MONITORING OF FIELD CORROSION INHIBITION PROGRAMS BY THE USE OF WELL FAILURE ANALYSES

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ABSTRACT

Computer programs are being developed to identify wells that are not responding to the current chemical corrosion control program. Computer corrosion monitoring programs are a method to quickly and effectively process large volumes of data that are necessary to document changes in well conditions and chemical inhibitor programs.

Decision support software is also being used to competently select corrosion inhibitors by correlating existing system parameters with a data base of inhibitors and their associated characteristics. Computer programs have been developed to select treatment program inhibitors based on the particular corrosion problems and well characteristics identified at a given well site.

Through the use of these computer programs, an operator can implement a customized treatment program that is continually monitoring itself for optimum performance and cost savings.

INTRODUCTION

Integrated computer networks are a vital part of evaluating corrosion problems and treatment programs in the oil field.

Effective treatment of corrosion problems requires the timely and orderly manipulation of a vast amount of complex data. When an upset occurs, many parameters must be quickly evaluated if there is to be a quick and cost-effective remedy. These include: well conditions, production rates, the inhibitor used, and other characteristics--all unique to the particular system.

Not only must this vast and complex volume of data be quickly evaluated, the information generated must also be understandable to the many different people involved in the production process.

Finally, any evaluation of this type must provide a complete economic analysis. While the direct costs associated with well failures are readily apparent (such as equipment failures), the indirect costs are more obscure. Omitting indirect costs (such as lost revenue during downtime[1,2]) can lead to less profitable decision-making.

In an effort to re-evaluate and improve current operating practices, many producers have allowed treatment programs to deteriorate. Discontinuing programs, cutting back on treatment dosages or altering treatment methods represent some of the changes that have been made. But these alterations often yield only short term cost reductions. Computer programs like Nalco's PROFIT DATA make it possible to maintain continuing maximum operating profits. In one example, program prototypes enabled a producer to document unprofitable increases in well failures resulting from a reduction in a previously successful corrosion treatment program. The increase in failure rates was approximately 5% per 100 wells, resulting in additional operating expenses of several tens of thousands of dollars per 100 wells.

In summary, computers are currently being used to monitor corrosion inhibitor programs, recommend inhibitors where necessary and provide the necessary information to ensure operators enjoy a maximum return on their corrosion mitigation programs.

BACKGROUND

Corrosion problems in the oil field have many economic aspects that must be considered to evaluate a comprehensive corrosion inhibitor program. Computer programs not only address the items directly affecting an existing corrosion problem such as the replacement of the corroded equipment, but the indirect costs associated with the loss of revenue. Thus, improvements in current corrosion mitigation programs can be evaluated by monitoring decreases in total costs associated with corrosion failures (Table IV). For example, when mitigation decisions incur additional expenses (i.e. chemical or equipment) the operator's total expenses may decrease. Computer programs can easily track successful mitigation changes by evaluating reduction in total expenses. The program allows oil field personnel to become aware of the complete treatment program and the total cost savings a computer monitored program can provide.

The following report formats are available to examine field operations:

1.) Quarterly and Annual Well Operating Cost Analysis

2.) Field Well Failure Analysis

3.) Battery and Multiple Failure Well Analysis

Manual documentation of production data is extremely laborious. The above discussed requirements for comprehensive economic analyses of producing field operations, combined with the staggering volume of information, therefore renders manual data management unacceptable. Also, assuming necessary information could be filled efficiently, manual report generation to compare operating economics by various time periods would be extremely tedious.

Computer data base management can easily manage the large volumes of information necessary to economically evaluate producing field operations.

In addition to storing volumes of information, computers can easily generate usage reports for any time period requested. Thus, economic comparison of operating data can efficiently determine trends in operations. Also, software can be written to create various economic ratios used to more effectively evaluate changes in corrosion mitigation programs.

By effective computer management of producing data, corrosion mitigation programs can be altered to ensure the highest levels of profitability. An additional benefit of similar programs is the operator's ability to trend changes in field operations over time.

DISCUSSION

Data Input

Comprehensive economic data analysis requires matching well information with well failure information. Well information includes data pertinent to the operating characteristics of each producing well. Failure information includes information germane to each well failure. By combining well and failure information with operating parameters such as price of oil and price of chemical, economic production reports can be written for any time period where information exists and can also include various economic ratios.

Well information contains specific information germane to individual wells. Information is stored on a periodic basis as well operating parameters change. The date of entry is used to ensure proper data retrieval in report preparation for various time periods. Information archived is listed in Table I. Well information includes: Barrels Water Per Day (BWPD), Barrels Oil Per Day (BOPD), well depth, treatment method, dosages, inhibitor(s) used and fluid level. As well conditions change, new data with the current date must be entered.

The well failure information (Table II) data base includes specific information concerning each well failure. The information archived includes both economic expenses attributable to the failure and information concerning the cause of failure. Specifically, economic information includes: cost of repairs (rod, tubing, or pump), cost of service company, and length of time well was off production. Cause of failure information includes: type equipment which failed, location of failure and cause of failure. Additional information includes: remarks concerning failure, date, location, etc.

Additional information necessary for economic analyses is the appropriate price of oil, chemical expenses and current stop charges. With the above information and an appropriate time period, comprehensive well and/or field economic analyses can be generated.

Program Design

The design goal of the computer software is to allow the user to choose needed information. Once well information and well failure information is updated and adequately stored in the computer, the operator needs to only

input the operating parameters of choice. Parameters requested by the program include: field name, time period for analysis, the price of oil, price of chemical, stop charges and the economic ratios the user would like to see on the reports. Also, the user can choose which output report(s) to be printed.

Output

Computer program output formats are designed to provide the user with general to specific information regarding the economic performance and failure record of any individual producing unit. Also, the economic reports include several ratios which assist in the interpretation of data over various time periods. The ultimate goal of the output reports is to help manage corrosion mitigation programs toward increasing profitability. Toward this end, output reports include the general economic operating condition of a field to the specific characteristics of an individual well and its failures.

The Well Operating Cost Analysis report format details field expenses for Total Failures (Table III) and Corrosion Related Failures (Table IV). These reports summarize expenses for any chosen time period. The expenses summarized include: equipment replacement or repair costs, pulling service costs, lost production expenses and chemical and treating costs. The Well Operating Cost Analysis report will establish the success of changes made in a mitigation program. If total expenses increase, then the charge can be assumed to be not economically viable.

The Well Operating Cost Analysis also may include several economic ratios. These ratios assist in the interpretation of economic analysis in various time periods. These ratios include: 1) chemical investment ratio - total expenses per dollar invested in chemical and treating costs, (2) chemical profit data factor - chemical and treating costs per well times the number of failures per well, (3) profit data factor - total expenses per well times the number of failures per well, (4) total expenses per barrel of oil, (5) total expenses per barrel of fluid, (6) percent oil production. These ratios will provide background information necessary to evaluate past operating characteristics in a producing field. For example, should mitigation changes result in increasing costs, the explanation may be found in historically increasing water production.

The Field Well Failure Analysis (Table V) report identifies the location on production equipment where failures are occurring. Many failures are assumed, but in fact, not related to chemical mitigation. This report will identify, for example, galvanic and pump compatibility problems. Also, this report delineates failures as corrosion related or non-corrosion related for easier evaluation of current mitigation efforts.

Total failures and corrosion failures are itemized by rod, tubing or pump location. Also, expenses attributable to failures at each location are listed. These expenses include equipment or repair, pulling service, lost production, chemical and treating costs.

The Battery Well Failure Analysis (Table VI) delineates failures by battery. This report identifies those batteries where unique production

characteristics have resulted in excessive failures. This report allows the operator to identify problem batteries and alter current treatment programs accordingly.

Finally, the Multiple Well Failure Analysis (Table VII) identifies wells which have failed more than once during the requested time period. Similar to the Battery Well Failure Analysis, this report enables a well by well management of corrosion mitigation programs. Information listed includes: the number of failures, cost of failures, location of failures, current treatment methods and several well parameters.

SUMMARY

Computer programs which archive, retrieve and format historical information regarding the profitability of oil producing fields contribute to the overall successful management of corrosion mitigation programs. Corrosion mitigation programs are ultimately judged by the profitability of the system being protected from corrosion. Traditionally, economic performance of oil producing units on a battery or well basis has been difficult because of the significant number of constantly changing parameters. Computer programs can easily manage and calculate the desired economic analyses and/or economic ratios necessary to successfully manage corrosion mitigation programs.

REFERENCES

1. C. J. Cron and G. A. Marsh, Journal of Petroleum Technology, June 1983, pp 1033

2. H. B. Byars, Petroleum Engineer International, October 1985, pp 43

Table I
Well Data Worksheet

Customer: _____ Field: _____

Well Name	Battery	Depth	BOPD	BWPD	Fluid Level	Current[1] Treatment Method	Inhibitor Name	Dosage[2]	Frequency[3]	Barrels[4] Flush

[1] Batch (b) or Continuous (c)

[2] Gallons per application or quarts per day

[3] No. per applications per week - Batch only

[4] No. barrels - Batch only

Table II
Well Failure Information

Customer _____ Field _____ Well Name _____

Date of Failure _____ Rod Equipment/repair Cost $_____

Pulling Service Cost $ _____ Tubing Equipment/repair cost $_____

Days Shut-In _____ Pump Equipment/repair cost $_____

Failed Equipment Code _____ Location of Failure _____ Cause of Failure _____

Rod	RD	Unknown	UN	Unknown	UN
		Body Break	BB	Scale	SC
Tubing	TB	Upset Break	UB	Paraffin	PA
		Pin Break	PB	Sand	SA
Rod Pump	RP	Thread Break	TB	Corrosion	CO
Downhole Hydraulic	DH	Wrench Flat-Break	WB	Wear	WE
Submersible Pump	SP	Coupling	CU	Make-Up	MU
		Unscrew	US	Coating	CT
		Pulled	PU	Damaged	DA
		Hole	HO	Other	OT
		Split	SP		
		Wear	WE		
		Plunger	PL		
		Barrel	BA		
		Valve,Balls,Seats	VB		
		Seals	SE		
		Cable	CA		
		Motor	MO		
		Hold Down	HD		
		Gas Lift Valve	GL		
		Other	OT		

Table III
Total Failures

Profit Data Economic Analysis PAGE 1

Prepared for CLIENT'S NAME
CLIENT'S LOCATION
SUGARVILLE

PROFIT-DATA DEMO

13-May-86
District -VOO

Well Operating Cost Analysis

TOTAL FAILURES

Period 11/ 1/1985 thru 1/ 1/1986

EQUIPMENT REPLACEMENT OR REPAIR COSTS:			
Rod cost	$ 4,050.00		
Tubing cost	$ 16,000.00		
Pump cost	$ 1,500.00		
Equipment cost		$	21,550.00
PULLING SERVICES:		$	9,500.00
LOST PRODUCTION:			
Selling price of oil	$ 15.00		
Total shut-in time (days)	26		
Total lost production (bbls)	2,565		
Net lost production		$	38,475.00
CHEMICAL AND TREATING COSTS:		$	7,865.14
TOTAL OPERATING EXPENSES:		$	77,390.14

CHEMICAL INVESTMENT RATIO	=	9.84
CHEMICAL PROFIT DATA FACTOR	=	133.81
PROFIT DATA FACTOR	=	1,316.66
TOTAL EXPENSES/BARREL OF OIL	=	0.43
TOTAL EXPENSES/BARREL OF FLUID	=	0.13
PERCENT OIL PRODUCTION	=	30.12

Table IV
Corrosion Failures

Profit Data Economic Analysis PAGE 1

Prepared for CLIENT'S NAME
CLIENT'S LOCATION
SUGARVILLE

PROFIT-DATA DEMO

13-May-86
District -VOO

Well Operating Cost Analysis

CORROSION FAILURES

Period 11/ 1/1985 thru 1/ 1/1986

EQUIPMENT REPLACEMENT OR REPAIR COSTS:			
Rod cost	$ 4,117		
Tubing cost	$ 2,800		
Pump cost	$ 1,500		
Equipment cost		$	8,415
PULLING SERVICES:		$	8,132
LOST PRODUCTION:			
Selling price of oil	$ 15.00		
Total shut-in time (days)	26		
Total lost production (bbls)	2,565		
Net lost production		$	40,386
CHEMICAL AND TREATING COSTS:		$	3,286
TOTAL OPERATING EXPENSES:		$	60,221

CHEMICAL INVESTMENT RATIO	=	8.80
CHEMICAL PROFIT DATA FACTOR	=	120.1
PROFIT DATA FACTOR	=	123.1
TOTAL EXPENSES/BARREL OF OIL	=	.33
TOTAL EXPENSES/BARREL OF FLUID	=	.41
PERCENT OIL PRODUCTION	=	20.20

Table V
Field Well Failure Analysis

Profit Data Economic Analysis

Prepared for CLIENT'S NAME
CLIENT'S LOCATION
SUGARVILLE

PROFIT DATA DEMO

13-May-86
District - V00

Field Well Failure Analysis

Period 11/ 1/1985 thru 1/ 1/1986

LOCATION	TOTAL FAILURES NUMBER	TOTAL FAILURES REPAIR Cost	CORROSION FAILURES NUMBER	CORROSION FAILURES % OF TOTAL FAILURES	CORROSION FAILURES REPAIR COST	CORROSION FAILURES % OF TOTAL COSTS
ROD						
BREAK						
Body Break	3	27,600	3	100.00	27,600	100.00
Upset Break						
Pin Break						
Thread Break						
Wrench Flat-Break						
Coupling						
Unscrew						
Pulled						
Unknown	1	4,800	1	100.00	4,800	100.00
TOTAL	4	32,400	4	100.00	32,400	100.00
TUBING						
Hole						
Coupling						
Unscrewed						
Split						
Wear						
Other						
Unknown						
TOTAL	0	0	0	0.00	0	0.00
PUMP						
Plunger						
Barrel						
Valve, Balls, Seats						
Seals						
Cable						
Motor						
Hold Down						
Gas Lift Valve						
Other						
Unknown						
TOTAL	0	0	0	0.00	0	0.00
GRAND TOTALS	4	32,400	4	100.00	32,400	100.00

Table VI
Battery Well Failure Analysis

Profit Data Economic Analysis — PAGE 6

Prepared for CLIENT'S NAME
CLIENT'S LOCATION
FIELD NAME

SALES REPRESENTATIVE

4-Feb-86
District - TS

Battery Well Failure Analysis

Period 11/ 1/1985 thru 11/30/1985

BATTERY	NUMBER OF FAILURES	ROD FAILURES		TUBING FAILURES		PUMP FAILURES	
		TOT	CORROSION	TOT	CORROSION	TOT	CORROSION
GULF COAST	3	2	2	1	0	0	0
WESTERN	1	0	0	0	0	1	1
GRAND TOTALS	4	2	2	1	0	1	1

Table VII
Multiple Well Failure Analysis

Profit Data Economic Analysis — PAGE 7

Prepared for CLIENT'S NAME
CLIENT'S LOCATION
SUGARVILLE

PROFIT-DATA DEMO

13-May-86
District - V00

Program Output — Page 3-7

Multiple Well Failure Analysis

Period 11/ 1/1985 thru 1/ 1/1986

TOTAL FAILURES NO.	TOTAL FAILURES COST	TOTAL FAILURES TYPE	NO.	COST	BOPD	BWPD	TREAT. METHOD	FLUID LEVEL	FLUSH BARREL
BATTERY NAME = GULF COAST									
WELL NAME = GILMORE #8									
3	27,600	RBB	3	27,600	160	160	281	2,000	1
BATTERY NAME = WESTERN									
WELL NAME = NOOK #7									
1	3,750	RUN	0	0	60	330	481	1,000	1
1	5,100	PHD	1	5,100					