Nozzle, Wellbore Tubular and Method

Field

The invention relates to wellbore structures and, in particular, nozzles and tubulars for wellbore fluid control.

Background

Various wellbore nozzles and tubulars are known and serve various purposes. Tubulars are employed to both inject fluids into and conduct fluids from a wellbore. In some cases, nozzles are employed to control the flow and pressure characteristics of the fluid moving through the wellbore.

Wellbore tubulars with nozzles have failed in some challenging wellbore conditions, such as in steam operations. Improved nozzles and tubulars are required.

Summary

In accordance with one aspect of the present invention, there is provided a nozzle assembly comprising: a nozzle having a body formed of an erosion resistant material; and an orifice through the body, the orifice being non-linear and having a diverting bend therealong.

In accordance with another broad aspect, there is a wellbore tubular comprising: a base pipe including a wall; a port through the wall providing access between an inner diameter of the base pipe and an outer surface of the base pipe; a nozzle in the port, the nozzle including an orifice including a bend therein.

In accordance with another broad aspect, there is a method for handling fluid in a wellbore comprising: passing fluid through a nozzle orifice between an inner diameter of a tubular and an outer surface of the tubular, the nozzle orifice diverting flow such that the flow passes in a non-linear fashion between the inner diameter and the outer surface.

It is to be understood that other aspects of the present invention will become readily apparent to those skilled in the art from the following detailed description, wherein various embodiments of the invention are shown and described by way of illustration. As will be realized, the invention is capable for other and different embodiments and its several details are capable of modification in various other respects, all without departing from the spirit and scope of the present invention. Accordingly the drawings and detailed description are to be regarded as illustrative in nature and not as restrictive.

Brief Description of the Drawings

Drawings are included for the purpose of illustrating certain aspects of the invention. Such drawings and the description thereof are intended to facilitate understanding and should not be considered limiting of the invention. Drawings are included, in which:

Figure 1 is a perspective view of a wellbore tubular;

Figure 2 is a section along line I-I of Figure 1;

Figure 3 is a section through line II-II of Figure 2;

Figure 4 is an enlarged section through a nozzle installed in the wall of a tubular;

Figure 5 is an exploded perspective view of the components of a nozzle to be installed in the wall of a tubular;

Figure 6 is a perspective view of a nozzle seat;

Figure 7 is an enlarged sectional view of a nozzle; and

Figure 8 is an enlarged section through a nozzle installed in the wall of a tubular.

Detailed Description of Various Embodiments

The detailed description set forth below in connection with the appended drawings is intended as a description of various embodiments of the present invention and is not intended to represent the only embodiments contemplated by the inventor. The detailed description includes specific details for the purpose of providing a comprehensive understanding of the present invention. However, it will be apparent to those skilled in the art that the present invention may be practiced without these specific details.

Referring to Figures 1 to 3, a wellbore tubular 10 is shown. The wellbore tubular is for conveying fluid into or out of a well and for permitting fluid to pass between its inner diameter and outer surface. The tubular has a durable construction and may even accommodate the significant rigors presented by handling steam flows. The wellbore tubular may be formed using various constructions. For example, the ends 10a of the wellbore tubular may be formed for connection to adjacent wellbore tubulars. As will be appreciated, while the tubular's ends are shown as blanks, they may be formed in various ways for connection end to end with other tubulars to form a string of tubular, such as, for example, by formation at one or both ends as threaded pins, threaded boxes or other types of connections.

Wellbore tubular 10 includes a base pipe 12 with one or more ports 14 therethrough through which fluids may pass between the base pipe's inner diameter ID defined by inner surface 12a to its outer surface 12b. Depending on the mode of operation intended for the wellbore tubular, fluid flow can be inwardly through the ports toward inner diameter ID or outwardly from inner diameter ID to the outer surface.

The inner diameter generally extends from end to end of the tubular such that the tubular can act to convey fluids from end to end therethrough and be used to form a length of a longer fluid conduit through a plurality of connected tubulars.

The tubular may include a shield 16 mounted to base pipe. The shield may be positioned to overlap the ports. Shield 16 may be spaced from outer surface 12b such that a space 18 is provided between the shield and outer surface 12b.

There are openings from space 18 to the exterior of the tubular, which is the outer surface 12b beyond the shield. For example, there may be openings 18a through the shield or at the end edges 16a of shield 16 where fluid can flow into or out of space 18. In the illustrated embodiment of Figure 2, shield 16 is spaced at at least some edges 16a from outer surface 12b such that there are openings 18a through which space 18 can be accessed at those edges. In some embodiments, as shown, the shield may be positioned to encircle base pipe 12 at the ports 14 and, therefore, may be shaped as a sleeve, as shown with space 18 formed as an annulus and with annular access openings 18a at both ends of the sleeve.

The openings may take other forms in other embodiments, depending on the form of the base tubular, sleeve, and mode of operation. For example, in one embodiment, the 118a openings may be formed in whole or in part by grooves 119 in the outer surface 112b of the base pipe (Figure 8).

Shield 16 may serve a number of purposes including, for example, protecting the ports from abrasion and diverting flow for fluid velocity control. For example, shield 16 diverts flow between the exterior of the tubular and ports 14, such that it must pass along outer surface 12b of base pipe. Flow, therefore, cannot pass directly radially between the exterior of the tubular and inner diameter ID. In particular, because shield 16 overlaps the ports, ports 14 open into space 18, flow between exterior of the tubular and the inner diameter changes direction at least once: at the intersection of port 14 and space 18. While flow through the ports 14 is radial relative to the long axis *x*b of the tubular, flow between the ports and the exterior of the tool is through

space 18 and that flow is substantially orthogonal relative to the radial flow through ports 14.

Each port 14 has a nozzle assembly 20 installed therein. The nozzle assembly permits flow control through the port in which it is installed. With reference also to Figure 4, nozzle assembly 20 includes at least a nozzle 22 and may include an installation fitting 24.

Nozzle 22 includes an orifice 26 extending through the nozzle body through which fluid passes through the nozzle and therefore through the port. In particular, a nozzle 22 is installed in each port such that flow through the port is controlled by the shape and form of orifice.

Nozzle 22 is formed of a material that can withstand the erosive rigors experienced down hole such as via abrasive flows, high velocity flows and/or steam passing through orifice 26. Nozzle 22 may, for example, be formed of a material different, for example, harder than the material forming base pipe 12. The base pipe is, for example, usually formed of steel such as carbon steel and nozzle 22 may be formed of a material harder than the carbon steel of base pipe 12. In some embodiments, for example, nozzle 22 may be formed of tungsten carbide, stainless, hardened steel, filled materials, etc.

Orifice 26 may be shaped to allow non-linear flow through nozzle 22. In particular, orifice 26 defines a path through the nozzle, through which fluid flows, and the path from its inlet end to its outlet end is non-linear, including at least one bend or elbow that causes at least one change in direction of the fluid flowing through the orifice. This bend may affect fluid flows in a number of ways to redirect the flow to a more favorable direction, to cause impingement of the fluid against a nozzle surface or another flow to diffuse energy from the flow, to mitigate erosive damage to certain surfaces and/or to create a back pressure to slow or otherwise control flows through the nozzle.

For example with reference also to Figure 7, orifice 26 may include a diverting bend at y that diverts flow through the nozzle from a first direction to a second direction

which is offset, out of line from the first direction. With reference to the direction of flow depicted through the nozzle of Figure 7, the first direction is shown by arrow Fa and the second direction is shown by arrow Fb. In one embodiment, the second direction is substantially orthogonal to the first direction.

Nozzle 22 is positioned in a port and will have one end open to the inner diameter ID of the tubular and the other end open to the outer surface 12b. Generally, the nozzle is installed so that a base end 22a is installed adjacent and open to inner surface 12a and an opposite end 22b is installed adjacent and open to outer surface 12b. Orifice 26 may be formed, therefore, to avoid straight through flow between base end 22a and opposite end 22b. Orifice 26, for example, may include a portion defining a main aperture 26a and a portion defining a lateral aperture 26b. Main aperture 26a extends from an opening 26a' at a base end 22a of nozzle 22 to an end wall 26a" at an opposite end 22b of the nozzle. Lateral aperture 26b extends from the main aperture and connects main aperture 26a to another opening 26b' adjacent opposite end 22b. Lateral aperture 26b extends at an angle from the long axis of main aperture 26a. The angular intersection of the axis of lateral aperture relative to the main aperture may be substantially orthogonal (+/- 45°) and in one embodiment, for example, the apertures 26a, 26b intersect at *y* at substantially 90°.

The nozzle may be substantially cylindrical with ends 22a, 22b and substantially cylindrical side walls extending between the ends. In such an embodiment, the main aperture portion opens at an end and the pair of lateral aperture portions opens on the cylindrical side walls.

End wall 26a" prevents straight through flow through the nozzle and acts to divert flow from the first direction in the main aperture to the lateral direction through lateral aperture 26b. Impingement of fluid flows against wall 26a" dissipates energy from the flow and concentrates erosive energy against wall 26a" rather than surfaces beyond the nozzle. Orifice 26 is formed through the material of the nozzle and, thus, walls 26a" and the other walls defining orifice 26 are of erosion-resistant material. Thus, the diverting bend and in particular end wall 26a", can reliably accommodate the passage therethrough of erosive flows including that of steam. This foregoing

description focuses on flow in only one direction through apertures 26a, 26b, but it is to be understood that flow can be from opening 26b' to opening 26a' (i.e. with the flow moving in the opposite directions of arrows Fa and Fb), if desired. See for example, Figure 8 wherein flow arrows F through nozzle 122 passes in the opposite direction from outer lateral aperture portions 126b to main aperture portion 126a of orifice 126.

Orifice 26 may be further configured to control the flow characteristics of fluid passing therethrough. In one embodiment, apertures 26a, 26b may be sized to limit the volume of fluid capable of passing therethrough. For example, apertures 26b may be smaller diameter openings, sized to allow less flow, than aperture 26a. For example, the total cross sectional area of apertures 26b may be less than the total cross sectional area of aperture 26a, such that a back pressure is created when flow is in the direction of arrows Fa, Fb.

Alternately or in addition, apertures 26a, 26b may be shaped to impart desired flow rate and/or pressure on the fluid passing therethrough. For example, lateral aperture 26b, as shown, has internal shape with a jetting constriction to impart a jet effect, which generally includes a fluid acceleration and pressure change (i.e. drop), in the fluid passing therethrough. The shape of apertures 26a may change depending on whether the flow is intended to be with arrows Fb or against them or a bidirectional jetting shape may be employed with a symmetrical constriction similar to an hour glass.

In addition or alternately, there may be more than one main and/or lateral aperture. For example, as shown, orifice 26 may take the form of a T-shaped conduit with at least two lateral apertures 26b extending from the main aperture. However, while two lateral apertures 26b are shown, there may be only one or more than two such apertures. Generally, there will be an even number of lateral apertures with pairs substantially diametrically opposed across the circumference of the main aperture 26a. The diametric positioning, with one lateral aperture 26b opening into main aperture 26a at a position substantially opposite another lateral aperture 26b (as shown in Figure 7), allows fluid impingement when flow is inwardly from apertures 26b to

aperture 26a. This impingement may create a desired back pressure on the flow through nozzle.

Nozzle 22 conveys fluid between openings 26a' and 26b' across the wall of the base pipe. One opening is exposed in the inner diameter of the base pipe and the other opening is exposed on outer surface 12b. If shield 16 is employed, fluid when exiting from nozzle 22, enters annulus 18. The position of orifice 26b' of lateral aperture 26b causes some fluid movement parallel to outer surface 12b, rather than straight radially out from port 14.

Nozzle 22 may be installed in any of various ways in its port 14. If desired, nozzle assembly 20 may include installation fitting 24 to hold nozzle 22 in its port 14. For example, if the material of nozzle 22 prevents reliable engagement to base pipe or is formed of a material different than the material of the base pipe, a fitting 24 may be employed to ensure a good fit of the nozzle in its port and may, for example, reduce the risk of nozzle falling out of the port.

Installation fitting 24 may be formed to fit between the nozzle and the port. For example, the installation fitting may include a portion for being engaged in the port and a portion for securing nozzle. The portion for being engaged in the port may vary depending on the form and the shape of the port and the desired mode of installation in port 14. In the illustrated embodiment, for example, installation fitting 24 includes a threaded portion 28 as that portion engageable in the port. The port may also include threads 30 into which fitting 24 may be threaded.

The portion for securing the nozzle may also vary, for example, depending on the form and shape of nozzle 22 and the desired mode of installation of nozzle 22. For example, in one embodiment, nozzle 22 can be held rigidly by the fitting and in another embodiment, nozzle may be installed have some degree of movement relative to the fitting, while being held against becoming entirely free of the fitting. Thus, as an example, fitting 24 in the illustrated example includes a passage 32 into which nozzle 22 fits. Passage 32 passes fully through the fitting such that it is open at both ends of the fitting and, in other words, the fitting is formed as a ring. When nozzle 22

is installed, opening 26a' is exposed at one end of the passage and opening 26b' is exposed at the other end of the passage.

In this embodiment, nozzle 22 is secured rigidly into passage 32. For example, nozzle 22 may be press fit and possibly mechanically shrunk fit, into passage 32. In one embodiment, fitting 24 may be heated to cause thermal expansion thereof that enlarges the diameter across passage 32, nozzle 22 may be fit therein and fitting 24 cooled to contract about the nozzle and, thereby, firmly engage it. In such an embodiment, fitting 24 may include features to modify the hoop stresses about the ring to best accommodate heating expansion for press fitting. For example, passage 32 and nozzle 22 may have a tapering diameter from end to end to facilitate press fitting these parts together. For example, nozzle 22 may have a tapering outer diameter from one end to the other and passage 32 may have a tapering inner diameter from one end to the other end. The nozzle 22 may then be inserted and forced into passage 32 with the narrow end of the nozzle wedged into the narrow end of the passage and the tapering sides of the parts in close contact. In addition or alternately, for modification of hoop strength, passage 32 may include notches 34 in the otherwise substantially circular sectional shape (orthogonal to the center axis x of passage 32).

In some embodiments, the material of nozzle 22 may have thermal expansion properties different than the material of base pipe 12. As such, if nozzle 22 was installed directly into base pipe 12, it may tend to become dislodged or damaged in use such as when in a high temperature (i.e. steam) environment. Generally, the materials most useful for the nozzle may have a low coefficient of thermal expansion, while the materials most useful for the base pipe 12 may have a reasonably high coefficient of thermal expansion and most often a nozzle firmly installed in a port at ambient temperatures may tend to fall out of a base pipe at elevated temperatures. To address issues caused by thermal expansion, installation fitting 24 may be formed of a material having a coefficient of thermal expansion selected to work well with both the nozzle and the base pipe. In one embodiment, installation fitting 24 is formed of a material having a coefficient of thermal expansion between those of the materials of the base pipe and the nozzle. In another embodiment, the coefficient of thermal expansion of fitting 24 is greater than that of base pipe 12. As such, when undergoing

thermal stress, fitting 24 will undergo thermal expansion ahead of base pipe 12 and fitting 24 stays firmly engaged in port. In such an embodiment, nozzle 22 and fitting 24 can be connected when the fitting is thermally expanded.

Shield 16, if employed, may overlap the nozzle assembly to hold nozzle 22 in the port 14. In one embodiment, nozzle 22 is fit in port such that any movement to fall out of port is radially out, as may be controlled, for example, by tapering of nozzle and the port/passage in which it is installed to have the wide ends on radially outwardly positioned. Shield 16 includes a plug 36 in a hole 38 that substantially radially aligns with port 14. Plug 36 is removable to allow opening of hole 38 and access to port 14 and, thereby, installation of nozzle assembly 20 to port 14 through hole 38. After nozzle 22 is installed, plug 36 may be reinstalled in hole 38 to overlie the nozzle. Plug 36 and hole 38, for example, may be threaded to facilitate removal and reinstallation of the plug.

Plug 36 can ensure that nozzle 22 remains in position in port 14 even if nozzle 22 comes loose. For example, plug 36 can be formed to penetrate into hole 38 sufficiently to bear down on end 22b of the nozzle. If there are tolerances that may prevent reliable fitting of the plug against end 22b of the nozzle, a flexible spacer may be employed. For example, as shown, there may be a spring 40 between plug 36 and nozzle 22.

Nozzle assembly 20, in this embodiment including nozzle 22 and fitting 24 in port 14, allows fluid to move between inner diameter ID and outer surface 12b through orifice 26. The lateral orifice 26b directs fluid flows that are adjacent opening 26b' to pass substantially parallel to outer surface 12b through annulus 18. To facilitate flows through the annulus with minimal erosive damage to shield 16, aperture 26b may be positioned such that flows therethrough pass somewhat parallel to the long axis *x*b of base pipe. For example, the nozzle 22 can be installed such that the axis *x*a of aperture 26b is within 60° and perhaps within 45° of long axis *x*b. In the illustrated embodiment, axis *x*a of aperture 26b is substantially aligned with long axis *x*b.

To install a nozzle assembly in such an embodiment, plug 36 can be removed from hole 38, the nozzle assembly including at least nozzle 22 but possibly also fitting 24 can be inserted through hole 38 and installed in port 14 with openings 26a' and 26b' exposed in inner diameter ID and annulus 18, respectively, and with axis *x*a of aperture 26b directed in a selected direction, for example toward the open edges 16a of shield 16. Then plug 36 can be installed in hole 38 over nozzle 22. If there is a spacer, such as spring 40, it is positioned between nozzle 22 and plug 36. In an embodiment where the nozzle assembly includes fitting 24 and nozzle 22, these parts can be installed separately or may be connected ahead of installation.

Tubulars according to the present invention can take other forms as well. In one embodiment, as shown in Figure 8, tubular 110 includes a screening apparatus 150. Tubular 110 is primarily useful for handling inflows, since screening apparatus 150 removes oversize particles from the flows to opening 118a. Grooves 119 in outer surface 112b extend under apparatus 150, through openings 118a under an edge of the shield and into space 118 between outer surface 112b and shield 116. Space 118 opens to nozzle. It is noted that tubular 110 illustrates a nozzle 122 without an additional installation fitting and, instead, nozzle 122 is secured directly into the material of base pipe.

During use of the tubular, fluid may pass through nozzle orifice 26 between inner diameter ID and outer surface 12b. Nozzle 22 diverts flow such that it passes in a non-linear fashion between inner diameter ID and outer surface 12b. Orifice 26 causes fluid flows to change direction as they pass through the nozzle including both: (i) substantially radially relative to the long axis *x*b of the base pipe and (ii) substantially parallel to the outer surface, which is possibly somewhat parallel to the long axis of the base pipe. This may direct flows through an annulus between outer surface 12b and a shield 16 spaced from the outer surface. The fluid may flow through space 18, along outer surface 12b through an opening 18a, 118a to the annulus about the tubular.

Flows outwardly tend not to cause formation damage, as the fluid jetting through nozzle is diverted from a radially outward direction (through aperture 26a) to a lateral

direction along the outer surface of the base pipe, which is parallel to the wellbore wall. As such, the force of the fluid passing from the tubular is dissipated at end wall 26a", where the flow path diverts laterally and by shield 16.

In use, nozzle 22 may control fluid flows by accommodating and avoiding erosion through ports and controlling velocity and pressure characteristics of the flow.

For example, a method for accepting inflow of steam or produced fluids in a paired, heavy oil (such as oil sand), gravity drainage well may employ a tubular such as is depicted in Figures 1 to 3 or Figure 7. In paired well steam production, it is desirable that introduced steam create a steam chamber in the formation that heats the heavy oil and mobilizes it as produced fluids. The produced fluids are intended to flow into a producing well. Sometimes steam from an adjacent well may break through and seek to enter the producing well. Using a tubular, as described, steam may be restricted from passing into the tubular due to the form of the nozzle and the configuration of the nozzle in the tubular. In particular, the limited entry size of the apertures first limits the volume of produced fluids that can pass into the tubular. Also, the impingement of flows from the diametrically opposed apertures 26b tends to resist flows through the orifice 26 and creates a back pressure that limits flows through the nozzle. Also, the diverted flow path from aperture 26b to aperture 26a dissipates fluid force so that the tubular tends not to problematically erode. As such, a steam chamber may form outwardly of the tubular, even if a break through occurs from the steam injection well to the producing well.

During use, while forces may tend to act to dislodge nozzle from its position, the method may include holding nozzle in place against forces tending to move the nozzle into an inactive position. For example, the method may include holding the nozzle down into the port, for example, by a shield thereover. Alternately, or in addition, the method may include holding the nozzle against dislodgement by differences in thermal expansion, for example, by use of a fitting. A fitting may act between the nozzle and the base pipe to hold the nozzle in place. For example, the fitting may prevent the nozzle from passing into the inner diameter due to a taper in the parts and the nozzle may have a thermal expansion that holds nozzle in place.

While the embodiment is described wherein nozzle 22 is rigidly installed in fitting 24, the nozzle in some embodiments can be slide ably mounted in the fitting. For example, nozzle can slide into and out of the fitting depending on the pressures against openings 26a' and 26b'. As such, nozzle 22 can operate as a form of valve.

The previous description of the disclosed embodiments is provided to enable any person skilled in the art to make or use the present invention. Various modifications to those embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments without departing from the spirit or scope of the invention. Thus, the present invention is not intended to be limited to the embodiments shown herein, but is to be accorded the full scope consistent with the claims, wherein reference to an element in the singular, such as by use of the article "a" or "an" is not intended to mean "one and only one" unless specifically so stated, but rather "one or more". All structural and functional equivalents to the elements of the various embodiments described throughout the disclosure that are known or later come to be known to those of ordinary skill in the art are intended to be encompassed by the elements of the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims. For US patent properties, it is noted that no claim element is to be construed under the provisions of 35 USC 112, sixth paragraph, unless the element is expressly recited using the phrase "means for" or "step for".

I CLAIM:

1. A wellbore tubular comprising: a base pipe including a wall; a port through the wall providing access between an inner diameter of the base pipe and an outer surface of the base pipe; a nozzle in the port, the nozzle including an orifice including a bend therein.

2. The wellbore tubular of claim 1 wherein the bend is approximately orthogonal.

3. The wellbore tubular of claim 1 wherein the orifice include a main portion and a second portion and the second portion is offset approximately 90° from the main portion.

4. The wellbore tubular of claim 1 wherein the orifice is formed as a T including a main aperture portion and a pair of lateral aperture portions extending from the main aperture portion.

5. The wellbore tubular of claim 4 wherein the pair of lateral aperture portions are substantially diametrically opposed to each other across the main aperture portion.

6. The wellbore tubular of claim 4 wherein the combined cross sectional area of the pair of lateral aperture portions is less than the cross sectional area of the main aperture portion.

7. The wellbore tubular of claim 4 wherein the pair of lateral aperture portions each are formed as jetting nozzles.

8. The wellbore tubular of claim 1 wherein the main aperture opens into the inner diameter and the pair of lateral aperture portions open on the outer surface.

9. The wellbore tubular of claim 1 further comprising a shield installed over the outer surface and a space between the shield and the outer surface and the orifice opens into the space and the bend diverts fluid adjacent the orifice to pass substantially parallel to the outer surface.

10. The wellbore tubular of claim 1 further comprising an installation fitting encircling the nozzle, the installation fitting including a passage in which the nozzle is secured and a threaded outer diameter.

11. A method for handling fluid in a wellbore comprising: passing fluid through a nozzle orifice between an inner diameter of a tubular and an outer surface of the tubular, the nozzle orifice diverting flow such that the flow passes in a non-linear fashion between the inner diameter and the outer surface.

12. The method of claim 11 wherein fluid flowing affected by the nozzle at the outer surface flows substantially parallel with the outer surface.

13. The method of claim 11 wherein passing fluid includes moving fluid from the outer surface to the inner diameter through the nozzle and creating impinging flows in the nozzle that resists flow through the nozzle.

14. The method of claim 11 wherein the wellbore is a producing wellbore in a steam-assisted heavy oil recovery operation and the fluids include steam.

15. The method of claim 14 wherein the method further includes resisting the passage of steam through the nozzle orifice to create a steam chamber outwardly of the tubular.

16. The method of claim 11 wherein the nozzle includes a body formed of an erosion resistant material; and an orifice through the body, the orifice being non-linear and having a diverting bend to change direction in a fluid flow passing through the orifice.

17. A nozzle assembly comprising: a nozzle having a body formed of an erosion resistant material; and an orifice through the body, the orifice being non-linear and having a diverting bend therealong.

18. The nozzle assembly of claim 17 wherein the diverting bend is approximately orthogonal.

19. The nozzle assembly of claim 17 wherein the orifice includes a main portion and a second portion and the second portion is offset approximately 90° from the main portion.

20. The nozzle assembly of claim 17 wherein the orifice is formed as a T including a main aperture portion and a pair of lateral aperture portions extending from the main aperture portion.

21. The nozzle assembly of claim 20 wherein the pair of lateral aperture portions are substantially diametrically opposed to each other across the main aperture portion.

22. The nozzle assembly of claim 20 wherein the pair of lateral aperture portions have a combined cross sectional area less than the cross sectional area of the main aperture portion.

23. The nozzle assembly of claim 20 wherein the pair of lateral aperture portions each is formed as jetting nozzles.

24. The nozzle assembly of claim 17 wherein the nozzle is substantially cylindrical with ends and cylindrical side walls extending between the ends and the main aperture portion opens at an end and the pair of lateral aperture portions opens on the cylindrical side walls.

25. The nozzle assembly of claim 17 further comprising an installation fitting encircling the nozzle, the installation fitting including a passage in which the nozzle is secured and a threaded outer diameter.