Panel Discussion On Methods Of Artificially Lifting Multiple Completed Wells

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INTRODUCTION

The discussion this afternoon will be on the methods of artificially lifting multiple completed wells. I'm the moderator, Medford McCoy, Continental Oil Company, Midland. Mr. W. C. Smith, assisted by Mr. Jack Gallian, will discuss the merits of rod pumping; Mr. Jay Morgan, assisted by Mr. Ray Elner, will discuss the merits of the hydraulic rodless method; and Mr. H. J. Irons, assisted by Pat Massey, will discuss the merits of gas lift installations for producing multiple completed wells. Mr. Smith will start the discussion.

MR. SMITH:

MERITS OF ROD PUMPING

As I understand it, the purpose of this panel discussion is to assist those in attendance in their selection of artificial lifting methods for multiple completed wells.

Several points should be considered when selecting equipment for dual completed wells:

1. Size of casing and depth of well.
2. The immediate and future anticipated fluid withdrawal rates and working fluid levels.
3. Would it be economical to temporarily abandon one zone and deplete the zones separately?
4. The original cost of equipment considered.
5. Complexity of equipment considered.
6. Anticipated operating costs.
7. Versatility of equipment considered.
8. Availability of equipment.
9. Salvage value.
10. Experience of field personnel.

Sucker rod installations are now being used to lift as much as 300 barrels of fluid per day from dual wells with tandem rod pumps installed at 10,000 feet, utilizing 2-7/8 in. O.D. integral joint and 1 inch integral joint tubing run through 5-1/2 in., 17 pound, extreme line casing.

The cost of dual sucker rod equipment varies considerably with the type of installation, but this type of equipment can be installed at a reasonable cost which will compare with the cost of at least one of the other two types of popular lift equipment.

It costs less to operate a dual well with tandem sucker rod equipment than it does to operate two single wells that are similar. Certainly, the operating cost of dual sucker rod equipment is comparable to that of the other lift systems.

Sucker rod installations are versatile. On completion of a dual well, downhole equipment may be run that will allow both zones to flow. Later, one or both zones may be pumped without pulling any equipment previously installed.

None of the three major dual lift systems are best for all applications, but the conventional, familiar rod lift system can most often be used economically.

MR. McCOY:

Thank you very much, Mr. Smith. Our next speaker will be Mr. Morgan, who is going to discuss the use of the hydraulic rodless system.

MR. MORGAN:

HYDRAULIC RODLESS SYSTEM

The best designed method of artificial lift for a multiple zone completion cannot approach the simplicity and efficiency to which we are accustomed in the single sell completion. Yet as prudent operators we are forced by economic necessity to sacrifice to a certain extent simplicity and efficiency and to take calculated risks in designing a workable artificial lift system for the multiple zone well. The properly designed system must be a compromise to a number of limiting factors such as: casing size, depth, volume requirements, corrosion, scale deposits, paraffin accumulation and the dissipation of gas trapped below a packer.

It is my purpose to present to you some of the applications of subsurface hydraulic pumping in the design of these systems.

The subsurface hydraulic pump is not unlike the other artificial lift methods described here today. With each of these it is necessary to provide a means of conducting power to the bottom of the hole and a means of conducting the producer fluids to the surface for each zone. It is possible with the subsurface hydraulic pump system to utilize a common element for transmitting power to both zones of a dual well. But like the other methods, it is necessary to sacrifice the advantage of individual zone control.

I would like to review very briefly the principles of the subsurface hydraulic pump and then elaborate on the application of these principles to the design of artificial lift for the multiple zone well.

The subsurface hydraulic pump utilizes a source of high pressure oil to transmit power to the subsurface production unit. The production unit located at or below the working fluid level in the well consists of a fluid driven engine directly connected to a single or double acting positive displacement pump. The production unit may be run into the well on a rigid conductor or may be designed as a free pump which is pumped into and out of the well by the power fluid.

Production units are now available with tandem pumps connected to a single fluid driven engine to double the pump displacement within a given size tubing. This is an oversimplified description of the subsurface hydraulic pump but it will suffice as a basis for considering the application of this type lift to multiple completed wells.

First let's look at the means of transmitting power from the surface to the produced fluid. Friction losses in a properly designed hydraulic system are very small; therefore, this system is very efficient in transmitting power from the surface to the production unit. The double acting production unit is hydraulically balanced. Receiving power from a nonelastic fluid supplied at a constant pressure, work is done on the produced fluid at a constant rate. There is no perceptible motion in either the power or produced fluid conductor.

How may these factors be applied to multiple well completions? Let's review three of the limiting factors to be considered in such a design.

Casing Size, Volume Requirements, and Depth

Within a fixed casing size, particularly at the greater depths, the high efficiency of the hydraulic system in transferring power to the produced fluid may be required to meet the desired fluid production. Also, the fact that there is no perceptible motion or stress reversal within either of the conductors reduces the strength requirements in selecting these conductors. For example, in 7 in. OD casing, 2 3/8 in. OD regular tubing may be used to depths in excess of 8,000 feet.

The added clearance available in the choice of regular over upset tubing is an important factor, particularly when a third string of macaroni tubing is used. The advantages of a rigid power conductor in the tubingless completion are well recognized. One has only to read the recent articles in the technical journals to perceive the importance of the role this type of artificial lift is expected to play in this newest type of well completion.

Corrosion, Scale Deposits, and Paraffin Accumulation

Now let's consider three more of the limiting factors to be considered in the design of an artificial lift system for the multiple zone well. I have grouped these together because they are problems which can generally be alleviated by some type of chemical treatment. The power fluid of the hydraulic pump system is a "made-to-order carrier" for these chemical treatments. Using the power fluid as a carrier, chemical treatment can be applied to all of the lift system above the pump intake valve and within the production conductor.

Dissipation of Gas

We have at this point considered all of the limiting factors mentioned previously except the dissipation of gas trapped below the packer. It is possible to design a single packer subsurface hydraulic pump installation in the larger casing size with a vent line for the gas from the lower zone. With the present commercially available equipment this is not possible in the smaller casing size. This is one advantage that must be conceded to the other type of pumping considered here today. However, I must also point out that with the other system, there is a depth limit below which they lose this advantage.

When it is impossible to vent the produced gas, the problem then becomes one of designing a pump which cannot be gas locked. The hydraulic pump is the immediate solution to this problem. One type of production unit is designed with a compression ratio in excess of 50 to 1 which is normally adequate to prevent gas locking of the pump. In addition a small volume of power fluid is injected into the pump on each stroke. Although this is injected primarily for lubrication, it also serves the purpose of displacing gas from the pump. In another type production unit a "flood valve" opens at the end of each intake stroke, filling the chamber with power fluid.

There are other basic considerations in the design of these artificial lift systems which are important and have not been mentioned here. I have attempted to point out in the limited time only those factors in which subsurface pumps might offer a particular advantage.

I have not elaborated on tubing arrangements for the subsurface hydraulic pump in dual wells. It is possible in 5 1/2 in. OD to run two free pumps using one string of 2 3/8 in. OD tubing, two external strings of macaroni tubing and the casing annulus as conductors in a two packer installation. There is another two packer installation for 5 1/2 in. OD casing in which conventional pumps are run in 2 3/8 in. tubing on 3/4 in. tubing and two external macaroni strings are used, thus avoiding the use of the casing annulus as a conductor.

CONCLUSIONS

It would not be fair to conclude this discussion without mentioning some of the limitations of the application of the hydraulic pump system. At the shallow depths, with small fluid volumes, the hydraulic pump may not be able to compete economically with other types of artificial lifts unless some peculiar circumstances are involved.

The economics of hydraulic pump operations are directly related to the quality of the power oil and treating system. Where high gravity crudes are used as power oil, a more expensive treating system is required to remove as much of the abrasive material as practical. Where low gravity crude is used, more abrasives can be tolerated.

There is one more point that I would like to bring forth. Hydraulic pumping for the past 20 to 25 years has been a specialty item not in widespread use. Consequently the only developments and improvements were those demanded by these few special cases.

In designing artificial lift for multiple well completions, each installation is a special case. The need has developed for new adaptions of hydraulic pumping. The interest has been stimulated as evidenced by the number of companies entering this field. I believe that there will be more development in this field during the next five years than has taken place during the entire history of this lift method.

MR. McCOY

Thank you Mr. Morgan. Our next speaker will be Mr. Irons, who will discuss gas lift as a means to produce multiple completed wells.

MR. IRONS:

GAS LIFT

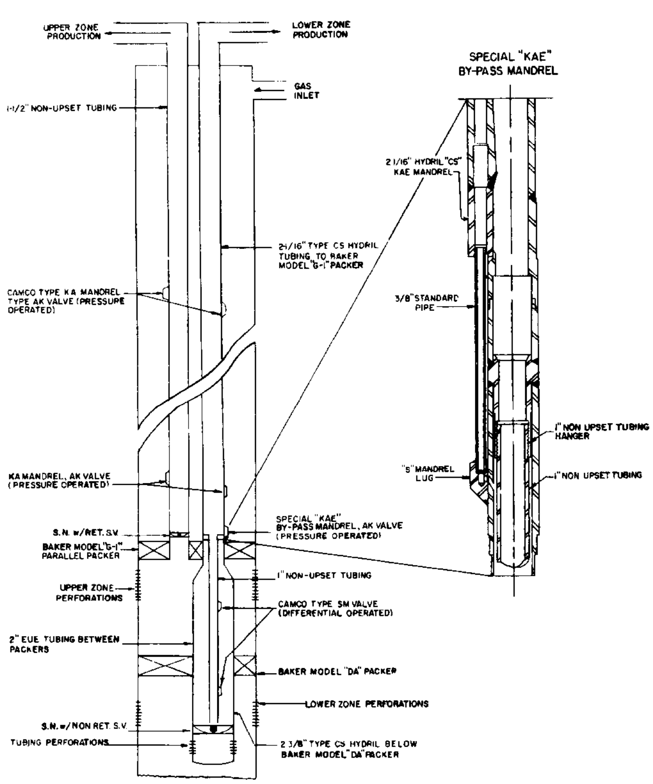
Gas lift, as a means of artificial lift, can be successfully utilized in either single or multiple zone completions. The basic principal of gas lift is as follows: (1) high pressure gas is injected into the casing annulus (2) a gas lift valve (either pressure or fluid operated) below the tubing fluid level is opened and (3) the casing gas passes through the valve and the fluid above that valve is lifted to surface. This can be accomplished through intermittent type operation where the fluid is lifted by slugs, or through the aeration of the fluid column, this permitting natural flow from the formation energy.

In multiple zone completions, various combinations of the above methods have been utilized. The productivity of the well is of utmost importance and actually dictates the method of gas lift operation. Generally speaking, the continuous flow method is limited to the medium or high capacity wells where large volumes of fluid are desirable.

However, in the medium capacity wells, fluid operation or pressure operation can also be used successfully. In the low-capacity low-BHP wells pressure operation, permitting positive surface control of either zone, is almost compulsory. Although numerous combinations of gas lift installations are being used, this discussion will be limited to pressure operation of all zones with positive surface control of each zone.

With reference to this method of operation (see attached drawing), the installation can be set up to include all wire line retrievable equipment from top to bottom. Therefore, valve and standing valve repairs can be made without distrubing the tubing strings. Also, it should be noted that the point of gas injection to the lower zone is not at the top of the upper packer, but has been lowered to the depth of the lower zone through the use of the dip tube arrangement. This is very important because in low-capacity low-BHP wells, the height of the fluid column from the upper packer to TD could hold an appreciable back pressure on the formation.

DUAL INTERMITTENT GAS LIFT
IN 5 1/2-INCH CASING

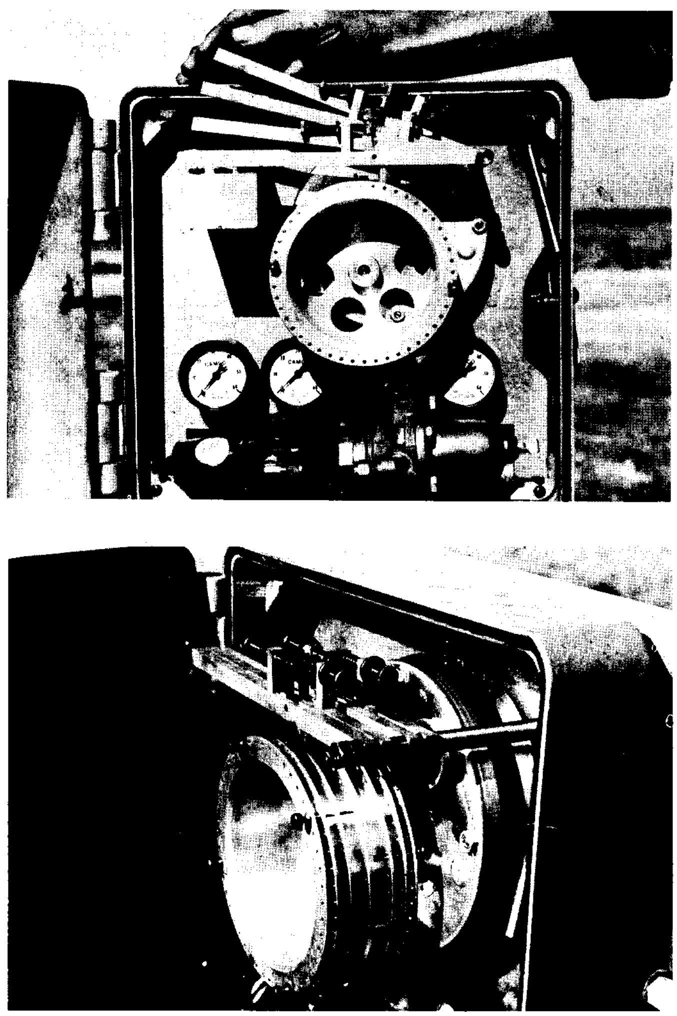


This drawing actually shows an installation in 5 1/2 in. casing; however, where 7 in. casing is available, this, or similar installations, are utilized. In 7 in. casing it should be noted that the dip tube can be sealed off at the bottom. Pressure operated valves can then be run between the upper packer and the lower zone. These valves can be in the wire line retrievable series if desirable.

As previously mentioned, positive surface control of each zone is possible in the intermittent operation of all zones in a multiple completion well. This is accomplished through the use of centrally controlled motor valves as follows: (1) gas is injected into the casing annulus (various injection cycles possible for each zone) to lift upper zone (2) motor valve on lower zone flow line (normally open) is closed (3) operating gas lift valve in upper zone opens (4) fluid from upper zone is lifted to surface and (5) lower zone flow line motor valve opens to permit maximum fluid buildup.

This operation is accomplished through the use of a single surface controller that operates all motor valves (see attached pictures). As can be seen, the controller consists of a single clock, a four-groove timing wheel and an individual adjustable control arm for each operation. This method of operation has proved satisfactory. Approximately 35 installations are currently in use in the Permian Basin Area.

SURFACE EQUIPMENT FOR DUAL
GAS LIFT INSTALLATION WITH
CAMCO TYPE JI SURFACE CONTROLLER



FRONT AND SIDE VIEW OF CAMCO
TYPE JI SURFACE CONTROLLER