retrieved, the subsea production tree is cut and the well is then plugged. Conventionally, casing is cut by attaching a cutting tool to the end of a work string and running the tool down into the casing.

There are various tools available for downhole cutting and severing of casing strings. These tools utilise multiple extendable arms or blades which rotate outwardly to contact the casing. The work string and cutting tool is rotated causing cutting of the casing string. In some cases the cutting tool is motor driven. For example, US2011220357 (A1) describes a method for milling a tubular cemented in a wellbore including deploying a work string-mounted bottom hole assembly (BHA) into the wellbore through the tubular, the BHA comprising a window mill with extending arms. The method further comprises rotating the work string, extending the arms of the window mill, and radially cutting through the tubular.

SUMMARY

According to an aspect of the disclosure there is provided a downhole tool according to the appended claims.

The tool may be configured to provide a stream of fluid flowing radially outwards from the perimeter of the tool, the stream of fluid extending continuously around the circumference of the tool, such that the stream of fluid may impinge on a circumferential area or surface, for example the inner surface of a downhole tubing.

The fluid flow path may be configured such that fluid may enter the fluid inlet at a first speed and leave the fluid outlet at a higher second speed.

The fluid flow path may be configured such that fluid may enter the fluid inlet in a first direction and leave the fluid outlet in a different second direction.

The first direction will typically be a predominantly axial direction, and the second direction will typically be a predominantly radial direction.

The stream of fluid may have a uniform flow rate from around the perimeter of the tool.

Fluid, typically a liquid, is supplied to the downhole tool from surface via a conduit, for example a work string. The tool is mounted on the support member, for example a drill string or work string. The support member may extend from surface through the downhole tubing. The support member is tubular such that fluid may be directed from surface through the member to the tool.

The tool may be configured to provide a jet of fluid for use in cleaning or treating tubing, or for eroding, forming, cutting or severing tubing downhole. The downhole

tubing may be, for example, casing strings or liners, or production screens. The tool may also be useful for cleaning a downhole element or device, such as a valve or a profile.

The fluid outlet may comprise a flow constriction, restriction or nozzle such that when the fluid is directed through the fluid outlet, the fluid is formed into a jet.

The fluid outlet may be less than 5 mm wide, less than 4 mm wide, less than 3 mm wide, or less than 2 mm wide, or around 1mm wide.

The fluid jet from the fluid outlet may be a continuous jet or a pulsed jet.

The fluid velocity of the jet exiting the tool may be selected as appropriate for the intended tool application, for example the fluid flow rate may be selected and/or the size of the flow constriction, restriction or nozzle through which the fluid passes may be configured to provide the desired fluid velocity. The fluid velocity for a given fluid flow rate may be changed by, for example, adjusting the size of the flow constriction or nozzle prior to positioning the tool in the downhole tubing.

The fluid may travel at a suitable speed to achieve a desired rate of material removal, for example the fluid speed may be 30.8 m/s (100 feet/sec) or more when the tool is being used as a cutting tool or 15.24 m/s (50 feet/sec) or more when the tool is being used for cleaning purposes.

The tool body may comprise an inner body and an outer body, wherein the inner body comprises the fluid inlet, and wherein the outer body comprises the fluid outlet.

The inner body may further comprise a plurality of radial flow passages, wherein fluid is directed into the inner body through the fluid inlet and is directed

cleaning, and when supplied with fluid containing abrasive material the tool may be used for cutting.

The tool may be provided in combination with a gripping or lifting tool, such as a fishing tool, spear or grapple. The gripping or lifting tool may be utilised to retrieve a cut casing or other "fish". The gripping or lifting tool may be provided on a support member, above or below the cutting tool, or may be integrated with the cutting tool.

The tool may be provided in combination with one or more stabilisers, for location above or below the tool, to facilitate centralising and stabilising the tool.

According to another aspect of the disclosure there is provided a method of treating or cleaning downhole tubing, according to the appended claims.

The jet of fluid may travel in a direction that is substantially perpendicular to the tubing wall, or may be inclined to the tubing wall.

The jet of fluid may impinge on a circumferential area or surface, for example the inner surface of downhole tubing.

The downhole tubing may be, for example, casing string and/or liner, a screen, or a completion. The method may also be used for cleaning downhole elements or devices, such as valves or profiles, or seal bores. The method may be used to clean elements of a well head.

The jet of fluid may be provided by a tool run into the tubing on a support member, such as a work string or a drill string, or coiled tubing.

The method may comprise positioning the tool downhole at the location to be cleaned.

The tool may be translated through the tubing as the jet of fluid is directed at the tubing wall. The rate of translation may be selected to provide the most efficient cleaning operation, for example the fastest speed that will achieve the desired degree of cleaning.

If left stationary in the tubing for an extended period, the jet of fluid may erode the surface of the tubing, and ultimately cut through the tubing.

The method may comprise supplying fluid to the tool via a support member, which may be a tubular support member.

The method may comprise accelerating and redirecting fluid supplied through the support member, typically fluid supplied from surface.

The velocity of the fluid jet may be selected to clean the wall of the downhole tubing, for example the velocity of the fluid jet may be selected to cause removal of a particular material from the inner surface of the downhole tubing.

The method may comprise adjusting the flow rate of fluid supplied to the tool.

The method may further comprise selecting the dimensions of a fluid outlet constriction in the tool providing the jet of fluid to provide the velocity of fluid as required by the application. The size of the constriction may selected by an operator prior to running the tool downhole.

The method may further comprise selecting the composition of the fluid to achieve the desired removal of material, for example surfactants or abrasive materials may be added to the fluid.

According to another aspect of the disclosure there is provided a method of cutting or severing downhole tubing, according to the appended claims.

The jet of fluid may be provided to impinge on a circumferential area or surface, for example the inner surface of the downhole tubing.

The jet of fluid may travel in a direction that is substantially perpendicular to the tubing wall, or may be inclined to the tubing wall.

The downhole tubing may be, for example casing strings and/or liners, a screen, or indeed any downhole structure.

The jet of fluid may be provided by a tool run into the string on a support member.

The stream of fluid may be supplied from surface through a support member.

The method may comprise positioning the tool downhole at the desired cutting location. The tool may be held stationary at the desired location for a period sufficient for the fluid to cut through the tubing. For certain flow and fluid conditions, translating the tool through the tubing may result in a cleaning or

CLAIMS

1. A downhole tool configured to receive a supply of fluid from surface and comprising:

a body having a fluid inlet and a fluid outlet and configured to accelerate fluid flowing along a fluid flow path from the inlet to the outlet, the fluid outlet comprising a flow constriction which extends around the circumference of the downhole tool for accelerating fluid passing through the constriction, the fluid outlet being configured to provide a radially directed and substantially circumferentially continuous stream of fluid therefrom,

and wherein the downhole tool is configured for mounting on a tubular support member and for receiving a supply of fluid delivered from surface through the support member.

2. The downhole tool of claim 1, wherein the fluid outlet is located at a radial periphery of the body.

3. The downhole tool of claim 1 or 2, wherein the fluid flow path is configured such that, in use, fluid enters the fluid inlet at a first speed and leaves the fluid outlet at a higher second speed.

4. The downhole tool of claim 1, 2 or 3, wherein the fluid flow path is configured such that, in use, fluid enters the fluid inlet in a first direction and leaves the fluid outlet in a different second direction.

5. The downhole tool of claim 4, wherein the first direction is a predominantly axial direction, and the second direction is a predominantly radial direction.

6. The downhole tool of any preceding claim, wherein the downhole tool is configured to create a jet of fluid for use in at least one of: cleaning tubing; treating tubing; eroding tubing; forming tubing; cutting tubing, and severing tubing downhole.

7. The downhole tool of any preceding claim, wherein the flow constriction is less than 5 mm wide, less than 4 mm wide, less than 3 mm wide, or less than 2 mm wide.

8. The downhole tool of claim 7, wherein the flow constriction is around 1mm wide.

9. The downhole tool of any preceding claim, wherein the body comprises a plurality of radial flow passages extending through a body wall portion, wherein, in use, fluid is directed into the body through the fluid inlet and is directed through the radial flow passages and out of the tool through the fluid outlet.

10. The downhole tool of any preceding claim, wherein the body comprises an inner body and an outer body, wherein the inner body comprises the fluid inlet, and wherein the outer body comprises the fluid outlet.

11. The downhole tool of claim 10, wherein the outer body defines the flow constriction such that when the fluid is directed through the outer body the fluid is formed into a fluid jet.

12. The downhole tool of claim 10 or 11, wherein the outer body defines an outlet manifold configured to distribute fluid to the fluid outlet.

13. The downhole tool of claim 10, 11 or 12, wherein the outer body comprises two parts having opposing surfaces which define the fluid outlet.

14. The downhole tool of claim 13, wherein one of the parts defines a larger diameter than the other part.

15. The downhole tool of any preceding claim, wherein the body comprises at least one lateral passage to facilitate flow of external fluid therethrough.

16. The downhole tool of claim 15, wherein a plurality of lateral passages are provided in the body.

17. The downhole tool of any preceding claim, wherein the downhole tool is configured for mounting on the distal end of the support member.

18. The downhole tool of any one of claims 1 to 16, wherein the downhole tool is configured for mounting between an upper portion of the support member and a lower portion of the support member.

19. The downhole tool of any preceding claim, wherein an axial communication passage extends through the downhole tool.

20. The downhole tool of any preceding claim, further comprising a bypass device having a closed first configuration and an activated second configuration, in the first configuration the fluid flow path being closed, and in the second configuration the fluid flow path being open.

21. The downhole tool of claim 20, wherein the bypass device is configured to be activated by an activating device delivered to the downhole tool from surface.

22. The downhole tool of claim 21, wherein in the activated second configuration the bypass device and the activating device cooperate to at least partially close an axial communication passage extending through the body, such that at least some of the fluid flowing from the fluid inlet is directed through the fluid outlet.

23. The downhole tool of any preceding claim, in combination with a filter to filter fluid supplied to the downhole tool.

24. The downhole tool of any preceding claim, in combination with a gripping or lifting tool for use in retrieving a section of downhole tubular that has been cut using the downhole tool.

25. The downhole tool of any preceding claim, in combination with at least one stabiliser, to facilitate centralising and stabilising the tool in a wellbore.

26. The downhole tool of any preceding tool, in combination with at least one of a tubing-cleaning brush, scraper or mill.

27. An elongate support member including at least two of the downhole tools of any preceding claim.

28. A method of cleaning or treating downhole tubing, the method comprising: supplying fluid to a downhole tool from surface, and directing a jet of fluid from the tool at a wall of the downhole tubing, wherein the jet of fluid is radially directed and substantially circumferentially continuous.

29. A method of cutting downhole tubing, the method comprising: supplying fluid to a downhole tool according to any one of claims 1 to 26 from surface, and redirecting and accelerating a stream of fluid in the downhole tool to create a jet

of fluid directed at the tubing wall, wherein the jet of fluid is a radially directed and substantially circumferentially continuous stream of fluid and erodes the wall.

30. The method of claim 28 or 29, wherein the jet of fluid impinges on a circumferential area of an inner surface of downhole tubing.

31. The method of any one of claims 28 to 30, wherein the speed of fluid in the jet is at least 15.24 m/s (50 feet/sec), or at least 30.8 m/s (100 feet/sec), or at least 70 m/s (200 feet/sec).

32. The method of any one of claims 28 to 31, wherein the downhole tubing is at least one of: casing; liner; a completion, and a screen.

33. The method of any one of claims 28 to 32, further comprising incorporating abrasive material in the fluid.

34. The method of any of claims 28 to 33, comprising translating the jet of fluid axially along the wall of the tubing at a controlled rate.

35. The method of claim 34, comprising translating the jet of fluid up the wall of the tubing.

36. The method of claim 34, comprising translating the jet of fluid down the wall of the tubing.

37. The method of any one of claims 28 to 36, comprising directing the jet of fluid at the tubing wall to form a cut and then pulling a portion of tubing above the cut.

38. The method of claim 37, comprising retrieving the portion of tubing.

39. The method of claim 37 or 38, comprising repeating the cutting operation at a second location to form a second cut, and then pulling a portion of tubing above the second cut.

40. The method of any one of claims 29 to 39, comprising translating the downhole tool through the tubing as the jet of fluid is directed at the tubing wall.

41. The method of claim 39 or 40, comprising supplying the fluid to the downhole tool from surface via the support member.

42. The method of claim 41, comprising supplying the fluid to the downhole tool through the support member and then accelerating and redirecting the fluid as it passes through the downhole tool.

43. The method of any one of claims 28 to 42, wherein the downhole tool has a fluid outlet configured to produce the jet of fluid, the fluid outlet having a first diameter and the downhole tubing having a second diameter, and the second diameter being: no more than 5 cm larger than the first diameter; no more than 4 cm larger than the first diameter; no more than 3 cm larger than the first diameter; no more than 2 cm larger than the first diameter; no more than 1 cm larger than the first diameter, or no more than 0.5 cm larger than the first diameter.

44. The method of any one of claims 28 to 43, wherein the downhole tool has a fluid outlet configured to produce the jet of fluid, the fluid outlet having a first diameter and the downhole tubing having a second diameter, wherein the second diameter is around 0.5 cm larger than the first diameter.

45. The method of any one of claims 28 to 44, comprising providing a path for downhole fluid to flow through the downhole tool.

46. The method of any one of claims 28 to 45, wherein the tool comprises a fluid outlet configured to produce the jet of fluid and mounting the tool on the distal end of the support member.

47. The method of any one of claims 28 to 45, wherein the downhole tool comprises a fluid outlet configured to produce the jet of fluid and mounting the tool between an upper portion of the support member and a lower portion of the support member.

48. The method of any one of claims 28 to 47, wherein the downhole tool defines a fluid flow path leading to a fluid outlet configured to produce the jet of fluid; and locating the tool downhole with the flow path closed, and opening the flow path.

49. The method of claim 48, comprising opening the flow path by delivering an activating device to the downhole tool from surface.

50. The method of claim 48 or 49, comprising providing an axial flow passage through the downhole tool, and at least partially closing the passage when opening the fluid flow path.

51. The method of any one of claims 28 to 50, comprising filtering fluid to be supplied to the downhole tool.

52. The method of any one of claims 28 to 51, comprising stabilising the downhole tool in the tubing.

53. The method of any one of claims 28 to 52, comprising mechanically cleaning the wall of the downhole tubing and wherein directing the jet of fluid at the wall of the downhole tubing follows the mechanical cleaning.

54. The method of any one of claims 28 to 53, comprising translating the jet along a length of the downhole tubing and eroding and removing a section of casing.