Problems Of Two Zone Pumping

By R. M. Erskine
EMSCO Manufacturing Company
Garland, Texas

PROBLEMS OF TWO ZONE PUMPING

I. Economics

Substantial economies are obtained in many areas by depleting two formations simultaneously within the same well bore. The saving in initial investment of drilling cost and equipping a dual well is forcibly evident over the costs of drilling twin wells. Present day methods for the practicable, and profitable production of dually completed wells have progressed to such a degree that as a matter of practical economics operators are virtually compelled to review the possible advantages of two zone production before starting additional drilling and work-over programs.

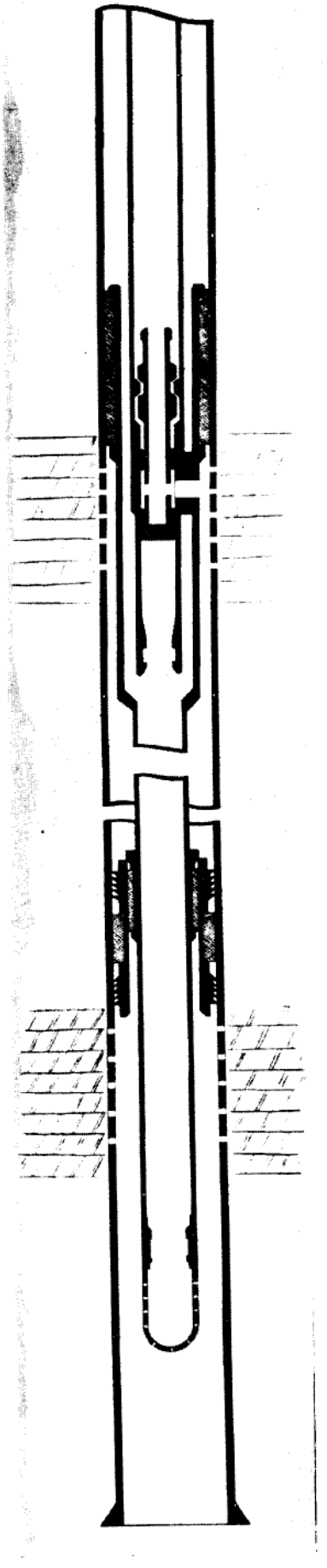
It is often economically feasible to recomplete a single completion by coming up the hole or by deepening the well to complete in another zone. Often a marginal zone, that may not be economical to produce singly, may be produced in a dual well with substantial profits.

Artificial lift equipment for the production of two zones simultaneously in the same well bore with the fluids separated at all times was developed in 1947. Some dual wells may flow for prolonged periods of time, others may have zones that will only flow for short periods, and then the operator must resort to artificial lift for one or both of these zones. The development of the equipment was primarily for three purposes. First, to enable the operator to flow both zones, secondly, to flow one and pump the other, and third, to pump both zones.

II. Structure

Presently there are various methods of artificial lift as applied to dual completions. Dual gas lift systems and dual hydraulic pumps have found application in certain areas, but the rod type dual pumps are the more widely used. These rod type pumps may be classified into two main categories. They are the intermittent and the simultaneous types.

In the intermittent type only one zone is produced at a time and the monthly allowable must be obtained in a 15 day period. This type of production equipment appears in various forms. There is the movable tubing intake which may be accomplished by either rotating the tubing or by raising and lowering the tubing. This is performed by certain mechanisms at



Schematic Diagram showing use of Removable Cross-Over Choke installed in the Upper Annular Packer. This enables the operator to flow the lower zone through the tubing casing annulus and the upper zone through the tubing. Certain completion and remedial operations may be performed through this equipment. →

FIGURE 1

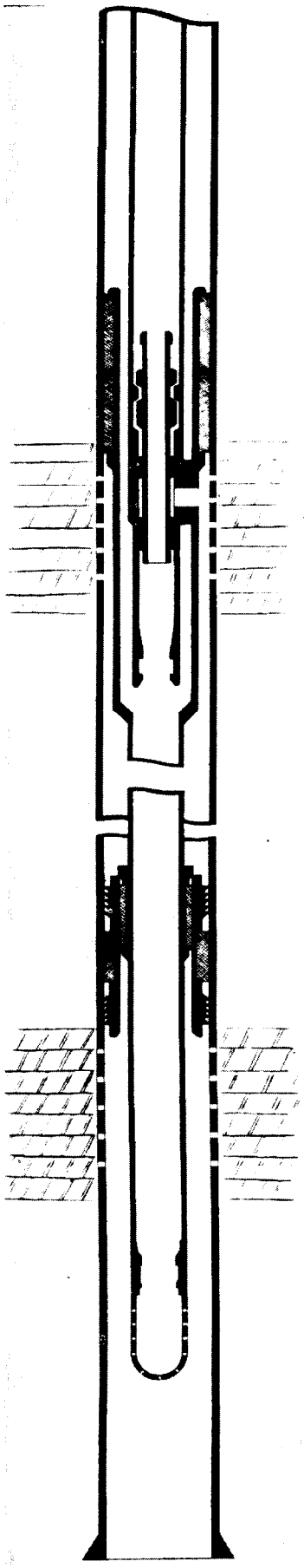


FIGURE 2

Schematic Diagram showing Removable Straight Through Choke installed in Upper Annular Packer. This equipment enables the operator to produce the lower zone through the tubing string. The upper zone is contained outside the tubing string and trapped between the two packers. Certain completion and remedial operations may be performed through this equipment. ←

the well head which open and close certain intake parts in the tubing string at the point of the production packer. There also is the movable pump seat which is accomplished by raising and lowering the sucker rod string.

The second class of rod type dual pumps is the simultaneous type where both formations are produced at the same time and the fluids are kept separated at all times. This class also appears in various forms. It includes the parallel tubing string type where two strings of tubing and rods are run in the same well bore and two surface pumping units are used. These two pumps work independently of each other. Another type of simultaneous dual rod pump employs a hollow sucker rod string. The upper zone fluid is conducted to the surface in these hollow rods. The lower zone fluid is pumped in the tubing string around these hollow rods.

The most prevalently used dual lift equipment is of the single, solid, API sucker rod type. Of the various makes on the market, they generally consist of four main assemblies. First is the upper pump, which produces the upper zone fluid. Second is the annular packer and cross-over assembly, which is placed above the perforations of the upper zone. This piece of equipment crosses the lower zone fluid over from the tubing to the casing and the upper zone fluid from the casing to the tubing. Hence, the name cross-over. Third is the polished rod and sealing section. This is attached immediately below the upper pump plunger and is used to separate the two fluids on the sucker rod string and the internal bore of the cross-over assembly. Fourth is the lower pump to produce the fluid from the lower zone.

Another important and necessary piece of equipment is the production packer, but it is not included as an integral part of a dual pump as it is necessary in any multi-zone completion. Most production packers presently used in dual flowing oil wells may be utilized for dual pumping. However, these packers should include the following features: Very little or no tubing weight should be necessary in order to obtain an effective seal. The internal bore of the packer should be no smaller than that of the tubing string, there should be ample slip area to eliminate the possibility of distorting the casing.

The lower zone fluid is pumped thru the tubing string from below the production packer to a point at the annular packer and cross-over assembly. Here the lower zone is diverted into the tubing-casing annulus by virtue of the sealing section of the polished rod and also the internal bore of the cross-over. The upper zone fluid is accepted into the cross-over and is pumped thru the tubing string to the surface.

III. Dual Well Completion Problems

It is important when planning dual artificial lift installations that a few of the general accepted well completion practices be observed. This is of prime importance because if the well is being serviced, perhaps because of poor completion practice, the operator is actually losing production from two wells. It is important that when the lower zone is completed an accurate test is made that separation has been obtained in the cementing operation. Also, accurate production requirements as to the amount and type of fluid that must be produced should be obtained. It is also possible to test the retainer type production packers at this stage. After the upper zone has been perforated an accurate test should be taken for the amount and type of fluid to be produced.

It is important that the well be cleaned of any excess propping sand in the event fracture treatment has been used on either zone. If either zone has been acidized, the operator should make certain that the well is clean of any unspent acid. Junk in the form of swab rubbers, packer elements, soft line, etc., should be removed by either bailing or circulating.

Casing scrapers are recommended to remove burrs, mud or cement sheathes, which will aid in getting the packers down the hole in good condition and afford a good clean surface for an effective seal.

After the well has been completed and tests have been made on both formations for production requirements and type of fluids, the proper type of equipment may be selected.

IV. Equipment Selection Problem

If one or both of the formations will flow for a period of time, it is important for the operator to consider the proper sub-surface equipment which will enable him to produce this well as a flowing dual and when the need arises he may also use this same equipment to pump both zones. This is accomplished thru the use of a removable bottom hole choke. This same equipment enables the operator to perform certain completion and workover operations through the tubing string on each zone on a selective basis. Selective testing may be accomplished on each zone through the tubing string, as well as testing of both packers and tubing for leaks. All of these operations may be performed without disturbing the tubing and packers once the tubing has been installed in the well. All of this is important for added tubing jobs decrease the amount of savings that are available in dual completions.

If the fluid from either, or both zones is corrosive or abrasive, it is important that proper materials be utilized in the down hole equipment to combat these problems. Stainless and Monel equipment may be used to

combat corrosion and hardened materials for abrasive conditions should be used.

Precaution should be taken in the event that the fluids are of a paraffin base. Scrapers may be installed on the sucker rod string to remove paraffin in the tubing. A circulating valve may be placed in the tubing string below the paraffin deposition level to circulate hot oil from the tubing to the casing. This will generally remove paraffin deposits in the annular space. This is important because difficulties may arise when pulling packers through these paraffin deposits.

If the lower zone fluid which is normally in the tubing-casing annulus is highly corrosive, or paraffin in the casing, is a major problem, the use of a parallel tubing string cross-over should be considered. The parallel string is used to conduct the lower zone fluid to the surface. The casing wall is then not contaminated by the lower zone fluid. Another important feature of this equipment is that the upper packer is eliminated and allows the gas from the upper zone to be vented. Likewise, paraffin solvents and corrosion inhibitors may be introduced into the upper zone through the annular space.

A tubing drain should be considered in the installation below the cross-over assembly in the event that the upper pump becomes stuck in the tubing because of sand or detrital material. The drain may be hydraulically actuated releasing all the fluid in the casing when the service job must be performed. This is important because it eliminates swabbing the casing by the upper packer and eliminates the tremendous load on the tubing string because of this swabbing.

A means of supporting the top packer should definitely be considered. The differential pressure across this packer generally results in a downward thrust which will tend to buckle the tubing string between the two packers, if the upper packer were not anchored by some means. This will result in wear on the sucker rods, couplings, and tubing string.

An overload valve should be considered on the pump if a paraffin formation is being produced. This is a spring loaded traveling valve and allows this specific pump to be taken out of service merely by closing a valve on the flow line at the surface.

A properly designed sucker rod string to effect maximum rigidity is an important factor to consider. The use of 5/8" sucker rods is not recommended even though there may be ample strength in this size rod for the existing loads. The larger size rod eliminates a certain amount of whipping and buckling on the downstroke of the pumps.

The well has been completed and the equipment installed. Now the problem is to operate this equipment efficiently in order that the overall dual completion program will be an economical success.

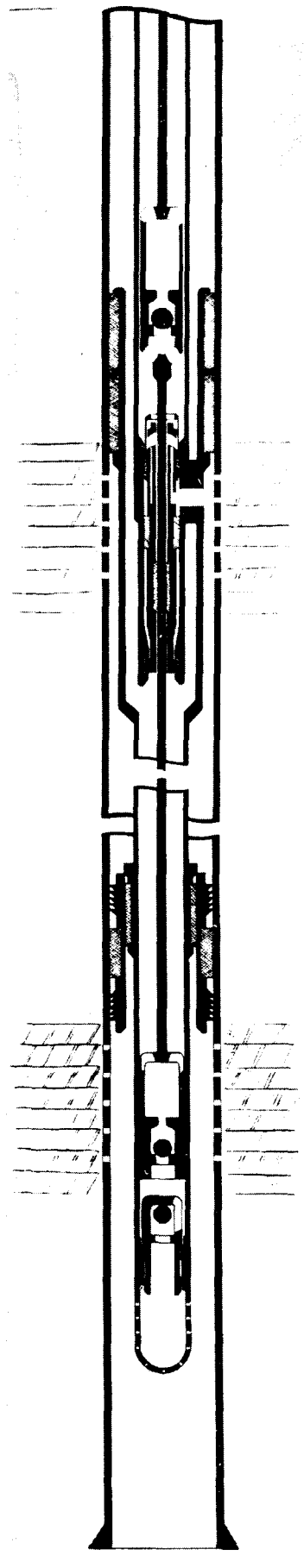
V. Operation Problems

When pumping oil wells under packers, which is a condition in dual wells, the gas may be an aid or a hindrance. All the formation gas must pass thru the pump unless specific equipment has been selected to vent this gas, such as the parallel tubing string cross-over assembly. If the formation gas remains in solution until after it has passed through the pump, then seldom do gas lock problems occur. Generally, in this event when the gas is released from solution sufficient energy exists to cause the formation to head and flow. This can exist not only for the zone being produced in the tubing but also the zone in the tubing-casing annulus. A formation in a standard single completion, that is being pumped without a tendency to flow, will occosionally head and flow once a packer has been installed. The pump will agitate the formation fluid to release sufficient gas energy to the same formation to flow through the tubing-casing annulus above the cross-over assembly.

When this healing and flowing occurs, several of the following problems may exist: Uneven loading conditions on the surface equipment, for example the engine and unit. This condition makes counterbalance on the pumping unit a problem. In the event of electrified leases, this results in excessive electric power usage. Repairs on multi-cylinder engines increase because of valve jobs, etc. Uneven loading will exist on the sucker rod string as well as surface equipment. Also, sub-surface pumps are affected when fluids flow thru various parts at high velocities. Cages, balls and seats may be damaged by virtue of the ball traveling unevenly on all surfaces. As the gas is being released from solution, the cooling effect that results will allow paraffin to settle and deposit on the walls of the tubing and casing. If sufficient fluid energy exists, the formation may heave and allow sand to come into the well bore affecting the operation of the mechanical pumping equipment, as well as form sand bridges. One of the major problems due to wells heading and flowing is the regulation of production and overloading tank battery facilities.

All the above type problems may be alleviated through the use of a spring loaded pressure control valve on both the tubing and casing flow lines. This device holds adjustable back pressure at the well head and sub-surface pump. This additional back pressure makes the pump do the actual work and decreases the possibility of the well flowing.

If, however, gas proves to be a hindrance, in form of gas lock and low efficiencies, then the problem must be met by other methods. First the proper selection of pumps to handle gasy fluids is imperative. It is recommended that the plunger not have a



Schematic Diagram showing Conventional Type Dual Pump Including Two Packers and the Two Pumps. The lower zone fluid is produced in the tubing casing annulus above the top annular packer and the upper zone fluid is produced in the tubing string. →

FIGURE 3

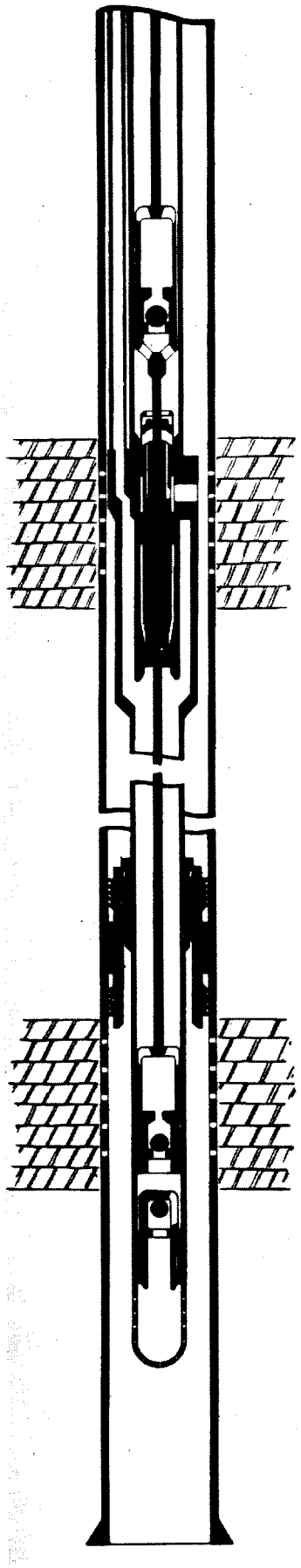


FIGURE 4

traveling valve on top and double valve on bottom. A single traveling valve on bottom of plunger as closely spaced to the standing valve as possible is recommended where severe gas conditions exist. Where only the one traveling valve is used, the best type of material for the ball and seat should be employed.

In two zone pumping, there are three friction loads on the mechanical system that affects the plunger travel on the down stroke. These are the friction loads of the two plungers falling in their respective liner columns and the polished section of the sucker rod string falling into the sealing section. Because of this, the travel of the plunger on the down stroke may be affected. To improve the condition, the use of 1-1/4" polished rod material as sinker bars, or 7/8" sucker rods with slim hole couplings may be recommended between the two pumps as well as immediately above the upper pump. This additional rod weight not only improves and increases the plunger travel, but also decreases the amount of sucker rod whipping and buckling on the down stroke. This, of course, decreases the possibility of sucker rod pin and coupling failures.

In the event that corrosion is a problem from either zone, proper selection of a cross-over device in order to use inhibitors below both pumps is an important factor to take into account. If paraffin is a problem from the lower zone, depositing in the tubing-casing annulus, the use of hot oil to circulate and remove this paraffin must be considered. The periods of time to circulate this hot oil is dependent upon specific areas and formations. It may be stated that in Southern Oklahoma a month's period is used as the basis of circulating. Immediately before a service job, when the tubing is to be removed, hot oil should be circulated.

If the production from the lower zone is relatively small, the amount of time to fill the tubing-casing annulus may amount to several days, especially, in large casing sizes. Because of this, the total fluid load on the sucker rod string may not be present until a matter of several days after the initial installation. It is sometimes important that the spacing of the pump immediately after installation be spaced as closely as possible. When the total fluid load is placed on the rod string it possibly will be necessary to re-space the pump by raising the rod string a few inuches after all the stretch has been placed in the rods. This will increase efficiency of both pumps due to the closer valve spacing available.

During initial installation of the equipment and subsequent service jobs, it is important that the tubing, rods, and pumping equipment be kept in as clean a condition as possible from sand and other foreign matter. Standing the tubing and hanging rods in a derrick will aid in this matter. If a blowing sand condition prevails during the service operation, a steam truck should be used to clean foreign material from the tubing and rods.

During initial installations and subsequent service jobs, it is important that correct tallies be made of the tubing and sucker rod string in order that all of the sub-surface equipment is properly placed in the well. Exacting well records should definitely be kept on each installation. These records should indicate where the perforations for each zone occur, the size and weight of casing, the size and type of sub-surface equipment and its exact location in the well. The record also should include an exact tally of tubing and rod string between the two pump seats.

VI. Conclusion

Dual pumps are operating in most areas of the United States, Canada and South America and have proven to be a practical and economical means of artificial lifting oil. Through the many improvements in design, better completion practices, proper selection and operation of equipment, the acceptance of dual pumps in the oil producing industry will grow many fold.

Schematic Diagram showing Dual Pump with Parallel Tubing Strings. This equipment eliminates the use of the upper annular packer. Therefore, the gas from the upper zone may be vented through the annulus. The lower zone fluid is produced through the small parallel tubing string and the upper zone fluid is produced through the main tubing string.

←