LIGHTNING MASTER VENT STACK HALO SYSTEM

One of the lesser mentioned, but still serious problems caused by direct or nearby lightning strikes or by static on plants is the ignition of vent stacks. Many of these fires have occurred on hydrogen stacks. These tend to be nuisance incidents, as they rarely cause catastrophic damage but can interrupt plant operations by requiring application of extinguishing agents or process shut down.

We were introduced to this phenomenon by a customer with a large chlorine plant in the southern US. We had worked with them to solve lightning problems in other parts of the plant. However, on a subsequent visit we were greeted with complaints that, after a lightning storm, the chlorine plant "looked like Kuwait" with all the stacks ablaze (this was right after the TV news coverage of the first Gulf War). We worked closely with that customer to determine the causes of the ignitions and to develop a solution.

Direct lightning attachment to the stacks is generally not the culprit. The actual cause is arcing in the presence of flammable gasses. This arcing is produced by static or lightning effects. Static may be produced by atmospheric mechanisms, including wind and airborne particles. Lightning arcing may be caused by secondary or electromagnetic pulse (EMP) effect.

Based upon the configuration of the stacks, we modified one of our existing products, an appliance designed in the mid-1980's to be part of a lightning protection system for tall broadcast towers. The stack system consists of a halo resembling Christmas-tree garland around the top of the stack, electrical bonding of potential spark producers, and grounding. The main conductor consists of a 316 stainless steel cable with small electrode wires inserted through it. The wires are available in 316 stainless, titanium or Hastelloy, as dictated by the environment in which it is installed. The mounting system holds the halo outboard of the stack, and reliably supports the halo throughout high winds and plant vibrations. In the case of static, the halo acts to neutralize static charges. In the case of lightning, it acts to conduct current and equalize potential.

STATIC

According to American Petroleum Institute API 2003, 4.1, sparks from static electricity are a significant source of ignition. For an electrostatic charge to be a source of ignition, four conditions must be present:

1. a means of generating an electrostatic charge
2. a means of accumulating an electrostatic charge capable of producing an incendiary spark
3. a spark gap
4. an ignitable vapor-air mixture in the spark gap

Ignition hazards from static sparks can be reduced by eliminating the presence of flammable gases or by controlling the generation or accumulation of static charges. The risk of ignition can also be reduced if spark promoters are avoided in areas of potentially high electric field. Although it may not be feasible to control the presence of flammable gas in vent stacks, the halo system controls the accumulation of static through point-discharge into the surrounding atmosphere. The halo system also electrically bonds spark promoters to the halo.

When we initially designed the halo, we looked for guidance to National Fire Protection Association NFPA 77, Recommended Practice on Static Electricity. Chapter 8, Control of Static Electricity and Its Hazards by Static Eliminators and Personnel Factors, discusses inductive neutralizers. These

devices do not prevent the generation of static charge. They provide ions to neutralize the static charge. The design of an inductive neutralizer consists of sharply pointed elements arranged for placement in the static electric field. The thousands of small radius points produce a localized electrical breakdown known as corona, ejecting ions that are free to travel to distant charges of opposite polarity, thereby reducing any arc producing difference in potential.

Static on the stack also allows micro arcing between any irregularities or gaps in the stack. If flammable gas is present, it may ignite. We also generally run a crisscross of conductive wire or metal bar stock across the mouth of the stack where an arc could otherwise occur. The combination of the halo around the stack perimeter and the crisscross bonding has proven very effective at controlling stack ignitions.

Although it would intuitively seem that stacks constructed of fiberglass or other non-conductive material would be more susceptible to ignition-causing arcing, metal stacks have also fallen victim to ignition. In any event, we electrically bond all system components together, then ground the bonded mass to the plant grounding system.

LIGHTNING

The primary cause of lightning related ignition of stacks is arcing caused by lightning secondary and EMP effect. Therefore, the basis of effective protection from lightning is the bonding of all masses capable of incurring a charge and discharging to another mass at a different potential. These masses are then electrically bonded to ground. On a steel stack, the construction of the stack accomplishes this role. The only masses requiring dedicated bonding are appurtenances such as vent pipes, sensors, brackets, etc.

The presence of the small radius electrodes in the halo also act to delay the formation of lightning-completing streamers. By virtue of the multiplicity of small radius points, the ground charge that would otherwise constitute a streamer is partially leaked off into the surrounding atmosphere, reducing the availability of ground charge to form a streamer. This reduces the likelihood of a direct lightning attachment.

In the event of a direct lightning strike to the stack, the central cable of the halo exceeds the requirements of NFPA 780 to serve as the strike termination device, and the support and grounding system conveys the lightning energy to plant ground.

CAVEAT

After years of in-service experience, we noticed that newly installed halos tend to be very effective, allowing very few ignitions. However, after six or seven years, previously effective installations have allowed occasional ignitions. This does not appear to be limited to one operator or one location. It appears that corrosion allows resistance to increase at various points in the mounting system to a level sufficient to allow arcing.

Therefore, we recommend reinstalling and tightening the mounting bracket connections using an appropriate anti-oxidant compound annually and replacing of the entire halo mounting system if an ignition occurs. We also recommend employing basic good practices installation techniques such as scraping paint between connections, and, if possible, welding the mounting system to the stack.