# A Field Study of Paraffin Control

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## INTRODUCTION

The primary purpose of this paper is to present a field evaluation of paraffin problems and to show how they can be alleviated by using certain plastic flow lines and plastic coated tubing. In order to more fully examine the advantages and disadvantages of the various methods available, a paraffin cost study of Field A and Field B is presented.

## COMPOSITION & CAUSES OF PARAFFIN:

Paraffin is defined as a waxy, solid mixture of hydrocarbons. Generally, an analysis of paraffin deposits indicates the presence of water, oil, asphaltic materials, gum, resins, and silt.

To study paraffin control, one must first understand the possible causes of this wax separation from solution and of the accumulation of these separated particles on equipment surfaces.

The separation of wax from solution is mainly caused by reductions in the temperature of the crude and the separation of volatile hydrocarbons from the heavier crude fractions, which reduces the solubility of wax in the crude. Following precipitation of the wax, the main factors governing accumulation of wax particles on equipment surface are the media through which the production moves, and the temperature reduction which occurs during its journey from the reservoir to the production heater treater. The produced fluid temperature reduction under winter conditions could decrease appreciably from reservoir temperature. Other factors which accelerate deposition are rod agitation, which increases growth of wax particles, low flow rate, intermittent flow, and the presence of extraneous materials such as sand and silt which may furnish nuclei for the consolidation of many individual wax particles.

During producing operations, production fluids tend to keep the paraffin moist and soft; however, during shut in periods, the accumulated wax has a tendency to dehydrate and become harder.

## PARAFFIN CONTROL:

Methods of paraffin control can basically be divided into three segments:

1. Keeping the wax in solution
2. Preventing either aggregation or adhesion of wax particles on equipment surfaces, and
3. Removal of deposits after the accumulation

The remaining portion of this paper will deal with the last two segments of paraffin control since we have not yet found an economical paraffin inhibitor which will keep the wax in true solution during production.

### Paraffin Control In Flow Lines:

In our field study of paraffin control, plastic flow lines proved most successful in reducing operational costs.

To better compare plastic and steel flow lines, let us discuss two fields: field A has steel lines and field B has plastic lines.

In field A, 216 wells are operated with a total of 248,000 feet of steel flow lines. Methods of alleviating paraffin in flow lines in this field are by steaming and running rubber plugs. Disregarding pumper's time and mileage, an average cost of 5.5¢ per foot per year is incurred as the result of paraffin deposition. This average cost per foot is relatively low, but the range in expense per foot per year throughout the field varies greatly. For example, 57 flow lines, or 26% of the total lines presently in use, have an annual cost beyond 10¢ per foot per year. To further extend the cost analysis, on 7 wells the cost was in excess of 40¢ per foot per year, and on 2 wells the cost exceeded 60¢ per foot per year. This information clearly reveals that paraffin control measures often are best approached on an individual well basis.

In most instances, the high costs incurred in removing paraffin from steel flow lines, as in field A, might have been reduced by careful evaluation of the field's crude from the discovery well.

As an example, in field B, upon completion of the first well, a laboratory crude analysis indicated that paraffin deposition would be a major operating problem On all initial well tie-ins, 2 inch plactic pipe was used for flow lines. The first pipe was installed in March, 1956 and now a total of 96,000 feet of plastic flow lines are servicing 55 wells. There are three types of plastic lines in service: 1. LOC plastic (Butadiene); 2. BOC plastic (Butyrate); and 3. PVC plastic (Polyvinylchloride).

## INSTALLATION OF PLASTIC FLOW LINES:

The success of plastic pipe definitely depends to a great extent on its proper installation. Using the correct thinner with BOC, LOC or PVC pipe, and taking care not to mix two different types of pipe in flow lines are very important practices to follow. The pipe should be laid below the freeze line and snaked in the ditch to take care of thermal contraction or expansion. The stringing of plastic lines can be done quickly due to their light, flexible composition.

Since the pipe used was not threaded, the collar and pipe were bonded together by dissolving each with a thinner compound prior to slipping together.

In field B, the lines were pressure tested using a compressor or the well pressure. After pressure testing each line, the ditch was back-filled. When caliche was present, top soil was used above and below the plastic lines. On 55 wells in field B, a total of 96,000 feet of line was ditched, installed and back-filled for an average cost of 14¢ per foot. The soil in this field varied from loose, unconsolidated earth to solid caliche.

For cost comparison, common 2 inch steel flowlines costs approximately five cents less per foot than 2 inch high impact plastic pipe. The installation cost is about the same without burying the steel lines as it is when the plastic lines are buried. Therefore, the main difference in initial cost of plastic pipe above steel lines is five cents per foot.

Causes Of Failure

Upon reviewing maintenance service, it has been found that most of the failures have been due to collar leaks. In one shipment of plastic pipe, there were a large number of poorly welded collars which failed in service. Failures have also been caused by bad collar installation in the field, and by opening wells that have high pressures, without bleeding down first. Caliche rocks had fallen in contact with the plastic pipe in one case, causing the pipe to split. Since the original installation and testing of lines, the average maintenance cost has been 2.1¢ per foot per year. In 1957, the maintenance cost averaged 1.6¢ per foot per year. The difference represents cost due to leaks that occured during the early service life of the pipe while it was still settling after back-filling. In the last months of 1957, we were averaging less than one break per month in the 96,000 feet of material in service.

Periodic random checks have been made of these flow lines throughout field B and no paraffin deposition has been found. The flow lines have been subjected to two full winter seasons, which should be a true test of paraffin deposition control.

Other operators are using steel flow lines and are hot oiling lines as they hot oil the wells. Some flow lines have to be cleaned every two to three months while others require less attention. One other operator is using plastic lines and has had satisfactory results.

Plastic pipe tested in this report has its limitations. It is important, as a general rule, not to operate over 75% of the working pressure rating. The normal rating on 2 inch high impact PVC averages 100 psig at 77$^{\circ}$F.

Of the three types of plastic pipe used, PVC, BOC & LOC, we have found in field B, that for general usage to control paraffin as well as corrosion, PVC has been the most desirable. PVC seems to be the most flexible during cold weather and has had fewer breaks.

The success of plastic pipe, if installed within the operating limits, depends to a great degree on the proficiency with which the crews install the lines. Education of these men as to the mechanics of field welding and tie-ins helps determine the maintenance cost in later years of operation.

PARAFFIN CONTROL IN DOWN HOLE EQUIPMENT:

The field study in preventing paraffin deposition in down hole equipment largely has been confined to plastic coated tubing. The use of baked-on plastic coated tubing strings has rapidly grown in the last ten years, with many different types of material available.

Normally, new steel tubing is plastic coated as this usually gives the best results. The general procedure in the plant is to clean the pipe of mill scale, grease, and varnish, and then sand blast the pipe to give a rough internal surface to aid adhesion of the plastic to the metal. The number of coats and bakings are usually designated by the applicators, but can be custom designed to other specifications. A final high temperature bake polymerizes the successive coatings into a single tough film 3 to 5 mills thick.

Reputable applicators use extreme care through the coating preparation and application by utilizing proper inspection equipment to assure proper adhesion and uniform coating thickness. In choosing coatings for paraffin control, especially in pumping wells, it is best to use a tough, flexible coating that will stand up during the stresses caused by tubing travel while pumping, as well as during the continual abrasion of rod and couplings. Other qualities desirable are high impact strength and the ability to withstand rough handling. If a coating tends toward brittleness, it is often unsatisfactory for paraffin control in a producing well.

Now consider down hole wax problems in field A and B. In field A, we are operating three types of wells using plastic coated tubing: 91 flowing, 8 gas lift, and 17 pumping. Paraffin removal cost per year by scraping was averaging $268 for each flowing and gas lift well, with the cost for each pumping well averaging $550. Hot oil or steaming could not be used due to high fluid levels. When inspected it was found necessary to use 1500 feet of plastic coated tubing to effectively alleviate paraffin deposition. The first plastic coating was installed ten years ago, with the major portion of the 175,000 feet now in service being installed 3 to 4 years ago.

Mechanically Effective

On the 116 wells, plastic coated tubing has proven 89.7% mechanically effective with payouts ranging from 15 to 48 months.

On original completion of wells in field B, no immediate down hole paraffin control projects were started. Paraffin accumulation was removed by scraping and hot oiling. The cost of scraping was averaging $90 per job while hot oiling was averaging $60 per job. In early 1957, increased costs caused us to test different means of down hole paraffin control.

Plastic coated tubing was tested and proved 100% effective in two wells, using 750 ft. in each string. The coating used was a baked-on modified phenolic, costing approximately 30¢ per foot with installation cost on these pumping wells averaging 20¢ per foot.

Well studies indicated paraffin cost per year in field B ranged from zero to $175 per well. The last inspection indicated that from 375 to 500 feet of plastic coated tubing would have been adequate. A string 375 to 500 feet installed would have cost $187 to $240, with a payout of a little over one year in the more severe wells. Another cost saving realized was the reduction in horsepower consumption over uncoated wells. From field measurements, the reduction of horsepower has been as high as 50% over wells with severe paraffin accumulation, which would amount to

$120 per year for additional power costs. Also, paraffin accumulation increases horsepower demand and in some cases has overloaded the present electric motors, causing early failures.

Other Methods Of Alleviating Deposition

Other methods of alleviating deposition in down hole equipment tested in field B, were chemical compounds and rod scrapers.

One chemical compound was a surface active agent that was claimed to act as a wax dispersant when injected daily down the casing. The injector was purchased and installed for $88 and the yearly chemical cost was $180. After eleven months of operation, the well paraffined-up in the top 300 feet of tubing and it cost over $100 to remove this deposition. Down hole paraffin costs totalled $368 for that year.

The second compound tested was an organic solvent which was claimed to disintegrate, dissolve and disperse wax cake. Initial cost to install and purchase an injector was $92, with a yearly chemical cost of $162. There was a considerable amount of paraffin deposition after eleven months of operation and a hot oil job was performed adding an additional $75 expense. The down hole paraffin costs using this organic solvent were $324 the first year.

It is apparent that truly exhaustive tests of all compounds have not been made in these two fields. There may be more effective chemicals available, or those tested may be effective in other types of crude.

Three wells in field B were tested using rod scrapers with strings of 400, 600 and 800 feet. The original cost of purchasing and installing ranged from $217 to $289. Results of rod scrapers were satisfactory; however, horsepower consumption was somewhat higher than on the plastic coated wells, and some paraffin was present when the wells were pulled for checking.

## CONCLUSION:

A paraffin study in fields A and B shows the magnitude of wax deposition and the field results that plastic flow lines and plastic coated tubing have given on several types of producing wells. The use of both plastic flow lines and plastic coated tubing has been effective and has resulted in a large monetary savings. The most economical method of utilizing plastics is the incorporation of flow lines and coated tubing on the initial completion rather than installing this equipment at some later date. If a lease is already developed with unprotected pipe, the best approach is then to justify plastic flow lines and/or tubing installation on an individual well basis.

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