METHOD OF CEMENTING AN OFF BOTTOM LINER

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ABSTRACT

A method of cementing an off bottom liner including the steps of establishing a first flow blockage in the liner at a location down-hole of a cementing valve located in the side wall of the liner, opening the cementing valve which exposes openings in the sidewall of the liner, pumping cement down the liner and out through the openings in the sidewall of the liner, establishing a second flow blockage up-hole of the cementing valve, closing the cementing valve, opening the second flow blockage to establish fluid communication through the second flow blockage, and opening the first flow blockage to establish fluid communication through the first flow blockage. The steps of opening the first and second flow blockages are achieved by increasing the pressure in the liner above the blockages. In this way, it is possible to cement an off bottom liner and regain fluid communication to the wellbore below the liner without the need for any drilling operations.
METHOD OF CEMENTING AN OFF BOTTOM LINER

FIELD OF THE INVENTION

[0001] The current invention relates to a method for cementing an off bottom liner comprising the steps of establishing a first flow blockage in the liner at a location downhole of a cementing valve located in the side wall of the liner, opening the cementing valve which exposes openings in the sidewall of the liner, pumping cement down the liner and out through the openings in the sidewall of the liner, establishing a second flow blockage up-hole of the openings in the cementing valve, closing the cementing valve, opening the second flow blockage to establish fluid communication through the second flow blockage, and opening the first flow blockage to establish fluid communication through the first flow blockage. Off bottom liners are used in wellbores where the end of the liner does not reach the end of the wellbore. Off bottom liners can also be used in wellbores which are not purely vertical. Some wellbores can even be arranged horizontally.

BACKGROUND

[0002] During the creation of a well, liners are inserted into a wellbore to line the wellbore. The liners are typically anchored to the wellbore via cement which is pumped out the bottom of the liner. The cement flows into the annulus between the wellbore and the liner. When it hardens the liner is firmly cemented within the wellbore. In other cases cement is pumped out through a cementing valve which is arranged as part of the liner and which comprises ports which allow the cement to flow out through the sidewall of the liner. For an example of the first case, see U.S. Pat. No. 5,829,523, U.S. Pat. No. 6,318,472 and US 2003/0164237. For an example of the second case, see GB 688,727.

[0003] When cementing an off bottom liner, the second method is typically used since it is usually not desired to introduce cement into the portion of the well below the end of the liner. In many cases where off-bottom liners are used, the bottom of the well could be hundreds to thousands of meters below the end of the liner. Therefore, pumping cement out the bottom of the liner would be unproductive.

[0004] A typical cementing procedure starts with the liner being run to installation depth via a liner hanger running tool. A one-way valve is located at the end of the liner to prevent fluid flow into the liner, but which allows fluid flow out the end of the liner. Two wiper plugs are suspended at the end of the liner hanger running tool. Once the liner has been run to the correct depth, the liner is hung off the inside of the casing 2 via the liner hanger, the bottom wiper plug is released from the running tool and pumped down the well until it engages a landing collar located near the bottom of the liner. The wiper plug is typically released by pumping a pump down dart into the wiper plug, increasing the pressure up hole of the wiper plug and causing shear pins to break and a release mechanism to trigger that releases the wiper plug.

[0005] When the bottom wiper plug engages the landing collar, the end of the liner becomes plugged and the pressure in the liner can be increased. By increasing the pressure in the liner, down hole equipment such as an open hole packer can be activated. The open hole packer is arranged on the outside of the liner and inflates when activated. The open hole packer inflates such that it presses out against the wellbore. In this way, a seal is created between the volume located above the open hole packer and the volume located below the open hole packer. Increased pressure is also used to open a cementing valve which is located near the bottom of the liner, but above the open hole packer. By opening the cementing valve, a port in the side of the liner is opened. Cement can then be pumped down the liner, out through the cementing valve and into the annulus surrounding the liner. Due to the seal created by the open hole packer, cement is only pumped into the annulus above the open hole packer.

[0006] When enough cement has been pumped into the annulus, a top wiper plug is released from the running tool and pumped down the liner until it engages a suitable collar located at the cementing valve. As with the bottom wiper plug, the top wiper plug is released by pumping a pump down dart into the wiper plug, raising the pressure in the liner and breaking shear pins that allows the wiper plug to be released from the liner running tool.

[0007] Once the top wiper plug lands in the collar near or inside the cementing valve, the pressure in the liner is increased again in order to close the cementing valve. Excess cement is then circulated out of the casing 2 on top of the liner and the liner hanger running tool is removed from the well after setting a liner hanger packer. When the cement has hardened, a drill string is introduced into the liner and is used to drill the top wiper plug, top collar, bottom wiper plug, bottom collar and one-way valve out with a drill bit in order to open the plugs and establish fluid communication with the wellbore beyond the bottom of the liner. Once fluid communication is re-established through the bottom of the liner, the drill string is removed from the liner.

[0008] However, one of the drawbacks of the method described above, is that the step of drilling the plugs out is time consuming. A drill string needs to be assembled and run down the well. When the drilling is complete, the drill string needs to be removed from the well and disassembled. Another drawback is that the drilling will leave debris in the well that could interfere with production equipment later in the well's life.

SUMMARY OF THE INVENTION

[0009] One aspect of the current invention is therefore to provide a method of cementing an off bottom liner where it is not necessary to drill the plugs out at the end of the procedure in order to regain fluid communication to the wellbore below the liner.

[0010] This aspect is solved by a method as mentioned in the introductory paragraph wherein steps of opening the first and second flow blockages are achieved by increasing the pressure in the liner above the blockages. By using blockages which open when the pressure is increased to a certain predefined level, it is not necessary to drill out the plugs.

[0011] In one embodiment of the method, the step of establishing a blockage at a location down hole of a cementing valve could comprise the step of pumping a wiper plug down the liner until it engages a collar located down hole of the cementing valve.

[0012] Once the first blockage has been established, the step of establishing a second blockage at a location up hole of the openings in a cementing valve could comprise the step of pumping a wiper plug down the liner until it engages a collar located up hole of the openings in the cementing valve.

[0013] In order to prevent cement from being filled into the end of the wellbore, the method could further comprise the
step of establishing a seal in the annular space between the liner and the wellbore below the cementing valve in order to separate the volume in the wellbore below the seal and the volume in the wellbore above the seal. The seal could for example be formed with an open hole packer.

[0014] In one embodiment of the method, the liner comprises a one-way valve located at the end of the liner. In this case, the method could further comprise the step of disabling the one-way valve. In this way, fluid can be pumped up the liner at the end of the procedure.

[0015] In an advantageous form of a wiper plug, the wiper plug could comprise an outer wiper part and an inner hollow sleeve, and where the inner hollow sleeve is sideably arranged within the outer wiper part and is held in place by a release mechanism. In one embodiment, the inner hollow sleeve could be formed with through-going openings which are exposed when the release mechanism releases and the inner hollow sleeve extends out the end of the wiper part. By arranging the through-going openings in the hollow sleeve and exposing them when the sleeve slides forward, a large flow can be achieved through the plug. The openings can be formed as slots in the side of the sleeve which allow the openings to achieve a very large area, thereby reducing the flow resistance of the plug.

[0016] The wiper plug could further comprise a restraining mechanism which locks the inner hollow sleeve once it is extended into its extended position. In this way, the inner sleeve is prevented from closing once it has been opened. This is beneficial during the production of oil, since it would be detrimental to the well if the well was blocked accidentally.

[0017] The wiper plug could also comprise a ratchet mechanism between the inner hollow sleeve and the outer part that would prevent the sleeve from closing. This is useful in the case where the sleeve only opens partially. In this case, a potential restraining mechanism hasn’t engaged yet.

[0018] In one method according to the invention, an assembly can be used which comprises a liner, a liner hanger, a liner hanger running tool, a top wiper plug suspended at the end of the liner hanger running tool, a side wall cementing valve comprising openings through the side wall of the liner, a top collar arranged up hole of the openings in the cementing valve, a bottom plug arranged below the cementing valve, and where the top collar is arranged such that the top wiper plug engages the top collar when the top wiper plug is pumped down the liner and where the bottom wiper plug and the bottom plug are of the type which can be opened by applying pressure up hole of the plug.

[0019] In another method according to the invention, an assembly can be used which comprises a liner, a liner hanger, a liner hanger running tool, a top wiper plug suspended at the end of the liner hanger running tool, a bottom wiper plug suspended below the top wiper plug, a side wall cementing valve comprising openings through the side wall of the liner, a top collar arranged up hole of the openings in the cementing valve, a bottom plug arranged below the cementing valve, and where the top collar is arranged such that the top wiper plug sealingly engages the top collar when the top wiper plug is pumped down the liner and lets the bottom wiper plug pass the top collar when the bottom wiper plug is pumped down the liner and where the bottom collar is arranged to sealingly engage the bottom wiper plug when the bottom wiper plug is pumped down the liner.

[0020] In one embodiment of this assembly, the inner diameter of the top collar could be larger than the outer diameter of the bottom wiper plug and the inner diameter of the bottom collar could be less than the outer diameter of the bottom wiper plug and the inner diameter of the top collar could be smaller than the outer diameter of the top wiper plug.

[0021] The assembly could be arranged such that the top and bottom wiper plugs are of the kind which can be opened by increasing the pressure upstream of the wiper plug.

[0022] It should be emphasized that the term "comprises/ comprising" when used in this specification is taken to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] In the following, the invention will be described in greater detail with reference to the embodiments shown by the enclosed Figures. It should be emphasized that the embodiments shown are used for example purposes only and should not be used to limit the scope of the invention.

[0024] FIGS. 1a-1e schematically show five steps according to one embodiment of a method according to the current invention.

[0025] FIG. 1f shows the liner at the end of the cementing operation with the cement shown.

[0026] FIGS. 2a-2e schematically show five steps according to a second embodiment of a method according to the current invention.

[0027] FIGS. 3a-3f schematically show six steps according to a third embodiment of a method according to the current invention.

[0028] FIGS. 4a-4d show more detailed cross section views of one embodiment of a top wiper plug which can be used in a method according to the current invention.

[0029] FIG. 5 shows the top wiper plug of FIGS. 4b and 4c in more detail.

[0030] FIG. 6 shows the top wiper plug of FIG. 4d in more detail.

[0031] FIGS. 7a-7c show cross section views of a first embodiment of a bottom plug which can be used in a method according to the current invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0032] One embodiment of the method according to the current invention can be described with reference to FIGS. 1a-1c. The Figs. show a wellbore 1, a casing 2, a liner 3, a liner hanger running tool 4, a top wiper plug 5, a cementing valve 6, an open hole packer 7 and a bottom plug 8. It should be noted that in the Figs., the wellbore is shown without a bottom. This is to show that the current technique can be used in wells where the liner 3 does not reach the bottom of the well.

[0033] As can be seen from the Figs., the casing 2 is suspended in the wellbore 2 by cement 22. The liner 3 is run into the wellbore and suspended near the end of the casing 2 by the liner hanger running tool 4. The liner 3 is then hung off the end of the casing 2 by a liner hanger (not shown). The liner hanger allows flow past the liner hanger and in this way allows flow from the outside of the liner 3 to flow up into the casing 2. At the end of the procedure a liner hanger packer (9) is expanded to seal the opening between the liner 3 and the casing 2 and to secure the top of the liner 3 to the casing 2.
The top wiper plug 5 is suspended near the top of the liner 3 at the end of the liner hanger running tool 4. The top wiper plug 5 is attached to the liner hanger running tool 4 by a release mechanism (not shown) which usually comprises a number of shear pins. However, the person skilled in the art will be familiar with other release mechanisms suitable for this use.

The cementing valve 6 is arranged near the bottom of the liner 3 and comprises two sliding sleeves 10a, 10b and a number of openings 11 through the side walls of the liner 3. The open hole packer 7 is arranged below the cementing valve 6 and is of the kind which when exposed to a pressure of a certain level, inflates such that it presses out against the sides of the wellbore 1, thereby establishing a seal between the volume of the wellbore 1 above the open hole packer 7 and the volume of the wellbore 1 below the open hole packer 7.

The bottom plug 8 is arranged at the bottom of the liner 3. The bottom plug 8 comprises a check valve 12 which allows flow out the end of the liner 3, but does not permit flow back up through the liner 3. In many cases, it is desired to be able to flush fluid out the bottom of the liner 3 in order to ease the insertion of the liner 3.

The top wiper plug 5 and the bottom plug 8, both comprise an outer part 5a, 8a and an inner sliding sleeve 5b, 8b, respectively. The inner sliding sleeves 5b, 8b both comprise openings 14, 15 which are covered by the outer part 5a, 8a. The inner sliding sleeve is held in place in the outer part by a release mechanism, for example shear pins. The outer part 5a of the top wiper plug 5 further comprises wiper blades such as are known from other wiper plugs in the industry.

At the start of the procedure the liner 3 is run into the well until it is in a position as shown in FIG. 1a. When it is desired to start the cementing operation, a ball 16 is dropped into the liner 3. The ball has a diameter which is small enough so that it can pass through the top wiper plug 5, but large enough so that it is caught by the bottom plug 8. The ball 16 is made of a material which is not too heavy. In many cases off bottom liners are used in horizontal wells, where a heavy ball would not reach the bottom plug. When the ball is made from a material which is not too heavy, the ball almost floats on the well fluid and can be pumped to the end of the liner 3, even if the liner 3 is horizontal.

As shown in FIG. 1b, when the ball 16 is caught in the bottom plug 8, a blockage is established by the bottom plug 8 at the bottom of the liner 3. Fluid is therefore prevented from leaving the liner 3. The pressure in the liner 3 can therefore be raised. The bottom plug 8 also comprises a retaining mechanism (not shown) such that once the ball 16 is caught in the plug, it cannot leave the plug.

When the pressure is raised above a predefined level, a port in the open hole packer 7 opens and the open hole packer inflates until it presses out against the wellbore. The pressure can then be raised again until the bottom sleeve 10b of the cementing valve 6 opens. This is shown in FIG. 1b. At this point, cement can be pumped out of the liner 3 through the openings 11 in the sidewalls of the liner 3 as shown by the arrows 17 in FIG. 1b. Note the cement is not shown in FIGS. 1a-1e in order to simplify the Figs. However, the cement 23 is shown in FIG. 1f.

As shown in FIG. 1c, when the desired amount of cement has been pumped out of the openings in the side walls of the liner 3, a pump down dart 18 is dropped into the well. The dart 18 is pumped down the well until it reaches the top wiper plug 5 where it is caught by the inner sliding sleeve 5b and locked into the sleeve. Once the dart 18 is caught, fluid flow is prevented from passing the top wiper plug 5. The pressure above the wiper plug 5 can then be increased until the release mechanism which holds the wiper plug 5 to the liner hanger running tool is broken. The top wiper plug 5 can then be pumped down the liner 3 until it reaches a landing collar 19 located at or inside the cementing valve 6. The pressure behind the top wiper plug 5 can then be further increased until the top sleeve 10a of the cementing valve 6 slides down and closes the openings 11 in the cementing valve 6.

As shown in FIG. 1d, at this point, the pressure behind the top wiper plug 5 can be increased, causing the release mechanism (not shown) between the inner sleeve 5b and the outer part 5a of the top wiper plug 5 to release, thereby allowing the inner sleeve 5b to slide down and expose the openings 14 in the inner sleeve 5b. Fluid communication is therefore established again to the liner 3 below the top wiper plug 5.

The pressure behind the bottom plug 8 can then be raised, causing the release mechanism between the inner sleeve 8b and the outer part 8a of the bottom plug 8 to release. The inner sleeve 8b then slides down to expose the openings 15 in the inner sleeve of the bottom plug 8. At this point, fluid communication is re-established with the wellbore below the bottom plug 8.

The production of hydrocarbons or the injection of liquids and/or gasses can now start as shown in FIG. 1e by the arrows 21, without the need for any drilling operations. The top wiper plug 5 and the bottom plug 8 can be left in the liner 3 since fluid flow through them is not prevented.

It should be mentioned that the top wiper plug 5 and the bottom wiper plug 8 are formed such that once the inner sleeves have been released and put into their free flow positions, the sleeves cannot move back into their closed positions. This could be with the help of a ratchet mechanism and/or some other form of locking mechanism. An example of a top wiper plug and bottom plug suitable for this method will be described in more detail later on in this specification.

FIGS. 2a-2e show some of the steps of a second embodiment of a method of cementing an off bottom liner according to the current invention. In this case, the steps are almost identical, with the exception of the bottom plug 30. The other elements are therefore given the same reference numerals as in the first embodiment. In addition, the process need not be described in detail, as the process steps are almost identical.

In the second embodiment, the bottom plug 30 is of the kind which is commonly called a “disappearing plug”. Plugs of this kind are well known in the industry and can, for example, comprise a plug 31 made of a hard packed material which dissolves when exposed to a high pressure. The plug 31 is arranged in an outer part 32. One example of such a plug is the “Mirage”™ plug manufactured by Halliburton.

The advantage of using a disappearing plug is that a simpler system is achieved. However, the disadvantage of using a disappearing plug is that during the running in of the liner 3, the bottom of the liner 3 is blocked and it is not possible to flush fluid out of the end of the liner 3. Not being able to flush out the end of the liner 3 is acceptable in cases where the well parameters are well known and there is little risk in the liner 3 installation. Therefore the solution with the disappearing plug is not always suitable.

The rest of the procedure is the same as the first embodiment, the only difference being that no ball is neces-
sary to block the bottom plug 30. When it is desired to open the bottom plug 30, the pressure inside the liner 3 is raised above the predefined pressure point of the disappearing plug 30 and the plug 30 opens.

[0050] It should be mentioned, that instead of using a disappearing plug 30, a mechanical plug which is similar to the bottom plug 8 of the first embodiment can be used but which is already blocked at the start of the procedure. In this way, it is not necessary to drop a ball 16 into the well. However, as with the disappearing plug, it is not possible to flush fluid out of the end of the liner 3 during the running of the liner 3 when the liner 3 is equipped with this type of bottom plug.

[0051] FIGS. 3a-3f show some steps of a third embodiment of a process for cementing an off-bottom liner. Most of the steps are the same as the previous methods, and the same elements have been given the same reference numerals.

[0052] In this embodiment, the difference is that two wiper plugs 4, 40 are suspended from the end of the liner hanger tool 4. The two plugs are a top wiper plug 5 which is identical to the one used in the first and second embodiments and a bottom wiper plug 40 which is similar to the top wiper plug 5. The bottom wiper plug 40 is attached to the top wiper plug 5 with a release mechanism such as shear pins (not shown). The wiper plugs are of the kind which permit fluid flow through them until they are blocked by a plug 18, 41 which is pumped down the well or dropped into the well. These types of plugs are known in the industry and need not be described in more detail. The plugs which block the wiper plugs are typically in the form of a ball or a wiper dart. In the current embodiment, a wiper dart is used. Again, this technology is well known to the person skilled in the art and need not be discussed further here.

[0053] The wiper plugs 4, 40 are further of the type which comprise means for re-establishing fluid flow through them at a time after they have been blocked by a plug. Plugs of this kind are known to the person skilled in the art from other cementing procedures. See for example the references in the introduction of this specification. However, the plugs of this kind have not been used in a method according to this invention before. Furthermore, while the known plugs can be used in a method according to the current invention, they are not optimal. An example of a plug designed for use in this method is described later on in this specification.

[0054] A bottom collar 42 is located near the bottom of the liner 3. The bottom collar 42 is designed such that when the bottom wiper plug 40 is pumped down the liner 3, the bottom wiper plug 40 will engage the bottom collar 42 and not be able to pass the bottom collar 42. A check valve 43 is arranged at the bottom of the liner 3. The top collar 19 is designed such that when the bottom wiper plug 40 is pumped down the liner 3, the bottom wiper plug 40 does not engage the top collar 19 and is able to pass the top collar 19. However, the top collar 19 is also dimensioned such that when the top wiper plug 5 is pumped down the liner 3, it engages the top collar 19 and is not allowed to pass it.

[0055] This could be arranged by ensuring that the outer diameter of the bottom wiper plug 40 was smaller than the inner diameter of the top collar 19 and greater than the inner diameter of the bottom collar 42. The top wiper plug 5 can be arranged such that its diameter is greater than the inner diameter of the top collar 19.

[0056] As can be seen from FIG. 3a, at the start of the procedure, the top 5 and bottom 40 wiper plugs are attached to the liner hanger running tool and there is free fluid flow through the wiper plugs and out the end of the liner 3. When it is desired to start the cementing operation, a dart 41 is dropped into the well. The dart 41 has an outer diameter which is greater than the inner diameter of the outlet 44 of the bottom wiper plug 40. The dart 41 therefore blocks the outlet of the bottom wiper plug 40 and blocks fluid flow through the bottom wiper plug 40. By increasing the pressure in the running tool, force is applied to the bottom wiper plug 40 and the shear pins between the top and bottom wiper plugs are sheared thereby releasing the bottom wiper plug 40. It should be mentioned that there are many release mechanisms available in the prior art which ensure that the bottom wiper plug 40 is released before the top wiper plug 5. The person skilled in the art will be familiar with these release mechanisms so details of different types of release mechanisms will not be presented here.

[0057] The bottom wiper plug is pumped down the liner 3, past the top collar 19 and past the cementing valve 6 until it reaches the bottom collar 42 as shown in FIG. 3b. The bottom wiper plug 40 engages the bottom collar 42 and blocks the end of the liner 3. It should be noted that when the bottom wiper plug 40 engages the bottom collar 42, the bottom wiper plug 40 is arranged to press the one-way valve 43 open. In this way, once the bottom wiper plug 40 is arranged in the bottom collar, the one-way valve is fixed in the open position.

[0058] The pressure can then be increased in the liner 3. The increased pressure first causes the open hole packer 7 to inflate and then causes the cementing valve 6 to open. This is shown in FIG. 3c. It should be noted that cementing valves 6 and open hole packers 7 of the type discussed here are known to the person skilled in the art. These devices have therefore been shown very schematically.

[0059] Once the cementing valve 6 has opened, cement can be pumped out through the ports 11 in the cementing valve 6 and into the annulus between the wellbore 1 and the liner 3. The fluid of cement is shown in FIG. 3c by the arrows 17. When enough cement has been pumped into the annulus, a second dart 18 is dropped into the well. The outer diameter of the second dart 18 is larger than the diameter of the outlet 20 of the top wiper plug. The second dart 18 therefore opens the outlet of the top wiper plug. Pressure can then be raised again in the running tool 4 causing force to be applied to the top wiper plug 5 which shears the shear pins between the top wiper plug 5 and the running tool 4. This releases the top wiper plug 5 which can be pumped down the liner 3 until it engages the top collar 19.

[0060] When the top wiper plug 5 engages the top collar 19, fluid flow is again blocked which allows the pressure in the liner 3 to be raised again. By raising the pressure, the cementing valve 6 is forced closed by sliding the top sleeve 10a of the cementing valve over the ports 11. This is shown in FIG. 3d.

[0061] As shown in FIG. 3e, the fluid flow through the liner 3 is now blocked completely. However, by increasing the pressure in the liner 3 further, the top wiper plug 5 can be forced open due to the design of the top wiper plug 5. The release mechanism between the inner sleeve 5b and the outer part 5a of the plug is released and the inner sleeve 5b slides down, exposing the openings 14 in the inner sleeve. This re-establishes fluid communication through the top wiper plug 5.

[0062] Once the top wiper plug 5 is open, pressure can be applied to the bottom wiper plug 40 which can also be opened in the same manner as the top wiper plug 5. By increasing the pressure, force can be applied to the inner sleeve 40b of the
bottom wiper plug 40. This causes a release mechanism arranged between the outer part 40a of the bottom wiper plug and the inner sleeve 40b of the bottom wiper plug to release, thereby allowing the inner sleeve 40b to slide downwardly, causing the openings 45 to be exposed. This establishes fluid communication through the bottom wiper plug 40.

[0063] Once the bottom wiper plug 40 is opened, fluid communication is established through the entire liner 3. Excess cement is also flushed from the top of the liner 3 whereafter the liner hanger packer (9) is set. Once excess cement is circulated out, hydrocarbon production, as shown by the arrows 21 in FIG. 5f, or liquid and/or gas injection can be started.

[0064] In this way, fluid communication through the liner 3 is established without the need for any drilling operations. This means that a significant amount of time can be saved during the establishment of the well.

[0065] FIGS. 4a-4d show more detailed cross section views of one embodiment of a top wiper plug which could be used with the above described methods.

[0066] FIG. 4e shows the wiper plug 5 suspended at the end of the liner hanger running tool 4 and arranged inside the liner 3. In the Fig., the dart 18 is shown on its way into the wiper plug 5. FIG. 4f shows the wiper plug 5 on its way down the liner 3 after it has been released from the liner hanger running tool 4. The dart 18 is fully engaged with the end of the wiper plug 5 thereby blocking the outlet 20 of the wiper plug 5. FIG. 4e shows the wiper plug engaged with the top collar 19 of the cementing valve 6. FIG. 4d shows the wiper plug 5 after the inner sleeve 5b has been released from the outer part 5a and the openings 14 in the inner sleeve 5b have been exposed. The wiper plug 5 is now open for free flow through the plug 5. It should be noted that in the open position, the sleeve is locked by a locking mechanism to prevent it from returning to its closed state.

[0067] FIG. 5 shows the top wiper plug 5 in its closed flow position in more detail and FIG. 6 shows the top wiper plug 5 in its open flow position in more detail. The wiper plug 5 comprises an inner sleeve 5b, an outer part 5a and a dart 18 which has been pumped down the well and into the plug 5 such that it blocks the outlet 20 of the inner sleeve. The dart 18 is equipped with a locking ring 60 which locks the dart 18 in the inner sleeve 5b once the dart is fully inserted in the sleeve.

[0068] The inner sleeve 5b is fastened to the outer part 5a with two independent release mechanisms. The first release mechanism 61 comprises shear pins arranged around the circumference of the inner sleeve. When the force between the inner sleeve 5b and the outer part 5a is great enough, these pins shear and release the inner sleeve 5b from the outer sleeve 5a. The second release mechanism 62 comprises a slideable pin 63 arranged in a slot in the outer part and a bendable hook 64 attached to the inner sleeve 5b. When the wiper plug 5 is on its way down the liner 3, the hook is engaged with the slot in the outer part 5a. When the wiper plug 5 lands in the collar 19, the pin 63 is pressed in thereby displacing the hook 64 inwardly. The hook 64 thereby releases the slot in the outer part 5a and releases the inner sleeve 5b from the outer part 5a. In this way, the inner sleeve 5b cannot be released until it is sitting properly on the collar 19. This ensures that the wiper plug 5 does not accidentally open on its way down the liner 3 if the pressure in the liner 3 were to increase above the shearing force of the shear pins. This could for example occur if the wiper plug 5 were to meet an obstruction at a position above the top collar 19.

[0069] The wiper plug 5 further comprises a locking mechanism 65 which engages when the inner sleeve 5b has been fully extended. The locking mechanism 65 comprises a spring biased split ring or c-ring connected to the inner sleeve which engages a recess 66 in the outer part near the end of the outer part 5a. The locking mechanism 65 ensures that once the sleeve has been fully opened, it cannot accidentally close again.

[0070] The wiper plug can furthermore comprise a ratchet mechanism (not shown) between the inner sleeve and outer part in order to prevent the sleeve from closing again if the sleeve does not open enough to engage the locking mechanism.

[0071] The wiper plug also comprises a second locking ring 67 which locks the wiper plug in the collar 19 when the wiper plug is engaged with the collar.

[0072] An end stop 68 is furthermore arranged at the end of the inner sleeve 5b which prevents the sleeve from sliding completely out of the outer part 5a. Seals 69 are arranged between the inner sleeve and the outer sleeve. Additional seals 70 are arranged on the outer part which establish a seal between the outer part and the collar 19.

[0073] It should also be noted that the openings 14 in the inner sleeve are arranged as slots. In this way, it is possible to provide a very large opening area through the plug thereby reducing the flow resistance of the plug.

[0074] FIGS. 7a-7c show an embodiment of a bottom plug 8 in different modes. The bottom plug 8 shown in the Figs. is suitable for use in a method which is similar to the method described in FIGS. 1a-1c. The bottom plug 8 is fixed to the liner 3 at a position near the end of the liner 3 before the liner 3 is run into position. The plug 8 has a one way valve 12 at its outlet which ensures that fluid can flow out of the liner 3, but not into the liner 3.

[0075] FIG. 7a shows the plug 8 in the state it is in when the liner 3 is being run into position. The plug 8 has an inner sleeve 8b which is fastened to an outer part 8a with shear pins 80. There is free flow through the plug 8 out of the liner 3. The bottom plug 8 also comprises seals 82 located between the inner sleeve 8b and the outer part 8a.

[0076] FIG. 7b shows the plug 8 after a ball 16 has been dropped into the plug 8. The ball 16 is held in place by the pressure in the tube. However, in case that the pressure should fall, a retaining mechanism 81 is arranged in the plug 8 to hold the ball 16 in place. Once the ball 16 is in place, the outlet of the bottom plug 8 is blocked.

[0077] FIG. 7c shows the plug 8 after the pressure in the liner 3 has been increased. The shear pins 80 have broken and the inner sleeve 8b has been displaced forward with respect to the outer part 8a. In this position, the openings 15 in the inner sleeve 8b which were previously blocked by the outer part 8a are now exposed and fluid is free to flow either way through the bottom plug 8.

[0078] It is to be noted that the Figures and the above description have shown the examples embodied in a simple and schematic manner. The internal details have not been shown since the person skilled in the art should be familiar with these details and they would just unnecessarily complicate this description and the Figs. For example, the details of open hole packers, liner hanger running tools, liner hangers, liner hanger packers, cementing values, etc. have not been disclosed in great detail since the person skilled in the art will be familiar with these items. Furthermore, the methods have
been discussed rather superficially since many of the steps will be familiar to the person skilled in the art.

Furthermore it should be noted that the above mentioned embodiments have only shown a limited number of embodiments of the method and the devices used in the methods. The person skilled in the art should be able to use the teachings of the current specification to develop other embodiments of methods and devices which are included in the scope of the current invention, but which are not explicitly disclosed herein.

Furthermore, a number of terms are used in this specification which should be understood more broadly than their literal meaning. For example, the current specification mentions the word “cement” quite often. However, the person skilled in the art should understand that cement is typically used to fasten off bottom liners in a well-bore. However, there are other materials for example polymer systems or other forms of cement which would also fulfill the demands of the fastening material. Therefore, the person skilled in the art should interpret the term “cement” more broadly than its pure literal meaning, thereby including the other suitable materials within the definition of the term cement in the context of this specification.

What is claimed is:

1. A method of cementing an off bottom liner comprising the steps of:
   establishing a first flow blockage in the liner at a location down-hole of a cementing valve located in the side wall of the liner;
   opening the cementing valve to expose openings in the sidewall of the liner;
   pumping cement down the liner and out through the openings in the sidewall of the liner;
   establishing a second flow blockage up-hole of the openings in the cementing valve;
   closing the cementing valve;
   opening the second flow blockage to establish fluid communication through the second flow blockage; and
   opening the first flow blockage to establish fluid communication through the first flow blockage;
   wherein the steps of opening the first and second flow blockages are achieved by increasing the pressure in the liner above the blockages.

2. A method according to claim 1, wherein the step of establishing a blockage at a location down-hole of a cementing valve comprises the steps of pumping a wiper plug down the liner until it engages a collar located down hole of the cementing valve.

3. A method according to claim 1, wherein the step of establishing a blockage at a location up-hole of the openings in a cementing valve comprises the steps of pumping a wiper plug down the liner until it engages a collar located up hole of the openings in the cementing valve.

4. A method according to claim 2, wherein the step of establishing a blockage at a location up-hole of the openings in a cementing valve comprises the steps of pumping a wiper plug down the liner until it engages a collar located up hole of the openings in the cementing valve.

5. A method according to claim 1 wherein the method further comprises the step of establishing a seal below the cementing valve in order to separate the volume in the well-bore below the seal and the volume in the wellbore above the seal.

6. A method according to claim 2 wherein the method further comprises the step of establishing a seal below the cementing valve in order to separate the volume in the wellbore below the seal and the volume in the wellbore above the seal.

7. A method according to claim 3 wherein the method further comprises the step of establishing a seal below the cementing valve in order to separate the volume in the wellbore below the seal and the volume in the wellbore above the seal.

8. A method according to claim 4 wherein the method further comprises the step of establishing a seal below the cementing valve in order to separate the volume in the wellbore below the seal and the volume in the wellbore above the seal.

9. A method according to claim 1, wherein the method further comprises the step of disabling a one-way valve located at the bottom of the liner.

10. A method according to claim 2, wherein the method further comprises the step of disabling a one-way valve located at the bottom of the liner.

11. A method according to claim 3, wherein the method further comprises the step of disabling a one-way valve located at the bottom of the liner.

12. A method according to claim 4, wherein the method further comprises the step of disabling a one-way valve located at the bottom of the liner.

13. A method according to claim 5, wherein the method further comprises the step of disabling a one-way valve located at the bottom of the liner.

14. A method according to claim 6, wherein the method further comprises the step of disabling a one-way valve located at the bottom of the liner.

15. A method according to claim 7, wherein the method further comprises the step of disabling a one-way valve located at the bottom of the liner.

16. A method according to claim 8, wherein the method further comprises the step of disabling a one-way valve located at the bottom of the liner.

17. A wiper plug comprising an outer wiper part and an inner hollow sleeve, and where the inner hollow sleeve is slideably arranged within the outer wiper part and is held in place by a release mechanism, wherein the inner hollow sleeve is formed with through going openings which are exposed when the release mechanism releases and the inner hollow sleeve extends out the end of the wiper part.

18. A wiper plug according to claim 17, wherein the wiper plug further comprises a restraining mechanism which locks the inner hollow sleeve once it is extended into its extended position.

19. A wiper plug according to claim 17, wherein the wiper plug further comprises a ratchet mechanism between the inner hollow sleeve and the outer part.

20. A wiper plug according to claim 18, wherein the wiper plug further comprises a ratchet mechanism between the inner hollow sleeve and the outer part.

21. An assembly comprising a liner, a liner hanger running tool, a top wiper plug suspended at the end of the liner hanger running tool, a sidewall cementing valve, a top collar arranged up hole of the openings in the cementing valve; a
bottom plug arranged below the cementing valve, and where the top collar is arranged such that the top wiper plug engages the top collar when the top wiper plug is pumped down the liner, wherein the top wiper plug and the bottom plug are of the type which can be opened by applying pressure up hole of the plug.

22. An assembly comprising a liner, a liner hanger running tool, a top wiper plug suspended at the end of the liner hanger running tool, a bottom wiper plug suspended below the top wiper plug, a sidewall cementing valve, a top collar arranged up hole of the openings in the cementing valve, a bottom collar arranged below the cementing valve, and where the top collar is arranged such that the top wiper plug sealingly engages the top collar when the top wiper plug is pumped down the liner and lets the bottom wiper plug pass the top collar when the bottom wiper plug is pumped down the liner and where the bottom collar is arranged to sealingly engage the bottom wiper plug when the bottom wiper plug is pumped down the liner.

23. An assembly according to claim 22, wherein the inner diameter of the top collar is larger than the outer diameter of the bottom wiper plug and where the inner diameter of the bottom collar is less than the outer diameter of the bottom wiper plug and where the inner diameter of the top collar is smaller than the outer diameter of the top wiper plug.

24. An assembly according to claim 22, wherein the top and bottom wiper plugs are of the kind which can be opened by increasing the pressure upstream of the wiper plug.

25. An assembly according to claim 23, wherein the top and bottom wiper plugs are of the kind which can be opened by increasing the pressure upstream of the wiper plug.

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