

FOAM CONTROL FOR NATURAL GAS WELLS

Final Report

July 1, 2006 – December 31, 2007

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Date Report Issued: July 31, 2008

DOE Award Number DE-FC26-04NT42098

Subaward: 3177-CEI-USDOE-2098

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ABSTRACT
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As America's natural gas wells continue to deplete, often increased, associated produced water and the natural reservoir pressures eventually reach equilibrium.

In an effort to enhance continued natural flow, certain chemicals are introduced into the well bore to create foam reactions in the water column.

This process has proven to enhance flow characteristics of the natural gas and water. Thus, allowing the wells to continue to produce the associated water along with the natural gas.

As continued depletion requires stronger chemicals to create foams, these foams become more complex and at some point, become so strong, they will no longer collapse back to liquid in the surface processing equipment.

By maintaining foam characteristics, the chemical residue escapes into the natural gas distribution system. The presence of this chemical residue causes problems in measurement accuracy, corrosion attack of the transmission systems and mechanical failure of gas compressors used to move natural gas to the market.

Research suggests carryover of this chemical residue costs millions of dollars in poor measurement results, aggravated corrosion and equipment damage.

This funded project represents an effort to design, construct and test an economical system that could efficiently neutralize the chemical residues, turning them back into common liquids that are captured in the surface processing equipment at the well and to formulate a foaming agent that will revert to liquid at the surface and approach a neutral pH to help control subsurface corrosion.

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INTRODUCTION
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The intent of the FOAM CONTROL SYSTEM is to function as an auxiliary system adapted to any natural gas well that is being treated with a foaming agent to facilitate the lifting of produced water from the well bore.

The old adage, "If a little does a little good. Then, a lot will do a lot of good" plays a part in the need for this system.

Soap sticks, acid sticks, capillary strings, slip streams all are mechanisms use to remove produced water from a natural gas well bore.

In today's workplace, everyone is busy, behind in schedule and under pressure to do more and do it better.

In the case of enhanced water removal, many producers "over treat" well in an effort to maximize water removal. This results in production excessive foam at the surface of a well bore. Natural gas purchasers are experiencing problems as a result of foams not breaking out in the separation equipment at the well site.

The result is, foam is transported into the gas gathering system and adversely affecting gas measurement and in severe cases has caused thousands of dollars in damage to compression equipment.

This system addresses this problem by treating any foam that reaches the surface of a well bore. By utilizing timers and chemical pumps, the system can be integrated into a plunger lift system to only treat foams that reach the surface and yet, not over treat or waste chemical by pumping more than is needed. This system can be installed on a naturally producing well, also.

The entire concept is to prevent any excess foam from entering the gas gathering system.

In areas where this is a chronic problem, some purchasers have actually closed in the sales valve on a well and refused to buy the gas that is being treated with a foaming agent. This system will be economical to purchase and operate, insuring the continued sales of natural gas without the fear of being shut in where foaming agents are necessary to continue gas production.

EXECUTIVE SUMMARY
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As the scope of this project was to create a chemical control system to enhance the performance of our depleting natural gas wells, certain setbacks were encountered during the efforts.

Creating an economical system to reduce foamed produced water as it reaches the surface in a well appeared to be basic and straight forward.

As basic electronic circuit designs began to develop, commercially available electronic components proved to be elusive. Efforts to adapt, modify, re-configure led to less than favorable results. Original concepts failed to mesh seamlessly creating incompatibilities between certain components. Although, more complex, more expensive industrial computers were available, it was decided that incorporating them into the original concept was not economically acceptable. Research led efforts away from totally electronic designs and toward electro/pneumatic concepts.

While attempting to find solutions to the electronic problems, the electro/pneumatic concept began to look more feasible within the budget constraints of the funding.

Sharing this information with key people and failure of the original timeline led to the suggestion additional, supplemental funding and additional time be applied for.

More research and extra effort led to scrapping the original design. But, it was decided the original timeline could not be achieved. The timeline was extended by six months without additional funding.

As the electro/pneumatic design prototype began to evolve, the footprint grew to an unacceptable size. An acceptable footprint was achieved and lab tests showed promise. However, the creation of extremely small flow paths led to a whole new set of problems. When clean supply air was replaced with wet, contaminated field gas, plugging caused unacceptable failures in the system. Cold weather also added to the problems in the field as moisture in the field gas froze during field trials.

This led to re-evaluating the totally electronic system. Time consumed in searching for more economical components was costly. But, the totally electronic system did evolve at a lesser cost than originally thought.

The electronic design had its merits in dependability but, was costly. The electro/pneumatic system was more economical to produce but, would require protection from the elements or select applications where colder weather was not a factor.

At that point, it was decided both systems would be field tested.

The second focus of the research was to formulate a de-foaming agent that could be economical at the surface and not be corrosive to the point well bore damage occurred. Commercial formulations and basic chemistry formulations were tested in the lab and in the field. This process did not prove custom formularies to be beneficial over the commercial products already available. Certain commercial versions proved to perform as well and even better than some basic chemical formulations generated. The results of the research have produced two different foam control systems capable of correcting the problems posed in the application for the funding. The research did not produce a custom formulary capable of performance above what is already commercially available.

EXPERIMENTAL
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The scope of the research was in two distinct fields of search.

One plan was to design and field prove an economical system capable of dispensing a chemical to reduce back to liquid, chemically foamed produced water at the well head of natural gas wells.

The other plan was to formulate a chemical compound capable of reducing the chemically foamed produced water, economically and limit corrosion induced by produced water and/or the chemical attack used to foam that water.

Research into components to be incorporated into the de-foaming system was vigorous trying to keep overall system costs at an acceptable level.

At the same time, basic designs were applied to various applications that would require the system to function with minimum re-configuration for any one process.

The main focus was to develop a design that would adapt to plunger lift systems, automatic soap stick launchers and capillary systems being the three most common processes currently in place.

Since the plunger lift system required coordination between that system and the foam control system would prove the most difficult, Focus was directed toward plunger lift knowing the other systems were less complicated and could be adapted.

The system design, component selection and prototyping was implemented first since it was believed that would require more time than developing a custom chemical formula acceptable to the scope of the research.

Many of the electronic components were available, commercially. Circuit design, function and adaptation to existing systems consumed more time than expected. By coordinating the interaction of plunger lift and the foam control system, the most difficult task was to find a way to limit the foam control system to one cycle while the plunger lift cycle exceeded the time cycle than the foam control system. Numerous timers, cycle controllers and time delay relays were studied and novel circuit designs were attempted without acceptable results.

At this point in the research, thoughts of a simple, less complex electro/pneumatic system began to evolve. The electronic system was set aside and work began on the electro/pneumatic concept. Major components were identified and those that were available, commercially were acquired. Those that were not available, were designed, prototyped tested in the lab. It was determined early that the physical size of these components posed a problem in relation to desired footprints.

Research evolved into a trade off between physical size and dependability.

As that effort continued, work was directed to the formulation of an acceptable chemical capable of collapsing chemically foamed produced water efficiently and economically. Formulations began with basic components known to collapse aqueous foams. As this progressed, commercially available foam control agents were acquired for comparison (see results in appendix).

Once maximum results were achieved in 100% produced water, condensate was added in small increments to determine if the compounds created could maintain favorable results with the introduction of condensates at increasing volumes. This proved to show negative effects as the condensate percentages increased. New compounds were created based on known chemicals capable of collapsing foams in the presence of hydrocarbons. Acceptable results were limited in the beginning. After numerous attempts to vary components in the compounds, it was decided to begin in a different direction with a completely different chemical base and work back to the introduction of hydrocarbons into the produced water. This proved to be a slow process that cost valuable time and money. The results eventually showed promise and efforts finally revealed acceptable results in collapsing aqueous foams containing hydrocarbons. But, pH levels became unacceptable in controlling corrosion attack.

Work was continued in an effort to create a compound capable of results in both arenas. In the end, it was determined custom formularies did not perform any better than commercially available chemicals.

The electro/pneumatic design of the foam control system was eventually completed knowing the reduced component size posed a problem when energized with contaminated field gas as an operating medium.

Long discussions about the two different systems led to re-investigating the electronic system.

This system proved to be much more reliable than the electro/pneumatic system. Both had merits and problems. Both systems were tested in the lab and in the field (see appendix).

Both systems functioned as expected. By adapting certain environments for these systems, both performed in an acceptable manner and commercialization has merit. Both these systems (schematics in Appendix) are available from Composite Engineers, Inc.

RESULTS AND DISCUSSION
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The overall results of the research has created two distinct foam control systems primarily designed to effectively correct the problems associated with the use of foaming agents used in flowing natural gas wells. The use of foaming agents is necessary to remove formation fluids in depleted wells and maintain flow of natural gas in commercial quantities.

These systems function seamlessly with plunger lift systems and with minimal changes can function with automatic soap stick launchers, capillary systems and soap sticks dropped by hand. These systems, once adjusted to well parameters can function automatically with minimum time required by operations personnel.

The electronic version of the system costs approximately 30% more than the electro/pneumatic version. However, the application of the later version is limited to installations on wells that have protection from the weather and/or a clean supply of air or natural gas.

Both functioned in the field trials (see Appendix) in a very acceptable capacity and were successful in controlling foam carry over from the well, through the surface process system and prevented contamination of the gas measurement/gathering systems.

The costs of either system is less than the revenue of lost production if a well is shut in by the gas purchaser because of foam carry over or the cost to repair a compressor caused by carry over. Efforts continue to improve and reduce the production costs and the physical size of the systems.

Composite offers both systems and make them available to any producing location in the lower 48 states.

CONCLUSION
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The conclusion of the research and development of a foam control system for our aging natural gas wells has produced two different systems that are available, commercially. The end results were not as simple as the original concept of producing a single system that could be installed on any and all wells requiring a foaming agent to keep the natural gas flowing. The electronic version is smaller but, more expensive to produce by approximately 30% over the electro/pneumatic version being approximately twice the size. Producers utilizing either version of this foam control system need to understand these systems are more susceptible to poor operating environments than some field equipment used in the production of natural gas. A clean supply air/gas is critical due to the small flow paths of certain components used in the systems. With care and attention to proper installation and careful selection of operating supplies will pay off in continued problem free operations. The research directed toward developing a custom formula for a de-foaming chemical that is more economical to use and improve corrosion attack by the produced liquids, chemicals used or the mixture of the liquids and chemicals did not produce anticipated results. Formulations were successful in controlling foam carry over. But, as hydrocarbon volumes increased in the produced fluids the pH was not controlled to the point expected. It was determined commercially available foam control chemicals performed as good as custom formulations. Research will continue in the improved operations and reduction in physical size of the systems to make them more appealing and economical to be installed on the wells. Reduced size is not expected to have a great impact on the production costs of the units. Improved component function and production volume will be the greatest factor in the reduced costs of either system. Support by BP America personnel in Durango, Colorado and Houston, Texas is appreciated and was vital in the positive results of this research.

Hazmat Report
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During testing of spray nozzle performance, a small volume (7.5 gal.) of chemical laden produced salt water was generated.

Research suggests the volume came under the classification of “small volume generator” and required no special handling to dispose of. Further research into the proper disposal of subject waste was initiated.

The United States Environmental Protection Agency, Region VI in Dallas, Texas was contacted. The details were discussed with a Ms. Margaret Olden (214 665-7200). She transferred me to Mr. Matt Rudolf (241 665-6434). He advised it be taken back to the oil and gas lease of origin. That solution was acceptable to Composite except for lack of documentation verifying such action.

Mr. Ron Smith with the Oklahoma Corporation Commission, Oil and Gas Division, Duncan District contacted Composite Engineers, Inc. and explained that Ms. Nancy Dorsey, US EPA, UIC (214 665-2210) had contacted him in reference to Composite’s inquiry, since the State of Oklahoma had primacy over such issues. Her suggestion to Mr. Smith was to advise Composite to “just flush it down the commode”.

Mr. Smith explained that since she was representing the Environmental Protection Agency concerning a formal inquiry, it could be considered a “Soft Approval”. Mr. Smith (OCC, O&G) agreed with Mr. Rudolf’s (EPA- Dallas) assessment and suggested it be taken back to the point of origin, the oil and gas lease. I again explained the need for documentation for such action.

Mr. Smith and Composite came to the conclusion the subject waste should be delivered to a commercial waste disposal facility.

Seven and one-half gallons of chemical laden produced salt water was delivered to the Briggett Inc. Disposals, Marlow facility in Dewey County, Oklahoma where it was disposed of in a State of Oklahoma approved commercial UIC well. Documentation is attached.

APPENDIX A
Foam Control System
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Defoamers tested from Commercial Chemical Companies

Gemini Technologies	Surfynd MD 20 (aqueous systems)
Belame Chemicals, LTD	Strata Foam ON 65 (aqueous systems)
Hebei Chemicals	PRS 688 (systems w/ hydrocarbons present)

Defoamers tested from custom blends-
(All mixed in a diesel base)

Aluminum stearate	(aqueous systems)
Triethylene glycol	(aqueous systems)
Octyl alcohol	(aqueous systems)
Aluminum hydroxide + stearic acid	(systems w/ hydrocarbons present)

All chemicals were tested in 10ml glass bottles containing 7ml of foamed produced water with a chloride level of 150,000.

1 ml of 56 gravity condensate replaced 1 ml of produced water when testing chemicals intended for elevated hydrocarbon content.

10 drops of each chemical was added with eye dropper and shaken by hand for 10 seconds.

Bottles were observed for foam collapse.

The 5 best defoamers tested were-

Beleme Chemicals, LTD's Strata Foam ON65

Aluminum stearate

Triethylene glycol

Octyl Alcohol

Aluminum hydroxide + stearic acid

APPENDIX B
Foam Control System
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The FOAM CONTROL SYSTEM is intended to correct the problem of foam carry over in gas gathering systems.

This is accomplished by injecting a chemical into the natural gas stream as it exits the wellhead. By collapsing the foam and turning it back into liquid it can be separated from the gas stream and prevented from entering the gas gathering system.

It is accomplished by assembling a selection of components, electrical wire and a housing in such a way the foam induced by the well operator injecting foaming agents into the well bore in an effort to foam the produced water in the bottom of the well bore. This action will cause a chemical reaction in the water causing it to foam. In a foamed state, the bottom hole reservoir pressure exerts enough energy to lift the foamed water out of the well.

Upon arriving at the surface, the Foam Control System energizes a chemical pump, dispensing a de-foaming chemical into the gas/foam stream.

The chemical reaction of the de-foaming chemical upon the foamed water causes the foamed water to return to a liquid state. Thus, allowing the water to be separated from the gas stream. The Foam Control System will cease injecting de-foaming chemical once the foamed column completely reaches the surface.

At that point, the Foam Control System ends the cycle and automatically resets to await the next foam flow to the surface.

All the various components work as a system whereby the well operator has corrected the problem of foam carryover.

APPENDIX C
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Small quantity tests were conducted to determine maximum foam volumes.
Test equipment consisted of a typical 1 quart food blender to generate foam.
Volumes of produced water, foaming agent and de-foamer were added to the blender
based on suggested concentrations from chemical supplier.

Blender- Kitchen Aid Mod. 2125, 120V AC, 1200 RPM

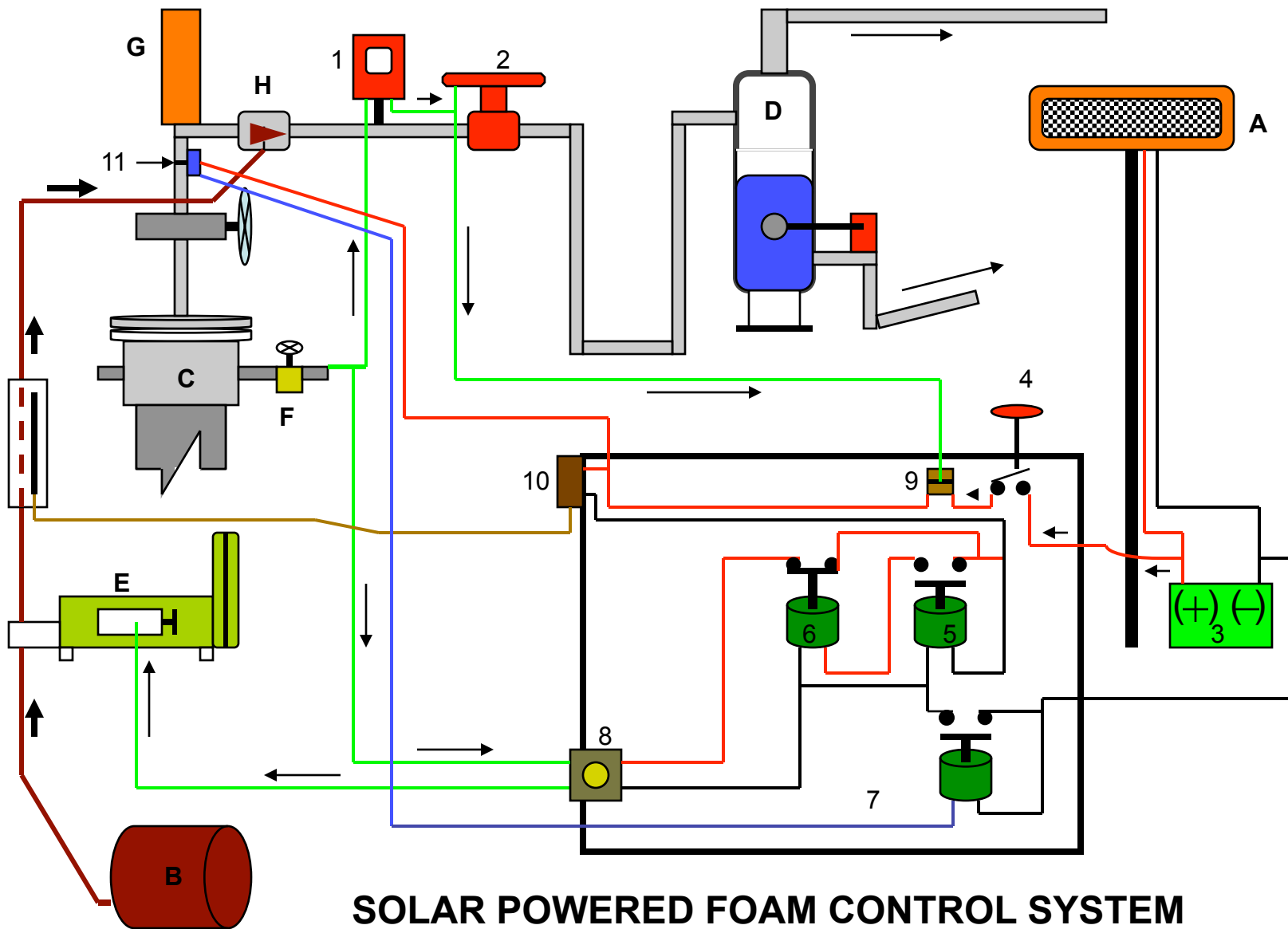
Water Volume	Chemical Volume	Mix Time	RPM	Foam Height Generated	Defoamer Volume	Mix Time	Collapse Time
360 ml	2.5 ml	20 sec	1200	17cm	3.0ml A	10 sec	3.0 sec
360 ml	2.5 ml	20 sec	1200	17cm	3.1ml A	10 sec	3.0 sec
360 ml	2.5 ml	20 sec	1200	17cm	3.2ml A	10 sec	3.0 sec
360 ml	2.5 ml	20 sec	1200	17cm	3.3ml A	10 sec	2.8 sec
360 ml	2.5 ml	20 sec	1200	17cm	3.4ml A	10 sec	2.8 sec
360 ml	2.5 ml	20 sec	1200	18cm	3.5ml A	10 sec	2.8 sec
360 ml	2.5 ml	20 sec	1200	17cm	3.6ml A	10 sec	3.1 sec
360 ml	2.5 ml	20 sec	1200	17cm	3.6ml A	10 sec	3.1 sec
360 ml	2.5 ml	20 sec	1200	17cm	3.7ml A	10 sec	3.7 sec.
360 ml	2.6ml	20 sec	1200	21 cm	3.0ml B	10 sec	3.4 sec.
360 ml	2.6 ml	20 sec	1200	21cm	3.1ml B	10 sec	3.4 sec.
360 ml	2.6ml	20 sec	1200	22cm	3.2ml B	10 sec	3.0 sec.
360 ml	2.6ml	20 sec	1200	21cm	3.3ml B	10 sec	2.9 sec.
360 ml	2.6 ml	20 sec	1200	21cm	3.4ml B	10 sec	2.5 sec.
360 ml	2.6 ml	20 sec	1200	21cm	3.5ml B	10 sec	3.4 sec.
360 ml	2.6 ml	20 sec	1200	21cm	3.5ml B	10 sec	3.4 sec.

Foaming agent used in this exercise was BJ Chemical Services TECHNI-FOAM™ 5820
De-foamer “A” was octyl alcohol
De-foamer “B” was aluminum stearate

The results of this test was used to-

Determine chemical pump requirements based on total liquids produced by well.

Determine estimated chemical volumes required for Flow Loop Tests



**SOLAR POWERED FOAM CONTROL SYSTEM
SCHEMATIC**

COMPONENT LEGEND FOR SOLAR POWERED FOAM CONTROL SYSTEM

A. SOLAR PANEL

B. CHEMICAL SUPPLY

C. WELL HEAD

D. GAS/LIQUIDS SEPARATOR

E. CHEMICAL PUMP

F. PRESSURE REGULATOR

**G. PLUNGER CONVEYED
CHEMICAL SYSTEM**

H. SPRAY NOZZLE

1. GAS WELL FLOW CONTROLLER

2. FLOW CONTROL VALVE

3. BATTERY- 12 VDC DEEP CYCLE

4. SYSTEM ON/OFF SWITCH

**5. SYSTEM TIME DELAY PROGRAMMABLE RELAY (Signaline
#368-12VDC-1min) (no)**

**11. CHEMICAL DISPENSE PROGRAMMABLE RELAY (Signaline
#368-12VDC-1min) (no)**

**12. SYSTEM CYCLE PROGRAMMABLE RELAY (Potter Brumfield
CHD-38-30001) (no)**

13. SOLENOID-12 VDC (Streamline #3454K1 (nc)(mc)

14. PRESSURE ACTUATOR (Streamline #3196K1 (no)(mc)

15. TEMPERATURE SENSOR (Therma Coil #3626K87 (nc)(mc)

21. Plunger Arrival Sensor

 **12VDC POSITIVE**

 **12VDC NEGATIVE**

 **60 PSI SUPPLY**

 **DEFOAMER**

 **TEMP. SENSOR**

 **PLUNGER ARRIVAL SENSOR**

FLOW PATH OF SOLAR POWERED FOAM CONTROL SYSTEM

Solar panel(11) keeps battery(3) charged. Battery powers system.

Controller(7) is NC, Time Delay.

Well Controller (1) senses well pressure and energizes Flow Control Valve (2) NC with gas pressure (60psi) from Pressure Regulator (F) allowing well to flow.

Gas Supply (60psi) also energizes Foam Control System by closing Diaphragm Switch (9) (NO) if Temperature Sensor (10) is closed (above 34 degrees F).

Assuming 10 is closed, Programmable Timer (5) (NO) begins it's time delay cycle (set to allow foam to arrive at surface).

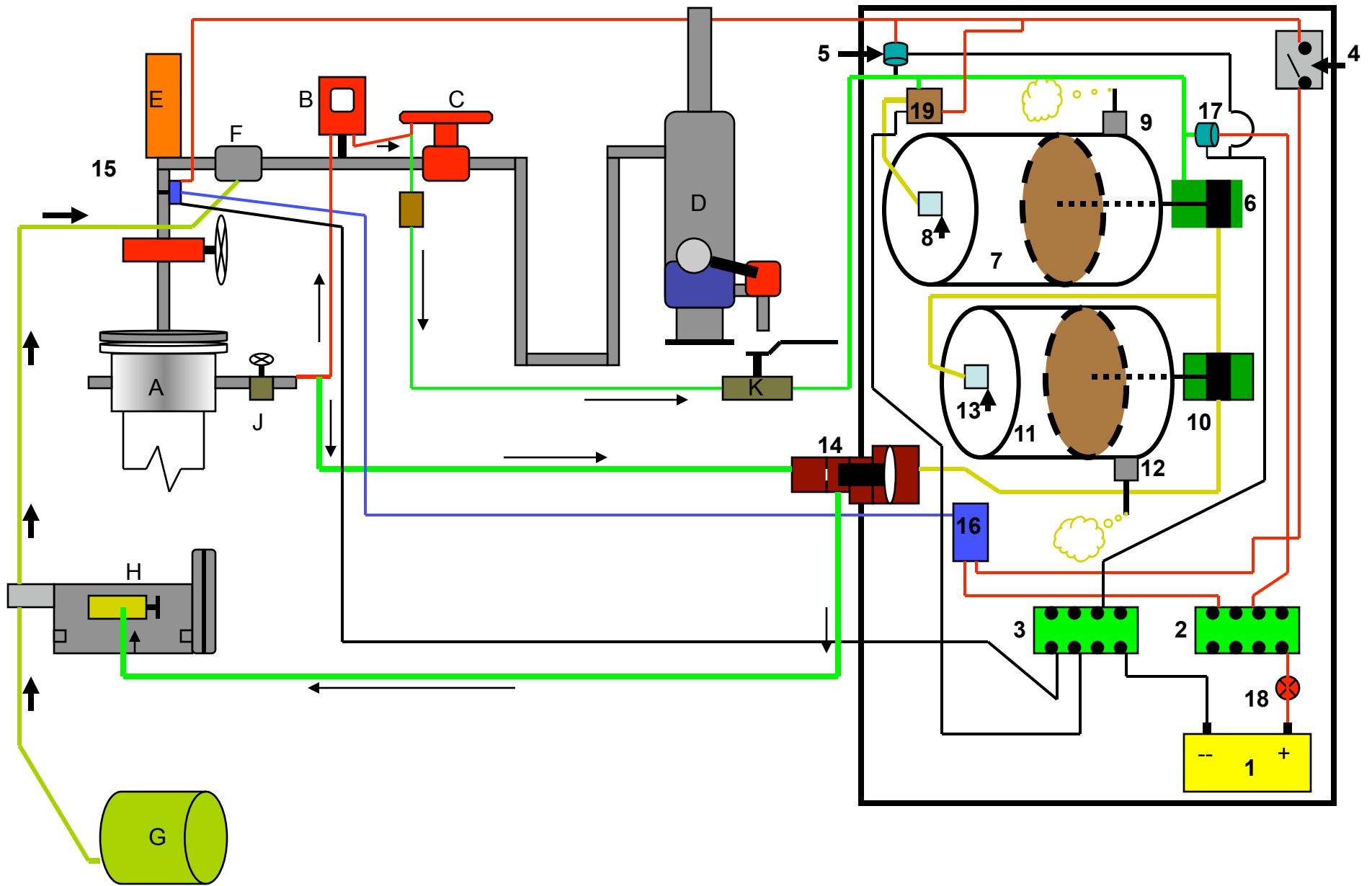
Upon timeout of 5, (adjusted to delay closing until foam reaches surface) it closes, energizing a second Programmable Timer (6) (NC).

6 closes thus, energizing 12VDC solenoid (8) (NO) allowing Supply Gas (60psi) from F to power Chemical Pump (E).

E pumps chemical to spray nozzle (H) until Plunger arrives, energizing Plunger Arrival Sensor (12) (NO).

12 being energized by Plunger Arrival opens Programmable Timer (7).

7 is adjusted to stay de-energized for a selected time interval that exceeds total well flow time before it re-energizes allowing the Flow Control System to begin a new cycle.



PNEUMATIC FOAM CONTROL SYSTEM

PNEUMATIC POWERED FOAM CONTROL SYSTEM SCHEMATIC LEGEND

- A. WELL HEAD**
 - C. COMPUTERIZED CONTROLLER**
 - E. FLOW CONTROL VALVE**
 - D. GAS/LIQUID SEPARATOR**
 - E. PLUNGER CONVEYED CHEMICAL SYSTEM**
 - G. FOAM CONTROL NOZZLE**
 - H. CHEMICAL SUPPLY**
 - I. CHEMICAL PUMP**
 - N. CONTROL GAS SUPPLY**
 - O. ISOLATION VALVE**
- 1. 6 VDC SEALED LEAD ACID BATTERY**
 - 2. POSITIVE TERMINAL STRIP**
 - 3. NEGATIVE TERMINAL STRIP**
 - 4. ON/OFF SWITCH**
 - 5. 6 VDC SOLENOID (energizes system) (NC)**
 - 6. VALVE-AIR-VALVE**
 - 7. TIME DELAY CYLINDER (diaphragm is in upper most position)**
 - 8. ADJUSTABLE ORIFICE (REGULATES TIME DELAY)**
 - 9. VENT TO ATMOSPHERE**
 - 10. VALVE-AIR-VALVE**
 - 11. CHEMICAL PUMP TIME SEQUENCE CYLINDER (diaphragm in upper most position)**
 - 12. VENT TO ATOMSPHERE**
 - 13. ADJUSTABLE ORIFICE (REGULATES PUMP TIME SEQUENCE)**
 - 14. DIAPHRAGM ACTUATED PUMP CONTROLLER (NC)**
 - 15. PLUNGER ARRIVAL SIGNAL GENERATOR (NO)**
 - 16. MASTER CYCLE- TIME DELAY CONTROLLER (NC)**
 - 17. MASTER SOLENOID**
 - 18. MASTER FUSE LINK**
 - 21. MAIN CONTROL SUPPLY GAS SOLENOID**
 - 22. PRESSURE REDUCER SET @ 5 psi**

FLOW PATH OF PNEUMATIC FOAM CONTROL SYSTEM

Closing ON/OFF SWITCH (4) that opens 6 VDC SOLENOID(5) and opening ISOLATION VALVE (K) prepares the FOAM CONTROL SYSTEM for operation. The well COMPUTER (B) sends pressure signal (30-60psi)(J) to FLOW CONTROL VALVE (C) and FOAM CONTROL SYSTEM through ISOLATION VALVE (K)(NO).

SUPPLY GAS flows through 6 VDC SOLENOID VALVE (5) (NO) and through MASTER SOLENOID (17) (NC).

SUPPLY GAS flows through ADJUSTABLE ORIFICE (8) into TIME DELAY CYLINDER (7). ADJUSTABLE ORIFICE is adjusted to limit SUPPLY GAS entry based on time required for free fluids to almost reach surface. Once diaphragm in TIME DELAY CYLINDER* (7) reaches bottom, stem shifts VALVE-AIR-VALVE (6) allowing SUPPLY GAS to continue on in two (2) directions. One reaches second VALVE-AIR-VALVE (10) and also enters CHEMICAL PUMP TIME SEQUENCE CYLINDER* (11) through ADJUSTABLE ORIFICE (13) adjusted to limit SUPPLY GAS entering CHEMICAL PUMP TIME SEQUENCE CYLINDER (11). As with cylinder (7), diaphragm is at opposite end from VALVE-AIR-VALVE (10). The time required to displace diaphragm to the point the attached stem shifts VALVE-AIR-VALVE (10) allowing SUPPLY GAS to continue to DIAPHRAGM ACTUATED PUMP CONTROLLER (14) (NC). This allows SUPPLY GAS from (J) to energize CHEMICAL PUMP (H).

The CHEMICAL PUMP continues to operate until the PLUNGER arrives at the surface, tripping the PLUNGER ARRIVAL SIGNAL GENERATOR. This energizes the MASTER SOLENOID CONTROLLER (16)(NC).

MASTER SOLENOID CONTROLLER begins it's time sequence exceeding well controller flow cycle preventing FOAM CONTROL SYSTEM from re-starting.

Once the MASTER SOLENOID CONTROLLER (16) Times out, the entire system is closed in and awaits the next plunger cycle initiated by the well COMPUTER.

* Both cylinders contain a return springs below the diaphragms.

Each of the five chemicals selected from the lab tests were to be tested in the field during the 30 day field trials. It was decided the chemicals should function in the field much the way they did in the lab as long as the well parameters stayed fairly constant.

In the preceding chart-

STRATA FOAM ON65 SHOWN IN RED

ALUMINUM STEARATE SHOWN IN BLUE

TEG SHOWN IN GREEN

OCTYL ALCOHOL SHOWN IN YELLOW

ALUMINUM HYDROXIDE + STEARIC ACID SHOWN IN RUST

All chemicals performed as expected based on lab findings.

The conclusion derived from this field test suggests there are a number of chemical formulations capable of suppressing foam in a process system with favorable pH control which is a leading factor in corrosion control.

Therefore, commercial formularies with proprietary components may well be simple compounds that can be applied to a wide spectrum of produced fluids.

With the pH of produced fluids from each well constant and no observed changes in the pH with de-foamer changes, corrosion coupons were not utilized in either well. The interior of the piping systems indicated no presence of corrosion activity. Although, some paraffin deposition was noted near the well head of the Hefner 19-4.

Weaver 24-1 Foam Control System Test Results w/ solar powered system

1	68	36K	.2	8%	147	.3	.7	60	4	5.5	.5	13	6	11	
2	67	35K	.3	8%	144	.3	.7	60	4	5.5	.5	14	5	11	NO FOAM AT SEPARATOR
3	54	38K	.5	6%	149	.3	.7	60	4	5.5	.5	14	6	10	NO FOAM AT SEPARATOR
4	54	38K	.5	6%	149	.3	.7	60	4	5.5	.5	14	7	9	NO FOAM AT SEPARATOR
5	NO DATA AVAILABLE														SOLAR PANEL, BATTERY STOLEN
6	NO DATA AVAILABLE														SOLAR PANEL, BATTERY STOLEN
7	55	37K	.5	6%	147	.5	.7	60	4	5.5	.5	13	6	11	NO FOAM AT SEPARATOR
8	57	38K	.6	8%	150	.5	.7	60	4	5.5	.5	11	7	12	NO FOAM AT SEPARATOR
9	53	37K	.4	7%	153	.5	.7	59	4	5.5	.5	13	5	12	NO FOAM AT SEPARATOR
10	61	35K	.4	7%	151	.5	.7	60	4	5.5	.5	13	8	11	NO FOAM AT SEPARATOR
11	63	36K	.4	8%	148	.5	.7	58	4	5.5	.5	14	8	8	NO FOAM AT SEPARATOR
12	66	39K	.5	6%	151	.5	.7	60	4	5.5	.5	12	10	8	NO FOAM AT SEPARATOR
13	66	38K	.6	8%	150	.5	.7	60	4	5.5	.5	13	10	11	NO FOAM AT SEPARATOR
14	67	39K	.5	7%	149	.5	.7	60	4	5.5	.5	11	10	9	NO FOAM AT SEPARATOR
15	67	39K	.5	7%	149	.5	.7	60	4	5.5	.5	12	10	8	NO FOAM AT SEPARATOR
16	50	43K	.9	5%	145	.5	.7	60	4	5.5	.5	13	10	7	NO FOAM AT SEPARATOR
17	45	37K	.6	5%	149	.5	.7	60	4	5.5	.5	12	10	8	NO FOAM AT SEPARATOR
18	50	40K	.5	7%	151	.5	.7	60	4	5.5	.5	11	10	9	NO FOAM AT SEPARATOR
19	NO DATA AVAILABLE														SYSTEM LOST POWER- CLOUDY
20	45	37K	.6	5%	149	.5	.7	60	4	5.5	.5	12	11	9	NO FOAM AT SEPARATOR
21	45	37K	.6	5%	149	.5	.7	60	4	5.5	.5	12	10	8	NO FOAM AT SEPARATOR
22	44	37K	.5	5%	148	.3	.7	60	4	5.5	.5	14	7	9	NO FOAM AT SEPARATOR
23	39	36K	.4	8%	148	.5	.7	58	4	5.5	.5	14	8	8	NO FOAM AT SEPARATOR
24	40	39K	.5	7%	149	.5	.7	60	4	5.5	.5	11	10	9	NO FOAM AT SEPARATOR
25	33	36K	.4	8%	148	.5	.7	58	4	5.5	.5	14	8	8	NO FOAM AT SEPARATOR
26	26	38K	.6	8%	150	.5	.7	60	4	5.5	.5	13	10	11	NO FOAM AT SEPARATOR
27	25	37K	.6	5%	149	.5	.7	60	4	5.5	.5	12	10	8	NO FOAM AT SEPARATOR
28	23	43K	.9	5%	145	.5	.7	60	4	5.5	.5	13	10	7	NO FOAM AT SEPARATOR
29	24	38K	.5	6%	149	.3	.7	60	4	5.5	.5	14	7	9	NO FOAM AT SEPARATOR
30	24	39K	.5	7%	149	.5	.7	60	4	5.5	.5	11	10	9	NO FOAM AT SEPARATOR
31	24	38K	.5	6%	149	.3	.7	60	4	5.5	.5	14	7	9	NO FOAM AT SEPARATOR
32	23	36K	.4	8%	148	.5	.7	58	4	5.5	.5	14	8	8	NO FOAM AT SEPARATOR
33	26	35K	.4	7%	151	.5	.7	60	4	5.5	.5	13	8	11	NO FOAM AT SEPARATOR

DAY	Amb. Temp.	Gas Produced	Liquids Produced	% hydrocarbons	Chlorides (K)	Foaming agent	De-Foamer used	Gas Supply	Cycles /day	S. I. Cycle	Flow Cycle	(1 event / D) Foam Arrival	Plunger Arrival	After Flow	Comments
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Weaver 24-1 Foam Control System Test Results w/ pneumatic system

1	40	39K	.5	8%	149	.7	.5	59	4	5.5	.5	12	10	8	PROBLEMS WITH SYSTEM PLUGGING
2	42	40K	.4	7%	148	.7	.5	60	4	5.5	.5	13	11	8	NO FOAM AT SEPARATOR
3	42	38K	.5	7%	151	.7	.5	60	4	5.5	.5	13	10	7	NO FOAM AT SEPARATOR
4	45	44K	.3	0%	147	.7	.5	60	4	5.5	.5	14	19	7	NO FOAM AT SEPARATOR
5	33	38K	.7	6%	149	.7	.5	60	4	5.5	.5	12	8	10	NO FOAM AT SEPARATOR
6	31	39K	.5	4%	148	.7	.5	60	4	5.5	.5	11	8	11	NO FOAM AT SEPARATOR
7	24	40K	.6	7%	149	.7	.5	60	4	5.5	.5	12	9	9	NO FOAM AT SEPARATOR
8	22	38K	.5	7%	149	.7	.5	60	4	5.5	.5	12	10	8	NO FOAM AT SEPARATOR
9	19	39K	.6	5%	148	.7	.5	60	4	5.5	.5	13	10	7	NO FOAM AT SEPARATOR
10	34	38K	.9	6%	150	.7	.5	60	4	5.5	.5	12	10	8	NO FOAM AT SEPARATOR
11	19	39K	.5	8%	149	.7	.5	60	4	5.5	.5	12	13	5	NO FOAM AT SEPARATOR
12	23	38K	.6	0%	145	.7	.5	60	4	5.5	.5	12	12	6	NO FOAM AT SEPARATOR
13	26	39K	.5	0%	151	.7	.5	60	4	5.5	.5	13	11	6	NO FOAM AT SEPARATOR
14	25	39K	.8	5%	148	.7	.5	60	4	5.5	.5	13	10	7	NO FOAM AT SEPARATOR
15	21	40K	.3	8%	149	.7	.5	60	4	5.5	.5	11	13	6	NO FOAM AT SEPARATOR
16	25	38K	.7	7%	149	.7	.5	60	4	5.5	.5	13	11	6	NO FOAM AT SEPARATOR
17	30	40K	.2	5%	150	.7	.5	60	4	5.5	.5	12	10	8	NO FOAM AT SEPARATOR
18	31	37K	.5	6%	150	.7	.5	60	4	5.5	.5	12	9	9	NO FOAM AT SEPARATOR
19	30	39K	.8	5%	151	.7	.5	60	4	5.5	.5	11	10	9	NO FOAM AT SEPARATOR
20	37	39K	.4	7%	151	.7	.5	60	4	5.5	.5	11	9	9	NO FOAM AT SEPARATOR
21	38	41K	.0	0%	150	.7	.5	60	4	5.5	.5	10	10	10	NO FOAM AT SEPARATOR
22	18	38K	.4	9%	147	.7	.5	60	4	5.5	.5	13	11	8	NO FOAM AT SEPARATOR
23	34	39K	.7	5%	148	.7	.5	60	4	5.5	.5	12	10	8	NO FOAM AT SEPARATOR
24	35	38K	.7	4%	149	.7	.5	60	4	5.5	.5	11	10	9	NO FOAM AT SEPARATOR
25	40	38K	.5	8%	147	.7	.5	60	4	5.5	.5	11	11	8	NO FOAM AT SEPARATOR
26	37	39K	.4	0%	149	.7	.5	60	4	5.5	.5	12	11	7	NO FOAM AT SEPARATOR
27	19	37K	.0	0%	148	.7	.5	60	4	5.5	.5	12	11	7	SEPARATOR DUMP LINE FROZE-NO FLUID
28	15	39K	.0	0%	N/A	.7	.5	60	4	5.5	.5	11	11	8	SEPARATOR DUMP LINE FROZE-NO FLUID
29	18	36K	2.7	0%	148	.7	.5	60	4	5.5	.5	12	10	8	NO FOAM AT SEPARATOR
30	34	35K	.6	0%	147	.7	.5	60	4	5.5	.5	12	10	8	NO FOAM AT SEPARATOR
31	22	36K	.5	9%	149	.7	.5	60	4	5.5	.5	12	10	8	NO FOAM AT SEPARATOR
32	25	37K	.7	4%	148	.7	.5	60	4	5.5	.5	12	9	9	NO FOAM AT SEPARATOR
33	27	39K	.5	6%	149	.7	.5	60	4	5.5	.5	12	8	10	NO FOAM AT SEPARATOR

DAY	Amb. Temp.	Gas Produced	Liquids Produced	% hydrocarbons	Chlorides (K)	Foaming agent	De-Foamer used	Gas Supply	Cycles /day	S. I. Cycle	Flow Cycle	(1 event / D)			Comments
												Foam Arrival	Plunger Arrival	After Flow	

HEFNER 19-4 Foam Control System Test Results w/ pneumatic system

1	44	19K	1.5	12%	169	.8	.6	55	6	3	1	24	10	26	PROBLEMS WITH SYSTEM PLUGGING
2	42	18K	1.4	11%	171	.8	.6	55	6	3	1	22	13	25	NO FOAM AT SEPARATOR
3	45	20K	1.3	10%	167	.8	.6	55	6	3	1	24	12	24	NO FOAM AT SEPARATOR
4	44	18K	1.7	12%	169	.8	.6	60	6	3	1	26	14	20	NO FOAM AT SEPARATOR
5	32	19K	1.5	14%	168	.8	.6	55	6	3	1	21	13	26	SOLENOID PLUGGED UP, INSTALL
6	51	18K	1.6	18%	164	.8	.6	55	6	3	1	23	14	23	PLUGGED AGAIN, INSTALLED DRIP POT
7	22	20K	1.8	14%	168	.8	.6	55	6	3	1	22	17	21	NO FOAM AT SEPARATOR
8	20	17K	1.5	16%	168	.8	.6	55	6	3	1	22	18	20	NO FOAM AT SEPARATOR
9	17	16K	1.8	13%	166	.8	.6	55	6	3	1	26	16	18	NO FOAM AT SEPARATOR
10	29	16K	1.2	10%	169	.8	.6	55	6	3	1	26	18	16	NO FOAM AT SEPARATOR
11	20	17K	1.4	13%	168	.8	.6	55	6	3	1	24	19	17	NO FOAM AT SEPARATOR
12	25	17K	1.3	13%	168	.8	.6	55	6	3	1	23	20	17	NO FOAM AT SEPARATOR
13	26	16K	1.5	14%	165	.8	.6	55	6	3	1	23	21	16	NO FOAM AT SEPARATOR
14	26	16K	1.5	14%	165	.8	.6	55	6	3	1	22	22	16	MADE MINOR ADJ. TO FLOW CYCLE
15	23	19K	2.5	10%	167	.8	.6	55	6	3	1	20	25	15	NO FOAM AT SEPARATOR
16	26	19K	1.5	11%	163	.8	.6	55	6	3	1	23	26	11	NO FOAM AT SEPARATOR
17	28	18K	1.0	17%	169	.8	.6	55	6	3	1	24	26	10	NO FOAM AT SEPARATOR
18	30	18K	1.4	16%	169	.8	.6	55	6	3	1	25	24	11	NO FOAM AT SEPARATOR
19	32	17K	1.3	14%	169	.8	.6	55	6	3	1	24	24	12	NO FOAM AT SEPARATOR
20	39	19K	1.4	13%	169	.8	.6	55	6	3	1	22	26	12	SUPPLY GAS FROZEN- SYSTEM DOWN
21	40	15K	1.9	11%	167	.8	.6	55	6	3	1	23	25	12	NO FOAM AT SEPARATOR
22	21	16K	1.4	15%	167	.8	.6	55	6	3	1	24	25	11	NO FOAM AT SEPARATOR
23	30	17K	1.5	14%	168	.8	.6	55	6	3	1	27	22	11	NO FOAM AT SEPARATOR
24	34	19K	1.1	13%	164	.8	.6	55	6	3	1	24	23	13	NO FOAM AT SEPARATOR
25	36	19K	1.4	11%	167	.8	.6	55	6	3	1	23	23	14	NO FOAM AT SEPARATOR
26	36	18K	1.5	16%	168	.8	.6	55	6	3	1	24	24	12	MADE ADJ. TO SUPPLY GAS REGULATOR
27	20	18K	1.3	14%	168	.8	.6	55	6	3	1	25	23	12	RE-ADJUSTED SUPPLY GAS
28	17	15K	1.9	15%	169	.8	.6	55	6	3	1	25	24	11	NO FOAM AT SEPARATOR
29	16	16K	1.3	13%	169	.8	.6	55	6	3	1	23	23	14	NO FOAM AT SEPARATOR
30	26	17K	1.4	15%	169	.8	.6	55	6	3	1	24	23	13	NO FOAM AT SEPARATOR
31	20	19K	1.0	13%	168	.8	.6	55	6	3	1	23	23	14	NO FOAM AT SEPARATOR
32	23	19K	1.3	12%	169	.8	.6	55	6	3	1	24	26	10	NO FOAM AT SEPARATOR
33	25	16K	1.9	10%	169	.8	.6	55	6	3	1	23	25	12	NO FOAM AT SEPARATOR

DAY	Amb. Temp.	Gas Produced	Liquids Produced	% hydrocarbons	Chlorides (K)	Foaming agent	De-Foamer used	Gas Supply	Cycles /day	S. I. Cycle	Flow Cycle	Foam Arrival	Plunger Arrival	After Flow	Comments
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HEFNER 19-4 Foam Control System Test Results w/ SOLAR SYSTEM

1	40	39K	.5	8%	149	.7	.5	59	4	5.5	.5	12	10	8	PROBLEMS WITH SYSTEM PLUGGING
2	42	40K	.4	7%	148	.7	.5	60	4	5.5	.5	13	11	8	NO FOAM AT SEPARATOR
3	42	38K	.5	7%	151	.7	.5	60	4	5.5	.5	13	10	7	NO FOAM AT SEPARATOR
4	45	44K	.3	0%	147	.7	.5	60	4	5.5	.5	14	19	7	NO FOAM AT SEPARATOR
5	33	38K	.7	6%	149	.7	.5	60	4	5.5	.5	12	8	10	NO FOAM AT SEPARATOR
6	31	39K	.5	4%	148	.7	.5	60	4	5.5	.5	11	8	11	NO FOAM AT SEPARATOR
7	24	40K	.6	7%	149	.7	.5	60	4	5.5	.5	12	9	9	NO FOAM AT SEPARATOR
8	22	38K	.5	7%	149	.7	.5	60	4	5.5	.5	12	10	8	NO FOAM AT SEPARATOR
9	19	39K	.6	5%	148	.7	.5	60	4	5.5	.5	13	10	7	NO FOAM AT SEPARATOR
10	34	38K	.9	6%	150	.7	.5	60	4	5.5	.5	12	10	8	NO FOAM AT SEPARATOR
11	19	39K	.5	8%	149	.7	.5	60	4	5.5	.5	12	13	5	NO FOAM AT SEPARATOR
12	23	38K	.6	0%	145	.7	.5	60	4	5.5	.5	12	12	6	NO FOAM AT SEPARATOR
13	26	39K	.5	0%	151	.7	.5	60	4	5.5	.5	13	11	6	NO FOAM AT SEPARATOR
14	25	39K	.8	5%	148	.7	.5	60	4	5.5	.5	13	10	7	NO FOAM AT SEPARATOR
15	21	40K	.3	8%	149	.7	.5	60	4	5.5	.5	11	13	6	NO FOAM AT SEPARATOR
16	25	38K	.7	7%	149	.7	.5	60	4	5.5	.5	13	11	6	NO FOAM AT SEPARATOR
17	30	40K	.2	5%	150	.7	.5	60	4	5.5	.5	12	10	8	NO FOAM AT SEPARATOR
18	31	37K	.5	6%	150	.7	.5	60	4	5.5	.5	12	9	9	NO FOAM AT SEPARATOR
19	30	39K	.8	5%	151	.7	.5	60	4	5.5	.5	11	10	9	NO FOAM AT SEPARATOR
20	37	39K	.4	7%	151	.7	.5	60	4	5.5	.5	11	9	9	NO FOAM AT SEPARATOR
21	38	41K	.0	0%	150	.7	.5	60	4	5.5	.5	10	10	10	NO FOAM AT SEPARATOR
22	18	38K	.4	9%	147	.7	.5	60	4	5.5	.5	13	11	8	NO FOAM AT SEPARATOR
23	34	39K	.7	5%	148	.7	.5	60	4	5.5	.5	12	10	8	NO FOAM AT SEPARATOR
24	35	38K	.7	4%	149	.7	.5	60	4	5.5	.5	11	10	9	NO FOAM AT SEPARATOR
25	40	38K	.5	8%	147	.7	.5	60	4	5.5	.5	11	11	8	NO FOAM AT SEPARATOR
26	37	39K	.4	0%	149	.7	.5	60	4	5.5	.5	12	11	7	NO FOAM AT SEPARATOR
27	19	37K	.0	0%	148	.7	.5	60	4	5.5	.5	12	11	7	SEPARATOR DUMP LINE FROZE-NO FLUID
28	15	39K	.0	0%	N/A	.7	.5	60	4	5.5	.5	11	11	8	SEPARATOR DUMP LINE FROZE-NO FLUID
29	18	36K	2.7	0%	148	.7	.5	60	4	5.5	.5	12	10	8	NO FOAM AT SEPARATOR
30	34	35K	.6	0%	147	.7	.5	60	4	5.5	.5	12	10	8	NO FOAM AT SEPARATOR
31	22	36K	.5	9%	149	.7	.5	60	4	5.5	.5	12	10	8	NO FOAM AT SEPARATOR
32	25	37K	.7	4%	148	.7	.5	60	4	5.5	.5	12	9	9	NO FOAM AT SEPARATOR
33	27	39K	.5	6%	149	.7	.5	60	4	5.5	.5	12	8	10	NO FOAM AT SEPARATOR

DAY	Amb. Temp.	Gas Produced	Liquids Produced	% hydrocarbons	Chlorides (K)	Foaming agent	De-Foamer used	Gas Supply	Cycles /day	S. I. Cycle	Flow Cycle	(1 event / D)	Foam Arrival	Plunger Arrival	After Flow	Comments
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