METHOD AND APPARATUS FOR EVAPORATING LIQUEFIED GASES

Kurt Kuhlmann, Portland, Oreg., assignor to Industrial Air Products Co., Portland, Oreg., a corporation of Oregon

Filed Feb. 9, 1966, Ser. No. 534,682
10 Claims. (Cl. 62—52)

ABSTRACT OF THE DISCLOSURE

A method and apparatus for disposing of liquefied gas, where gas in the liquid state is elevated above the ground and dispersed as droplets into the atmosphere.

The present invention relates to the disposal of liquefied gases having boiling temperatures substantially below 0° F. More particularly, the invention relates to a method and apparatus for disposing of such gases by evaporation. Exemplary of gases which may be handled as contemplated herein are oxygen, nitrogen, argon, hydrogen, helium, methane, etc.

In the making of certain products, liquid gases of the above description, oftentimes for one reason or another, must be discarded. Such gases are difficult to handle because of the extremely low temperatures at which they persist in a liquefied state. Many are hazardous also because of their flammability. To further complicate the problem, with modern production facilities, waste streams of such gases may be quite large, as much as 50,000 pounds per hour or more. Known methods for disposing of such a gas by evaporation have included introducing heat into the gas with electrical heating elements. Electrical heating, however, may be expensive because of the amount of electricity needed to produce the required amount of heat to vaporize a waste stream of any significant size. Evaporation by circulating a gas through an air cooler heat exchanger has also been proposed. This may also prove to be an expensive procedure, due to the high cost of the rather extensive heat exchanging equipment needed.

A general object of the present invention, therefore, is to provide a novel method and apparatus for disposing of a liquefied gas by evaporation, whereby a relatively large quantity of gas may be disposed of economically and relatively safely.

More particularly, an object is to provide such a method and apparatus characterized by the feature that the liquefied gas is elevated, while in a liquid state, above the ground, and then dispersed as liquid droplets into the atmosphere, with the droplets then absorbing heat from the atmosphere and evaporating.

A related object is to produce dispersion of a liquefied gas into the atmosphere as liquid droplets in such a manner, that under prevailing atmospheric conditions the droplets vaporize completely before dropping to the ground.

To accomplish these objects, the invention features novel dispersing means supported out in the open above the ground adapted to disperse liquefied gas as a liquid spray directly into the atmosphere. An important feature of the invention also comprises novel means for supplying liquefied gas under pressure to such dispersing means.

A further object is to provide apparatus for the purposes indicated which is relatively inexpensive and simple to use.

These and other objects and advantages attained by the invention will become more fully apparent when the description which follows is read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a schematic diagram illustrating apparatus as contemplated herein for evaporating a liquefied gas;

FIG. 2 illustrates dispersing means constructed according to the invention and employed in the apparatus of FIG. 1; and

FIG. 3 is a view taken along the line 3—3 in FIG. 1, with portions of the dispersing means broken away to illustrate details of construction.

Turning now to the drawings, and with reference first to FIG. 1, at 10 is shown a catch drain or tank, also referred to as a collector, for holding a liquefied gas, such a gas being shown in the collector having a level indicated A. At its upper end, the collector has a vent 12 through which it vents to the atmosphere, and at its lower end it has a drain cock 13 for draining liquid therefrom.

Liquefied gas to be disposed of is carried to the collector by means such as conduit 14. The collector is connected adjacent its base through conduits 15, 16 and 18 to a normally closed valve 20 to the intake side of an intermittently operated centrifugal pump 22. Pump 22 is of a type readily available adapted to pump low temperature fluids, and constitutes means for forcing gas herein while such is in the liquid state. The collector and pump together in the apparatus form what is referred to herein as a supply of liquefied gas.

A conduit 24 connects the discharge side of pump 22 to a dispersing means 26. Conduit 24 includes a hollow, still stand pipe portion 24a, held in a vertical position as by support structure 27. The stand pipe portion constitutes support means for the dispersing means, and in the embodiment illustrated in FIG. 1, supports the dispersing means out in the open a substantial distance above ground level, indicated at 25. The hollow interior of conduit 24 (seen at 24b in FIG. 2) provides a fluid passage, connecting dispersing means 26 to the supply of liquefied gas mentioned above.

Referring now to FIGS. 2 and 3 which illustrate a form of dispersing means in detail, the dispersing means comprises a hollow housing 32, including a cylindrical wall portion 32a, and integral top and bottom portions 32b, 32c, respectively. Suitably secured to and projecting out from wall portion 32a at circumferentially distributed locations are spray nozzles 34, six of such nozzles being shown in the embodiment illustrated. These nozzles have their inner set of ends communicating with the hollow interior of the housing, and discharge openings for the nozzles, shown at 34a, communicate with the surrounding atmosphere. The housing is suitably fastened to the upper end of stand pipe portion 24c of pipe 24, with passage 24b communicating with the interior of the housing.

Suitably mounted on top of dispersing means 26, through posts 28, is a hood 30. The hood serves to prevent moisture from collecting on the dispersing means. Liquefied gas on being ejected from the nozzles cools the nozzles to a low temperature, and if water is allowed to collect on the nozzles it freezes and may cause clogging.

In FIG. 1 a conduit 35 is shown which connects with tank 10 at a point above the usual liquid level in the tank. This conduit is used to introduce continuously dry waste gas at a moderate pressure into the empty portion of the tank. The gas escapes through vent 32, and on flowing through the tank serves to purge the system upstream of valve 20 of any moisture.

Connecting with stand pipe 24a is a conduit 37, provided with a check valve 39. In practice, a source of dry waste gas at a moderate pressure is connected to the conduit which gas, during operating periods of the pump and when liquefied gas is not flowing through the stand pipe, flows through the check valve into the
stand pipe, thence to escape to the atmosphere through nozzles 34. This gas also functions to purge the system, of more streams introduced by conduits 35, 37 by inhibiting water accumulation, tend to insure reliable operation of the disposal apparatus.

Referring again to FIG. 1, shown at 36, 38 are two conduits with a set of ends joined to collector 10 at vertically spaced levels indicated at B and C. The interior of the conduits communicate with the inside of the collector where the conduits join the collector. A convexitual fluid level indicator and switch assembly 40 interconnects the other set of ends of conduits 36, 38. Assembly 40 includes a switch shown schematically at 42 which is actuated to close when the level of fluid drops to level C.

Switch 42 is connected in a series circuit between a pair of source conductors shown as L1, L2, this circuit comprising a conductor 43, switch 42, a conductor 44, and a solenoid 48. Connected in parallel with solenoid 48 is the series combination of a solenoid 46a and a time delay mechanism 47. Solenoid 46a forms part of a relay 46 which also includes a normally open switch 46b. Time delay mechanism 47 normally opens the circuit between conductor 44 and solenoid 46a, but is operable after closing of switch 42 and a predetermined lapse of time delay to complete a circuit between conductor 44 and solenoid 46a.

At 52 is an electric motor which is connected directly to source conductor L4 as shown, and is connected to source conductor L1 through a conductor 54 and normally open relay switch 46e. The motor is suitably coupled to pump 22, and is adapted to drive the pump. The apparatus just described, including switch 42 of level indicator and switch assembly 40, relay 46, solenoid 48, and motor 52, comprises what is referred to herein as means for automatically controlling the operating periods of pump 22. Explaining how this means operates, when liquefied gas in the collector reaches level B, level indicator and switch assembly 40 operate to close switch 42. On closing of this switch, power is supplied from the source conductors to solenoid 48 whereby the solenoid is energized. Solenoid 46a remains deenergized, however, until such time the time delay mechanism 47 completes a circuit from conductor 44 to solenoid 46a. On energizing of solenoid 48, valve 20 opens. With valve 20 open, liquefied gas in the collector flows to the intake side of pump 22 through conduits 16, 18 and the valve. This produces an initial cooling of the pump before start up of the pump. After the time delay period of delay mechanism 47 has elapsed, solenoid 46a energizes and switch 46e closes, with power then being supplied to motor 52. The motor then operates pump 22, whereby liquefied gas is pumped from the collector into conduit 24. The reason for admitting liquefied gas to the intake side of pump 22 before operating the same, is that a cryogenic pump will experience better wear if operated only after precoolsing and with the fluid to be pumped present.

With pumping of fluid out of collector 10, the level of liquefied gas in the collector drops, and when this level reaches level C, switch 42 of the level indicator and switch assembly reopen. With reopening of this switch, solenoids 46a, 48 are deenergized, and valve 20 again closes, and motor 52 stops. This condition remains until such time as the level of liquefied gas in the collector again reaches level B.

Considering now how the apparatus as a whole operates to evacuate a liquefied gas fed into collector 10 through conduit 14, the liquid is collected in the collector until its level reaches level B, whereupon liquefied gas is pumped out of the collector in the manner described above. Such gas is pumped through conduit 24 to dispersion means 26, whence it is ejected through nozzles 34 directly into the atmosphere as a spray. The liquid droplets in the spray, on being dispersed in the atmosphere, extract and absorb heat from the atmosphere and quickly evaporate. The pressure at which liquefied gas is pumped by the pump, and the elevation of the dispersing means, are selected so that the droplets formed in the spray will completely evaporate before striking the ground.

Thus, the invention provides a relatively simple method for disposing of liquefied gas wherein electrical heating coils nor expensive heat exchanging equipment is required. The apparatus is easy to construct, and is capable of evaporating liquefied gas at a relatively high rate. For example, where the interior of pipe 24 has a diameter of about 3/4 inch, and where the pressure at which gas is pumped in this pipe is about 200 lbs. per square inch, an evaporation rate of 4,000 lbs. of liquefied gas per hour is possible.

Moreover, the method disclosed herein is a relatively safe one to carry out. Fire hazard is minimal, particularly in view of the fact that heating equipment is not necessary. With complete vaporization in the air, no liquid concentrations ever collect on the ground.

While the invention has been described in connection with a preferred embodiment, it will be obvious to those skilled in the art that modifications and changes may be made without departing from the spirit of the invention, and it is intended to cover all such modifications and changes which come within the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:
1. Apparatus for evaporating a liquefied gas comprising liquid dispersing means located above the ground for dispersing the liquefied gas while such is in the liquid state into the atmosphere, including a discharge opening communicating with the atmosphere, support means supporting said dispersing means above the ground, a supply of liquefied gas under pressure spaced from said dispersing means, and fluid passage means connecting said supply with said dispersing means for conveying gas in a liquid state from the former to the latter, said supply including means forcing gas while in a liquid state through said fluid passage means to said nozzle.
2. The apparatus of claim 1, wherein said dispersing means comprises at least one spray nozzle for directing dispersed liquefied gas into the atmosphere, and said support and fluid passage means comprise a hollow pipe.
3. The apparatus of claim 2 which further comprises means inhibiting the collection of droplets in said means.
4. The apparatus of claim 1, wherein the supply comprises a collector and an intermittently operated pump for pumping liquefied gas from the collector into said fluid passage means.
5. The apparatus of claim 4, which further comprises means controlling operating periods of the pump automatically, depending upon the volume of liquefied gas in the collector, and wherein a valve is included between the pump and the collector controlling flow of liquefied gas from the collector to the pump, and said valve is opened to admit liquefied gas to the pump automatically at a predetermined time before operation of the pump.
6. A method of evaporating a liquefied gas comprising elevating the liquefied gas above the ground, dispersing the elevated gas as droplets into the atmosphere, extracting heat from the atmosphere with such droplets, by such extracted heat, vaporizing the droplets, and mixing the vaporized product with atmospheric gases.
7. The method of claim 6, wherein said dispersing of the liquefied gas is accomplished by pumping the liquefied gas under pressure through a nozzle.
8. The method of claim 6, wherein the elevation at which the droplets are dispersed, and the size of the
droplets produced in the dispersion, are selected so that under prevailing atmospheric conditions the droplets completely vaporize before striking the ground.

9. The apparatus of claim 3, wherein the means inhibiting the collection of moisture comprises a conduit connecting with said fluid passage means for introducing a stream of dry gas into said fluid passage means.

10. The method of claim 7, wherein pumping is done intermittently, and a stream of dry gas is passed through the nozzle during nonpumping periods.

LLOYD L. KING, Primary Examiner.