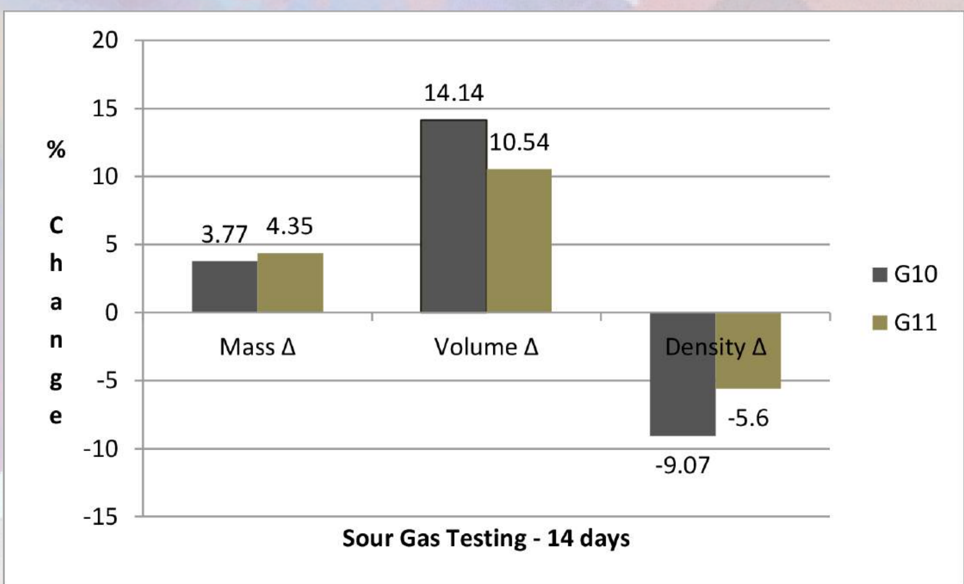
A new option to traditional plastic isolation gaskets

No one can argue that pipelines have changed tremendously in the last 75 years. Pipeline metallurgy has become stronger and less prone to corrosion. New exotic metallurgies have been introduced to further resist the chemicals that are now often found in oil and gas streams (sour gas, chlorides and steam). Pressures and temperatures have increased and emission reduction requirements have become a way of life for most companies. Meanwhile, the operation of a fire safe pipeline has also become a higher priority. During that same time period, isolation gaskets have pretty much stayed the same. Seventy- five years ago, the isolation material was a plastic with filler. Today, by far the majority of isolation materials are still plastic with filler. Some have a metal core, but still are plastic with filler (glass reinforced epoxy). How well does a plastic isolation gasket with filler fair in today's oil and gas pipelines?

We will analyze the chemical compatibility, the temperature resistance, the pressure resistance, the emissions capabilities and even the ease of installation of these materials. The world's oil and gas is becoming more and more sour. As we drill deeper and farther than ever before, we are encountering higher percentages of H2S than we had seen in the past. This has significant effect on isolation gaskets. Below is a test performed at Amtec test laboratories. It is a fourteen day exposure at 150°C, 2000psi in a mixture of 18/71/11 mol % H2S/Ch4/CO2. As you can see from the images, both G10 and G11 are significantly attacked by this mixture. G10 is a glass reinforced epoxy rated to 150°C and G11 is a glass reinforced epoxy (GRE) rated to 200°C.

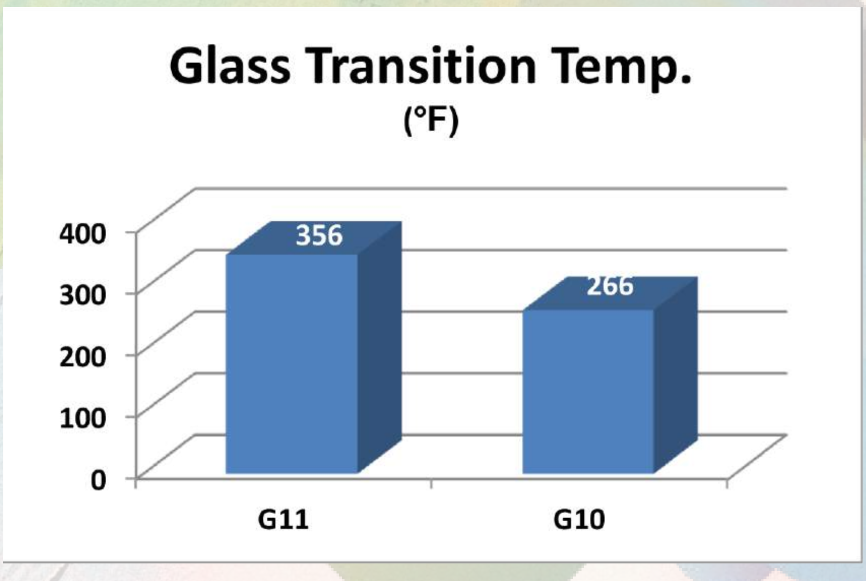
As you can see, both the G10 and G11 had a significant amount of bubbling on the surface of the gasket samples. Density, mass and volume were all tested before and after the test as indicators for chemical attack. Both the G10 and G11 had major shifts in all three areas (see graph below):



Changes of this magnitude in a 14 day period indicate chemical attack of the material. An isolating gasket that loses density and gains volume is more likely to blow out at high pressures.

Steam can be as much an issue with GRE (both G10 and G11) as sour gas. This was a G11 isolation gasket after 34 weeks in steam/carbonic acid service. The epoxy in the GRE is compatible with carbonic acid so the carbonic acid wasn't the issue, but it is not compatible with steam as can be seen from this image. G11 is rated for 392F/200C, so the 270F is not the cause of failure. Steam causes hydrolysis in the epoxy and this dramatically softens the laminate. With softening of the gasket and volume loss, blowout is a real danger.

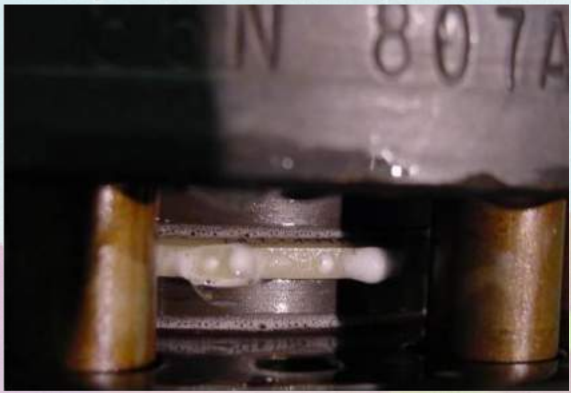
As we drill deeper and utilize enhanced oil recovery(EOR) methods to recover oil and gas, temperature gradients within the pipelines have grown. It is not uncommon to see HPHT (high pressure, high temperature) or uHPHT (ultra high pressure, high temperature) applications today. These wells are



either operating at over 15,000psi or 177°C. It is rare to see a well operating at both limits simultaneously. This can be challenging for plastic based isolating gaskets for a couple of reasons. First, the pressure capability for most plastic based isolating gaskets (even with a stainless steel core) is only about 12,000psi. At pressures above that, the plastic can separate from the stainless core and cause a blowout. Secondly, the glass transition temperature (the point where the hard plastic material becomes a semi-solid) is not tremendously high. G10 GRE (the most common plastic isolation material) has a glass transition (Tg) of only around 266°F/130°C. G11 GRE has a Tg of around 356°F /180°C.

To the right is an image of a G10 based plastic isolation gasket that was installed in a hydrocarbon application and subsequently blew out. Gaskets had been in operating service up to 1,100psi and 260°F/127°C for a period of one year. Analysis indicated bubbling of the epoxy in spots and delamination from the 316SS substrate. Temperature exposure at or above the glass transition temperature reduces the mechanical strength of the G10 or G11. High temperature, coupled with improper installation techniques or high pressures, can cause joint blowout.

Manufacturers of plastic isolation gaskets have long known that GRE permeates quite profusely. The straight glass fibers in the epoxy act as a direct “escape route” for media (particularly gaseous media, but certainly not relegated to just gaseous media). Engineers of isolation gasket manufacturing companies have utilized the permeation issue to an advantage and have the media activate the seal. Normally, the seal is located somewhere between the inside diameter and outside diameter of the gasket. The media is allowed to permeate though the GRE and activate the seal. For homogeneous GRE designs, the seal is normally located in a groove with an angled surface (see image).



The pressure of the media permeates through the GRE, then contacts the angle in the groove and is forced at an upward angle. The force then pushes the seal against the flange face creating a tighter seal. This works well for surface leakage,

however media that permeated into the body of the gasket is able to potentially permeate from the inside diameter (ID) of the gasket to the outside diameter (OD) of the gasket causing emissions or visible leakage. Many users that use soapy water on the outside diameter of their plastic isolating gaskets have found bubbles forming from just this reason. I don't think many installers understand that the media is permeating through the body of the gasket to activate the seal. We call it a "leak to seal" technology. It performs well when the media is chemically compatible with the GRE and the user does not have emissions concerns. As we mentioned at the outset of this article, pipelines have changed tremendously over the years. With sour gas and steam on the increase, a "leak to seal" design allows chemically incompatible materials into the body of the gasket while the media is under pressure. This can significantly accelerate chemical attack.

For emissions reductions efforts, GRE isolation gaskets are not the answer due to the above reasons. Ethane, methane, etc. can easily pass through the glass fiber and epoxy matrix often-times creating a less than desirable emission rate.

A new technology for isolating flanges has been developed. It is a 316SS core encapsulated with a high temperature, robust isolating barrier. The design is very novel in that it eliminates all of the above issues that have plagued plastic based isolation gaskets for years.

The product has a Gylon® style #3500 primary ID (inside diameter) seal. This seal stops media immediately at the pipe bore. It also is sized so that under compression the seal matches the pipe bore exactly. This prevents conductive media from building up in the flange gap, keeps microbial growth at a minimum to reduce microbial induced corrosion (MIC) and also reduces fluid cavitation which can cause flange face erosion. The seal also has two angles designed into the fluid contact area that promote pressure activated sealing.

The secondary seal is an Inconel 718C C-ring that provides a seal that will not be compromised in the event of a fire. The product has been tested to API 6FB fire testing successfully in multiple sizes and classes. The open face of the C-ring also faces towards the media creating a pressure activated seal.

The C-ring and Gylon seal are seated in a 316SS core with a proprietary coating. This design yields an extremely high pressure capable product that is chemically resistant with the chemicals in today's oil and gas pipelines and has much better thermal properties than the previous plastic based, GRE isolation options.

The gasket is a nominal .125" thick so it is much easier to install than most plastic based high pressure isolation gaskets that were anywhere from .250" thick to .308" thick.
It is readily apparent that the gasket has a handle. This is unique and there are practical reasons for that. The first reason is that it is nearly impossible to laser mark or ink mark the proprietary coating of the gasket, so for traceability, the plastic handle is laser etched with the gasket size/class/lot #. In case the plastic handle is ever broken, the size/class/lot # is also stamped into the 316SS metal under the plastic handle. The handle additionally provides a non-coated area for electrical testing to be performed on each batch of gasketing products to insure the gasket isolates fully before ever sending out of the manufacturing plant. Finally, the handle makes installation and removal of the gasket much easier than traditional gaskets. Traditional gaskets can often be difficult to remove from the flange area and installers will be tempted to try to dislodge the gasket by pushing screwdrivers and crowbars into the flange face area to hit and push the gasket out of the flange. This can mark and mar the flange face and damage the contact area of the flange. The handle simplifies the process without damage to the flange. The last key point is that this gasket has the highest dielectric strength value of any isolation gasket available today at a typical 1,100 volts per mil per ASTM D149 dielectric testing and hydrotesting or exposure to moisture has very little effect on its isolating properties. A typical G10 type isolating gasket will have a dielectric value of around 800 volts per mil and a typical G11 type isolating gasket will have a dielectric value of around 850 volts per mil. We discussed the permeation of GRE of gases, but water can also permeate if pressurized. To test this, a test was conducted at ambient temperature (74°F/23°C). Water was pressurized to 5,575 psig(383 Barg). The gasket was exposed to the pressure for a minimum of 10 minutes. The gasket was tested pre-hydrotest and post hydrotest for electrical resistivity and was evaluated for pressure drop during the test. To make the test even more difficult, a gouge was put in the face of the flange to insure the gasket could seal and isolate a flange that was in "less than ideal" conditions. Less than 278 psig(19 Barg) loss (5%) was deemed acceptable during the test. In actual results, the gasket lost an average of 102.5 psig (7 Barg) over multiple tests. Resistivity results were >10 Gohm at 50 Vdc and an average of 40 Gohm at 1,000 Vdc indicating that this isolating gasket can be hydrotested and still maintain significant electrical resistance. The same cannot be said for plastic GRE type gaskets. A similar hydrotest evaluation was done with metal cored, plastic GRE isolation gaskets and the resulting resistivity results were an average of only 4.77Mohm at 1,000 Vdc….a 10,000 times improvement!

The new fully encapsulated gasket also handles much higher pressure than the earlier plastic based GRE isolation gaskets. As we mentioned earlier, even if a plastic GRE isolation gasket has a metal core, it still struggles to surpass 12,000 psi in a flange. The fully encapsulated stainless steel core has been tested and averaged over 30,000 psi before blowout/leakage and the lowest value found was 28,000 psi. A dramatic increase over plastic based GRE products.
Pipelines have evolved over the years and it is comforting to see that isolation gaskets are now evolving as well. It seems that the days of plastic gaskets for isolation are history.

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