Static Control in PE Fuel Gas Pipe

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Why address this issue?

As of 2002, 525,959 miles (or about 46%) of gas distribution mains in the US were plastic and PE is the material of choice for distributors. It doesn't corrode, doesn't need cathodic protection and has a life of at least 100 years. It is a remarkable fuel gas distribution material. During a Plastic Pipe Fuel Gas Symposium I attended, a southern California gas distributor told me about a damage assessment he conducted after an earthquake. In open gaps in the ground he saw PE pipe which had stretched to the diameter of a drinking straw but had not broken!

There are distributors who use plastic and know there is static in their system and in some way believe that this is caused either by the defective manufacturing of the pipe or fittings or improper operation of their distribution systems. In winter, when you reach for the door handle of your car and get a shock, you don't blame it on the car manufacturer. Generation of static by friction caused by motion is normal physics. Static in your plastic gas distribution system is not due to defective materials or improper operation of your system. It is just natural physics.

Conversely, if distributors don't respect the fact that static is present in their system, they run the risk of catastrophic accidents and damage. GTI (formerly GRI) was repeatedly called upon by the distribution industry to develop methods and products to eliminate static because it is a widespread problem. Gas Research Institute report 92-0460 notes static electricity is a problem for every gas distributor:

"As the use of PE pipe for gas distribution lines increases, the safety issues related to electrostatic discharge of PE pipe during repair operations continue to be a major concern to the gas industry." - Technical Perspective page iv, line 1

The laws of natural physics are not suspended in your system simply because static's presence isn't obvious to you. Every system has static to some degree. Static in distribution pipe is not limited to plastic. I have measured 10,000 volts of static in steel pipe.

While we would all like a perfect distribution material (like a perfect wife or husband!), PE is as close to an ideal material that current technology can deliver. A realistic approach to controlling static in your PE system will make a great distribution material nearly perfect.

Static control in PE distribution pipe has both a safety and integrity component.

Safety considerations

There is an odd paradox of transmitting gas through PE pipe. This gas passage creates it own ignition source – static! In the phase 1 report of the Integrity Management for Gas Distribution Committee investigation, a key finding was there is a decreasing rate of reportable distribution incidents resulting in fatalities and injuries. Clearly, current safety and operating procedures have been effective in reducing incidents to a point where the study group said there is no discernable trend.

The wildcard in the safety component of static control is excavation damage. As the Integrity Management for Gas Distribution Committee reported, excavation damage poses by far the single greatest threat to distribution systems. Moreover, excavation damage often causes incidental damage beyond the damage to your distribution systems. As good as your safety procedures are, excavation damage exposes the self generated ignition source in PE pipe – static – to the public as well as your workers. Your safety procedures, therefore, must take into consideration 3rd party contractor's damage as well as your worker's safety.

Integrity considerations

A less recognized but more significant aspect of static in PE pipe is the integrity impact of electrostatic pinholing. Most leak studies in PE pipe have dealt with slow crack growth leaks which are very rare but catastrophic failures. However, there is an increasing number of reports of pinhole leaks in PE pipe. While not as dramatic a leak as a slow crack leak, it like being nibbled to death by mice. You're not aware of the seriousness of what's occurring until it's too late.

The lack of discovery of pinhole leaks should not deceive operators into believing they don't have any electrostatic pinhole leaks in their system. Since all PE pipe must be buried, these leaks are difficult to locate. The associated costs to repair or replace these leaks, when necessary, are significant. These electrostatic pinhole leaks have been reported during squeeze off, at fittings, in service risers and service lines.

Basics of static electricity

In order to control static, you must have an understanding what you're attempting to control. So you must understand static electricity. What is static electricity? Static electricity is electrical energy. Electrical energy can either be current or static. Since most people are more familiar with current electricity, understanding that form of electricity will give us better understanding insight into static electricity.

Current electricity is the electricity that powers our lights, dishwashers and heaters. It is electrical energy that is conducted though electrical conductors like copper wire. While we assume the electricity flow is inside the copper wire, in reality it is conducted on the outside surface of the wire. It is conducted by the motion of electrons on the surface of the copper. If you could see the copper atoms on a molecular level, you would see an electron pushed out of the atomic orbit of the copper molecule and jump into the orbit of another copper molecule pushing out the electron previously there. This continuous process is current electricity.

This ease of electrons jumping from the atomic orbit of one molecule to another molecule is a characteristic of the material used to conduct electrical current. Some materials, such as copper, by nature allow easy movement of electrons from one atom to another. These materials make excellent electron conductors. They are good electrical conductors because they have low surface resistivity – there is virtually no resistance to the movement of electrons or electricity on the surface of the material.

However, other materials by nature do not easily allow electrons to jump out of their atomic orbit. In fact, the electrons in the atomic orbit of the material are so strongly held that it takes a tremendous effort to get an electron to jump out of their orbit. Polyethylene is such a material. Physicists say polyethylene exhibits high surface resistivity. Therefore, if somehow you put electrons on the surface of polyethylene, those electrons will not conduct on the surface without a great deal of electrical force. Therefore, these electrons tend not to move - they are static. However, they are still electrical energy. PE is considered an electrical insulator since it isolates (or has high surface resistivity) instead of conducting electrons while copper is considered an electrical conductor since it has low surface resistivity thus easily conducting electrons.

How static electricity is created

Current electricity is the movement of electrons. In most cases, mechanical motion is needed to create a separated electron. At the local power plant, the force of steam boilers forces a magnet to move past a copper wire. Since copper electrons are easily pushed out of their atomic orbit, the passing magnetic field pushes the electron out of orbit. That stray electron is pushed up against another copper molecule which the forced electron pushes that electron out of that orbit to replace it leaving another stray electron.

However, if by motion of one material is rubbed against the other, and one material is an electrical insulator, the forced off electron just sits on the surface of that material. If you rub wool against PE, a stray electron will be deposited on the PE and just sit there since it can't conduct away. These electrons accumulate into invisible piles of electrons consisting of electrical energy which is static electricity.

How static electricity is measured

In one sense, as a distributor you really don't need to measure static. If you've ever had an ignition or electrostatic pin hole, then you know you have static in your distribution system. GRI has said static is widespread in PE systems.

If you want to measure static, you must have an exposed pipe to measure. Since all plastic pipe is buried, you must dig it out in order to take a static reading.

If you had current electricity, you would connect an ammeter (to measure "flow") and a voltmeter (to read "pressure") in the electron stream. However, with static electricity our electrons are static and not moving. Therefore, we can't measure the charge with the ammeter and voltmeter. However, there is an electrical charge present when electrons accumulate since there is a surplus of electrons at a location. Since each electron has a charge, that amount of electricity can be measured by measuring the strength of the electrical field created by this accumulation of stray electrons.

The device that measures the strength of an electrical field is called an electrostatic voltmeter. It has a sensor on the top of the meter that when placed near a surface (according to the meter manufacturer's instructions), will measure the strength of the field in volts. There are numerous manufacturers of electrostatic voltmeters. However, since most electrostatic voltmeters are made for electronics manufacturing industries, these meters are not rugged enough for use in measuring static in the field. Therefore you should carefully choose a model designed for outdoor use.

It is important to recognize that all volts are the same. If you have 120 volt electricity in your house, the 120 volts read on a polyethylene pipe surface is the same as the 120 volts at each electrical outlet in your home. The only difference between the two is that the 120 volt outlet in your house will continue to deliver 120 volts at a continuous flow rate of up to 15 amperes (or whatever is the amp rating of the circuit). However, the 120 volt static electric charge will rapidly diminish when grounded since it does not have any current. However, the fact the static charge has no current does not diminish the static threat. Once it ignites a gaseous mixture or arcs through the pipe wall creating a pinhole, the damage is done and no additional current is needed.

How static electricity is dissipated

First one must understand that static electricity is not normal in the natural world. Mother Nature does not like electrical imbalances. The physical world is designed to be at electrical neutrality. If electrical imbalances occur, these electrical charges will attempt to go to electrical neutrality. When static builds up in the atmosphere because hot moist air is rising, it will arc to ground to eliminate the charge. External or internal charges on PE pipe will arc to ground in the need to go to electrical neutrality unless the charge is dissipated by static suppression methods.

Since static electricity by definition does not conduct or move, the method of dissipating the charge must be brought to the charge. There are two basic methods of dissipating static charges – ionization and grounding.

Ionization is a process that is not used in the natural gas industry because is uses high electrical voltages and therefore in hazardous environments might cause an ignition. Additionally it requires an electrical supply and a bulky transformer and is generally unsuitable for field operations where all static elimination would need to be conducted.

The second method to eliminate static is to conduct the charge to ground or dissipate the charge. Since the electrical charge cannot conduct away, you must bring the grounding path to it. Therefore, you create an electrical conductive path to ground. This is what a soapy burlap/wet rags accomplishes. It directs the electrical charge to the ground via a conducting wet rag and grounding.

Basics of static in PE distribution pipe

Now that a basic understanding of static electricity is laid we can begin to address static as it is particular to PE gas distribution pipe. GTI (formerly GRI) has been called upon numerous times to investigate static in PE pipe so we can draw on their professional conclusions.

Gas Research Institute report 92-0460 states:

"Because of the serious electrostatic problems in PE pipe, GRI initiated this research project to develop methods and techniques for discharging PE pipe to eliminate spark discharge hazard." - Introduction page 1, last line

So where does the static begin? Gas Research Institute report 92-0460 continues:

"When PE pipe is charged by dust or particulate flowing in the gas (triboelectrification), charge is generated initially in the interior of the pipe." - Technical Perspective, page iv, line 3

This is the most important and fundamental fact of understanding how to control static in your systems. <u>*The static begins inside the PE pipe with the passage of gas.*</u> This occurs because of normal physics. The rubbing of gas and particulate against the inside wall of the pipe creates static. This static buildup is a function of how much scale or particulate in the gas, moisture content, velocity, pressure and flow patterns. The more particulate (all things being equal) the more static generated. The more velocity (all things being equal) the more static generated. The less moisture content (all things being equal) the more static generated. The more pressure (all things being equal) the more static is generated. The more elbows and flow changes (all things being equal) the more static generated. One of the particular difficulties in dealing with static control in PE gas systems is the phenomenon that static is not uniformly distributed or predictable in the exact location where it will be generated. While the same particulate levels are in all gas, some areas of PE will develop a higher static charge that other areas. Because of this you must assume that dangerous levels of static are present everywhere unless you are willing to accept the risk that static is not present.

GRI goes on:

"The electric field resulting from the interior charge induces exterior charge on the pipe." - Technical Perspective, page iv, line 3

This phenomenon is not intuitively obvious but it is very important to understand. If the charge is on the inside of the pipe and since PE is an electrical insulator, how can an exterior charge be induced? Imagine a PE pipe buried in the earth which is electrical ground. Generally, electrical charges can conduct and pass through the ground. Gas passes through the PE pipe and generates a static electricity charge on the inside. The electric charge generated on the inside of the buried PE will exert a field charge around it. Remembering that Mother Nature doesn't like electrical imbalances and wants to go to electrical neutrality, this will attract the OPPOSITE charge through the soil surrounding the pipe. Therefore, if there is a 1000 negative charge on the inside of the pipe, it will attract an equal opposite charge that will be conducted through the soil and deliver that charge to the outside of the pipe where it will stop and reside. It will stay there because it is attracted to the opposing charge located on the INSIDE of the pipe. When you uncover the pipe, the charge attracted to the exterior of the pipe through the ground is now exposed and capable of arcing. This is why you use exterior static suppression procedures. Therefore, to accomplish static control in PE distribution pipe, we need to dissipate charges both inside and outside of the PE pipe.

To measure static in a pipe, you must first dissipate the exterior induced static charge. If you neglect to do this, your reading will include the opposite induced charge and the reading will incorrectly read low. The external charge can be dissipated using standard anti static procedures. When the surface is treated and dried, the resulting charge measured with an electrostatic voltmeter is the interior static charge. The static on the interior walls of PE pipe does not dissipate. Why? Static cannot conduct away because it is residing on an electrical insulator.

Gas Research Institute report 92-0460 continues:

"Charges imparted to the interior PE pipe surfaces act as point sources and are immobile because of the inherent high resistivity of PE." - Introduction, page 1 line 4.

Static inside PE pipe, once it is generated, remains and poses a serious spark discharge hazard at any time it is exposed to an electrical ground - either by tools, machines, workers or third party damage. For gas to ignite, a temperature of approximately 1200 degrees F is required. A static charge of 3,000 volts or more will produce this amount of heat when it arcs. So even though there is no current, once the charge arcs, it produces enough initial heat to ignite a gaseous mixture. In a sense, PE pipe is like a battery since it stores energy. Operators think that once gas flow has stopped the possibility of static ignition has ended. GRI says this is wrong. I've heard anecdotally of pipe that has gas shut off for some time igniting due to static because the charge remains on the interior pipe surface since it has not been dissipated.

Gas Research Institute report 92-0460 continues:

"The interior charge problem is still evident after gas flow has been cut off, and a defective section of pipe is cut for repairs by using a saw or circular cutter. When a metal object penetrates the inner wall of a charged pipe, a spark discharge is inevitable." - Charge Removal Procedures, page 1 line 5.

One of the most common incidents and explanation for ignitions illustrates a fallacious understanding of static in PE pipe. A contractor strikes your PE gas line and a fire starts with no obvious ignition source. The assumption is that the tool hitting the pipe created a spark that ignited the gas mixture. But how hard would a tool have to hit a PE pipe to create a spark? What really happened in a majority of these incidents was the tool exposed the static inside of the PE pipe to gaseous mixture and a ground. The static normally created by the passage of gas inside the pipe arced to a ground (either through the tool or to earth) and ignited the gaseous mixture resulting in a fire.

Some distributors have hoped that by controlling the factors that generate static inside PE pipe, they can prevent static buildup from beginning. A major factor in generating static in PE pipe is particulate content of the gas. However, unless you can prevent any scale and dust in your system, this cannot be controlled. Some operators want to design systems so the velocity will not be fast enough to generate static. However, can you be assured that no 3rd party excavation damage will ever occur that will cause a free flow of gas and maximum velocity through your system? Since flow patterns create obstacles that cause flow friction, can you make all gas lines straight with no elbows, tees or fusion points? To prevent pinholes, can't we can just increase the wall thickness of the PE pipe so its so thick it can't pinhole? While that might work for new pipe installation, what about the 525,000 miles of pipe currently in the ground? While the approach to design systems to eliminate the factors that cause static generation in your system might be possible it could never be completely foolproof and from a cost standpoint is really not practical. The production of static in your system for all practical systems is unstoppable without the implementation of interior and exterior anti static products. Therefore, static control appropriate to your system is the only cost effective approach.

Distributors static control issues created by static electricity in PE pipe

There are two problems created by static electricity in PE pipe – ignitions of gaseous mixture and electrostatic pinholing. For static electric ignitions to occur, 4 elements are necessary – oxygen, gas, electrical ground and a temperature of about 1200 degrees F to begin the reaction. If a static charge of less than 3,000 volts arcs, it will not generate enough heat to ignite a gaseous mixture. Therefore, in any instance where these four factors are present, such as 3rd party damage, repair operations or purging, an ignition can possibly occur even when no visible ignition source is present. While these four elements can be somewhat controlled during planned construction or repair operations, distributors cannot control these four factors if 3rd party damage unexpectedly occurs and therefore ignitions occur proportionally more often during these 3rd party incidents. Unless you can always control these 4 factors, static control of ignitions will be uncertain in all instances of 3rd party damage.

Integrity issues due to electrostatic pinholing date back to 1981 when Mark Staker at then Mountain Fuel (now Questar) first documented pinhole leaks. Since then other distributors have reported pinholes in their systems. However, the lack of numerous reports must be tempered with the fact that over 99% of the possible leaks are buried and difficult if not impossible to detect. However, in the 1% of the pipe that pinhole leaks are easily detectable – the service riser – leaks at this point are beginning to generate national attention. The presence of leaks at risers is a strong indicator of more buried leaks since if there was enough static to create an electrostatic pinhole leak in the riser, static is probably present in other places in the service line.

"Squeeze-off operations, combined with particulate flowing in the gas, increase the charging problem. In such cases, the squeeze-off constriction in the pipe produces higher particulate velocities and results in higher charge levels. The charge conditions across the pipe wall can increase high enough to exceed material breakdown. This breakdown phenomenon produces a small burned hole (about the size of a pinhole) through the pipe wall that can leak minute quantities of gas. Even under apparently normal operations when the pipe is not being squeezed, pinholing is observable because of high-turbulent flow conditions occurring near tees, elbows, etc." - *Introduction page 1, 2nd paragraph.*

Static, and not manufacturing defects, is the source of unexplained holes in your systems. Distributors initially tend to blame pipe manufacturers for defective pipe if any holes are discovered in pipe. However, this begs the question if the pipe was manufactured defective, how did it pass pressure testing prior to service? Since PE pipe doesn't degrade except over one hundred years, how could the hole have developed in so short a time?

Some distributors believe pinholes in PE pipe are attributable to "regrind" included by pipe manufacturers in the virgin PE pipe extrusion. They claim either the regrind is the source of pinhole pipe defects or they create a weakness or defect in the pipe wall that allows for an electrostatic pinhole.

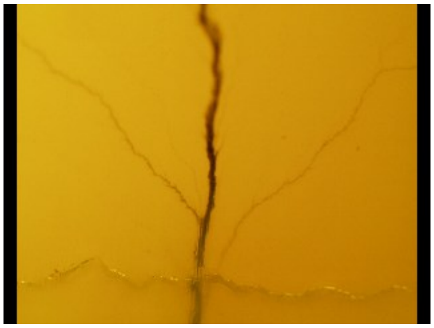
Regrind is pipe material recovered from extruded pipe that for some reason did not meet spec at the time of extrusion. Note that this regrind is not scrap material but inhouse material that was originally virgin material. Therefore, it is scrapped, ground up and placed back into the feeder hopper to be reheated and re-extruded into pipe. Pipe manufacturers have an ASTM standard for allowing regrind in PE fuel gas pipe extrusion. ASTM standards allow for the use of a certain amount of regrind since testing has shown the presence of a certain amount of reground material does not affect the physical properties of the final extruded PE pipe. The ASTM standard, however, did not test the effect of regrind in creating pinholes. However, one would expect that if the presence of regrind in the pipe didn't affect the physical properties of the pipe it would not affect pinholing.

If the presence of regrind in pipe is the cause of pinhole defects, the same question applied about initial pressure testing. If the pipe with regrind present in it during manufacturing was the cause of pinholes, how could it pass pressure testing after installation? Something must have created the pinholes after installation.

Electrostatic pinholing occurs when the static inside the PE pipe reaches a high enough voltage to overcome the dielectric (or insulating strength) of the PE pipe. The internal static charge arcs through the pipe wall to the surrounding earthen ground. The heat produced from this arcing melts the plastic during arcing causing a pinhole. For medium density PE pipe this dielectric factor is 510 volts per thousand of an inch thickness. For example, a 1" IPS PE pipe with a 0.122 inch nominal wall thickness and a dielectric strength of 510 V/mil would require62,220 (510 times 122) volts of interior static to overcome the dielectric strength of the PE and arc through the pipe to the exterior buried earth creating a pinhole. While distributors might think these are impossible voltages to achieve in PE pipe, we have documented such events in the field. In the example noted, consider that the static charges might be capable of going even higher. However, the charge can't increase beyond 62,220 volts since at that point it arcs through the pipe to ground itself thus creating a hole in the process.

Material analysis can definitely determine if pinholes are material defects or electrostatic pinholing. The shape of the pinhole identifies whether the pinhole is a material defect or due to electrostatic discharge. The shape of the channel caused by electrostatic discharge is distinctive in 2 aspects. First, the diameter of the pinholes on the inside and outside will be different. One pinhole will be substantially larger than the other. This is because the electrostatic voltage charge is higher one side of the pipe wall than the other. When discharge occurs and the voltage drops, the heat from the static declines and the final exit hole diameter is smaller. The larger hole indicates where the charge started and the small hole indicates where it ended.

The second distinctive of electrostatic pinholing is the shape of the channel. The channel will be tree shaped with branching. Electrostatic pinholes will rarely be a direct channel through the pipe wall and the channel will become smaller as the charge diminishes. Material defect pinholes, unlike the distinctive shape of the tree, will generally be a single channel with no branches, will be larger than 1 MM and are evident during manufacture. While it is very difficult to determine in the field if the cause of the hole is static electricity or manufacturing defect, if the hole is small (1 MM or less), it is probably static created. The only definitive method to determine the cause of the pinhole is to have the pipe manufacturer's lab microscopically examine the hole.


Typical channel of an electrostatic discharge. Note the branching off the main channel

Generally, electrostatic pinholes occur in places in your system where there are flow disruptions and friction is created. You can expect static to be generated at butt fusion points, elbows and tees. While normal operations might not generate enough flow turbulence to create voltages to pinhole the pipe, if 3rd party damage breaks a line causing free flow of gas upstream from that break, or if high flow rates occur at a time when other adverse factors (particulate levels, moisture levels, etc) are present, velocities might create static levels at butt fusion points, elbows and tees that reach the dielectric strength of the PE and then pinhole. It is theses uncertainties which your static control plan must consider in order to prevent pinholing.

The electrostatic pinholing incidents we have observed conform to the one common characteristic of pinhole leaks in PE fuel gas pipe – it generally occurs in smaller diameter pipe. Given this observation, we theorize that as load increases in a system, the velocity of gas passing through a smaller diameter pipe is proportionally greater than that of a larger diameter pipe. This "velocity effect" is further enhanced by the fact the pressures are generally lower in smaller diameter pipe since pressures have been stepped down for delivery. Therefore, all things being equal, velocity must increase proportionally more in smaller lower pressure PE pipe than higher pressure PE to deliver the load. If this is true, this higher velocity results in greater friction of the gas against the pipe wall creating higher static charges inside the pipe wall. The result is pinhole leaks in small diameter pipe when load and conditions are such to generate excessive static electricity inside the pipe.

The gas distribution industry's experience with pinholes in mains and service risers is not isolated or unique. This phenomenon of leaking risers has been recently cited in Fire Findings Newsletter. This quarterly newsletter for fire investigators published an article about the possibility of pinholes in gas service risers in response to numerous incidents around the US where fires have begun as gas meters. They suspect the leaks at these gas meters are due to pinhole leaks caused by static.

The claim that static is specific to one brand of PE pipe is incorrect. I have seen PE service lines which have been replaced and seen pinholes in 3 different brands of PE pipe in the same service line. The good news is if you have not discovered any pinhole leaks in your service lines, you probably don't have a widespread problem. However, if distributors find one service line with pinhole leaks, our field experience has been there is a very high probably all of the other service lines in the immediate area have pinhole leaks - even if there are different brands of PE pipe.

External anti static products for gas distributors

Since ionization is not suitable for gas distributors, the only suitable anti static process is grounding or passive dissipating. For controlling static on the outside of PE pipe, grounding the charge is accomplished either by liquid or conductive tape. To conduct away the stationary (or static) charge, you must completely cover the pipe surface to insure you have electrical contact with any static that might be present on the outside pipe surface.

The oldest liquid dissipative method is soapy water in burlap wrapped around the pipe and the wet burlap dropped to the ground. The burlap holds the water to the surface of the pipe and the soap acts as a surfactant causing the water to flatten out and not naturally bead up and therefore completely covers the pipe surface. The burlap holds the soapy water to the pipe surface which creates an electrical circuit to conduct the electrical charge from the surface of the pipe through the burlap to the ground.

Another commercially available liquid system is Norton McMurray ASG. Like the soapy water in burlap, the ASG system provides a liquid conductive path to ground. It includes a film wrap that is wrapped around the pipe and then sprayed with the ASG solution. Unlike the soapy burlap, since it is pre mixed it is less likely to improperly mixed in the field and therefore cover the pipe surface properly. Remember that any external liquid systems are only as good as the field personnel have proper coverage of the pipe and path to ground. Both the ASG system and soapy burlap are effective in eliminating exterior pipe static but have no effect on internal pipe static.

Ionix makes an aerosol static suppressor which is formulated specifically for the natural gas distributor. Unlike soapy burlap or the wet film wrap which are electrical conductors and must be grounded to be effective, the Ionix Aerosol uses molecular anti stat technology. Spraying the pipe surface with the product immediately dissipates the static charge without grounding or keeping the pipe wet. It continues to dissipate any static even after it dries until it is washed or scrapped off.

GRI's assessment of exterior static control:

"Prior to this project, standard safety procedures involved wrapping the pipe with wet soapy burlap. This procedure is effective for neutralizing exterior charge accumulation but does not affect the interior charge." - *Technical Perspectives page iv, line 7.*

Your choice of an exterior static control system should be based upon the cost to apply to pipe to dissipate exterior static since they are ineffective for dissipating interior charges.

External anti static products for gas distributors

The only commercially available static suppression system for static inside PE pipe is the Ionix system. It is specifically designed to prevent static inside a distribution system.

For distributors who receive their gas odorized, an Ionix cartridge systems is installed at the beginning of the distribution system you want to eliminate interior static. After gas passes through our filter, static inside PE downstream of Ionix is dissipated inside the pipe and prevented from building up again. For distributors who odorize their gas, Ionix MA delivery system is added to mercaptan. When the gas is odorized, Ionx MA is carried off through the system dissipated interior static. Both the cartridge and Ionix MA dissipate static through the systems to burner tip. The Ionix cartridge system can also be installed in odorized gas systems if the distributor desires.

Ionix accomplishes static suppression by reducing the surface resistivity of the gas and essentially making the gas an electrical conductor instead of an electrical insulator. When the Ionix is employed, it also eliminates the exterior static charge since there is no interior charge to induce an exterior charge.

Static control of ignitions

Distributors are most familiar with static induced ignitions because of their immediate obvious effects. Virtually all static control efforts in the gas distribution industry are directed, prudently so, to prevent ignitions.

In order to understand and evaluate static control of potential ignitions, we need to categorize the activities that ignitions might occur. While different operations pose different static risks to operators and even though current practices have no effect on interior static charges, it is prudent practice to use exterior static control at all times. You have nothing to lose and everything to gain by such practices.

Tapping or repairs would generally be the most common event where static control is important. Current industry best practices require the use of an exterior antistat liquid or wrap to dissipate the induced static present on the exterior of the pipe prior to the commencement of work. While this will eliminate the exterior static charge, it will do nothing to eliminate the interior static charge since the liquid or wrap is applied externally. If an interior static charge is randomly present and this charge is exposed to a gaseous mixture and a grounded tool, an ignition could result. You must prevent the interior of the pipe (especially the exposed edge of the pipe interior) from contacting any electrical path to ground. Remember that workers can also be a path to ground for a static charge to ignite a gaseous mixture. Generally, current exterior static control practices are adequate for these operations.

Squeeze off operations always create static risks. These risks originate inside the PE pipe and are due to the venturi effect. When squeeze off begins, the flow of gas is being restricted. At the point of squeeze off, like any other fluid, gas compresses in order to accelerate through the narrowing opening caused by squeeze off. As it does, the friction of the gas against the side of the pipe increases. This is aggravated by any particulate in the gas. Static charges rapidly build up inside the pipe and often arc through the pipe either through the tool or into the ambient air if enough humidity is present. The result is electrostatic pinholes. However, if the pipe is open, the static charges on the open edge can arc to ground igniting a gaseous mixture. However, unless there is an open pipe being squeezed off, the static created during squeezeoff does not create an ignition threat.

Purging PE lines also creates potential for ignitions. When high velocities pass through the pipe, the interior develops static charges. Current industry best practices call for grounded metal pipe ends at exposed ends of the line being purged. While this does not conduct away any interior charges in the PE pipe, the grounded ends do prevent buildup of static charges at the open end of the pipe which might arc to ground causing an ignition if a gaseous mixture is present. However, since you cannot effectively reach inside the pipe to eliminate charges, your must exercise extreme caution. Current industry practices of external static control and metal ends are adequate but do not remove interior static charges.

Open lines or 3rd party damage are the most problematic static control situation for operators. Obviously, when these events occur distributors are unable to dissipate the pipe exterior of static. Worse yet, since damage generally causes a pipe rupture, gas flow increases to maximum rates increasing static inside PE pipe to maximum possible levels. Since external static control cannot occur until gas flow is stopped and squeezed off, entering the pit must be done with maximum fire protection. As soon as practical, external anti static procedures should be accomplished with special attention to get anti stat spray inside the exposed pipe hole. However, even if anti stat treated on the exterior of the pipe, the exposed pipe edges are extremely dangerous and very probably capable of igniting a gaseous mixture if exposed to ground. External static suppression is marginally helpful in these situations.

Operators also have questioned the danger of static electricity created by vacuum excavation during keyhole operations. GTI was asked to determine if the ignition of natural gas can occur during the use of vacuum excavation equipment near leaking gas lines and/or during the removal of water from gas mains. GTI concluded that vacuum excavation can be used safely without incident if proper precautions currently used for static electricity around plastic pipe are taken.

Static control of electrostatic pinholes

While most distributors believe pinholing only occurs during squeezeoff and purging operations, in fact most pinholing occurs during normal operation of your systems and is a function of the velocity of gas passing through your system and not a consequence of repair or construction activities. Therefore, to accomplish anti stat control of pinholing you must prevent the possibility of static buildup inside your PE pipe.

The only repair or construction activities that can in particular generate electrostatic pinholes is squeezeoff and purging.

As squeezeoff essentially increases the velocity of gas inside the pipe at the squeeze off point, this increases velocity generates more static inside the PE pipe. These charges build up to a point overcoming the dielectric strength of the PE and arc through the material to either the squeezeoff tool or the ambient air causing a pinhole leak. Exterior static control is ineffective to eliminate this interior static.

There are 2 viewpoints on whether or not to ground the squeezeoff tool in this situation. If your company policy is to ground the tool in order to prevent the worker from being shocked, you will cause the static charges from the inside of the pipe to be directed to the tool and then to ground. By grounding the squeezeoff tool you increase the risk of pinholing since you have placed a grounding point on the outside edge of the pipe underneath the point which is the highest static charge. If charges get to dielectric strength, these charges will arc through the pipe to the tool. It has also been reported that charges arc through the pipe even when not grounded to a tool. If your policy is not to ground the tool and isolate the tool, you run the risk of the charge jumping to the worker and grounding through him. I have read experts who insist on the correctness of both options. It is your company decision. Understand, however, the company decision to ground tools has no effect in static control, but only how you direct the charge to ground – either through the tool or through the operator.

Purging provides the unique possibility of both ignition and pinholes. As the velocity increases, if a gaseous mixture is present, the charge builds up inside the pipe, especially at the exposed edges and induces an exterior charge. The external charge can be eliminated by standard external anti static procedures. However, the high velocities during purging can increase interior voltage to pinholing levels which external static control treatment has no effect.

Finally, the normal operation of your systems can create interior voltages high enough to pinhole. If a severe cold front comes through and in the morning everyone turns up their heaters and jumps in the shower while the gas you are currently being supplied has a little more particulate than normal and a little less moisture than normal, the conditions are ripe for pinholing. When distributors report numerous service risers or service lines all with small leaks, this is probably these conditions that have caused these pinholes happen. Unfortunately, distributors have no control over the conditions that caused those pinholes. The only effective anti stat procedure is interior pipe static prevention.

This scenario is the same for free flow of gas caused by 3rd party damage. While there might not be an ignition when a line is broken, the excessive gas flow upstream in the right conditions can cause numerous undetected pinhole leaks.

Remember that once these static charges inside PE pipe reach the dielectric threshold point of the pipe, the electrostatic arcing creates a pin hole. The long term effects of pinholing are far greater than ignitions. If the conditions necessary for an ignition create an ignition, after the ignition is extinguished the static incident is over. However, when a pinhole is created, it leaks forever until repaired. Any static control efforts directed to pinholing must be preventative measures. If you let voltages inside your system get to pinholing levels once, it's too late. It's cheaper to prevent holes than repair them.

The Ionix Static Eliminator will prevent the creation of static inside PE pipe wall. As GRI reported, all other anti-stat products will eliminate static on the exterior pipe wall but is ineffective on preventing or eliminating static buildup inside PE pipe walls.

Conclusion

Technologies are commercially available to control static both inside and outside PE gas distribution pipe to whatever extent the distributor wishes to eliminate it. However, there are two major issues of static control distributors must consider.

First, as stated earlier, the Integrity Management for Gas Distribution pointed out that after 13 years of decreasing incidents there is now "no discernable trend in reportable incidents". There is an important implication in this statement. This flattening of incidents is due to the industry's admirable uniform safety training and strict implementation of safety procedures within their organizations. However, the implication of the report is saying that in the area of ignitions, unless distributors make a major change in the way they control static, the number of reportable incidents will not decline but probably remain the same. If the current level of risk exposure to static is unacceptable to a distributor, then the only remedy to eliminate remaining potential static ignitions is to address eliminating internal pipe static.

Second, as the Distribution Integrity Report showed, 3rd party damage continues to be the wild card in static control accidents. As good as your company's policies and safety training is, excavation damage will expose internal pipe static to a hazardous mixture. The implication from the report is that it will be excavation damage that will become an increasingly larger portion of the incidents. Therefore it will fall to distributors to reduce the possibility of ignitions as a result of 3rd party dig ins. Unless you can guarantee you will not have dig ins, in addition to a program of preventing dig ins, distributors will have to think through a program of eliminating interior pipe static prevent ignitions from those dig ins.