CHEMICAL PROGRAM BASICS

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ABSTRACT

Most operating areas require chemical programs, but most operating companies do not have chemical knowledgeable personnel to help set a program up, evaluate its performance, and/or optimize the overall program. This paper presents an overview of chemical programs along with a brief discussion of various potential parts of a program. An operator will be able to use the information presented here to set up performance indicators to evaluate a program and decide how best to optimize their chemical program.

INTRODUCTION

A successful chemical program is a necessity to have long term success in a field. Through having a well formed chemical program the wellbore, downhole assets, surface equipment and pipelines are protected. By allocating money to a chemical program more expensive failures are reduced that cause loss of production, environmental releases, and overall loss of revenue.

This paper will cover the steps necessary to establish a successful chemical program and protect a company's assets downhole and on surface while minimizing lease operating expenses. However, a successful program requires good communications between the operator and vendor. It is never too late to make sure that both sides are on the same page and that an operator's expectations match the vendor's understanding.

CONTRACT TYPES AND VENDOR SELECTION

There are two basic types of chemical contracts; 1) the cost of labor (salesman, technicians, etc.) is included in the cost of the chemical so the agreed pricing will directly affect the number of personnel dedicated to the operator and 2) the cost of the chemical and personnel are broken out such that the operator decides how much manpower they want to pay for so that the resultant costs are out front. However, neither includes the costs of batch treating which is typically a set cost per stop. The first is the most common type of contract, but whatever the contract, both sides should agree on the manpower requirements understanding the impact on the program's total cost, related services, and the overall program's effectiveness. Remember that if a field is actively adding wells and facilities, the manpower versus cost should be monitored as volume typically brings economic efficiencies but may limit manpower.

An operator should have an idea of the contract type they prefer and communicate this during the bid process. In the bidding process it is effective to have the vendors take a variety of samples from the field and build recommendations based off of this data, lift types, and problems occurring in the field. This allows the vendor to recommend better fit for use chemicals and give an accurate cost estimation from chemical concentration types and treatment styles. Chemical selection is important as the wrong chemical may cause greater problems than it is solving but an effective program will be more dependent on services rather than chemical. It is important to remember that in many cases, the operator does not have a chemical background so the vendor's expertise will be relied upon so make sure the personnel working your account have that knowledge. It is also crucial to understand that chemicals come in various base compound strengths so a more expensive chemical may require less of it and vice versa to be effective. Trials can be done to assist in choosing the most effective chemical for a targeted concentration.

Beyond the cost of manpower and chemicals is related lab services such as water, oil, and sample analysis, coupon testing, and other tests as required to ascertain the proper product, treatment volume, frequency, and treatment method. This also may be included in the costs of the chemical (sometimes treated as overhead and included in the base chemical pricing) or an added cost depending on the vendor's resources. This should be defined and included in the bid as there may be limits to how much testing will be accomplished without additional cost.

This can be assisted by agreeing and setting goals and criteria that produce positive results. Any key performance indicators (KPI's) should be measureable and achievable with set implementation and completion dates. Testing and monitoring are conducted to identify and select the proper chemical, a well's response, and to optimize treatments (reduce failures, improve oil and/or water quality, and reduce downhole issues such as paraffin, scale, and iron sulfide). Resampling should be required to record, track, and trend results to properly evaluate a chemical's response over time. However, three things should be considered when discussing testing and sampling.

When testing and sampling, ensure the quality of the data, select those tests that bring the greatest worth, and don't collect data for the sake of collecting. As an industry we love data but over collecting can take labor away from more critical tasks and can add to the overall costs. A chemical company can assist in prioritizing these activities. The next section details the types of data that can be collected.

DATA COLLECTION, CHEMICAL SELECTION AND TREATMENT TYPE

Once a vendor has been selected or during the selection process, the vendor must present their product selection ideas to the operator to receive approval from the chemical team on the operations side. The recommended products must be based on an understanding of the field including system variables such as the injection point, composition of all streams and operating conditions throughout the system. This will allow for improved understanding of optimal injection points and insurance that chemicals are not mixed when they are not compatible. Without an experienced chemical team it can be difficult to make educated decisions on accuracy of recommendations so reference analog field data and application conditions where products have had success for all product recommendations. Data must be shown for any recommendations with what issues that are the objective to solve. By discussing these items with the vendors the accuracy of the recommendation can be vetted without detailed knowledge of chemical.

Application of the chemicals should also not be done as a cookie cutter approach for the entire field. Chemicals should be recommended for specific uses to prevent unnecessary treatment on wells that may have different issues than the field wide approach. The product/method efficacy and monitoring program for recommended application and chemical type should also be addressed as needed sampling or application types change man power needs.

The below list describes multiple examples of data collection that can be used to select the chemical type and effectively monitor the success of the chemical.

- Full water analysis (FWA): Used for establishing baseline, predicting scaling or corrosion potential, and other issues caused by dissolved gases, solids, or compatibility
    - Scale modeling for $CaCO_3$, $BaSO_4$, $CaSO_4$, etc
    - Dissolved iron (Fe^+) is an indicator of corrosion
    - Dissolved Manganese (Mn) is an indicator of corrosion
    - Dissolved H_2S – partial pressure reflects severity of corrosion
    - Dissolved CO_2 – partial pressure reflects severity of corrosion
    - Dissolved O_2 – existence enhances corrosion
    - Total Dissolved Solids (TDS) as an indication of water salinity
    - PH to determine the water's acidity
    - Water compatibilities

    - Recommended to periodically take FWA to monitor the change over time in a well and beneficial to have a flowback monitoring program to establish baselines
    - Frequency must be determined by operator and vendor depending on needs
- Bacteria testing
    - ATP
    - Bottle Test
    - Frequency must be determined by operator and vendor
- Solids analysis: Used from solids taken at facility or during workover operations
    - Determines % hydrocarbon, water soluble, acid soluble, and insoluble
    - Can define relative quantities of different solids
    - Membrane filtration in flowlines to collect solids
- Oil analysis: Used to establish paraffin concern and treatment
    - Cold finger test
    - Pour point test
- Product Residuals
    - Residual trends overtime can be a great indicator of treatment success
- Coupons
    - Metal loss in mpy to determine corrosivity of the fluids
    - Determine chemical residual (is chemical getting through the system and how long is it lasting)
    - Monitor for paraffin
    - Critical to have proper installation and handling
- Emulsions
- Carryover

All of the above test types must have a frequency of testing as decided by the operator and vendor. It is beneficial to periodically gather FWA for wells to track changes over time with frequency determined by data trending. From the data collected above recommendations should be given for different chemical treating types. Each treatment may be necessary at different point in the production system. These are listed below:

- Corrosion inhibition
- Scale inhibition
- Paraffin inhibitor, dispersant, or solvent
- Solids control requirements
- Oxygen scavenger
- Bacteria removal or inhibition

During the bidding process it is difficult to judge differences between vendors recommended chemicals due to different concentrations of chemical with varied percentage of specific chemicals. This can, to an extent, be clarified by looking at the SDS sheets with the generic breakdown of chemical components and rough percentages but in general chemicals are similar and the recommended treatment volume is the tell-tale sign of the concentration. The volume of treatment is determined by volume, depth, fluid level, well tests, and type of chemical and is typically expressed in PPM. Along with volume, the treatment frequency must also be considered. An example is below:

- <10 bfpd – monthly
- 10-150 bfpd – every other week
- 150-250 bfpd – weekly
- 250-400 bfpd – biweekly or continuous
- >400 bfpd – continuous

Treatment type can also affect chemical selection. Wells can be truck treated/batched or continuously treated. With batch treatment there can be additional cost for the truck but the dosage and flush are much more controlled. Treatment size varies with application type and purpose and frequency of treatment is normally limited to a maximum of two to three times a week with a dependence on truck availability. Batch treating can be periodic and in combination with continuous to address a specific issue such as solids, paraffin, etc.

Continuous treatment has an additional cost as the operator is typically required to purchase the chemical injection pump, piping for set up, and tank so initial cost may be high. Tanks can be provided by the chemical vendor which is preferred as they are better able to properly dispose and manage a tank inventory. The vendor will typically install, maintain, and periodically monitor, but this should be discussed as the operator may need to help in this effort. For continuous treatment flush is provided by slip stream from tubing (for a rod pump application) that is unmeasurable and often difficult to control. There are meters that can be used for this application but they are pricey and have difficulty measuring a 3-8 BFPD flush. There is also a necessary training requirement for continuous treatment as slip streams can be found closed because the well was losing production back down the annulus or after a well is placed back on production the chemical and/or slip stream is not returned to use. Training and man power are concerns with continuous treatment as pumps quit pumping or the rate can inadvertently increase due to multiple reasons, tank levels and pumps must be consistently monitored, capillary strings may have to be a consideration if backside gas rates are too high and if the operator owns the tanks there are liabilities there.

For deciding between continuous and batch a cost comparison over time should be considered along with the issue that is being treated. Scaling issues in particular are continuous problems that need inhibition consistently whereas paraffin concerns may be able to be addressed on a batch basis. Both treatment types can be used in a combination to batch treat some chemicals and continuous treat others or perform a downhole cleanup prior to initiating

Specialty treatments may also be required and these can include the below:

- Squeezes-typically not used for shale plays in horizontals
    - Typically designed to place chemical in the reservoir
    - Designed to produce product back slowly
    - Residuals should be monitored to determine retreatment
    - Could be used if scaling at perfs is concern
    - Often used for scale but is used for other applications
- Acid jobs and soap jobs
    - Larger batch treatments to clean up a wellbore before or during other treatments if problems are not being addressed by smaller clean up jobs
    - These are more “designed” treatments with calculated contents of flush and combinations of chemicals to address specific problems
- Kill fluid treatment for workovers, hot watering/oiling, load and tests, etc. must have protection against bacteria, corrosion, and scales.

ESTABLISHING TESTING EXPECTATIONS AND KPI’S WITH VENDORS

Before entering the bid process the operator should have a general idea of testing needs and expectations but these can become more defined once a vendor and treating strategy is decided. As discussed above there is a variety of data needs, chemical types, and treatment options. When establishing testing expectations it is crucial to remember that collecting data for the sake of having data does not add value to a chemical program. All data collected must serve to establish an issue, prove treatment of the issue, or be used to ensure the value of the chemical program and integrity of a well. A summary of general expectations and KPIs are listed below. These must be agreed upon by the vendor

and operator and communicated frequently on both sides. The frequency of the sampling must also be decided between the vendor and operator for each specific type of data collected.

General expectations to be set:

- HSE expectations in line with both company standards (reporting of spills, PPE requirements, etc.)
- Service and communication
- Types of reporting for inventory, testing results, failure analysis with frequency
- Necessary meetings such as failure meetings, quarterly reviews of KPIs, monthly reviews of treatments and field issues, etc.
- Response time and an understanding of manpower limitations

Program tracking measures:

- Ensure technical aspect of product/method efficacy by utilizing tools such as but not limited to: water, solids, failure analysis and trending, etc.
- Vendor to accomplish listed data collection at required frequency and give proactive recommendations based on the data. Vendor recommendation must be challenged and checked with existing data and treatment success/failure. The success treatments can be tracked by ensuring frequency targets are hit for majority of wells.
    - Flowback sampling
    - Full Water Analysis
        - Recommended annually with the ability to test more frequently for newer wells.
        - It is beneficial for the vendor to put together a schedule of this sampling to give to the operator.
    - Bacteria Testing
        - Frequency is dependent on concern of the issues, once a baseline or treatment is established this may not need to be frequent
    - Solids Analysis
    - Oil Analysis
    - Product Residuals
        - Timing dependent on the man power available
        - For wells with consistent results monthly sampling or longer can be done if so decided
        - It is beneficial for vendor to collect samples before and after chemical change
    - Coupon utilization
    - Failure Analysis
        - To be done per operator request and results discussed with chemical team
        - Expectation for vendor to visit rigs, gather samples, and track parted rods, holes in tubing etc.
- Collected data must be input into vendor or operator database by a certain time period after data is received. This data must be communicated to the operator within that time period. The timing is dependent on the testing type and urgency of the issue.
- Inventory data should be received monthly and include beginning and ending tank levels, delivery dates and amounts, calculated pump efficiencies and calculated treated concentration versus recommended target concentration
    - Utilization of pump efficiencies or target concentrations are some of the best KPIs for both a per well and overall basis. They also help to control cost and ensure wells are not being over or under treated based on the vendor recommendations.
    - Exceptions to the over/under treating should be reported
    - Information concerning pumps working/not working or issues with the set up should also be provided in the inventory with what was done to fix the issue.

- Vendor to ensure product/method of treatment adds value to operator by submitting monthly costs with the pump efficiencies and percent of wells that hit their target concentrations
- Vendor to submit quarterly business review to the operator's production engineering and chemical team. Quarterly cost and cost/product units trending required.
- Vendor to prepare and present an annual business/technical review with goals for the upcoming year to reduce failure, optimize treatments, etc.

Leading indicators of a program's success can be taken from hitting target concentrations, seeing good product residual trends consistently, and successful cost management. The best lagging indicator is an overall reduction in chemically related failure rates of downhole equipment (ex. Rod pump) or surface equipment (ex. Plugged flow lines) and this is best tracked by both the operator and vendor.

OPERATOR AND MANAGEMENT BUY IN

For a successful chemical program it is crucial to have buy-in by both management and field staff for the operator. This can be achieved by communicating the success of the chemical program to reduce failures, downtime and costs. Field staff must be involved in the chemical program and vendors should always work to maintain a good relationship with them. It has been found effective to have training put on by both the operator's chemical team and the vendor to discuss what the field staff should be aware of on the chemical side and the effects that the chemical will have on their lease operating expenses. For example, discussing the cost of chemical compared to the cost of a rod pump failure due to a lack of chemical treatment is a very effective method to show the value of a chemical treatment followed by how to best maintain pumps, check rates, ensure no chokes in the slipstream system for continuous treatment. By doing this operations is able to see the direct impact they can have on managing their LOE. This type of communication is important as it established the big picture effect of the chemical program and reduces the likelihood of chemical being the first thing to go in a cost cutting environment. If the vendor and operator are not able to prove the positive effects of the chemical program to reduce overall costs by expending smaller amounts then the chemical program is not effectively treating a problem.

CONCLUSION

The success of a chemical program is most greatly affected by the culture of the operator and the communication between the operator and vendor. If the chemical program is always the first to get cut in lower cost environments then the value of the program is not being effectively communicated or the correct issues are not being addressed and the current program does not effectively manage issues in the field. At Anadarko Petroleum Corporation our management has trusted the operations and chemical teams to optimize the chemical program and have seen cost savings from these optimizations rather than cutting costs from cutting chemical. Without communication between the field, engineering, and the chemical vendor the program will not be successful as opportunities will be missed.

In conclusion, for the development of a successful program the operator must have a general idea of the contract type that best fits after assessing sampling and treatment needs, any treatment decisions must be based on data to ensure the root cause of a problem is being treated, and a cookie cutter approach should not be taken rather treatment should be decided on a well by well basis. Additionally, operations must have a basic understanding of treatment decisions with the training to know what they can directly impact as it never hurts to have as many eyes as possible on the chemical treatment of a well.

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