DUAL STRING PRODUCTION DEVICE

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The present invention is directed to apparatus for producing fluids simultaneously from a plurality of subsurface earth formations. In its more specific aspects, the invention is directed to a device for arrangement in a dual string well tubing. More particularly, the invention is concerned with apparatus for producing hydrocarbons from a plurality of subsurface earth formations.

The present invention may be briefly described as apparatus for arrangement in a parallel dual string of first and second well tubings arranged in a well casing in which each of the tubings is in separate fluid communication with spaced apart hydrocarbon productive zones. The apparatus comprises an elongated mandrel having separate means on its upper and lower ends for connection into the first and second well tubing. Arranged in the mandrel is a tubular pocket having an open upper end communicating with the first of the tubings and arranged on the inner wall of the mandrel such that the longitudinal axis of the pocket forms an acute angle with the longitudinal axis of the mandrel. The wall of the pocket and the mandrel are provided with first and second spaced apart ports providing fluid communication with the annular space between the casing and the dual string. A passageway in the lower end of the pocket communicates with the second of the tubings. Arranged in the pocket is at least one retrievable gas-lift valve in fluid communication with the annular space through one of the ports and with one of the tubings. Means are provided on the inner wall of the mandrel above the pocket for guiding the gas-lift valve into the pocket. The gas-lift valve may suitably comprise first and second interconnected retrievable gas-lift valves provided with means on the outer surface for sealing or isolating the ports from each other and for isolating the passageway from the first tubing. The gas-lift valve may comprise a blank valve, such that one of the ports is closed off completely from one of the tubings. Where a blank valve is arranged in the gas-lift valve, it may be provided to seal or close the upper or the lower of the ports. In fact, prior to running in the gas-lift valve of the present invention in the pocket, it may be desirable to provide therein blank or dummy valves which serve to close off both of the ports to both of the tubing strings.

The present invention is of considerable utility and advantage because it allows provision of gas-lift valves in a mandrel connected into dual tubing strings for simultaneous production from both of the tubing strings or for production from only one or a selected of the tubing strings. For example, production may be obtained through one of the tubing strings with a device of the present invention while one of the zones is being serviced. The invention also provides a considerable saving in equipment installation for installing the device and for running in the gas-lift valves.

The present invention will be further illustrated by reference to the drawing in which:

Fig. 1 is a sectional view showing the mandrel with interconnected retrievable gas-lift valves arranged in the pocket;

Fig. 2 is a sectional view taken along line 2—2 of Fig. 1 with the gas-lift valve removed;

Fig. 3 is a partial sectional view of the gas-lift valve of Fig. 1; and

Fig. 4 is a view showing the mandrel and the dual tubing string arranged in a well casing.

Referring now to the drawing in which identical numerals will be employed to designate identical parts and particularly to Figs. 1 and 2, numeral 11 designates a mandrel adapted to be connected into the dual tubing strings. The mandrel 11 is provided with threaded connections 12 and 13 on its upper end for connecting into the tubing strings and with threaded connections 14 and 15 also for connecting into the tubing strings on its lower end.

Connected to the inner wall of the mandrel 11 is a gas-lift valve pocket 16 having an open upper end 17 and provided with a passageway 18 on its lower end. The wall 19 of the mandrel 11 is provided with spaced apart ports 20 and 22 which communicate with the annulus A between the casing and dual string of tubings which will be described in more detail hereinafter. The wall 23 of the gas-lift valve pocket 16 is provided with spaced apart ports 24 and 25 which communicate with ports 20 and 22.

Arranged in the pocket 16, as shown in Fig. 1, is a gas-lift valve assembly 26 which is comprised of gas-lift valves 27 and 28. The gas-lift valve assembly 26 has a fishing neck 29 provided with a fishing head 30 which is engageable with a wire line fishing tool, not shown, and is provided with spaced apart packing or sealing means 31, 32, and 33. The sealing means 31 and 32 isolate the assembly 26 from the dual string which will be described further.

The pocket 16 is provided with a guide member 16a which serves to guide the gas-lift valve assembly 26 into the pocket 16. A suitable positioning tool, such as that described in the 1952–53 edition of the Catalog of Oil Field and Pipe Line Equipment at page 995, may be used to position assembly 26 in the pocket 16.

It is to be noted especially with respect to Fig. 2 that the mandrel 11 provides a passageway 34 and 35 with one passageway communicating with one of the dual strings of tubing and the other passageway communicating with the other of the dual strings of tubing as will be described.

Referring now to Fig. 3, it will be seen that the gas-lift assembly 26 is comprised of two gas-lift valves 27 and 28 which are interconnected by a threaded sleeve 36 which engages with mating threads 37 and 38 of the valves 27 and 28, respectively. The threaded sleeve 36 provides a recess 39 to receive the packing member 32.

The gas-lift valve 28 has a bellows arrangement 40 which may suitably include an internal spring 41, 42, and 43 which is operably connected by a piston arm 41 to a seating member 42 which is designed to seat on seat 43 and close the passageway 44 leading through the valve 28 and communicating with passageway 18.

The valve 28 is provided with ports 45 which communicate with port 42 and thence with annulus A. The packing member 33 is arranged in a recess 46 on the surface of the valve 28.

The valve 28 is similarly constructed to the valve 28 and is provided with bellows and spring arrangement 48 and also with a piston arm 41 and seating member 42 which is designed to seat on seat 43 and close off passageway 47 which extends through the fishing neck 29 and fishing head 30.

Like valve 28, valve 27 is provided with ports 45 which communicate with ports 42 and 40 and thence with annulus A.
The packing member 31 is also arranged in a recess, such as 46.

Referring now to Fig. 4, it will be seen that the mandrel 11 is connected into a first tubing string 50 by a suitable connection means, such as a pipe collar 51, and is connected into a second tubing string 52 by means of a connection, such as pipe collar 53. Mandrel 11 is connected also into the tubing strings 50 and 52 on the lower end of the mandrel by connections 54 and 55. The tubing strings 50 and 52 extend upwardly through the casing 56 to the surface of the earth, not shown, and downwardly through the casing 56 to communicate with a plurality of spaced apart hydrocarbon productive zones, intervals, horizons, strata, formations, and the like (also not shown) from which hydrocarbons, such as oil and/or gas, may be produced. The casing 56 is suitably cemented in the well bore 57 by primary cement 58.

It is to be understood, of course, that the casing 56 and cement 58 will be suitably perforated in the hydrocarbon productive zones from which the production is to be had.

In employing the device of the present invention a plurality of mandrels, such as 11, are connected into the tubing strings and arranged at spaced apart intervals therein as may be desired. The dual string mandrels in the tubings will be run into the well casing with double blanks arranged in the valve pocket 16 until need for actual gas lifting arises. Thereafter, the double blanks or dummies are retrieved and either a blank or a valve suitably interconnected is installed in the pocket 16 or a double valve, such as 25, is run in and arranged in the pocket 16. When the double valves are employed, the upper valves, such as 27, will receive gas through the ports 20 and will inject gas into the tubing 50 through the passageway 47. The lower valve 28 will receive gas through the ports 22 and discharge gas through the passageway 44 and 18 into the tubing 52.

The gas-lift valves on one of the tubing strings 50 or 52 may be casing pressure operated valves while the gas-lift valves for the other of the tubing string may be fluid operated valves which may permit lifting both zones simultaneously at individual depths resulting from changing bottom hole conditions.

The present invention provides a mandrel and gas-lift valve installation which permit simultaneous intermittent flow for any combination of constant flow and intermittent installations with the required number of mandrels. Thus with six gas-lift mandrels, such as 11, and a suitable gas-lift valve, an exceedingly more versatile installation may be obtained than is currently being obtained with the conventional oil manrels employed in a hydrocarbon productive oil field in Texas. It will be seen, therefore, that the present invention is quite advantageous.

The gas-lift valves 27 and 28 are suitably biased into the closed position by the bellows and spring arrangement 40 and are opened by pressure building up in the tubing to overcome the force exerted by the bellows and spring arrangement 40. The valves are open when the hydrosstatic head in the tubing overcomes the force of the bellows and spring arrangement 40 which then allows gas to be bled into the tubing lightening the column and causing the valve to close; then the cycle is repeated.

The nature and objects of the present invention having been completely described and illustrated, what we wish to claim as new and useful and to secure by Letters Patent, are as follows:

1. Apparatus for arrangement in a parallel dual string of first and second well tubing arranged in a well casing in which each of said tubings is in separate fluid communication with spaced apart hydrocarbon productive zones which comprises an elongated mandrel having separate means on its upper and lower ends for connection into said tubings, an elongated tubular pocket having an open upper end communicating with the first of said tubings arranged on the inner wall of said mandrel such that the longitudinal axis of the pocket forms an acute angle with the longitudinal axis of the mandrel, the wall of said pocket and said mandrel having first and second spaced apart ports providing fluid communication with the annular space between the casing and the dual string, and a passageway in the lower end of said pocket communicating with the second of said tubings.

2. Apparatus for arrangement in a parallel dual string of first and second well tubing arranged in a well casing in which each of said tubings is in separate fluid communication with spaced apart hydrocarbon productive zones which comprises an elongated mandrel having separate means on its upper and lower ends for connection into said tubings, an elongated tubular pocket having an open upper end communicating with the first of said tubings arranged on the inner wall of said mandrel such that the longitudinal axis of the pocket forms an acute angle with the longitudinal axis of the mandrel, the wall of said pocket and said mandrel having first and second spaced apart ports providing fluid communication with the annular space between the casing and the dual string, and a passageway in the lower end of said pocket communicating with the second of said tubings, and means on the inner wall of said mandrel pocket for guiding a gas lift valve into said pocket.

3. Apparatus for arrangement in a parallel dual string of first and second well tubing arranged in a well casing in which each of said tubings is in separate fluid communication with spaced apart hydrocarbon productive zones which comprises an elongated mandrel having separate means on its upper and lower ends for connection into said tubings, an elongated tubular pocket having an open upper end communicating with the first of said tubings arranged on the inner wall of said mandrel such that the longitudinal axis of the pocket forms an acute angle with the longitudinal axis of the mandrel, the wall of said pocket and said mandrel having first and second spaced apart ports providing fluid communication with the annular space between the casing and the dual string, and a passageway in the lower end of said pocket communicating with the second of said tubings, and at least one retrievable gas lift valve arranged in said pocket in fluid communication with the annular space through one of said ports and with one of said tubings.

4. Apparatus for arrangement in a parallel dual string of first and second well tubing arranged in a well casing in which each of said tubings is in separate fluid communication with spaced apart hydrocarbon productive zones which comprises an elongated mandrel having separate means on its upper and lower ends for connection into said tubings, an elongated tubular pocket having an open upper end communicating with the first of said tubings arranged on the inner wall of said mandrel such that the longitudinal axis of the pocket forms an acute angle with the longitudinal axis of the mandrel, the wall of said pocket and said mandrel having first and second spaced apart ports providing fluid communication with the annular space between the casing and the dual string, and a passageway in the lower end of said pocket communicating with the second of said tubings, and at least one retrievable gas lift valve arranged in said pocket in fluid communication with the annular space through one of said ports and with one of said tubings, and means carried by said gas lift valve for isolating said port and said tubings from each other.

5. Apparatus for arrangement in a parallel dual string of first and second well tubing arranged in a well casing in which each of said tubings is in separate fluid communication with spaced apart hydrocarbon productive zones which comprises an elongated mandrel having separate means on its upper and lower ends for connection into said tubings, an elongated tubular pocket having an open upper end communicating with the first of said tubings arranged on the inner wall of said mandrel such that the longitudinal axis of the pocket forms an acute angle with the longitudinal axis of the mandrel, the wall of said pocket and said mandrel having first and second spaced apart ports providing fluid communication with the annular space between the casing and the dual string, and a passageway in the lower end of said pocket communicating with the second of said tubings, and means carried by said gas lift valve for isolating said port and said tubings from each other.
said tubings arranged on the inner wall of said mandrel such that the longitudinal axis of the pocket forms an acute angle with the longitudinal axis of the mandrel, the wall of said pocket and said mandrel having first and second spaced apart ports providing fluid communication with the annular space between the casing and the dual string, a passageway in the lower end of said pocket communicating with the second of said tubings, and first and second interconnected retrievable gas lift valves arranged in said pocket with the first gas lift valve in fluid communication with the annular space through the first port and the second gas lift valve in fluid communication with the annular space through the second of said ports, means carried by said gas lift valves for isolating said ports from each other and for isolating said passageway from said first tubing, said first gas lift valve communicating fluidly with the first tubing and said second gas lift valve communicating fluidly with the second tubing.

6. Apparatus for arrangement in a parallel dual string of first and second well tubing arranged in a well casing in which each of said tubings is in separate fluid communication with spaced apart hydrocarbon productive zones which comprises an elongated mandrel having separate means on its upper and lower ends for connection into said tubings, an elongated tubular pocket having an open upper end communicating with the first of said tubings arranged on the inner wall of said mandrel such that the longitudinal axis of the pocket forms an acute angle with the longitudinal axis of the mandrel, the wall of said pocket and said mandrel having first and second spaced apart ports providing fluid communication with the annular space between the casing and the dual string, a passageway in the lower end of said pocket communicating with the second of said tubings, and first and second interconnected retrievable gas lift valves arranged in said pocket with the first gas lift valve in fluid communication with the annular space through the first port and the second gas lift valve in fluid communication with the annular space through the second of said ports, means carried by said gas lift valves for isolating said ports from each other and for isolating said passageway from said first tubing, said first gas lift valve communicating fluidly with the first tubing and said second gas lift valve communicating fluidly with the second tubing.

7. Apparatus for arrangement in a parallel dual string of first and second well tubing arranged in a well casing in which each of said tubings is in separate fluid communication with spaced apart hydrocarbon productive zones which comprises an elongated mandrel having separate means on its upper and lower ends for connection into said tubings, an elongated tubular pocket having an open upper end communicating with the first of said tubings arranged on the inner wall of said mandrel such that the longitudinal axis of the pocket forms an acute angle with the longitudinal axis of the mandrel, the wall of said pocket and said mandrel having first and second spaced apart ports providing fluid communication with the annular space between the casing and the dual string, a passageway in the lower end of said pocket communicating with the second of said tubings, at least one retrievable gas lift valve arranged in said pocket in fluid communication with the annular space through one of said ports and with one of said tubings, and means on the inner wall of said mandrel for guiding said gas lift valve into said pocket.

No references cited.