

[54] **METHOD OF DISSOLVING LIQUEFIED CHLORINE IN AN AQUEOUS SOLVENT**

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219; 261/66, 71, DIG. 13

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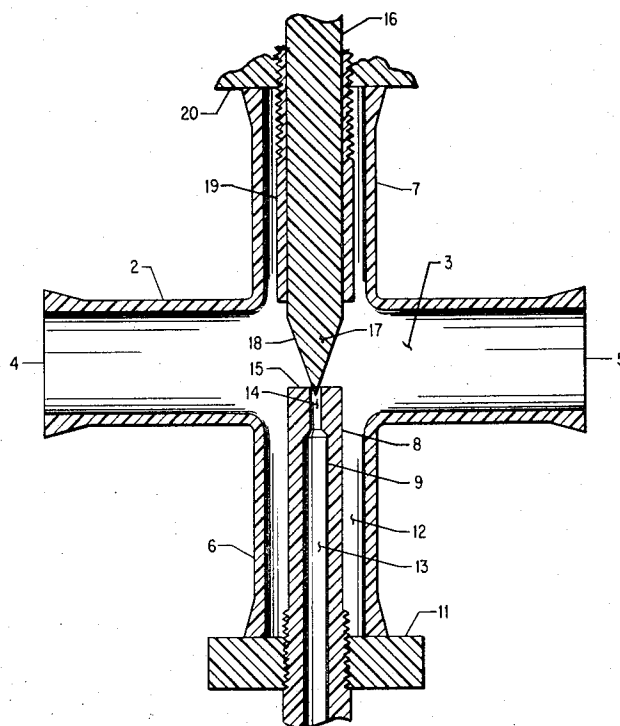
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[57]

ABSTRACT

A single-seated valve assembly for introducing a controlled, non-surfing flow of soluble liquefied gas directly into a stream of liquid solvent flowing through a conduit permits essentially full pressure on the liquefied gas to the region of incipient solution while suppressing vaporization of the gas. The valve body can be essentially cross-shaped with the valve passage forming a passage of the solvent conduit. The side passage into the valve passage for introducing the liquefied gas into the solvent terminates in a valve seat housing an orifice sealed by the end of a valve stem depending from across the valve passage.

1 Claim, 2 Drawing Figures



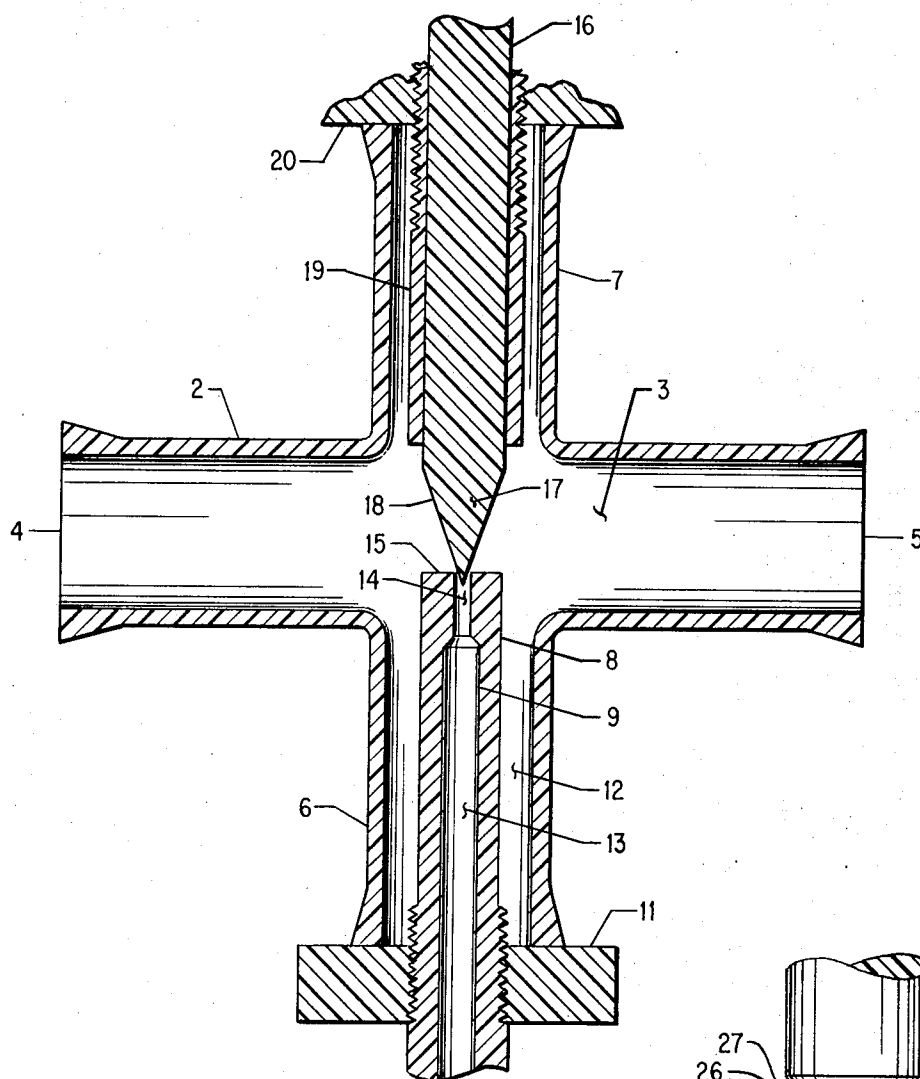


Fig. 1

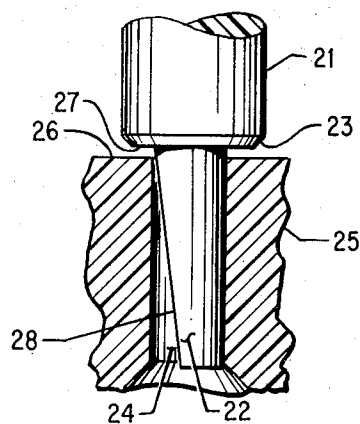


Fig. 2

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METHOD OF DISSOLVING LIQUEFIED CHLORINE IN AN AQUEOUS SOLVENT

CROSS-REFERENCE TO RELATED APPLICATION

This application is a divisional application, serial No. 832,747, filed June 12, 1969.

BACKGROUND OF THE INVENTION

The introduction of a soluble liquefied gas into a liquid solvent, such as by combining streams thereof in a valve assembly, can often lead to flashing of the liquefied gas into discrete gaseous bubbles within the solvent. This retards solution efficiency and prolongs solution time. This can be a particular problem with a substance which is normally gaseous at standard temperature and pressure and thus may be under a pressure of 2-3 atmospheres or greater when in liquid condition. Additional problems can often arise; for example in the addition of liquid chlorine to water under certain temperature and pressure conditions, substantial, deleterious formation of chlorine hydrate may result if rapid dispersion is not achieved. Thus, although solution is slower, many substances which may often be shipped and/or stored in liquid state may be permitted to become gaseous before combining with a solvent.

SUMMARY OF THE INVENTION

A valve assembly is now provided which can be employed for the direct introduction of a liquefied gas into a stream of liquid solvent. The valve assembly permits at least essentially full pressure on the liquid gas to the point of incipient solution. Moreover, the valve assembly suppresses vaporization of the liquefied gas dissolving in the solvent. Where the liquefied gas is chlorine and the solvent is water, the valve assembly can permit enhanced dispersion of the liquid chlorine into aqueous medium and can operate to introduce substantial amounts of the chlorine into such medium, which operation is nevertheless free from hydrate formation.

Broadly, the single-seated valve assembly of the present invention comprises: a valve body having a valve passage therethrough connecting spaced apart inlet and outlet ports, and forming a portion of a conduit confining the liquid solvent, with the body having two hollow side protrusions, the first of which extends outwardly from the body between the ports, and the second of which extends outwardly from the valve body at least substantially coaxial with the first and opposite same across the valve passage. A substantially rigid, stationary valve seat forms with the first protrusion a side passageway terminating in an end port opening at an end surface of such valve seat, with the end surface being positioned so that the end port opens directly into the valve passage at least along a wall thereof.

A movable stem within the second protrusion opposite such end port and across the valve passage, terminates in an end section adapted for at least partial insertion within the end port and for sealing thereof. The end section has at least one beveled surface longitudinally along same providing diminishing cross-sectional area for the end section toward the end port. The valve assembly lastly has means for reciprocally transporting the shaft to remove and insert the end section within the end port. Thus the end section seals the end

port when in snug engagement therewith and the beveling of the end section permits fluid to flow from the end port into the valve passage in amounts increasing with the increasing removal of the shaft from the side passageway.

The invention is further directed to a method for introducing a controlled, non-surging flow of soluble liquefied gas directly into a stream of liquid solvent which method involves the operation of the above described valve assembly. The invention is further most particularly directed to use with substances which are normally gaseous at standard temperature and pressure and are often available in liquid condition such as sulfur dioxide and chlorine.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a cross-sectional view of a valve assembly of this invention.

FIG. 2 is a sectional view of a representative embodiment of a valve seat and sealing member for the valve assembly.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the valve assembly of FIG. 1 a valve body 2 has a valve passage 3 therethrough connecting an inlet port 4 spaced apart from an outlet port 5, and forming a portion of a conduit, not shown. A first hollow side protrusion 6 extends outwardly from the valve body 2 and transverse thereto at about the mid-section of such body 2. A second hollow side protrusion 7 also extends outwardly from the valve body 2 and is coaxial with the first protrusion 6 and opposite same across the valve passage 3.

Within the first hollow side protrusion 6 there extends a substantially rigid, stationary valve seat 8 from a side conduit 9. This side conduit 9 is in threaded engagement with an end block 11 for sealing the annular area 12 between the outer surface of the side conduit 9 and the inner wall of the hollow protrusion 6. The side conduit 9 projects inwardly so that the channel 13 within the side conduit 9 narrows into an end port 14 opening at the end surface 15 of the valve seat 8. The valve seat 8 is positioned so that the end port 14 opens directly into the valve passage 3. Within the second hollow side protrusion 7 there depends a guide ring 19 which is in threaded engagement with an end block 20 which seals the upper end of the side protrusion 7. Within the guide ring 19 a movable shaft 16 terminates in a conical end section 17 having an outer surface 18 adapted for partial insertion within the end port 14. The shaft 16 is reciprocally transported by means not shown within the guide ring 19.

In FIG. 2 the end section of the shaft 21 terminates in a finger 22 extending from a shoulder 23 around the shaft 21. The finger 22 is shown positioned within the end port 24 of the valve seat 25. The valve seat 25 terminates in an upward direction in an end surface 26 shown opposite a coplanar end surface 27 of the shoulder 23. The finger 22 has a beveled surface 28 extending along the finger 22 and providing diminishing cross-sectional area for the finger away from the shaft 21.

Referring again to FIG. 1, the beveled surface 18 on the conical end section 17 of the shaft 16 is used in

snug engagement with the valve seat 8 thereby sealing the end port 14. Liquid solvent can then be passed through the valve passage 3 at a pressure substantially as great as, to higher than, vapor pressure of the liquefied gas in the channel 13, at the temperature of the solvent in the valve passage 3. The solvent flows around the valve seat 8 projecting into the valve passage 3, across the end surface 15 of the seat 8, and around the portion of the beveled surface 18 of the shaft 16 exposed above the end surface 15. Liquefied gas at a pressure above that of the liquid solvent within the valve passage 3, may then be fed into the channel 13 and flows into the end port 14 of the valve seat 8 and thus into contact with the portion of the end surface 18 of the shaft 16 extending therein.

Withdrawing the shaft 16 upwardly permits a flow of the liquefied gas from the end port 14 into the valve passage 3 and thus into immediate contact with the flow of liquid solvent within the valve passage 3. The flow of liquefied gas from the end port 14 into the valve passage 3 may then be increased with the increasing removal of the end section 17 of the shaft 16 from such port 14. Transverse movement of the upwardly displaced shaft 16 back for snug engagement of the end section 17 with the valve seat 8 thereby closes the end port 14.

As shown in FIG. 2 the outer surface of the finger 22 can be coaxial to, and in engagement with, the inner surface of the end port 24 for the entire area of such outer finger surface, with the exception of the region opposite beveled surface 28 of the finger 22. Thus removal and insertion of the finger 22 in the end port 24 is accompanied by engagement of such surfaces until complete removal of the finger 22 beyond the end surface 26 of the valve seat 25. Sealing of the end port 24 will be achieved by snug contact between the coplanar end surface 27 of the shoulder 23 with the end surface 26 of the valve seat 25.

The end surface of the valve seat should be at least along a wall of the valve passage to insure introducing the liquefied gas directly into contact with the solvent liquid flowing within the valve passage. Also, the side protrusions of the valve body need not be at the mid-section thereof and need not be transverse to the valve passage but can be canted either against the flow of the liquid solvent within the passage or away from same, so long as the protrusions are substantially coaxial with one another across the valve passage to permit sealing of the end port with the end section of the shaft. Preferably, the side protrusions are completely solid and/or filled up to the wall of the valve passage thereby preventing flow of solvent liquid into such side protrusions. For example, in FIG. 1 the side conduit 9 can be provided by the hollow side protrusion 6 and the valve seat 8 may thereby extend over the side protrusion 6 from the wall of the valve passage 3, thus eliminating the intermediate annular area 12. The beveled surface for the end section of the shaft, or valve stem, can be a beveled surface completely around such section, e.g., the conical surface of FIG. 1 or a truncated cone for the finger 22 in FIG. 2, or only one or more beveled surfaces, e.g., the single beveled surface shown in FIG. 2. Also, the end surface of the valve seat need not be flat but can be a rounded surface projecting into the valve passage.

The valve assembly can be typically employed in commercial operation involving the introduction of a soluble liquefied gas such as chlorine into an aqueous medium or into a liquid hydrocarbon, or liquefied carbon dioxide into water or liquefied sulfur dioxide into waste waters, e.g., industrial waste waters. In the special application of liquid chlorine into an aqueous medium, such medium can typically be at a temperature within the range from about 35°–120° F. and under a pressure of between about 20–200 psig. For such conditions the pressure on the liquid chlorine is advantageously between about 10–40 psig above the pressure of the aqueous medium although greatly higher pressure differences, e.g., 100 psig or more, are operational. A pressure differential below about 10 psig can provide inefficient introduction of liquid chlorine into the aqueous medium and a pressure differential above about 40 psig over an extended period may lead to a deleterious mechanical erosion of assembly parts within the valve.

For this typical application of chlorine into water the entire surface area of the valve assembly exposed to the liquid chlorine or to the liquid chlorine dissolving in the water is best provided by a vinylidene fluoride resin or a fluorinated ethylene-propylene resin. At the elevated pressures for the liquid chlorine, e.g., approaching 200 psig, a fluorinated ethylene propylene resin valve seat such as the valve seat 8 in FIG. 1 can show some deflection under pressure which, when the pressure is relaxed, will return to a normal state. For example, the inner section of the valve seat 8 around the entry port 14 in FIG. 1 can be displaced slightly inwardly toward the center of the valve passage 3. Thus the valve seat can be somewhat flexible.

More particularly, in referring again to FIG. 1, water under a pressure of 115 psig and at a temperature of 73° F. is passed through the valve passage 3 at a rate of 6.6 gallons per minute. As the water is flowing through the valve passage 3, the end section 17 of the shaft 16 is initially in snug engagement with the valve seat 8 and is thereafter gradually removed so that liquid chlorine, feeding into the end port 14 of the valve seat 8 at a pressure of about 175 psig is fed through the valve port 14 into the valve passage 3 in increasing amounts. Such amount is gradually increased to a chlorine feed rate of 1.0 pound per minute. At such a rate the valve and downstream conduit are visually inspected and no chlorine flashing is visually observed; the results are thus regarded to be excellent.

Another run involving the valve of FIG. 1 is made with water passing through the valve passage 3 at a temperature of 40° F. and a pressure of 80 psig at a rate of 5 gallons per minute. Liquid chlorine entering the end port 14 at a temperature of 83° F. and a pressure of about 165 psig is fed into the water within the valve passage 3 at a rate of 1.5 pounds per minute. At such rate of chlorine feeding into the water at the valve is in an amount of 0.3 pounds per gallon of water. Under these conditions there is no noticeable formation of chlorine hydrate, i.e., $\text{Cl}_2 \cdot 8\text{H}_2\text{O}$ formation, in the valve or the conduit downstream therefrom. The valve assembly is thus deemed to demonstrate excellent operation and introduce substantial amounts of chlorine into water, without ostensible hydrate formation. The conditions for hydrate formation, and especially with

reference to a water temperature of 40° F., a pressure of 80 psig, and a chlorine content of 0.3 pounds per gallon, may be best understood by referring to the data presented for example, in Perry, *Chemical Engineer's Handbook*, 3rd Edition, page 674 and re-charting such data, as equal pressure lines, on a chart showing solubility of chlorine in water vs. temperature of the water.

Another test conducted with the valve assembly as shown in FIG. 1 is run with water passing through the valve passage 3 at a temperature of 107° F. under a pressure of 150 psig and a rate of 7.7 gallons per minute. Liquid chlorine at a temperature of 85° F. and under a pressure of 175 psig is passed at a rate of 1 pound per minute from the outlet port 14 into the valve passage 3 thereby providing 0.130 pounds of chlorine per gallon of water in the valve passage 3 and downstream conduit. Under such conditions, that is, at a temperature of 107° F. and a pressure of 150 psig, liquid chlorine will vaporize, yet there is virtually no deleterious formation of chlorine vapor. Thus these results demonstrate that the conditions under which the water is present in the valve passage need not be such conditions as can be typically expected to achieve suppression of chlorine vaporization, to actually achieve desirable suppression, for downstream use of liquid chlorine dissolved in water, and during the successful operation of the valve assembly.

Although the total amount of the liquefied gas which will be introduced into the liquid solvent is dependent upon a number of factors including type of solvent and type of liquefied gas as well as the pressure under which the solvent is flowing through the valve passage, for the typical introduction of liquid chlorine into an aqueous medium at a pressure for example of 120 psig, useful solutions of liquid chlorine in aqueous medium will typically include such containing not substantially above about 0.5 pounds of chlorine per gallon of water.

It is to be understood that, although the invention has been described with specific reference to particular embodiments thereof, it is not to be so limited, since changes and alterations therein may be made which are within the full intended scope of this invention as defined by the appended claims.

I claim:

1. An elevated pressure process for initiating and sustaining immediate solution of a pressurized and controlled, non-surging flow of liquefied chlorine directly

into a liquid aqueous medium flowing through a conduit, said process retarding chlorine hydrate formation while permitting at least essentially full pressure on the liquid chlorine to the point of incipient solution in the aqueous medium, and while suppressing vaporization of the liquefied chlorine dissolving in such medium including freedom from subsequent formation of a separate chlorine vapor phase, which method comprises:

- A. passing a flowing aqueous medium within and through a valve passage at a pressure substantially as great as, to higher than, the vapor pressure of chlorine at the temperature of the aqueous medium and at least above about 20 psig, said valve passage being housed in a valve body having a first hollow side protrusion extending outwardly from said valve passage, a substantially rigid, stationary valve seat member within the hollow side protrusion, the valve seat member terminating in an end surface having an end port opening directly into said valve passage at least along the extent of the valve passage;
- B. feeding said liquefied chlorine into said valve seat member at a pressure of about 20-100 psig above the pressure of the aqueous medium in the valve passage, and into contact with a valve shaft end section sealing said end port and extending at least partially into said end port from a shaft depending from within a second hollow side protrusion, said second side protrusion extending outwardly from the valve passage within the valve body in substantially coaxial alignment with said first protrusion and opposite same across said valve passage, said valve shaft end section having at least one beveled surface longitudinally along same providing diminishing cross-sectional area for the end section within the end port opening;
- C. withdrawing said valve shaft end section from said end port by means for reciprocally transporting said shaft, thereby permitting a controlled flow of said liquefied chlorine from said end port directly into said aqueous medium in an amount providing not substantially above about 0.5 pound of chlorine per gallon of water; and
- D. withdrawing a flow of liquid chlorine solution in liquid aqueous medium downstream from said valve passage.

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