

A valve device for a side pocket or sub in a well

The present invention relates to a valve for use in a side pocket or sub in a well, comprising a housing with a first port and a second port, where the first port normally leads to the annulus and the second port normally leads to the production tubing, where there is at least one valve body mounted internally in the housing in order to open and close the valve for through-flow.

In some cases in a well, where a well fluid with a high specific gravity has been introduced into the well, it is desirable to be able to replace this well fluid with another well fluid with lower specific gravity. This may be the case, for example, when a displacement fluid has been introduced down in the well in order to conduct an operation. In order for this fluid to be circulated out, it is advantageous to be able to pressurise the tubing with the desired well fluid and circulate the well fluid with higher specific gravity out in the annulus and up to the surface. For this to be possible, it is necessary to have devices mounted in the tubing wall in order to open up access between the tubing and the annulus. Such devices in the tubing wall can be arranged in a so-called sub or in a side pocket mandrel. A known method of performing an operation of this kind is to provide a so-called "shear dump kill" valve in a sub or a side pocket in order to obtain this functionality for circulation from the tubing out into the annulus. A valve of this type is closed until a given pressure is applied in the annulus, whereupon a shear pin is broken and the valve is opened and remains open. The valve has no functions for closing the valve again and therefore has to be withdrawn and replaced by a plug or a new valve of the same type in order for the well to be operational again. This is a time-consuming and costly process.

US 20040182437 A1 describes a valve device for fluid connection between the annulus and the production tubing with a first valve body and a second valve body which open by pressurising the annulus.

AU 763592 B2 also describes a valve device for fluid connection between the annulus and the production tubing.

An object of the present invention is to simplify the procedure round the process where a well fluid requires to be circulated out by means of circulation from the production tubing to the annulus.

This is achieved by a valve as defined in the attached independent claim where further features of the invention are indicated in the dependent claims.

The invention relates to a valve device for use in a side pocket and/or sub in a well, comprising a housing with a first port and a second port, where during normal use the first port normally leads to the annulus and the second port normally leads to the production tubing, and a first valve body is movably mounted internally in the housing. Both a side pocket and a sub normally form a space arranged at the side of

the main channel in tubing, generally in the material forming the main channel. The space normally has a port to the tubing's main channel and a port to the annulus formed outside the tubing, between it and a casing in the well. Devices mounted in a side pocket are normally capable of being pulled out, while devices in a sub are not capable of being pulled out.

According to the invention the valve device further comprises a second valve body mounted internally in the housing and movable relative to both the housing and the first valve body, a first locking device configured between the first valve body and the second valve body in order to lock the movement of the first valve body relative to the second valve body in one direction and in such a manner that when the first locking device is activated, to hold the first valve body in an open position as long as the second valve body is in an open position, thereby providing through-flow through the valve device and a third locking device configured between the second valve body and the housing, with the result that release of the third locking device will permit movement of the second valve body relative to the housing and thereby to a closed position of the valve device, thereby also permitting the first valve body to go to a closed position.

In an embodiment the first valve body may be designed in such a manner that together with a valve seat composed of a surface in the housing it shuts off the second port in the housing, forming a barrier for fluid flow from the tubing into the valve device and thereby also out into the annulus. In an embodiment the second valve body may be designed in such a manner that together with a valve seat formed in the housing it shuts off the first port in the housing, forming a barrier for fluid flow from the annulus into the valve device and thereby also into the tubing. The valve device housing is provided with external devices which enable it to be placed in a sub and/or side pocket, forming seals between the two ports in the sub or side pocket, so that all flow through the sub or side pocket runs through the valve device.

When the valve is in use it will normally be configured with the first valve body in a closed position and the second valve body in an open position. On this basis, when the first valve body is pressure-activated, the annulus will then be pressurised in order to move the first valve body from a closed position to an open position and by means of this movement thereby lock the first valve body relative to the second valve body in the first locking device. In such an open position of the valve device it will be possible to circulate fluids from the tubing to the annulus and in the opposite direction, depending on the requirement. When the desired fluid has been circulated in/out, either the annulus or the tubing is closed and the fluid in the well is pressurised until the third locking device is released. When it is released, the second valve body will move from an open position to a closed position and the first valve body will therefore also be moved to a closed position and the valve device

closed. There will then be no fluid communication between the annulus and the tubing through the valve device.

According to an embodiment the first locking device may comprise a detent latch, where the first valve body has a detent device facing in one direction and the second valve body has a detent device facing in the opposite direction. When these two detent devices engage with each other, they permit further movement in one direction, but prevent movement in the opposite direction. Alternatively, the first valve body may comprise a locking ring which, when the valve body has moved to an open position, engages with a groove in the second valve body, locking them relative to each other.

According to an embodiment the valve device may also comprise a second locking device configured between the second valve body, the housing and the first valve body, in such a manner that the second valve body is permanently locked relative to the housing in an open position until the first valve body is locked in the first locking device and thereby in an open position of the valve device. A locking device of this kind may also prevent the third locking device from being released before the first valve body is locked by the first locking device of the second valve body. The introduction of this second locking device therefore provides a greater guarantee that the operation of the valve device will follow the desired procedure.

According to yet another embodiment the valve device may also comprise a fourth locking device configured between the housing and the first valve body in such a manner that it locks the first valve body to the housing in a closed position and is further arranged so that it has to be released before the first valve body can be moved and locked by the first locking device. Such a locking device may be arranged to be broken by a higher pressure differential between the annulus and the tubing than the pressure differential which without this fourth locking device will move the first valve body from a closed position to an open position if the valve body is pressure-activated. This fourth locking device may be a shear pin mounted between the first valve body and the housing, or alternatively a rupture disc which admits fluid in order to influence the first valve body or another type of rupture element which after rupture enables the first valve body to be moved to an open position. As an alternative to a fourth locking device, choking of the fluid supply may be employed instead, causing the first valve body to go to an open position on account of the pressure differential across the valve body. This ensures that the valve body does not open on account of sudden and brief pressure variations in the fluids round the valve device. In a further alternative embodiment this choking process may furthermore be provided by a ball, which enables the rate of flow through the valve to be regulated/choked in order to open the first valve body relative to the housing, but also to arrange the ball and the flow rate so as to be able to have a larger flow diameter in the opposite direction, for example reduced flow

rate in the direction from the annulus to the tubing and greater flow rate in the direction from the tubing to the annulus.

According to an embodiment the first locking device may be activated from a neutral position to a locked position by the first valve body being moved relative to the housing from a closed position to a locked open position when there is a given pressure differential between a pressure in the annulus and a pressure in the tubing. This is achieved by having pressure faces on the first valve body which, when influenced by fluids in the annulus and in the tubing, will exert forces on the first valve body, causing it to be moved between a closed and an open position. The valve body may also be prestressed in a closed position by means of an elastic element mounted between the housing and the valve body.

According to an embodiment of the invention a chamber provided with a given pressure before installation of the valve device in the well may be provided between the second valve body and the housing. This pressure may be a vacuum or other pressure set before installation of the valve device in the well. Furthermore, an embodiment of the housing and the second valve body may be such that this chamber is opened and/or punctured, thereby no longer forming a closed chamber when the second valve body is moved, with the result that no "fluid cushion" is formed for movement of the second valve body as a consequence of this chamber.

According to an embodiment the third locking device may be configured in such a manner that when the valve device is in an open position, the third locking device can be released when there is a given pressure differential between the chamber and a pressure applied in the well, with the result that the second valve body goes to a closed position. In an embodiment where there is also a second locking device in the valve device, release of the third locking device requires that the second locking device should already be released. The third locking device may be a shear pin or also a rupture disc, locking ring or other device.

According to an embodiment a second locking device may be configured with at least one recess internally in the housing, a through-going groove in the second valve body and a recess in the first valve body, with a locking ring or dog/claw mounted in the groove in the second valve body. When it is aligned with the recess in the housing, this locking ring will be engaged with it and will only permit relative movement between these parts when a force is overcome and the recess of the first valve body is aligned with the groove and the recess in the housing so that the locking ring has room to be moved out of the recess in the housing. When the recess of the first valve body is not aligned with the groove in the second valve body and the recess in the housing, the locking ring will have no room to be moved out of the recess in the housing, with the result that the second valve body is permanently locked to the housing.

According to a further embodiment the valve device according to the invention may comprise a fifth locking device which locks the second valve body securely relative to the housing in a closed position. In an embodiment this fifth locking device may be composed of detents mounted on the second valve body and in the housing, which when engaged do not permit movement in the opposite direction.

According to a possible embodiment of the invention the first valve body may be mounted relatively inside the second valve body, where the first valve body in a closed position shuts off the port to the tubing and the second valve body in a closed position shuts off the port to the annulus. In a possible embodiment the second valve body may be substantially sleeve-shaped and comprise an admission port through the sleeve wall for fluid through-flow. The first valve body may comprise a substantially cylindrical main part with a central through-flow passage with a port at one end of the cylinder facing the first port of the valve device and a closed opposite end of the cylinder with ports arranged in a side wall of the cylinder facing the second port of the valve device. The closed end of the cylinder gives an area which enables opening/closing of the valve to be controlled so that it is pressure-controlled. According to another embodiment the first valve body may be of another shape than cylindrical, for example polygonal, octagonal, hexagonal, triangular, etc. The second valve body will then have a complementary shape to the shape of the first valve body. These alternative embodiments may also have a central through-flow passage through the first valve body which is open at one end and closed at the opposite end with ports in the side wall near this closed end. In these cases too this internal end surface may be employed for pressure control of the movement of the first valve body between an open and a closed position. A device of this kind also provides a large flow area and only a small number of deflections on the flow path through the valve.

The present invention also relates to a method for operation of a valve device between the production tubing and annulus in a well, where the valve device comprises a first port and a second port. According to the method fluid in the annulus is pressurised and permitted to flow into the valve device until a pressure differential is achieved between annulus pressure and tubing pressure, thereby causing the second port of the valve to be opened and the valve locked in this position and fluid is permitted to flow through the valve, whereupon the fluid in the well is pressurised so that a locking device internally in the valve is broken and both the second and the first port are shut off.

The invention will now be explained by a non-limiting embodiment with reference to the attached figures, in which;

Fig. 1 is a sectional view of the valve in a first closed position,

Fig. 2 illustrates the valve in fig. 1 in a second open position,

Fig. 3 illustrates the valve in fig. 1 in a third closed position,

Fig. 4 shows a detail in fig. 3, and

Fig. 5 illustrates a valve according to the invention placed in a sub in tubing.

Fig. 1 illustrates a valve according to the invention. It comprises a housing 1 which is elongated so that it fits down in a side pocket or sub (see fig. 5) and has a first port 2 in the side wall and a second port 3. Furthermore, the housing 1 has a first gasket surface 4 and a second gasket surface 5, arranged on each side of the first port 2 and one of the gasket surfaces 4 arranged between the first port 2 and the second port 3. The housing has an internal space in which are mounted a first valve body 11 and a second valve body 20, movable relative to the housing and movable relative to each other. Both valve bodies 11, 20 can be moved in the longitudinal direction of the housing. The first valve body 11 is a substantially cylindrical body with an internal flow passage 14. This flow passage 14 extends in the direction of travel of the first valve body 11. The cylindrical element forming the flow passage 14 has an open end 15 and is closed at the opposite end, but has wall ports 13. In an open position of the first valve body, the wall ports 13 are aligned with the second port 3 of the housing. The second valve body 20 is substantially sleeve-shaped and arranged located partly outside and surrounding the first valve body. The open end 15 of the first valve body 11 ends internally in the second valve body 20. The second valve body has port 21 in its side wall, which when the second valve body is in an open position is aligned with the first port 2 in the housing. With such a configuration of the two valve bodies, a relatively large flow passage is obtained through the valve device. This flow passage is also designed with a minimum of direction changes in the flow through the passage. The flow passage flows in radially before flowing axially through the valve to a more radial outlet. There are only two deflections in the flow path through the valve.

In an embodiment the first valve body 11 is secured to the housing 1 by a fourth locking device D. The first valve body 11 is then in a closed position so that sealing surfaces 12 on the first valve body 11 are in contact with a valve surface 6 in the housing 1, as illustrated in fig. 1. In the illustrated embodiment this fourth locking device D comprises a shear pin opening 18 in the first valve body 11, a shear pin 26 and a shear pin opening 27 in the housing. When pressure is applied in through the first port 2 which is open since the second valve body 20 is in an open position, the pressure will influence the first valve body 11, for example at the internal end surface in the flow passage and when the pressure differential between the first 2 and second 3 port in the housing reaches a given size, the fourth locking device will be broken and the first valve body will move to an open position, as illustrated in fig. 2. Instead of shear pin openings and shear pins, an alternative is to have a rupture disc which prevents movement of the first valve body before a given pressure differential has been attained. As indicated above, the fourth locking

device is not necessary either, since it is possible to allow the first valve body to be opened on attaining the pressure differential without a locking device as such.

When the first valve body 11 has moved to an open position, see fig. 2, by moving the first valve body 11 in the longitudinal direction of the housing 1, the first
5 locking device A goes into engagement and locks the first valve body 11 relative to the second valve body 20, so that they can only move in one direction relative to each other. The first locking device A comprises detents 17 mounted at an outside of the first valve body 11 and oppositely arranged detents 22 mounted internally in the second valve body 20. These detents 17, 22 go into engagement and lock. The
10 detents 17 on the outside of the first valve body are also provided with some flexibility in the radial direction, thereby facilitating the joining process. This flexibility can be achieved by providing the detents round the circumference with at least one split. Alternatively, the first locking device may comprise a locking ring mounted on the first valve body and a groove in the second valve body.

As indicated in fig. 2, in this position a second locking device B, which securely locks the second valve body 20 relative to the housing 1, is also released. The second locking device B comprises a recess 8 in the housing, a through-going groove 23 in the second valve body 20 and a recess 16 in the first valve body 11, and a locking segment 28, best seen in fig. 4. The locked position of the second
20 locking device is produced by the locking segment 28, which is mounted in the through-going groove 23, being pushed into the recess 8 in the housing, since a wall of the first valve body 11 prevents the locking segment 28 from coming out of the recess 8 in the housing, see fig. 1. The second valve body 20 will then be permanently locked to the housing 1, and cannot be moved relative thereto. When
25 the first valve body 11 is moved to an open position, see fig. 2, a recess 16 in the outer wall of the first valve body will be aligned with the groove 23 in the second valve body 20, thereby permitting the locking segment 28 to be moved out of the recess 8 in the housing, and the second valve body 20 is not longer permanently locked to the housing 1. The locking segment 28 may be a locking ring, or one or
30 more dogs, claws or jaws, arranged in the groove 23 in the second valve body 20.

As illustrated in fig. 2, in this position full through-flow is obtained through the valve, and the valve remains in this open position until a third locking device C is activated. The third locking device C can be activated by pressurising the well, thereby breaking the third locking device comprising a locking pin 30 mounted in a
35 locking pin groove 25 in the second valve body 20 and a locking pin groove 29 in the housing 1. Other solutions may be envisaged here where an element is broken, thereby releasing movement. This may, for example, be a pin mounted on one element located in a groove in the other, a rupture disc, a friction coupling etc.

The pressure required for releasing the third locking device is a pressure differential
40 between the fluid in the well and a pressure in an atmospheric chamber. In the

illustrated embodiment, this chamber 31 is formed between the second valve body 20 and the housing 1. The chamber 31 is defined by a sealing surface 7 round the first port 2 and an additional gasket 32 between the second valve body 20 and the housing 1. In an alternative embodiment, the chamber is comprised by the open end 31' on the second valve body and against the housing 1, limited in the rear by the tool behind (see e.g. figure 2) The chamber 31 (or 31') is provided with a given pressure during assembly of the valve. When the third locking device is broken, on account of the pressure influence on the second valve body 20, a movement of this second valve body will be obtained so that it moves in the longitudinal direction of the housing 1. By means of this movement the chamber 31; 31' will also be opened, since the second valve body 20 moves away from the sealing surface 7, as illustrated in fig. 3. There is therefore no "fluid cushion" for the movement of the second valve body 20 relative to the housing 1 on account of the chamber 31. This movement of the second valve body 20 will also permit the first valve body 11, which is prestressed by an elastic element 19 between the housing 1 and the first valve body 11, to go to a closed position. The valve device is therefore completely closed since both the first and second valve bodies are in a closed position and thus there is once again a barrier between the tubing and the annulus in the well.

Furthermore, when the second valve body 20 has moved relative to the housing to a closed position, as illustrated in fig. 3, there is a fifth locking device E which locks the second valve body 20 relative to the housing 1 in this position. This fifth locking device E comprises detents 9 mounted internally in the housing 1, and oppositely directed detents 24 mounted externally on the second valve body 20. The detents 9 in the housing are provided with some radial flexibility. This can be achieved by providing them with a split. They may, moreover, be prestressed to a position at a centralising ring which supports the detents.

In a first locked position of the second locking device, the locking segment 28, which may be one or more segments arranged round a circumference, will interact with a first groove 8a provided in the housing 1. When the third locking device is released and the fifth locking device has gone into engagement, the locking segment 28 will be located in connection with a second groove 8b provided in the housing 1. A seal in connection with the chamber 31 is also located in this position in connection with the groove 8b, with the result that the chamber in this position is also opened on this side of the chamber 31. In a variant the valve may be designed so that the locking segment 28 in this position is not located in connection with any groove in the housing.

In fig. 5 a valve device according to the invention is shown placed in a sub 40 in tubing with a main channel 41. The valve device is placed in a side compartment with a port 43 to the annulus and port 42 to the tubing. In the illustrated embodiment an internal sleeve 44 is further arranged in the tubing. The sleeve 44

has a plurality of ports 45. When the valve device is to be used, the sleeve 44 is moved so that they are aligned with the port 42 and flow-through can be obtained.

The invention has now been explained with reference to an embodiment. A person skilled in the art will appreciate that several modifications and changes to this
5 embodiment will be possible within the scope of the invention as indicated in the following claims. For example both the second, fourth and fifth locking devices may be omitted while still having a valve which fulfils the object of the invention. The valve may also be realized with other types of locking devices than those illustrated.

CLAIMS

1. A valve device for use in a side pocket and/or sub in a well, comprising a housing (1) with a first port (2) and a second port (3), where during use the first port (2) leads to the annulus and the second port (3) leads to the tubing, and a first valve body (11) is movably mounted internally in the housing(1),
5 characterised in that it comprises
- a second valve body (20) mounted internally in the housing (1) and movable relative to both the housing (1) and the first valve body (11),
10 - a first locking device (A) configured between the first valve body (11) and the second valve body (20) in order to lock the movement of the first valve body (11) relative to the second valve body (20) in one direction and in such a manner that when the first locking device (A) is activated, the first valve body (11) is held in an open position as long as the second
15 valve body (20) is in an open position, thereby providing through-flow through the valve device, and
- a third locking device (C) configured between the second valve body (20) and the housing (1), with the result that release of the third locking device (C) will permit movement of the second valve body (20) relative
20 to the housing (1) and thereby to a closed position of the valve device, thereby also permitting the first valve body (11) to go to a closed position.
2. A valve device according to claim 1,
characterised in that it comprises a second locking device (B) configured
25 between the second valve body (20), the housing (1) and the first valve body (11), in such a manner that the second valve body (20) is permanently locked relative to the housing (1) in an open position until the first valve body (11) is locked in the first locking device (A) and thereby in an open position of the valve device.
3. A valve device according to claim 1 or 2,
characterised in that it comprises a fourth locking device (D) configured
30 between the housing (1) and the first valve body (11) in such a manner that it locks the first valve body (11) to the housing (1) in a closed position and further arranged so that it (D) has to be released before the
35 first valve body (11) can be moved and locked by the first locking device (D).
4. A valve device according to one of the above-mentioned claims,
characterised in that the first locking device (A) is activated from a

neutral position to a locked position by the first valve body (11) being moved relative to the housing (1) from a closed position to a locked open position when a given pressure differential is attained between a pressure at the first port (2) and a pressure at the second port (3).

- 5 5. A valve device according to one of the above-mentioned claims, characterised in that a chamber (31; 31') set at a given pressure before installation of the valve device in the well is provided between the second valve body (20) and the housing (1).
- 10 6. A valve device according to one of the above-mentioned claims, characterised in that the third locking device (C) is configured in such a manner that when the valve device is in an open position, the third locking device (C) can be released when there is a given pressure differential between the chamber (31; 31') and a pressure at the first or second port (2, 3), with the result that the second valve body (20) goes to
15 a closed position.
7. A valve device according to one of the above-mentioned claims, characterised in that it comprises a fifth locking device (E) which locks the second valve body (20) permanently relative to the housing (1) in a closed position.
- 20 8. A valve device according to one of the above-mentioned claims, characterised in that the first valve body (11) is mounted relatively inside the second valve body (20), where the first valve body (11) in a closed position shuts off the second port (3) and the second valve body (20) in a closed position shuts off the first port (2).
- 25 9. A valve device according to one of the above-mentioned claims, characterised in that the second valve body (20) is substantially sleeve-shaped and comprises an admission port (21) through the sleeve wall for fluid through-flow.
- 30 10. A valve device according to one of the above-mentioned claims, characterised in that the first valve body (11) comprises a substantially cylindrical main part with a central through-flow passage (14) with a port (15) at one end of the cylinder facing the first port (2) of the valve device and a closed opposite end of the cylinder with ports (13) arranged in a side wall of the cylinder facing the second port (3) of the valve device.
- 35 11. A method for operation of a valve device between the tubing and annulus in a well, where the valve comprises a first port and a second port, characterised in that it comprises the steps of pressurising fluid in the

annulus which is permitted to flow into the valve device until a pressure differential is achieved between annulus pressure and tubing pressure, thereby causing the second port of the valve to be opened and the valve locked in this position and fluid is permitted to flow through the valve, whereupon the fluid in the well is pressurised so that a locking device internally in the valve is broken and both the second and the first port are shut off.