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Driller's Challenge: The 28,000 Foot Hunton

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ABSTRACT

The deep Anadarko Basin is expected to become a major gas producing province within the next decade. The Hunton formation, sometimes occurring as deep as 28,000 feet, is the primary objective of today's gas exploration in the Basin.

The drilling industry faces the challenge of providing the equipment, and technology, to drill wells of this depth on a continuous and economical basis.

Because of the many wells drilled below 20,000 feet in the past five years, the industry today has the experience and the technical ability to successfully meet this challenge.

INTRODUCTION

The Petroleum Industry must find new gas reserves. The Anadarko Basin, long one of this nation's major gas producing provinces, now is being explored to it's deepest extent for this gas. This nation's continuing need for energy has made what once seemed uneconomical and impractical, a necessity.

Today, the Hunton formation of Devonian age is one of the primary targets for this deep gas exploration. There are presently several wells drilling to the Hunton, which may occur as deep as 28,000 feet.

A few years ago, a 28,000 foot well would have been totally uneconomical. Deep drilling, at that time, had not become the routine matter that it is today, and the demand for gas had not reached the point where gas transmission companies were willing to bid for the gas before the well was spudded. The combination of these two facts, the improvement in drilling and the improvement in the supply and demand for gas, has made the 28,000 foot well a reality.

However, a well of this depth still represents a tremendous challenge to the industry. Well costs in excess of 2 million dollars, well depths deeper by 2,000 to 3,000 feet than any ever drilled, unknown geological problems, and finally the risk of wildcatting at any depth, makes this one of the most dramatic challenges the drilling industry has ever faced.

THE CHALLENGE

Today, the driller is challenged to drill the well successfully to the Hunton formation so that the producer can test this reservoir. If the reservoir is sufficient to be commercial at this depth, the driller then faces the challenge of drilling the 28,000 foot development wells on a sustained basis, successfully and economically.

The problems of the Anadarko Basin are many and depth will create many more. The driller must look at the usual problem areas of long shale sections, loss circulation, high pressure gas, steeply dipping beds, and hard rock. The increased depth of the Hunton well will create new problems. These will be large diameter holes required for large surface and intermediate strings of casing, small diameter production holes at great depths, special casing requirements, special surface equipment requirements, possible extreme pressures and heat, and the added factor of more time of exposure to all of the routine problems.

The driller is better prepared to face these problems today due to the experience of the past 5 years. Much has been learned in that period about rig requirements, personnel, and techniques.

PERSONNEL AND PLANNING

To solve these problems and plan this well, the industry today depends on the top personnel in several companies. With well costs of over 2 million dollars, the Producer does not hesitate to put his best engineers and management into the project. The Contractor who will drill the well will provide his best supervision and crews to insure the Operator a successful job. The service companies will send their most qualified personnel to plan and assist the Producer and the Contractor in their specialized phase of the operation. Together, these men form a drilling team that will take the well from planning to production.

Of the improvements made in the past decade in deep drilling techniques, the one that stands above all others is the team approach to successful drilling. By detailed planning, based upon the knowledge of all of the people involved, by constant communication between these parties throughout the drilling operation, and by the refinements of the very basic drilling techniques, deep wells have become routine.

Since the success of the 28,000' well, like any other, depends on the casing program, the planning will start at this point. The basic questions of where to set pipe are much the same as on any well, but now these questions are compounded by the depths at which the pipe will be set. The Engineer designing the casing will begin by determining the size of tubing needed at 28,000 feet to permit the production of the amount of gas anticipated. This decision will determine the production casing size and the hole size needed through the pay zone.

As the casing program evolves, consideration must be given to some factors not considered on shallower wells. Depths at which certain size casing is set may require special weights and grades of casing. The size hole that can be drilled through a heavy wall casing becomes extremely critical. The size intermediate strings determine the surface and the surface hole size can become critical. The weight of a particular string of casing may dictate larger surface equipment than is available.

Each of these factors may affect the success or failure of the well and will certainly effect the cost of the well. The less expensive casing, although it may permit the well to reach total depth, may prove to be the more expensive design. The reasons for this are that drilling rigs and drilling tools can drill certain size holes much faster than others. An example of this would be a situation which would permit a 12-1/4" hole being used in place of a 12" hole. In the 12-1/4" hole size the driller has a wide choice of bits and bearing types. In addition to this, the 12-1/4" bit, because it is a common size, has the advantage of years of engineering refinement. If the casing used should be so heavy that the 12-1/4" bit cannot be run, a 12" or a special order bit of 11 and some fraction inches may be used. The penetration rates will then suffer because of the lack of bit selection and because of the poorer performance of these bits.

When looking at a well bore of 28,000 feet, it becomes obvious that many casing strings are going to be required to be completely safe. This creates the problem of large surface strings of casing. The problem here is not in handling the loads at the surface but in drilling the hole required for this pipe. Regardless of the size rig available, the industry today does not have the tools or equipment to make a bit larger than 17-1/2" perform like an 8-3/4". The reason for this is that enough holes of this size have not been drilled to depth to warrant the tool makers time and money to perfect the bits. Drill strings have not been designed to provide the energy at the bit to do the job like an 8-3/4". The only salvation has been that the surface strings are usually set in the softer beds where fair drilling rates can be maintained. When these holes are extended into harder formations at greater depths, well costs will increase dramatically.

The problem then for the designer on the deep hole is to limit the casing strings to as few as possible, to try to maintain common hole sizes, and to wind up at total depth in a hole large enough to

permit an economic string of production tubing.

On a well of this depth, rig and drilling costs will run between $3,500.00 and $4,000.00 per day. It is obvious that every day gained on penetration rate will permit money to be used in designing the most "drillable" casing program. Contractors and tool company personnel should become involved in the planning of this pipe program to advise on rig requirements, tool availability, and bit performance. No other decision on this well will be as important as the selection of the correct casing program.

The solution to some of these casing problems may be in the mud program. Mud companies have experienced greatly from the deep work of the past decade and their knowledge has not only cut mud costs, but has also cut time on wells and improved well productivity. In the earliest planning stages, the mud company personnel should be involved on the planning team to assist by pointing out problem areas and suggesting mud specifications for various intervals of the hole.

Only after the casing program and the mud program have been planned in as much detail as possible, with alternates to allow for the unexpected, will the Operator be able to select the drilling rig needed for the job.

RIG AVAILABILITY

Most of the deep wells of recent years have been drilled with equipment that was designed and built over 10 years ago. The general label of "big" has been applied to rigs capable of handling loads of one million pounds.

These rigs are available today to drill most of the wells in the Basin to depths of 24,000 feet. As the Anadarko Basin is explored, it will be evident that this size rig will be able to handle most of the drilling on an economical basis. This will be true because total depths will be fairly closely established, casing programs will be modified with experience, and overall requirements will be such that the one million pound class rig will meet all of the requirements.

However, the 28,000 foot well is another matter. During the exploration stage, the limits of the Hunton are not known and a well in good condition at 28,000 feet with a dry Hunton zone may be pushed on to the Arbuckle at 30,000 feet. For this reason, a new big rig era faces the Contractors interested in drilling in this area. There are a very few rigs in the U.S. capable of handling hook loads of over 1,000,000 pounds and capable of the type of loads imposed by a 30,000 foot well. Two of the rigs presently drilling on deep Hunton wells have been brought to the oilfield from large diameter jobs for the A. E. C.

If the Hunton proves to be commercial at 28,000 feet, more rigs will have to be built to meet the demand. The cost of building these rigs is the only obstacle in the way of the Contractor who is interested. Masts, traveling equipment, wire line and drawworks are all available today which are capable of handling loads of 1,500,000 pounds.

Other rig components including power units, mud pumps, and support equipment will vary little on these rigs from that being used on deep hole rigs today. The reason for this is that most of the time on a well will still be in depth ranges and hole sizes that are the same as those on shallower wells. At the deeper depths, small hole sizes will limit the amount of horsepower that will be required.

Drill strings capable of reaching as deep as 30,000 feet can be designed using present day weights and grades. This is accomplished by running a combination of sizes. When this is permitted, the Contractor can provide a drill string which will meet normal oilfield safety standards at total depth.

As casing programs are refined, it will probably become evident that casing loads can be reduced and this may lend itself to the use of more of today's 1,000,000# class rigs being used on the 28,000 foot well. This will certainly permit a reduced drilling cost to be realized on some wells, and will also help provide the necessary rigs for future development.

DRILLING TOOLS AND TECHNIQUES

Most of the improvements made in reduced drilling costs on deep wells have been due to refinements in the very basic drilling techniques used in rotary drilling for years. More savings are attributable to proper casing design and personnel improvements than in hole making itself, but all of these factors are so interrelated that progress has been constant due to many small changes.

The one area in which improvements have been occuring constantly, with dramatic results, is in rock bit technology. The various bit manufacturers have brought to the market in the past 5 years a complete new generation of rock bits. These bits have improved cutting structures and improved bearings. The major improvement has been in the tungsten carbide insert bit which was once used as only a last resort in hard rock. Today, with new

cutting structures, these bits are run at all depths in all formations, except the very soft shales.

Because of the fact that these bits do not become dull as quickly, the manufacturers have had to design new bearings to permit the bits to stay in the hole for extended runs. The combination has permitted the driller to stay on bottom continuing to make hole and eliminating many time consuming trips that once made the deep well a two year project.

Improved knowledge of drilling fluids and rheology has played an important role in hole making. Perhaps the best way to describe the advances made in this area is to point out that the driller has learned that he can clean the hole and drill faster with less mud.

Shale inhibition, underbalanced drilling and hydraulics based on low return velocities, have all been factors in this improvement. By controlling shales, lower viscosities have been made possible. Underbalanced drilling has permitted wells to be drilled through gas zones with less mud weight. Reduced annular velocities have decreased hole erosion allowing holes to be drilled with fewer hole cleaning problems. Each of these have contributed greatly to the overall reduction in mud costs and improved penetration rates.

Optimized drilling is the technical name applied to the best present day drilling practices. The better educated drilling personnel of today are aware of the many factors effecting penetration rate. Through the use of offset well information, including bit records, logs, and mud data, each bit run is planned to permit the cheapest foot of hole possible. The optimized program may be no more sophisticated than a Toolpusher planning each bit run off his trailer house table top, or it may be the results of a computerized program from one of the major oil company's research laboratories.

Once again the team approach will provide the best program. The geologist, the company supervisor, the toolpusher, and the bit manufacturer's engineers working together will provide the driller with the right bit in the right place and the correct RPM and weight for the maximum performance.

Drilling with high pressure gas, although never routine, has become so common that today's drilling crews have learned to handle the gas kick with a minimum of lost time. Crews are also better educated in blowout procedures, making the operation safer as well as less expensive.

CONCLUSION

The combination of personnel, equipment and techniques are available today to drill to 28,000 feet. The knowledge gained in the past 5 years has given the industry the confidence needed to attempt this test. The agressive attitude that has continually cut time and costs on all drilling will be applied to these wells so that some day in the near future these wells will be referred to as routine.