Stopping Storage-Tank Safety-Vent Leakage

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The process of storing large volumes of liquid VOC's (volatile organic compounds) in storage tanks requires a complex operation. Numerous pressure controls and emergency pressure relief vents are included in the vapor control system. Filling and draining the tanks changes the gas pressure above the liquids as do changes in atmospheric pressure and temperature, especially when the tanks are located above ground.

To maintain a consistent pressure, the tanks are fitted with pressure/vacuum relief vents that allow the tanks to "breathe" under normal operating conditions. Storage tanks also require emergency pressure relief vents that are set to open and allow rapid release of large volumes of vapors if tank pressure exceeds prescribed limits.

In addition, tanks may be fitted with a system of valves and pumps that add or release gas above the stored liquids. Usually, nitrogen or natural gas is used in the headspace above the liquid, rather than air, since these do not contain oxygen, which could combine with a tank's contents to create a combustible mixture.

The slight leakage of vapors that can occur with traditional emergency pressure-relief designs, even when the vent is closed, are no longer viewed as insignificant. Federal Standards under the Clean Air Act require that these leaks, termed fugitive emissions in the industry, be sealed "bubble tight," which means keeping them below 500 parts per million (PPM). While some storage tanks are maintained at a slight vacuum (less than atmospheric pressure) in order to minimize leaking, they still must have emergency-relief vents and sometimes pumps and valves to maintain a consistent pressure level.

Traditional emergency-relief vents use a spring or weight to hold a pallet in a closed position. The pallet then lifts up, letting excess gas escape when the system pressure exceeds the set point. When tank pressure comes close to the set point, the pallet frequently cracks open or flutters between the open and closed position, emitting fugitive VOCs into the atmosphere. In the petroleum industry, the

phenomenon is called "simmering" or "popping".

Another consideration with traditional vents is that they can be labor-intensive to maintain if the internal vapors or the surrounding environment degrade the effectiveness of the seal. Frequent trips to the top of the tanks are then required to test the vents for fugitive emissions, repair the seats and determine that they will function in the event of an emergency.

Rupture disks that break apart when the set point is reached are another option for emergency pressure relief. While rupture disks prevent leaking, accurate set points are difficult to achieve, especially at low pressure settings. On large disks, set points that are less than atmospheric pressure are uncommon. For smaller sizes, minimum set points can be higher; but tolerances at those levels can be in the ±25% range.

The Protectoseal Co., Bensenville, IL, offers two bubble-tight emergency vent designs. The first is a patented device for a liquid seal vent, combined in series with a mechanical seal. This alleviates the problem of vent leakage. The chamber above the pallet is connected in series with an-oil filled reservoir. If tank pressure increases to near the set point, the combination liquid seal/pallet seal prevents fugitive emissions. If the set pressure is reached, the pallet seal opens fully to relieve excess pressure.

When the design was used for emergency relief vents installed at a Tosco Corp., refinery in California, fugitive emissions were held in the 1 PPM to 100 PPM range, far below the 500 PPM that Federal Standards require. According to a consulting engineer hired for the project, the relief vents have performed flawlessly for the two years they have been in service.

A second innovation by Protectoseal uses a new design approach to reduce fugitive emissions in emergency relief vents. Called Pin-Tech, it performance has been verified under the Environmental Technology Verification Program (ETV) sponsored by the U.S. Environmental Protection Agency (EPA). The ETV program was established by the EPA to encourage acceptance of environmentally beneficial products. Products are voluntarily submitted by manufacturers for testing and to verify that their performance claims are met. Protectoseal submitted emergency relief vents employing the Pin-Tech technology for testing under the ETV program and the results were positive.

Pin-Tech vents work by using a buckling pin to hold a piston closed until the axial force caused by tank pressure causes the pin to buckle. This buckling action allows the piston to move to a full open, pressure-relieving position. The vents were tested by ETV for leak tightness, set pressure accuracy and for fugitive emissions when the pins were subjected to repeated stress levels below the buckling point.

The buckling force for a specific pin is governed by Euler's Law. Smaller pin diameter or increased pin length results in lower vent set points. Metallurgical characteristics of the metal used to manufacture the pin also affect the pressure required to bend the pin. Buckling pressure can be calculated and the pins

manufactured in a specified length and diameter with the appropriate metal. The predictable behavior permits design of a pin with an exact set point. Replacement pins can easily be installed without removing the vent from service after one has buckled.

Protectoseal engineers have designed pins matched with piston diameters to provide Pin-Tech vents with accurate and repeatable pressure or vacuum set points from 1 oz. per sq. in. to 15 lbs. per sq. in. above atmospheric pressure in sizes from 2 in. through 24 in., with an accuracy of ±5%. Emissions in all Pin-Tech vents tested in the closed, non-venting mode were never greater than 25 PPM, versus base-line tests of two weight-loaded conventional pressure-relief vents whose emissions exceeded 1,000 PPM before the set points were reached.

The ETV report also stated that "after the pin had been stressed to visible deflection multiple times, there was no significant increase in [VOC] concentration. Measured concentrations remained below 20 PPM throughout the test." In the words of the ETV report, Pin-Tech allows "no detectable emissions." Today, emergency relief vents using the Pin-Tech technology are being installed on VOC storage tanks throughout the world.

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