A Case History Of Paraffin Control Using Butane

By CHARLES O. LUKEHART
Samedan Oil Corporation

ABSTRACT

Numerous methods of paraffin control are in use today. In pumping wells the utilization of rod scrapers, commercial paraffin solvents, hot oil treatments, flow line steaming, internal plastic coated tubing, and plastic flow lines have been found to be effective. However, the cost of these methods for paraffin control is often high.

In an attempt to reduce these costs, experimental equipment for the injection of butane was installed on a pumping well in Carter County, Oklahoma, April 6, 1958. After two years of operating, the downhole injection of butane has successfully controlled the accumulation of paraffin in this well at a savings of approximately $1,100 per year over previous control methods. Extension of the butane injection process to eight other lease wells in April, 1959, should result in an additional savings of $2,900 per year.

The frequency and quantity of butane injection varies with the prevailing surface temperature conditions, and to date only minor problems have been encountered using the butane injection process.

INTRODUCTION

Associated with the production of crude oil is a substance commonly referred to as paraffin, a material which creates many additional and costly problems for the producer. The problem of paraffin accumulation is not limited to any specific type of well, crude oil, or stage of reservoir depletion. Because of the variable nature of this accumulation, many control methods are in use today. The methods used in a particular field or pool are generally based on the relationship between the cost and effectiveness of the method.

A relatively new and inexpensive method for the control of paraffin accumulation in the tubing and flow line of pumping wells is the downhole injection of a butane-crude oil mixture. Reductions in paraffin control costs by as much as 90 per cent have been obtained. The purpose of this paper is to outline the process and to indicate the savings that may be obtained by using this method.

RESULTS OF STUDY

Solubility Factor

In conducting a study of the paraffin problem it was found that the key factor involved in paraffin separation was solubility. Crude oil as it exists in the reservoir contains in solution varying percentages of waxes, gums, resins, and asphaltic materials; but in producing the crude oil to the surface and to the tank battery, the solution equilibrium is disturbed, and the paraffin material separates from solution. The most important cause of solubility change and resultant paraffin separation is temperature decrease.

Since it is difficult and expensive to maintain reservoir temperature throughout the flow string, an inexpensive method that increases crude oil solubility to allow for a temperature decrease is of value. Also of value is the solvent effect obtained by increasing the solubility of the crude.

Hydrocarbon Product

Butane, a relatively inexpensive hydrocarbon product, when mixed with crude oil increases the gravity and thus the solubility of the crude oil. Because the product is readily available at low cost, experimental equipment was designed to use butane.

One of the problems of downhole butane injection was the possibility that the injected liquid butane would vaporize and flow out the tubing-casing annulus, as most pumping wells must have the casing vented in order to pump the wells satisfactorily. It was noted that most of the casings were vented into the flow line against a separator pressure of 20 psig. Since butane has a vapor pressure of 52 psi at 100° F and 30 psi at 68° F, it was apparent that butane would have to be mixed with crude oil so that the resultant mixture would have a vapor pressure less than 20 psi. Thus a mixing vessel was added to the surface equipment design.

Surface Equipment

Surface equipment shown in Figs. 1 and 2 includes a butane storage tank with a liquid valve, a 24 in. x 49 in. 125 psi pressure mixing vessel with necessary valves and fittings, a 3/8 in. copper tubing for connecting the vessels, 1 in. line pipe from the pumping tee to the mixing vessel, a custom built bull plug in the wellhead with copper tubing connecting the mixing vessel to the wellhead, and a 30 ft. section of copper tubing (or plastic hose) in the tubing-casing annulus.

The cost necessary to install this equipment is $165 per well and is tabulated in Table 1.

TABLE I - COST TO INSTALL SURFACE EQUIPMENT PER WELL

Pressure mixing vessel	$72.00
Butane tank rental per year	18.00
Connections	60.00
Labor for installation	15.00
Total Cost	$165.00

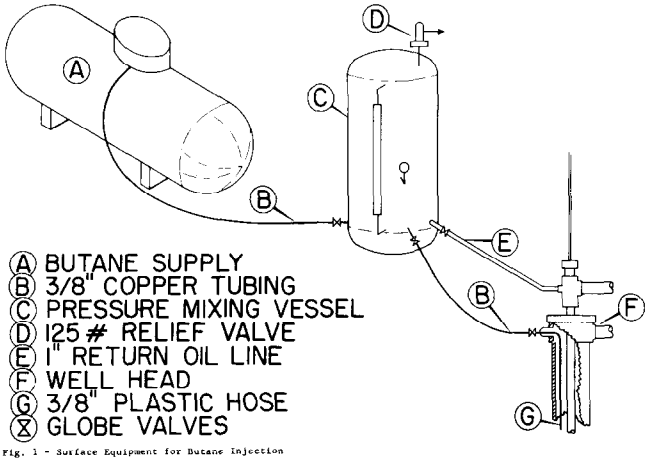

Fig. 1 - Surface Equipment for Butane Injection

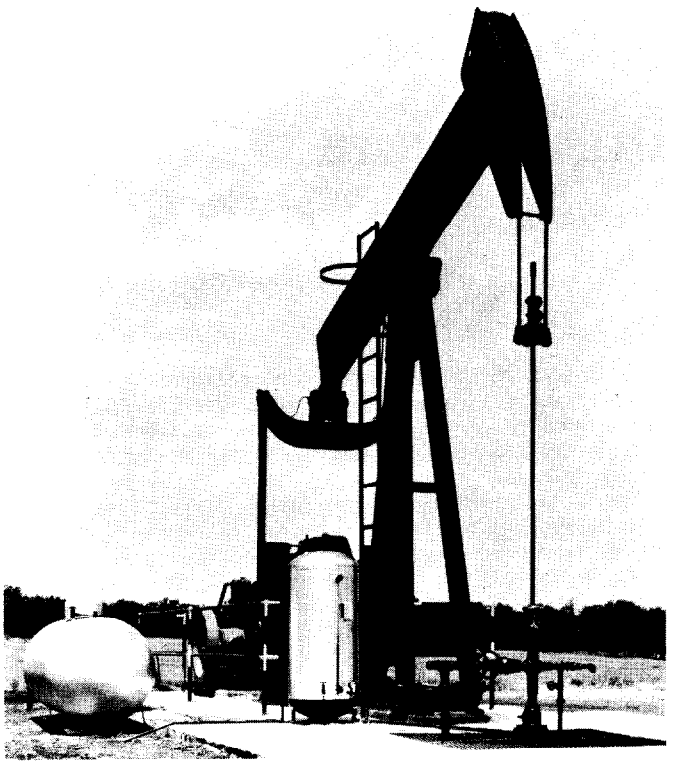

Fig. 2

Process

Crude oil is routed from the pumping tee to the mixing vessel through the 1 in. line pipe as the well pumps. Butane is then introduced into the base of the mixing vessel through copper tubing. The ratio of butane to crude oil depends to a great extent on the resultant vapor pressure desired. In the experimental project, a rate of 20 gal. of butane to 60 gal. of crude was used. The quantity of crude oil used was never less than 40 gal. in any of the tests.

When the pressure in the mixing vessel is greater than the casing pressure, the mixture readily enters the casing. When the vessel pressure is less than the casing pressure, the pressure equalizes and the mixture lubricates into the casing.

Once the quantity per treatment and the frequency have been determined, a pumper can perform the injection process as a routine duty.

EXPERIMENTAL PROJECT

Experimental equipment for butane injection was installed on a well in the Wheeler Morris Pool, Carter County, Oklahoma, on April 6, 1958. This well was chosen because of the difficulty and expense involved in paraffin control the previous year.

Butane and crude oil were mixed in a ratio of 20 gal. of butane to 60 gal. of crude, and the injection interval varied from daily to once every two weeks.

Periodic checks were made of the flow line, and no paraffin accumulation was found. The daily production remained fairly constant at 38 BPOD, and the rods fell freely during normal injection periods. The gravity of the crude oil from the well prior to treatment was 36° API at 60° F. When 20 gal. of butane were mixed with 60 gal. of oil, the gravity of the mixture was 56° to 57° API. Return oil from the well after treatment varied from 36° to 42° API, depending upon the amount of butane injected down the well.

During the warm summer months one injection every two weeks was found to be satisfactory, but with the advent of cold weather the well paraffined up and two or three injections per week were required to control paraffin deposition during the winter months.

For the one-year test period, the total cost of butane was $111. Cost of paraffin solvents and flow line steaming for this well during the previous year was $1,276.

Expansion of Project

In April, 1959, eight additional wells in the Wheeler Morris Pool were equipped for butane injection and results were satisfactory. During the ten-month period (April, 1959 - February, 1960) the cost for butane was $995 and that of flow line steaming was $105. Cost of paraffin solvent and flow line steaming for the previous ten months was $3.700. The cost to equip the eight wells was $1,320 with a payout obtained in five months. Based on the indicated cost reduction, a savings of $2,900 per year will be realized after the equipment payout. Combining this savings with the $1,100 per year for the initial experimental well, a total savings of $4,000 per year will be realized.

Three installations were made in other pools to test the effectiveness of butane in different types of crude oil. These installations were successful, but the savings were small because paraffin accumulation was not severe. The indicated savings per year for these wells was $200. However, two of the wells are located on leases that have ten wells per lease, and in cases such as this consideration will be given to mounting the equipment on a trailer. The trailer can be moved from well to well and the initial investment of $165 per well or $1,650 for ten wells can be materially reduced.

MINOR PROBLEMS

In general, the downhole injection of a butane-crude oil mixture has satisfactorily controlled the accumulation of paraffin in the tubing and flow lines; however, the following minor problems have been encountered:

1. If the prevailing surface temperature is below 50° F, propane must be added to the normal butane to have sufficient tank pressure for mixing.
2. If a well produces a small amount of water emulsified with the oil, the mixing of butane with this emulsion in cold weather forms a viscous fluid. Difficulty will be experienced flowing this fluid through a 3/8 in. line.
3. In wells that produce crude oil containing asphaltic materials, the mixing of butane may cause the precipitation of the asphalt in the mixing tank. This material will tend to plug the 3/8 in. line.
4. In wells that only pump off occasionally, the lighter butane-crude oil mixture tends to float on top of the fluid column, which decreases the effectiveness of the treatment since the butane must enter the tubing and return to the surface to produce the desired effect.
5. As the temperature decreases from summer to fall to winter, the frequency of butane injection must be increased to meet the increased rate of paraffin deposition.
6. In making new installations the injection of 15 gal. of butane every other day for one week will generally clean a well; however, if the well has previously produced through the tubing-casing annulus, difficulty may be encountered when the paraffin removed from the annulus enters the tubing.

SUMMARY

Butane injection effectively controlled the accumulation

of paraffin in the tubing and flow line of the 12 wells tested. The cost of paraffin control was reduced by as much as 90 per cent.

The frequency and quantity of injection varied with the prevailing surface temperature conditions.

Wells that pump off or pump and flow off are satisfactory for butane injection.

Wells that produce asphaltic crudes are not recommended for butane injection.

ACKNOWLEDGMENT

The author wishes to express his appreciation to the management of Samedan Oil Corp. for permission to publish this paper.