Natural Gas Piping Pressure Testing, Purging, and Equipment Restarts: Ten Hazards and How to Avoid Them

by Bryan Baesel & John Puskar, P.E.

The Danger

Whenever new equipment is installed, gas piping is repaired or added on to, or installed new for the first time it must be purged. The rules and best practices for handling these situations are often misunderstood, even by those conducting the work. This has resulted in deaths, explosions, and the loss of billions of dollars in industrial assets. This article seeks to clear up some misconceptions and provide the insights needed to make sure this work is done safely at your facility. This article speaks to three areas of codes and standards that apply to these kinds of situations. These are OSHA 1910, NFPA 54, and equipment standards such as NFPA 85 or NFPA 86.

First of all, there are two applicable codes that apply to this kind of situation. These are OSHA 1910.147 for lockout/tagout of energy sources. Much has been written about this and most people make some attempt to comply with it, at least on the electrical side. In our opinion, it's followed religiously for electrical equipment, but less than half the time for gas piping, steam, and other situations that could be dangerous in a pipe. We often find a lock on a disconnect and a gas valve that is just closed but not locked. Even when people try to do this correctly we find that they often do not understand the issues surrounding lubricated plug valves and their need to be sealed to hold properly. Our website (www.purgesafe.com) has a paper that specifically addresses this issue. In the case of a plug valve—which represents 60 to 80% of natural gas piping system valves— there is a space between the plug and the body. If the sealant is not applied annually, as required by code, gas will leak past the plug and the body even when they are in the closed position. We find that most plants do not have the knowledge or the equipment to seal these valves and have never sealed them in the life of the valve. Hence, closing or locking out a valve in this condition does not necessarily isolate the energy source.

The other applicable code is NFPA 54 (found at and available for purchase from the National Fire Protection Associations website, www.nfpa.org). This is also called the National Fuel Gas Code. It provides all that you would ever want to know about this topic. It a rather large document and takes some time to study and truly understand. We find that many consulting engineering firms and contractors not only have not heard of it but do not understand it. We know this because of the lack of isolation points (i.e., blanks, blinds, pancakes, etc.) and the lack of purge points installed in most industrial plants. There seems to be little forethought given to the actual installation of the gas pipe and how the gas pipe will be put into service and the equipment started up. Here are some highlights from NFPA 54 about getting piping into service or the more complex matter of adding pipe to an existing system. Let's look at that case.

Listed below are ten hazards involved in purging natural gas piping and how to avoid them. These tips and techniques should be incorporated into a comprehensive, documented procedure for natural gas piping purging, piping system design, and equipment start-ups.

Design/Planning

1. Purge Points

Purge points are pipe nipples installed at strategic locations in the piping system for the purpose of introducing or removing nitrogen and natural gas at various stages of the process.

These are generally 1" schedule 80 nipples with natural gas rated ball valves on the ends. It is important to select locations or orientations to make sure these are not susceptible to damage from things like vehicle traffic (being run into with a tow motor or scissors lift, for example).

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Fig. 1: An example of a pipe nipple

USDA Issues Oil Crops Outlook *(continued from page 5)*

soybean area to 9.5 million hectares—down slightly from 9.6 million in 2008. This reduction in sown area (from the previous estimate of 9.8 million hectares) and a lower yield outlook drops the soybean production estimate to 9 million tons versus 10 million previously.

The dry spells may have affected 2009/10 peanut output even more than soybeans. Indian peanut production is forecast down this month to a 24-year low of 5.2 million tons. Output would decline from last month's forecast of 6.8 million tons and last year's crop of 6.25 million. The revised crop estimate is primarily based on a smaller estimate of unsown area in southern states. At 5.4 million hectares (formerly 6.5 million), the peanut area may drop to a 40-year low. Lower peanut yields are also likely to contribute to the reduction because of a lengthy dry period during crop establishment. The Government has extended crop insurance deadlines from August 31 to September 15 in some southern districts, which could increase planted area slightly.

The uneven rainfall pattern in India also affected its cotton crop. Despite the country's record 9.9 million hectares of cotton, lower yields are expected to curb the production of cottonseed to 10.2 million tons against the previous forecast of 10.65 million. The shortfall in Indian oilseed crops should constrain exports of oilseed meal and prompt additional imports of vegetable oil next year. Lower production and greater retention of soybean meal for the domestic market (needed to make up for a decline in peanut meal use) is expected to constrain India's soybean meal exports. For 2009/10, soybean meal shipments abroad are expected at 3.9 million tons compared to the previous forecast of 4.8 million. Losses of domestic production for soybean oil and peanut oil in 2009/10 are also expected to raise imports of palm oil to a record 5.6 million tons, while stabilizing soybean oil imports at around 890,000 tons. Although India usually exports only a minor amount of vegetable oil, the Government has extended a ban on exports through the end of September 2010.

Smaller Canola Crop and Higher Domestic Use Reduce Export Prospects from Canada

Due to lower expected yields, USDA reduced its forecast of Canada's canola production this month to 10 million tons from 10.5 million. Cool weather continued in the prairie provinces throughout much of July and August and slowed crop development by 7-10 days, on average. Alberta and western areas of Saskatchewan remain dry and, in mid-August, a light frost reached parts of Alberta's Peace River Valley. Warmth in early September benefited maturing crops, but delayed maturity may still lead to yield losses and a smaller harvest. In September, farmers will have to wait for seed color to change before they can begin to swath the crop. Cutting swaths too early can result in yield loss and increase the amount of green seed, but can also minimize the effect of frost.

At the close of the August-July marketing year, Canada's 2008/09 ending stocks of canola declined to a lower-than-expected 1.7 million tons. Despite last year's large production increase, stocks were only slightly above the previous 5-year average due to strong demand. Although a lower supply is anticipated in 2009/10, crush is forecast to grow to 4.9 million tons from 4.2 million in 2008/09. Expansion of a crushing facility in Clavet, Saskatchewan is now complete and two other facilities are under construction there. The decline in Canada's canola production will bear more heavily on its exports, which are forecast down from 7.6 million tons in 2008/09 to 5.9 million in 2009/10. Large carryover stocks of seed and oil in China should help to cushion the impact of lower canola exports from Canada.

(Prepared by the Economic Research Service, U.S. Department of Agriculture. The complete report, released August 13, is available at http://usda.mannlib.cornell.edu/usda/current/OCS/OCS-09-14-2009.pdf)

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2. Isolation Points

Great care must be exercised to ensure that fuel trains are not exposed to excessive pressures that can damage components during pressure testing. This can be done with the use of line blinds. Valves can be left open or leak through in the closed position. Blinds provide positive isolation and eliminate the possibility for damaging devices in a fuel train that are not rated for the elevated test pressures (such as regulators). In some cases blinds also help to do pressure testing correctly. In some cases, pressure testing can not be done against a valve.

3. Piping Support

During repairs, sections of piping may be disconnected to allow the addition of tees or to install blinds. It is important to ensure that adequate pipe supports exist to prevent sections of pipe from falling when disconnected. The closest support may be on the other side of the disconnected joint.

4. Gaskets

NFPA 54 prohibits the reuse of flange gaskets even if they appear to be in good condition. To ensure leak-free joints, it is important that new gaskets are used as well as proper rated bolts for the flanges. Also remember that when mating up flanges, the rule is raised face to raised face and flat face to flat face.

5. Material Specifications

It is important that only proper rated pipe and fittings be used. Be sure that only reputable suppliers are used and that these materials are free from manufacturing and installation defects; watch in particular for pinholes in cast iron fittings, cast iron

fittings where the threads are misaligned, and pipe that is not of the proper grade.

Implementation

6. Nitrogen

The air we breathe is 78% nitrogen but two full breaths of pure nitrogen can kill. This inert gas is nothing to fool with. Make sure everyone understands this hazard and make sure purge points are marked and located in well ventilated areas. Also, verify pressure ratings of hoses and regulators; large liquid nitrogen tanks are capable of producing high discharge pressures. When discharging nitrogen purge discharge areas must be monitored. All personnel involved must be trained in the safe handling of nitrogen.

Fig. 2: A nitrogen tank in an typical industrial application

7. Discharge Locations

Make sure that purge end points where natural gas may be released are outside and at least 25 feet from any ignition source. Have areas roped off for security to keep ignition sources (including vehicles) and plant personnel out of the area.

8. Sampling Devices

Fig. 3: A hand held LEL meter

Do not use a combustion flue gas analyzer; instead, use a good quality recently calibrated LEL (lower explosive limit) meter during natural gas introduction and removal. A four gas meter can be used to monitor oxygen levels during nitrogen post repair purging. Make sure that two of each device are available. Stopping the process due to instrumentation error can cause a hazard. One can be used as a barrier protector for personnel near the purge end point and the other for use with at least a 6 foot long sensing tube that can monitor conditions at the actual discharge point. Don't actually put yourself in harm's way at the discharge point. Instead, do a timed and measured discharge and then with the flow stopped carefully approach to do an LEL check in the end of the purge hose.

9. Piping Integrity

In some cases, piping may have been improperly installed or disturbed during repairs or additions. NFPA 54 requires documentation of pressure testing for new or repaired piping systems prior to the introduction of natural gas. The results of these tests should be retained for the life of the piping system. Any section of piping that has undergone recent additions or repairs should be evaluated if no test records exist. Our firm has established as

Fig. 4: A pressure chart recorder

a best practice the use of pressure chart recorders. These paper and pen battery powered recorders come with very small pressure increment gradations (1 psig) and provide excellent records of pressure and hold times of tests.

10. Emergency Isolation

During the reintroduction of natural gas after the post repair purge it is imperative that the natural gas valve source valve be continuously attended during the reintroduction process. Communication with this individual should be continuously maintained. If a problem is detected the supply of natural gas can be immediately isolated. In addition, valves should be serviced, handles installed, and valve function verified.

Whenever natural gas piping systems are designed or worked on, these potential hazards should be evaluated and addressed. While the process is not simple, it can be completed safely if properly planned and carefully implemented.

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PEOPLE NEWS

South Dakota Oilseeds Council Elects Officers

The South Dakota Oilseeds Council has elected Brad Bonhorst of Fort Pierre as chairman and Tom Young of Onida as vice chairman for the next year.

Bonhorst raises corn, wheat, sunflowers and cattle on his farm east of Pierre. Young grows wheat and sunflowers, and he will also be president of the National Sunflower Association next year.

Bonhorst and Young will represent South Dakota on the National Sunflower Board.

The Oilseeds Council supports research and market development for South Dakota sunflowers and other oilseeds such as safflowers and canola.