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1. 3,489,168 FLARE STACK Y-LEG SEAL
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ABSTRACT OF THE DISCLOSURE

The instant disclosure is directed to an improved safety seal to be used between a flare stack which is open to the atmosphere and a process unit safety valve discharge collection system containing inflammable hydrocarbons, the seal being integral with the stack and forming the lower portion thereof. The seal in its improved form is particularly suited for use in refinery and chemical plant installations since it provides a positive seal under static and dynamic conditions, is troublefree in its operation and is low in cost. The improved seal which is of the type generally designated as a "Y-Leg" seal is provided with means for skimming off condensed hydrocarbons as they accumulate and, in addition, with means for the safe, orderly disposal of seal water during dynamic conditions, thereby improving its operating characteristics over those of prior art devices.

FIELD OF THE INVENTION

This invention relates in general to safety apparatus and more particularly to apparatus used to dispose of inflammable or toxic vapors collected in a closed safety system for burning or disposal in an elevated flare stack or vent after they are passed through a water seal. In its most specific form the invention relates to improvements in the configuration of water seals used in conjunction with the associated vapor handling equipment.

Various types of devices are used to safely dispose of vapors collected in a closed safety system. These include burning pits, ground flares, venturi burners, elevated flares and/or elevated vents.

When an elevated flare or vent is used, the vapors to be burned or vented therein are released to the atmosphere from the closed safety system through a water seal. While several types of water seals are known in the art, a type of seal often used due to its simplicity and low cost is that designated as a "Y-Leg" type seal, the name being derived from the general configuration of the seal. Despite the cost and minimum size advantages offered by the Y-Leg seals used in the past, several drawbacks have been experienced with their use. These drawbacks become particularly troublesome when the seals are employed in petroleum refineries and other chemical installations where condensed hydrocarbons and the like may be present in the sealed collection system. Thus, for example, while the prior art Y-Leg seals can relieve gas blows from a refinery safety valve discharge collection system, quite often they also discharge liquid hydrocarbons that have accumulated in the collection system over a period of time. The discharge of liquid hydrocarbons to the atmosphere at an elevated level, of course, poses a safety problem as well as a nuisance. The hydrocarbon liquids accumulate from condensation of the hot hydrocarbon vapors present in the closed collection system.

Another problem often encountered with prior art devices is that during a safety valve blow to the flare, there is no way to adequately dispose of seal water. As a result, back pressure is built up until the seal is blown, thus permitting gas to enter sewers and other areas surrounding the flare via the seal water disposal facilities. During a prolonged safety valve blow, the inability to adequately dispose of continuously added seal water causes a fluctuating safety system back pressure which is dangerous in that the process unit equipment can be overpressured.

The improved Y-Leg seal and flare stack arrangement of the instant invention does not exhibit the deleterious operational characteristics hereinabove discussed. In contrast to the prior art devices, the device to be subsequently described herein relieves gas blows smoothly, skimms off condensed hydrocarbons as they accumulate so that they are not discharged to the atmosphere when the flare blows and, in addition, safely disposes of seal water added during a blow thereby avoiding the dangers of having the water seal blown or fluctuating safety system back pressure.

SUMMARY OF THE INVENTION

The above highly desirable results are achieved by providing a modified Y-Leg seal which comprises a vapor inlet header obliquely affixed to a flare stack or vent. The base of the stack or vent is filled with water to a level above the junction so as to provide a water seal between the vent which is open to the atmosphere and the collection system containing inflammable hydrocarbons or toxic vapors. The seal water is continuously circulated to remove condensed hydrocarbons and to prevent freezing of seal water. One overflow seal leg is provided for the normal discharge of the seal water and a second overflow seal leg is provided for discharge of seal water during a gas blow. The height of each of these legs as well as the location of the tie-in points are interrelated, as will be more fully discussed hereinafter.

It is a general object of the instant invention to provide a Y-Leg flare stack design which has improved operating characteristics over those designs in the prior art. A specific object of the instant invention is to provide a system of the character described which can adequately dispose of seal water added during a blow which prevent bypass vapors and, hence, does not permit the same to enter sewers and other areas surrounding the flare.

Yet another specific object is to provide a Y-Leg flare stack design which may be used on vapor lines containing condensed hydrocarbons without the possibility of having these condensed hydrocarbons discharge to the atmosphere during a gas blow.

These and other objects as well as a fuller understanding of the invention may be had by referring to the following description and claims taken in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

The drawing illustrates schematically a Y-Leg flare stack design according to the teachings of the instant invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

In the drawing reference numeral 2 designates a flare stack which terminates in a Y-Leg seal of the type disclosed, indicated generally at 3. The seal 3 comprises a vertical portion 4 and an oblique portion 6. Portion 6 is in communication with a collection header 8 which serves to conduct the vapors from a closed safety system
A water seal 20 is provided in the Y-Leg seal. The level of this water is maintained about 12 inches above the point designated a in the figure. The slope of the inlet line 6 is designed to provide a volume of water below the normal sealing water level 21, which volume is equivalent to the volume of about 10 feet of the inlet line. The purpose of this is to put a large water seal between the flare stack 2 and the flare header 8 to prevent the mixing of inflammable hydrocarbons or toxic vapors with air which can cause a flashback if there is ignition or combustion at the exit of the vertical portion 4. The seal water level 20 is maintained by a seal loop 30. A continuous flow of seal water is fed into portion 4 of the Y-Leg via the line 7 and out via two water outlet lines 28 and 26 provided on the Y-Leg at points corresponding to the desired seal water level 21. This continuous flow of seal water results in the removal or skimming off of any condensed hydrocarbons which may be present. The continuous flow also prevents freezing and in cold climates or when cold gases are being discharged, steam from line 10 may be injected into the water inlet line 7 thereby heating the seal water to a suitable temperature to prevent freezing.

During normal operation, the water continuously added to the Y-Leg seal is relieved through the overflow pipes 28 and 26 as hereinbefore indicated. These pipes are in communication with a primary seal leg 36 which in turn has a discharge end 31 in communication with a sewer system (not shown). The upper extremity of leg 36 is located on the same level as the water seal in the Y-Leg, i.e. at the level indicated by reference numeral 21. The location of the tie-in of the seal water discharge line 28 with the primary seal leg 36 is indicated by the point b. The minimum allowable distance below the sealing water level 21 at which the seal water discharge line 28 from the vertical portion 4 of the flare stack ties into the primary seal leg 30 is according to a preferred embodiment dictated by the following equation:

\[ B = A(1-1/\sin \alpha) \]

where

- \( B \) = minimum allowable distance below the sealing water level 21 at which line 28 may tie into primary seal leg 30;
- \( A \) = the height of the sealing water above the point designated a in the figure; and
- \( \alpha \) = an angle which is equal to 90° minus the angle between the oblique portion 6 of the Y-Leg and the vertical portion 4.

If the tie-in is located at a distance less than that dictated by the above formula, the possibility of bypassing gas from the oblique portion 6 to the vertical portion 4 via discharge line 28 might provide a volume of water below the sealing water level 21 which will not be possible.

As an additional feature, the system of the instant invention is also provided with a secondary seal leg identified in the figure by the reference numeral 29 to dispose of seal water during a gas blow. Leg 29 has an apex 23 which is somewhat higher than the normal level 21 of seal water 20. The functioning of this leg is as follows:

During a large blow of vapors into the Y-Leg from the header 8, the skin off connections 19 and 25, communicating with lines 28 and 26, cannot relieve additional seal water that is added to the system because the driving forces of the incoming vapor depress the liquid level in the oblique portion 6 below the drawoff point 25 and create a turbulant two phase mixture in the region of drawoff point 19, thus preventing any seal water drawoff. If the secondary seal leg was not provided, this additional seal water would cause increases in the back pressure in the flare header 8. With the secondary leg, however, after a small increase in back pressure is experienced, the secondary seal leg is able to relieve the additional water made up during the blow. By designing the Y-Leg seal so that the distance designated c in the figure is approximately three times the diameter of the secondary seal leg connecting pipe 18, good liquid-vapor disengaging for the secondary seal leg is assured. Syphon breaking vents 24 and 32 are positioned at the apices of seal legs 29 and 30 respectively to ensure that the seal legs do not operate as syphons thereby draining the seal water.

Although the instant invention has been described with a certain degree of particularity, it is to be understood that the present disclosure has been made by way of example and that obviously changes in the details of construction and arrangement of parts may be resorted to without departing from the spirit and scope of the invention. For example, the type and arrangement of seals described for an elevated flare or vent would be equally applicable where the vapors or air are burning pit, ground flare, etc. Accordingly, reference should be had to the following appended claims in determining the full scope of the invention.

What is claimed is:

1. In a venting flare stack system, a safety seal for a flare header which comprises in combination, a compartment for containing sealing water, said compartment having a vertical section and an oblique section, said vertical section forming the base of said flare stack, said oblique section being in communication with said flare header, means for introducing a flow of water into said vertical and oblique sections, means for maintaining a predetermined level of said sealing water, said means including means for discharging sealing water from said vertical and said oblique sections so as to preferentially draw off liquids lighter than water, said means also including a primary seal leg having an apex at substantially the same level as said sealing water level and a secondary seal leg having an apex at a level higher than the apex of said primary seal leg, said secondary seal leg being in communication with the lower portion of said vertical section.

2. A safety seal to be used between a flare header and a flare stack, said seal comprising in combination, a chamber for containing sealing water, said chamber being formed from a vertical section and an oblique section, said vertical section forming the base of said flare stack, said oblique section being in communication with said flare header, means for introducing a flow of sealing water into said chamber, means for maintaining a predetermined level of sealing water in said chamber, said means including a first discharge tube, one end of which is located at said level on said vertical section and a second discharge tube having one end located on said oblique section also at said level, said means also including a primary seal leg having an apex at substantially the same level as said sealing water leg and a secondary seal leg having an apex at a level higher than the apex of said primary seal leg, said secondary seal leg being in communication with the lower portion of said vertical section.

3. The seal of claim 2 wherein said oblique section forms an angle of 90°-\( \alpha \)° with said vertical section and said first discharge tube tube is inclined at an angle that said leg a distance below the apex of said primary seal leg, said distance being at least equal to B in the formula

\[ B = A(1-1/\sin \alpha) \]

where A equals the height of said sealing water level above the upper point of intersection of said oblique section and said vertical section.

4. The apparatus of claim 2 wherein said secondary seal leg has a diameter of d and the vertical section of said chamber extends a distance of 3 times d below the
lower point of intersection of said oblique section and said vertical section.

5. The apparatus of claim 3 wherein said secondary seal leg has a diameter of \(d\) and the vertical section of said chamber extends a distance of 3 times \(d\) below the lower point of intersection of said oblique section and said vertical section.

6. The apparatus of claim 5 wherein means are provided for heating said sealing water.