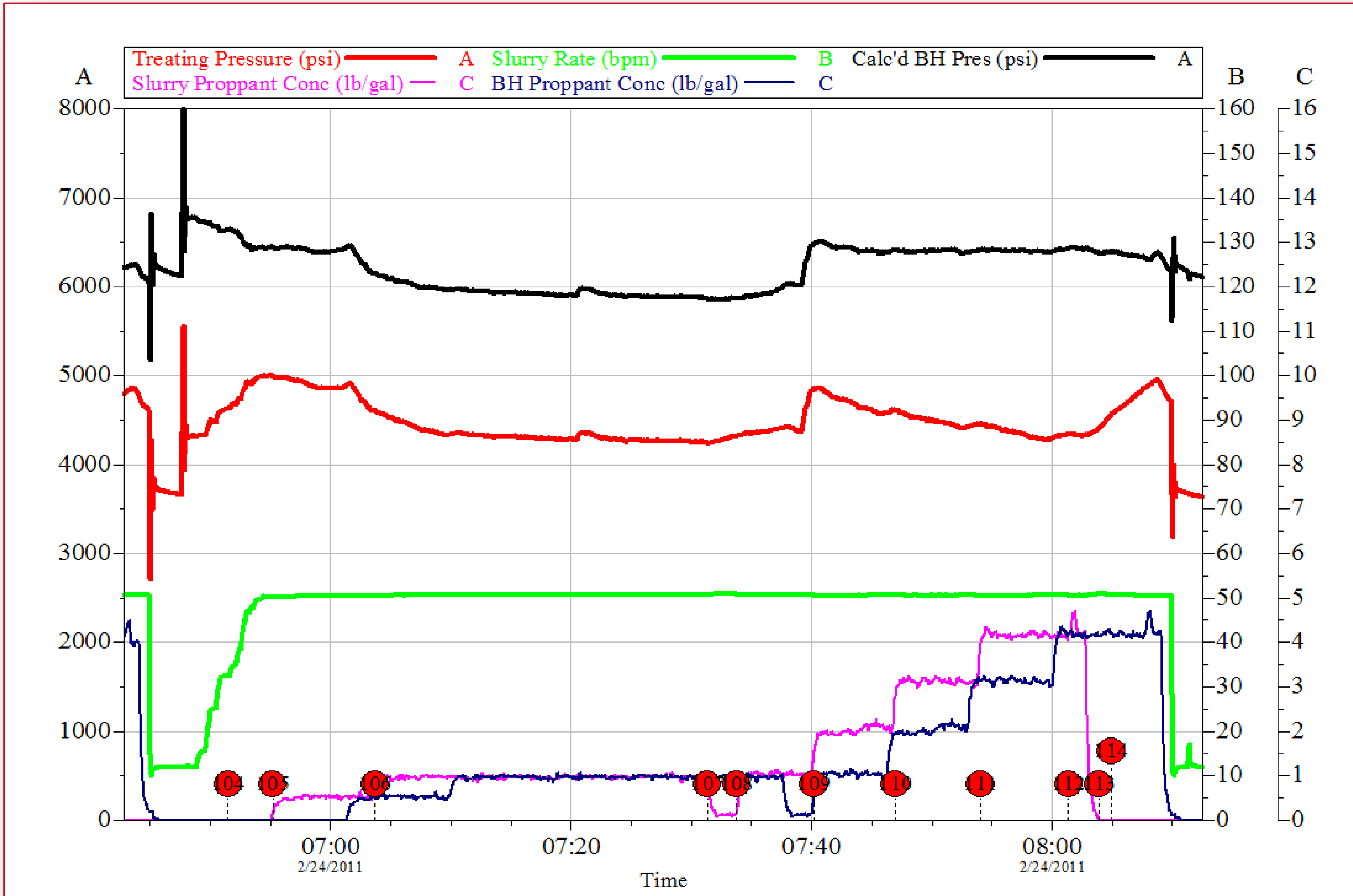
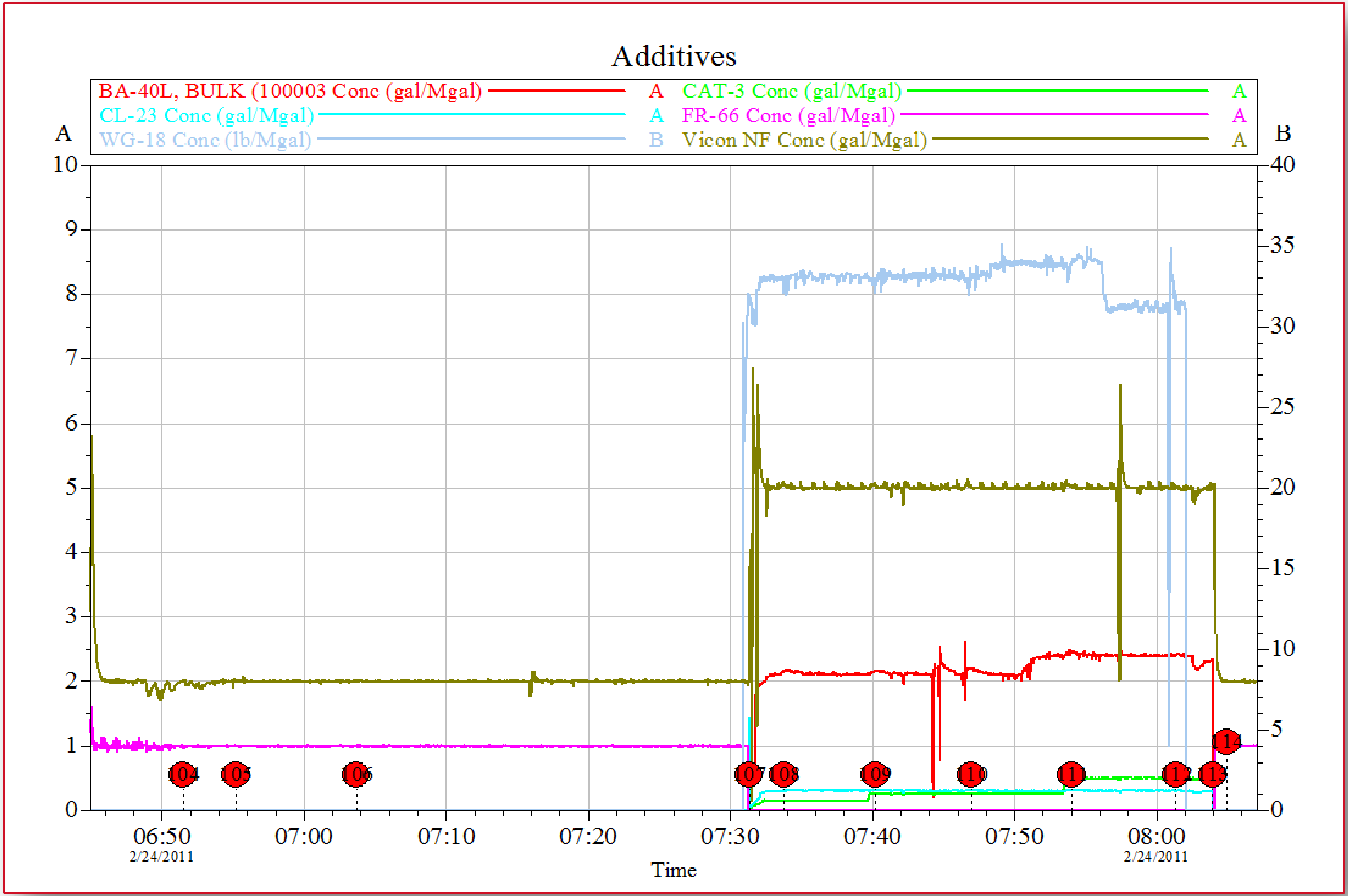
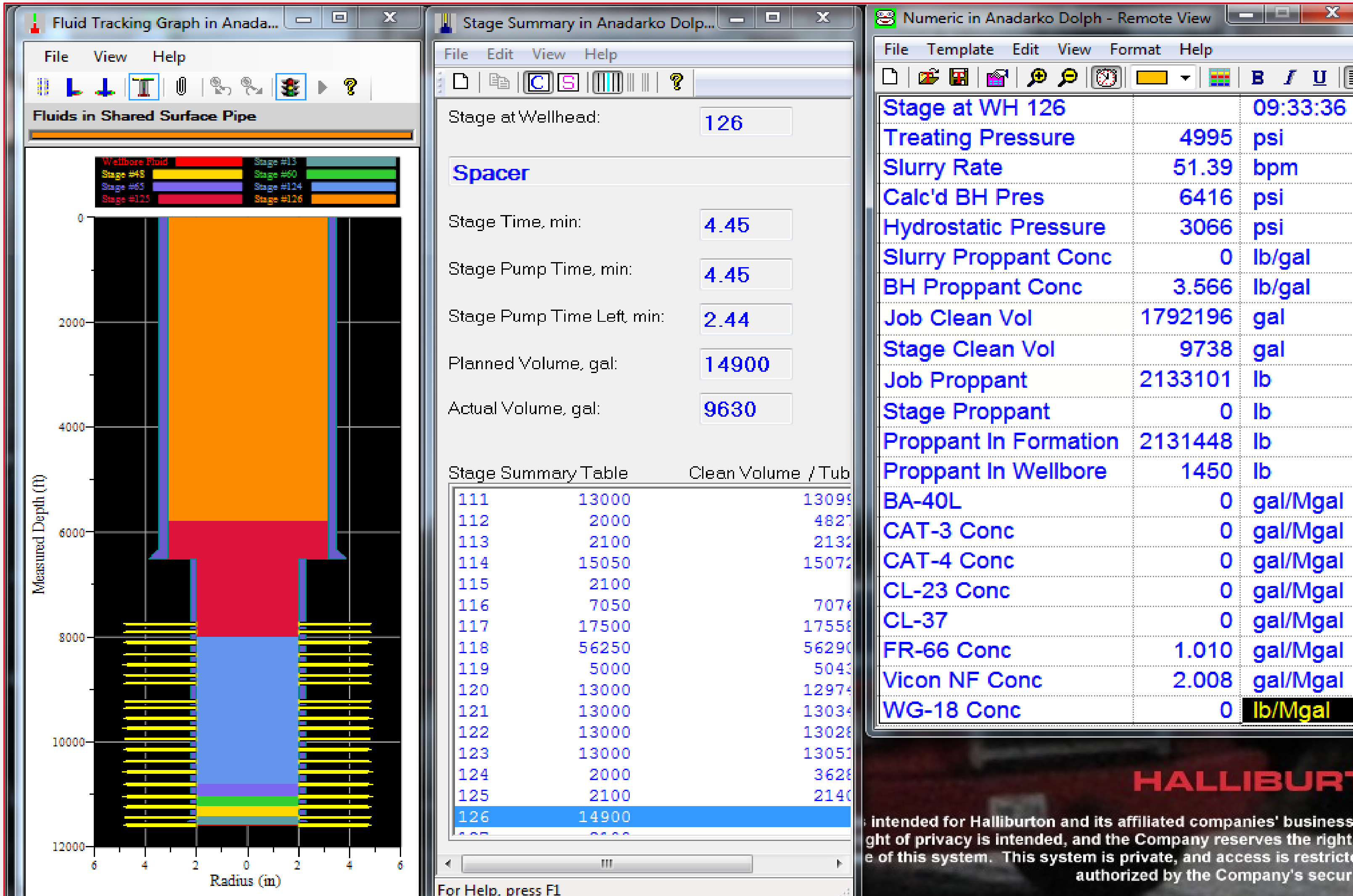
Treatment Chart



Additives Chart



Additional Real-time Information



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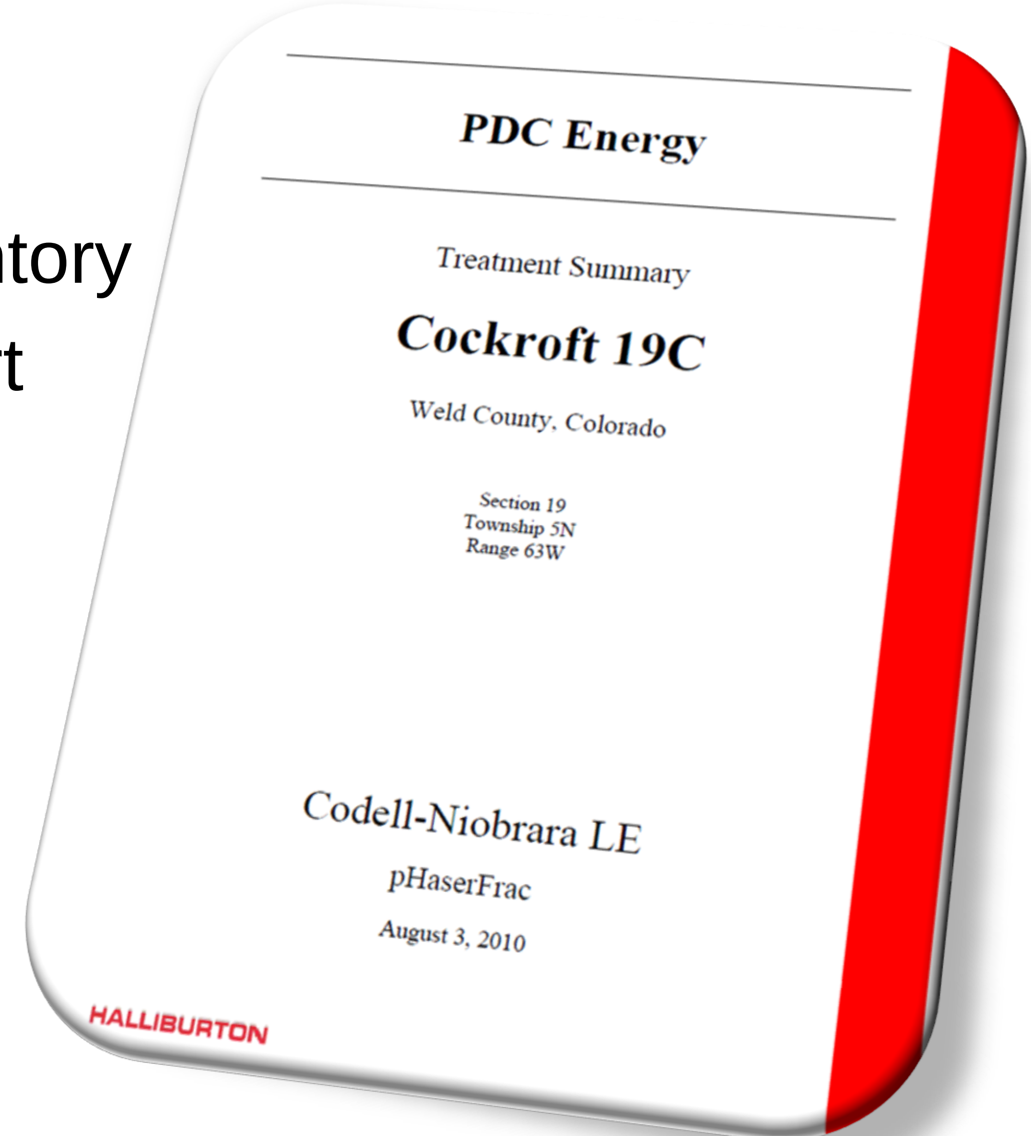
After the Frac

- Safety meeting
- Post treatment inventory
- Post treatment report



Questions

- Well Construction
- Before the Treatment
- Well Site Rig-up
- Monitoring the Treatment
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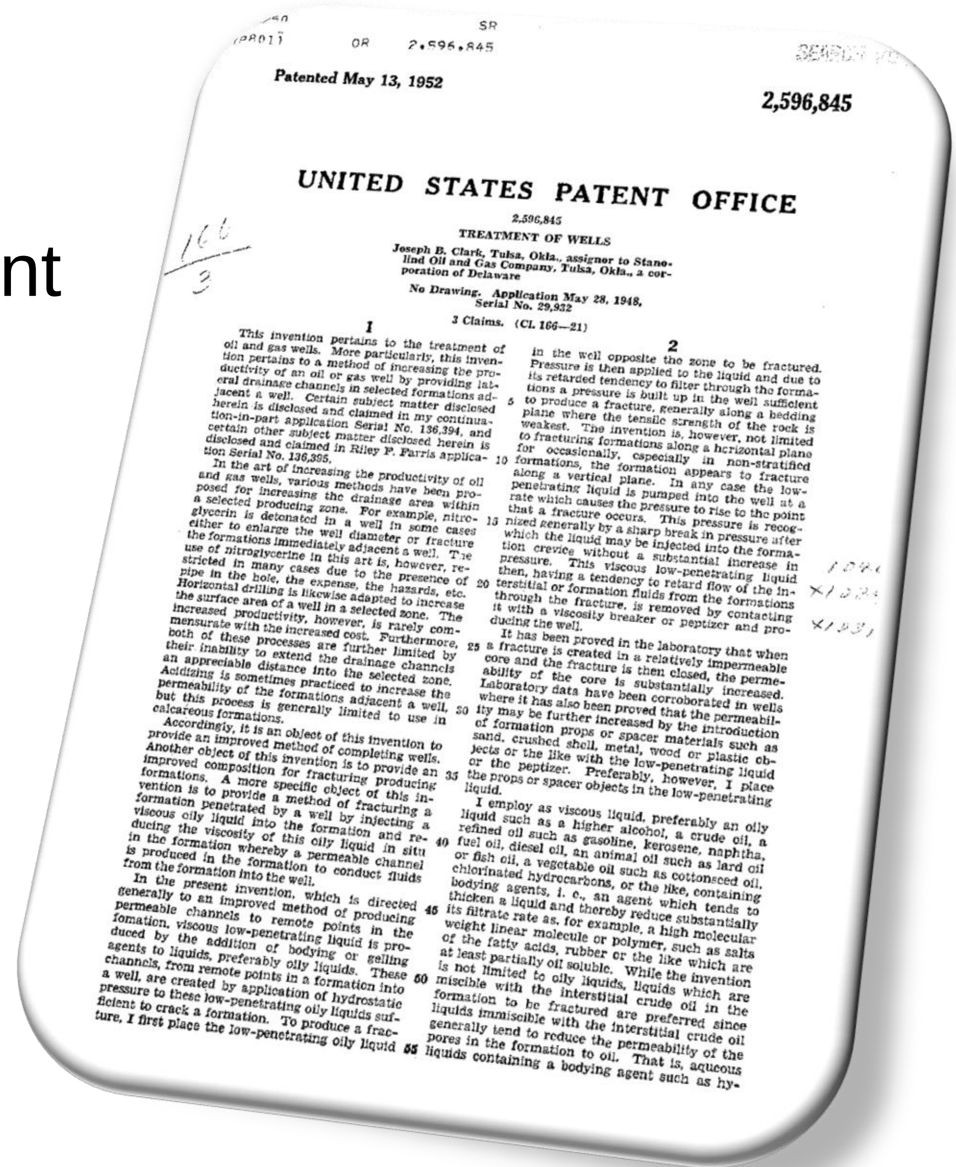

Patented May 13, 1952

2,596,845

UNITED STATES PATENT OFFICE

2,596,845

TREATMENT OF WELLS

Joseph B. Clark, Tulsa, Okla., assignor to Stanolind Oil and Gas Company, Tulsa, Okla., a corporation of Delaware

No Drawing. Application May 28, 1948, Serial No. 29,932

3 Claims. (Cl. 166—21)

1

This invention pertains to the treatment of oil and gas wells. More particularly, this invention pertains to a method of increasing the productivity of an oil or gas well by providing lateral drainage channels in selected formations adjacent a well. Certain subject matter disclosed herein is disclosed and claimed in my continuation-in-part application Serial No. 136,394, and certain other subject matter disclosed herein is disclosed and claimed in Riley F. Farris application Serial No. 136,395.

In the art of increasing the productivity of oil and gas wells, various methods have been proposed for increasing the drainage area within a selected producing zone. For example, nitroglycerin is detonated in a well in some cases either to enlarge the well diameter or fracture the formations immediately adjacent a well. The use of nitroglycerine in this art is, however, restricted in many cases due to the presence of pipe in the hole, the expense, the hazards, etc. Horizontal drilling is likewise adapted to increase the surface area of a well in a selected zone. The increased productivity, however, is rarely commensurate with the increased cost. Furthermore, both of these processes are further limited by their inability to extend the drainage channels an appreciable distance into the selected zone. Acidizing is sometimes practiced to increase the permeability of the formations adjacent a well, but this process is generally limited to use in calcareous formations.

Accordingly, it is an object of this invention to provide an improved method of completing wells. Another object of this invention is to provide an improved composition for fracturing producing formations. A more specific object of this invention is to provide a method of fracturing a formation penetrated by a well by injecting a viscous oily liquid into the formation and reducing the viscosity of this oily liquid in situ in the formation whereby a permeable channel is produced in the formation to conduct fluids from the formation into the well.

In the present invention, which is directed generally to an improved method of producing permeable channels to remote points in the fomation, viscous low-penetrating liquid is produced by the addition of bodying or gelling agents to liquids, preferably oily liquids. These channels, from remote points in a formation into a well, are created by application of hydrostatic pressure to these low-penetrating oily liquids sufficient to crack a formation. To produce a fracture, I first place the low-penetrating oily liquid

2

in the well opposite the zone to be fractured. Pressure is then applied to the liquid and due to its retarded tendency to filter through the formations a pressure is built up in the well sufficient to produce a fracture, generally along a bedding plane where the tensile strength of the rock is weakest. The invention is, however, not limited to fracturing formations along a horizontal plane for occasionally, especially in non-stratified formations, the formation appears to fracture along a vertical plane. In any case the low-penetrating liquid is pumped into the well at a rate which causes the pressure to rise to the point that a fracture occurs. This pressure is recognized generally by a sharp break in pressure after which the liquid may be injected into the formation crevice without a substantial increase in pressure. This viscous low-penetrating liquid then, having a tendency to retard flow of the interstitial or formation fluids from the formations through the fracture, is removed by contacting it with a viscosity breaker or peptizer and producing the well.

It has been proved in the laboratory that when a fracture is created in a relatively impermeable core and the fracture is then closed, the permeability of the core is substantially increased. Laboratory data have been corroborated in wells where it has also been proved that the permeability may be further increased by the introduction of formation props or spacer materials such as sand, crushed shell, metal, wood or plastic objects or the like with the low-penetrating liquid or the peptizer. Preferably, however, I place the props or spacer objects in the low-penetrating liquid.

I employ as viscous liquid, preferably an oily liquid such as a higher alcohol, a crude oil, a refined oil such as gasoline, kerosene, naphtha, fuel oil, diesel oil, an animal oil such as lard oil or fish oil, a vegetable oil such as cottonseed oil, chlorinated hydrocarbons, or the like, containing bodying agents, i. e., an agent which tends to thicken a liquid and thereby reduce substantially its filtrate rate as, for example, a high molecular weight linear molecule or polymer, such as salts of the fatty acids, rubber or the like which are at least partially oil soluble. While the invention is not limited to oily liquids, liquids which are miscible with the interstitial crude oil in the formation to be fractured are preferred since liquids immiscible with the interstitial crude oil generally tend to reduce the permeability of the pores in the formation to oil. That is, aqueous liquids containing a bodying agent such as hy-

Fracture Design and Stimulation –Monitoring

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The statements made during the workshop do not represent the views or opinions of EPA. The claims made by participants have not been verified or endorsed by EPA.

DC01:570405.2* This abstract provides a general overview only and is applicable to a majority of the hydraulic fracturing treatments currently being pumped. It is not intended to address all situations/scenarios that may occur.

As the previous sections have shown there is considerable work that goes on before a fracture treatment is pumped. Two points that bear repeating concern (1) the importance of proper well construction and (2) the availability of information about conditions to be expected during the treatment. It is through the well construction process that drinking water aquifers are protected, producing formations are isolated, casing is protected from corrosive fluids, etc. In addition, since the fracture treatment is carefully designed beforehand and expected pressures and other parameters are established, the casing and tubulars will have been designed to handle the treatment and subsequent well production without compromising the integrity of the well.

There has also been discussion about what goes into the design of a hydraulic fracture treatment, *i.e.*, knowledge of the mechanical rock properties of the formation to be treated as well as adjacent bounding layers, reservoir properties of the target formation, information about the fluid systems to be used and how the formation will interact with these fluids. From this information the operator and pumping service company can set up the hydraulic fracture treatment and know what will be pumped, what equipment will be required, and what is to be expected during the actual treatment.

What Do You Need to Know before Showing up on Location

The first step in setting up a fracture treatment job is to know the expected treatment rate and pressures. These two parameters are based on several factors discussed more thoroughly within this workshop, but for this section it is important to note that they are calculable. For a given formation there is a pressure which when applied will cause the rock to fracture. This pressure is often referred to in terms of a gradient (fracture gradient - fg). Knowing the fracture gradient, the actual bottom hole treating pressure (BHTP) required to fracture the rock can be calculated for a given depth:

BHTP = fg * depth + excess pressure .... (1)

In this equation excess pressure is the additional pressure required to extend a hydraulic fracture; *i.e*., net extension pressure, process zones stress, etc. These excess pressures are typically significantly lower than the pressure required to fracture the rock.

Once the BHTP is known then an expected wellhead treating pressure (WHTP) can be calculated by accounting for additional pressures that occur while treating a well:

$WHTP = BHTP + P_{pipe} + P_{perf} - P_{hyd}$ .... (2)

In this equation P_{pipe} is the friction pressure resistant to flow down the wellbore during pumping operations and is fluid and rate dependent; P_{perf} is the pressure drop across the perforations; and P_{hyd} is the hydrostatic pressure of the fluid in the wellbore and is also fluid dependent.

Once the expected BHTP and WHTP are determined, the proper casing string or tubular configuration can be designed to handle the pressures experienced while treating the formation. The WHTP is also used to calculate the hydraulic horsepower (number of trucks; HHP) required to pump the job at the desired treatment rate from the following equation:

$HHP = (WHTP * Rate) / 40.8$ .... (3)

The next step in setting up a job is to know what will be pumped, *e.g.*, the additives required and the rates at which the additives are to be used, proppant type and volume, etc. For some jobs this requires pre-job testing to determine whether the fluid system intended for use in the fracture treatment is compatible with the base fluid being supplied on location. This is an important step since it also establishes what will be required for the fluid system to perform as desired. Once this information is known then a final treatment design is determined and communicated to the field location for execution. This information is then put together in tabular form, giving the operator and service company a ready guide for setting up the job. An example of a typical pump schedule is included in the appendix.

Rigging Up the Pumping and Monitoring Equipment

The care that is taken in designing a fracture treatment job carries over to the implementation of the job, beginning with the set-up for the job. After the equipment, personnel, and materials are on location a safety meeting is held. During this safety meeting items such as well site concerns, proper PPE, rig-up concerns, etc. are reviewed to ensure that appropriate steps are being taken to ensure safety on the job site. The time it takes to rig up the pumping equipment and surface treating lines can vary from a couple of hours to a couple of days depending on the treatment. During this time there is also quality control work going on to ensure that the fracturing fluid will perform as expected and that the correct materials are on location in the appropriate quantities.

After all the surface equipment has been rigged up there is another safety meeting. During this safety meeting details of the job are reviewed, including the maximum WHTP, expected WHTP, pump rate, overall job schedule, who is responsible for what, etc. After the safety meeting all surface piping is pressure tested to a predetermined maximum pressure. At this time the pop-off valves on the surface lines are tested to make sure they work at the desired pressure and the pressure kick-outs on the high-pressure pumps are also tested to insure they work properly. In addition, the pumps used for liquid additives are bucket tested to ensure that they are functional and are calibrated properly. The proposed pumping schedule is loaded into the on-site computer system to assist the fracturing treatment operator in running the job as close to design as possible. While computers are capable of actually running the treatment, at this time most service companies still rely on a team in the treatment van to control the actual fracturing treatment with the assistance of the computers.

Pumping the Treatment

Once everything has been calibrated and pressure tested there is generally one last review between the operator's representative and service company representative to go over the treatment parameters. Once everyone is in agreement, the wellhead is opened up and the high pressure pumps are brought on line. At this time fluid is being pumped down the wellbore at a slow rate as pressure starts to increase. The rate and pressure are increased to the anticipated WHTP where the formation should fracture (breakdown). This is one of the first points where the actual treatment can be calibrated to the job design. If breakdown does not occur within a reasonable pressure compared to what is expected then the treatment is shut down and possible causes are investigated.

There are several points on the surface where rates, pressures, and densities are monitored and recorded during a treatment. (A simplified location schematic showing where the different treatment monitoring occurs is provided in the appendix.) For example, highly accurate transducers are placed at several different locations in the surface lines and equipment to monitor real-time pressure data, a variety of different flowmeters are used (depending on the material being metered) to record treatment rates and additive rates, and densometers are used to measure the density of the fluid being pumped downhole. Examples of some of the data being monitored and recorded include: WHTP, annular pressure, downhole slurry pump rate, clean fluid rate, wellhead proppant concentration, and individual additive rates, along with an extensive amount of mechanical information about the equipment on location. All the information from these multiple sources is collected and displayed by state-of-the-art computer systems located in treatment control vans. Most of the time, these data are transmitted using hard wires connecting the computer to the monitoring device.

It is also important to note that in addition to monitoring there are also mechanical devices which are used during a fracture treatment to provide additional safety for the wellhead. Two of these devices are pressure pop-off valves on surface lines and pressure kick-outs on the high pressure pumps.

While pumping the treatment both the operator and service company continually monitor the computer screens displaying information about the treatment as it is being pumped. The main concern is pressure. Both the operator and the service company want to make sure the maximum WHTP is not exceeded to protect the wellbore from any possible damage. (It is important to understand that it is inefficient to have to repair wellbores so every effort is made to prevent them from being damaged.) Some variations in pressure are normally seen during a fracture treatment. These variations are interpreted to determine their causes and significance; there are constant decisions being made about what the status of the treatment is and what to do as the treatment proceeds. An example of a treatment chart can be found in the appendix of this abstract.

Close attention is also paid to the annulus. In many cases the annulus is monitored with a gauge for any pressure increase in excess of normal fluid cool-down and heat-up, in other cases the annular valve is open and any fluid flow up the annulus can be seen at the wellhead and appropriate steps can be taken to address the fluid flow in the annulus.

Since any additive used in a hydraulic fracturing treatment serves a specific purpose, it is important that these additives are run at their designed concentrations. As mentioned earlier all additive rates are monitored during the treatment to insure they are run correctly. (An example of an additive rate chart is shown in the appendix.) In addition, overall job treatment information is displayed in the treatment control van in real-time to assist the operator and service company in understanding how the treatment is progressing. This allows for spot checks throughout the treatment process to compare the physical inventories of volumes of additives pumped with those calculated to again insure the treatment is being pumped as planned.

In addition, during the pumping operation there is continual monitoring of the surface lines, equipment, and wellhead to make sure there are no leaks. If a leak does develop, it is either isolated if possible or the treatment is shut down and the leak fixed before pumping is resumed.

The majority of hydraulic fracture treatments are pumped as planned or with changes that are based on the way the treatment is proceeding. On occasion, the formation may be difficult to fracture stimulate, resulting in a rapid pressure increase while pumping; this is called a screen-out. Even if there is a rapid increase in pressure relative to normal increases in pressure due to pumping, the system is still compressible so there is still time to react. As the pressure increases, the fracture treatment operator will start bringing pumps off-line to counteract the rapid pressure increase. In a worst case scenario, if the pressure increases too fast then the pump kick-out will activate and shut down the treatment.

After the Fracture Treatment

After the well has been treated the equipment used in the fracture treatment is rigged back down. At this time there is another safety meeting to discuss any possible issues that may be associated with this rig down. A final physical inventory of materials still on location is conducted to determine the actual volume of materials that was pumped during the treatment. During the rig-down of the pumping equipment steps are taken to prevent any spills and surface contamination. Finally, the operator is provided with a post job report that provides details of the treatment, a summary of what occurred during the time on location, and what was pumped into the well.

Appendix

Nomenclature and Terminology

Treatment Rate (bpm) – the downhole rate that fluid is entering the formation
Hydraulic Horsepower (hhp) – horsepower being applied to the formation while pumping
Wellhead Treating Pressure (psi) – the surface pressure at the wellhead during pumping
Max Pressure (psi) – the maximum WHTP that will be allowed
Bottom Hole Treating Pressure (psi) – pressure being applied to the formation including net pressure
Frac Gradient (psi/ft) – pressure at which fluid will cause the formation rock to part
Pipe Friction Pressure (psi) – friction pressure of the fluid being pumped down the wellbore
Perf Friction Pressure (psi) – pressure drop across the perforations
Hydrostatic Pressure (psi) – pressure the fluid column exerts on the formation
Net Pressure (psi) – excess pressure over frac pressure required to extend the fracture
Instantaneous Shut-in Pressure (psi) – a pressure used to calibrate the frac gradient
Clean Volume (gal or bbl) – volume of fluid pumped without proppant
Dirty Volume (gal or bbl) – volume of fluid pumped with proppant
Proppant Concentration (lb/gal) – the amount of proppant added to one gal of fluid
Proppant – small diameter material used to keep the fracture open
Solid Additive (lb/Mgal) – a solid chemical added to the fluid system for a specific purpose
Liquid Additive (gal/Mgal) – any liquid chemical added to the fluid system for a specific purpose
Pop-off – a mechanical device activates at a preset pressure to prevent damage to surface and downhole tubular
Kick-outs – mechanical or electrical devices that activate at a preset pressure to disengage high pressure pumps
High Pressure Pumps – Positive displacement pumps used for pumping downhole
Centrifugal Pumps – used on the low pressure equipment to mix and move fluid
Additive Pumps – used to inject liquid additives; different types based on the additive type and additive rate
Pressure Transducer – device used to measure and transmit pressure data
Flowmeter – used to measure and transmit fluid flow rates; different types depending on application
Annulus – Area between two concentric casing strings or tubular strings

Figure 6. Simplified Location Schematic

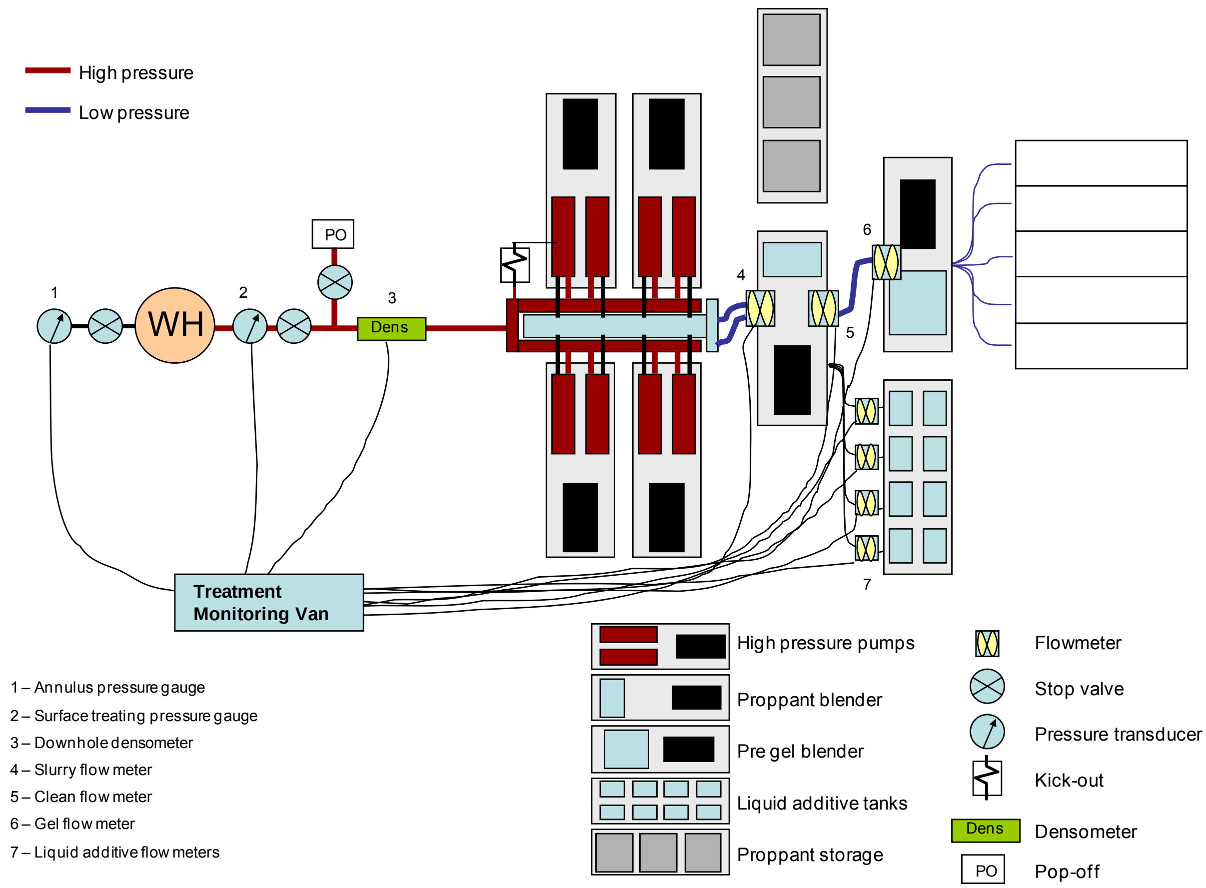

Figure 7. Inside the treatment monitoring van

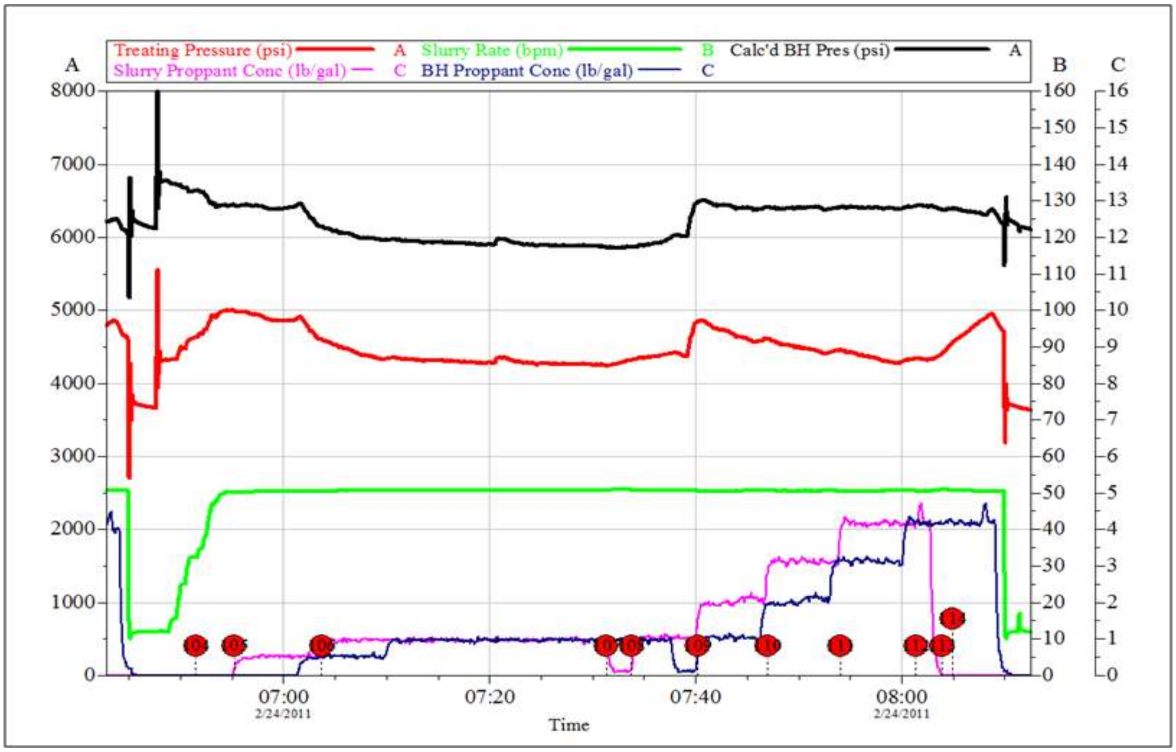

Figure 8 Treatment Chart -- Pressure, Rate and Prop Concentration

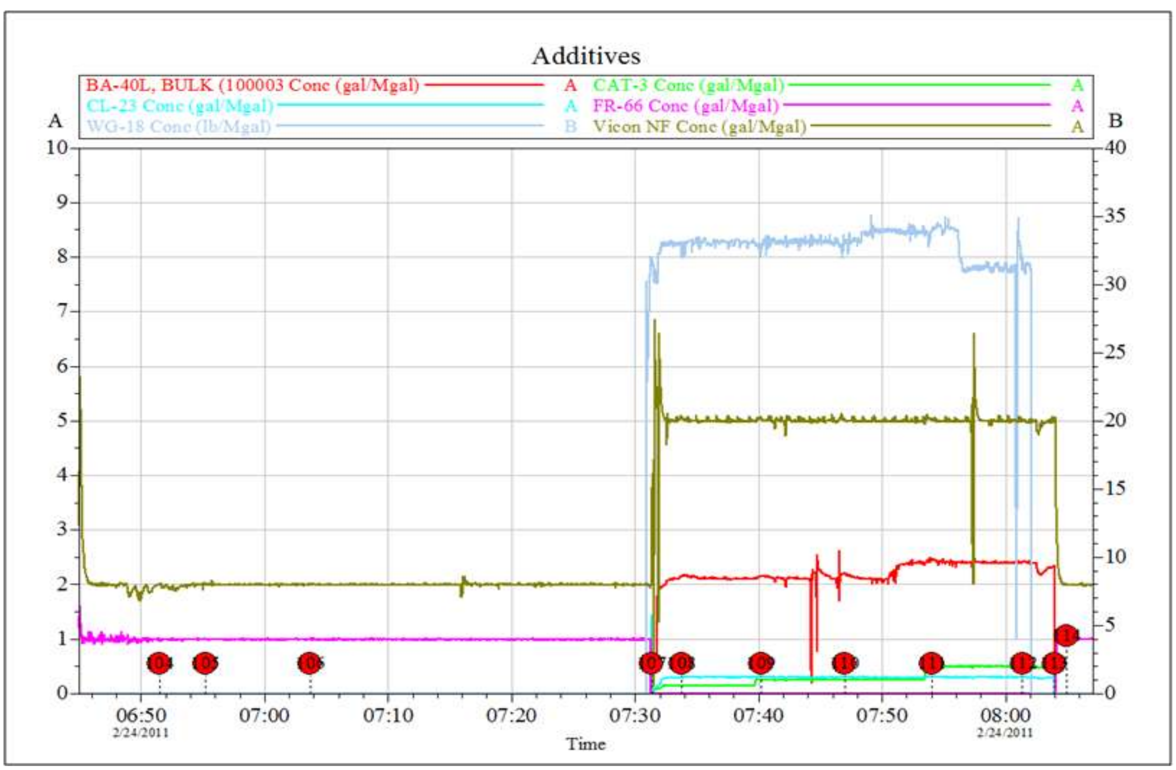

Figure 9. Additive Chart

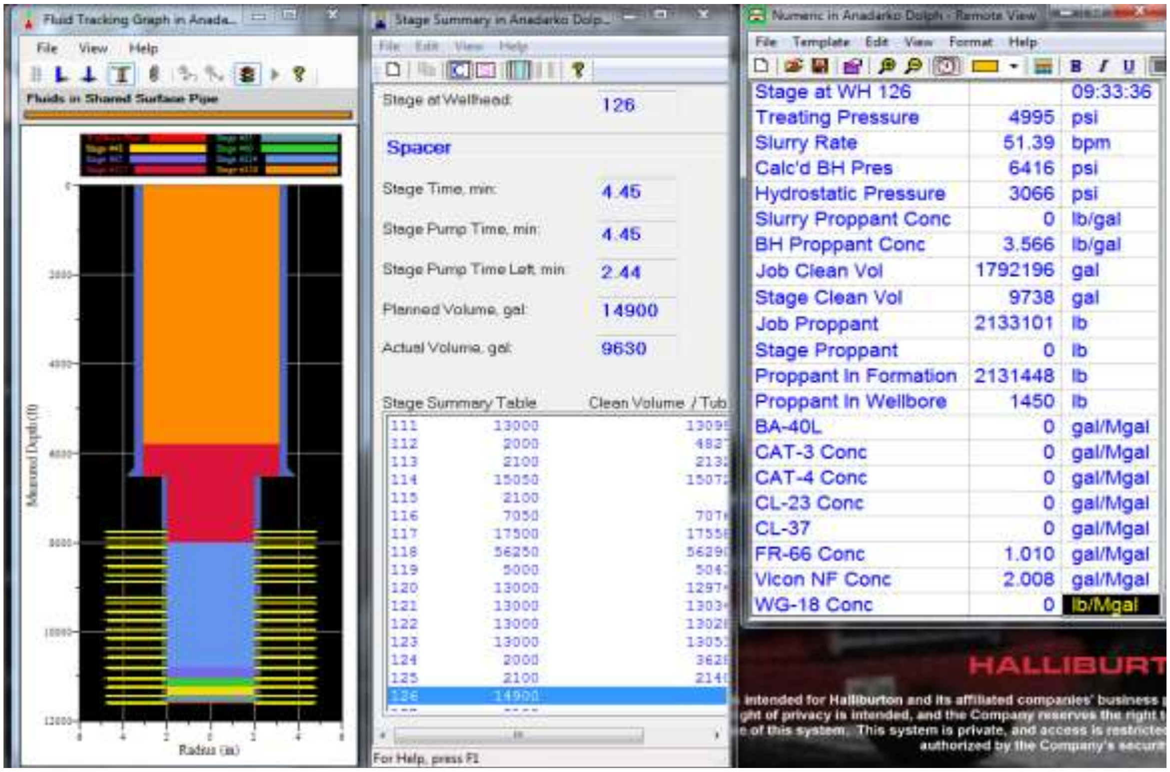

Figure 10. Fluid Tracking, Numeric Value, and Stage Summary Screen

Company:
Lease: SilverStim
Formation: CW 230 **Location:**

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Stage	Fluid Schedule	Volume (gal)	Proppant Type.	Prop Conc. (ppg)	Prop Total (lbs)	Slurry Vol. (gals)	Rate (bpm)	Stage Time (h:min:sec)	Exposure Time (h:min:sec)	CL-37 (gpt)	CL-23 1.3.2 (gpt)	BA-40L (gpt)	GasPerm 1100 (gpt)	Clayfix 3 (gpt)	VICON NF (gpt)	CAT-3 (gpt)	CAT-4 (gpt)	FR-66 (gpt)	WG-18 Variable (ppt)
1	FR Water Pad	50000				50000	50	0:23:49	1:18:43				1.50	1.25	3.00			1.00	
2	SilverStim Pad	6000				6000	50	0:02:51	0:54:55	0.50	0.30	0.50	1.50	1.25	3.00	0.25			28.00
3	SilverStim 24 visc	7000	Ottawa 30/50	1	7000	7317	50	0:03:29	0:52:05	0.50	0.30	0.50	1.50	1.25	3.00	0.25			28.00
4	SilverStim 24 visc	33000	Ottawa 30/50	2	66000	35986	50	0:17:08	0:48:34	0.50	0.30	0.50	1.50	1.25	3.00	0.25			28.00
5	SilverStim 24 visc	22000	Ottawa 30/50	3	66000	24986	50	0:11:54	0:31:26	0.50	0.30	0.55	1.50	1.25	3.00	0.25	0.10		28.00
6	SilverStim 24 visc	13000	Ottawa 30/50	3	39000	14765	50	0:07:02	0:19:32	0.50	0.30	0.70	1.50	1.25	3.00	0.50	0.10		28.00
7	SilverStim 24 visc	10000	Ottawa 30/50	4	40000	11810	50	0:05:37	0:12:30	0.50	0.30	0.80	1.50	1.25	3.00	0.50	0.25		28.00
8	SilverStim 24 visc	8000	Ottawa 30/50	4	32000	9448	50	0:04:30	0:06:53	0.50	0.30	0.90	1.50	1.25	3.00	0.50	0.50		28.00
9	Flush	5000				5000	50	0:02:23	0:02:23				1.50	1.25					
								0:00:00											

Total Pump Time: 1:18

TOTAL FLUID: 154000 gal Total Proppant: 250000 165312

	CL-37	CL-23	BA-40L	GasPerm 1100	Clayfix 3	VICON NF	CAT-3	CAT-4	FR-66	WG-18
Final Design Used	50	30	59	231	193	447	33	10	50	2772
Loaded	67	42	70	294	246	564	46	18	68	3470

Pad+SLF+Flush: 154000 gal Average Rate: 50.0 bpm
Pad+SLF: 149000 gal Treatment Down: Casing
Percent Pad: 37.6% Abs. Min. HHP: 6,130 HHP

MAX PRESSURE: 5000 psi S.G.: 0.9
Anticipated Surface Pres: 4743 psi

		T Perf	B Perf
Perforations: 48	Perf Zone #1	6,846	6858 NioA
Dia. in: 0.73	Perf Zone #2	6,977	6989 NioB
Calc. Perf Fric (psi): 11	Perf Zone #3		
Est. Well Bore Fric (psi): 1,500	Perf Zone #4		

WELL-BORE PATH
4 1/2" 11.6# 6846 ft
ft
ft

MAXIMUM CHEMICAL ADDITIVE

	CL-37	CL-23	BA-40L	GasPerm 1100	Clayfix 3	VICON NF	CAT-3	CAT-4	FR-66	WG-18
Pump Rates (gal/min), 50.0 bpm	1.05	0.63	1.89	3.15	2.63	6.30	1.05	1.05	2.10	58.82
Bucket Test Time for 1 gal (min:sec)	0.57	1.35	0.32	0.19	0.23	0.10	0.57	0.57	0.29	0.01

Gelled Fluid = 99000 Linear Gel = SLF = 93000 FR Water = 50000

Figure 11. Blender schedule