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Extending the Life of Aging Pipeline Infrastructure

America's pipeline infrastructure is aging. According to PHMSA, there are almost 2.8 million miles of pipelines active in the United States (2017). Many older pipelines are operating beyond their "design life" but most continue to operate safely due to requirements for inspections, maintenance, and repairs. In fact, there is a high percentage of pipelines still in use today that were constructed prior to 1970 (most notably from 1950-1969), but these pipelines continue to operate safely thanks in part to the various integrity management programs implemented across the industry and advancements in pipeline components and inspection technologies. It is also important to note that by the end of 2017, the majority of active pipelines were made of steel and plastic while roughly 3% were made from cast and wrought iron pipe - a direct result of the active conversion of cast/wrought iron pipe to steel, due to the degrading nature of iron alloys. Steel on the other hand, is much more stable. By itself, steel is considerably more resistant to change and does not weaken on its own with age. It takes the addition of external mechanisms and forces to initiate changes in its structure such as: corrosion, welding or equipment failures, excavation damage, incorrect operation, natural events or external applied forces. These are the challenges that most piping designers and corrosion engineers face, and battling them successfully can equate to a healthy lifespan for pipeline infrastructure.

One of the most famous pipelines in the world, the Trans Alaska Pipeline System (TAPS), transmitted its first barrel of oil in 1977. With an initial 30 year right-of-way Federal grant, and an extension of the right-of-way grant for an additional 30 years granted in 2002, the pipeline is expected to continue operation until the year 2042; at which point the pipeline will be over 60 years old! Interestingly enough, the limiting factor on the TAPS is not based upon the integrity of the infrastructure, nor upon the material limitations of the pipeline, but rather on the ability to flow enough oil through the pipeline to maintain profitability. Essentially, it is believed that there will be a shortage of product long before the integrity of the system is compromised. This brilliant engineering feat is impressive enough under its own right, but the fact that the life of this system continues to expand is a testament to the forethought and ability of engineers to combat a never ending slate of challenges that continue to threaten the pipeline infrastructure.

One of the arguably less understood methods of corrosion comes from stray soil currents. Most US pipelines are buried, which can make soil assessment and a *complete* understanding of subterranean environments difficult. Recently, GPT has seen an increasing number of inquiries regarding the influence

of stray current from sources like power lines, other cathodic protection systems and public transport. The common belief is that these values are much more substantive than previously realised and can quickly impact buried steel. Figure 1, below, shows corrosion deterioration times with varying stray current discharges:

Figure 1: Time to complete perforation based upon varying stray currents.

Time-Varying Stray Current Discharged From Structure To Earth, 30% Duty Cycle	CORROSION DETERIORATION	
	STEEL PIPE	STEEL REINFORCING BAR
	1 Square Inch Having 0.25-Inch Wall Thickness, Complete Perforation	6-Inch Long Section of #4 Bar, 0.5-Inch Diameter, 50% Loss
1 Ampere	4.3 Days	10 Days
0.1 Ampere	43 Days	100 Days
0.01 Ampere	1.2 Years	2.8 Years
0.001 Ampere	12 Years	28 Years
0.0001 Ampere	120 Years	280 Years


As stray current increases, the impact on steel increases. All too common are the statements that recorded values are much higher than predicted values, and quite often currents are introduced after the current infrastructure has been in place for years. While the best method of long term corrosion mitigation is to control these stray currents at their respective sources, it isn't reliable and sometimes isn't an option. Active monitoring and proper isolation techniques are imperative to preventing stray current corrosion from occurring on pipelines. While not necessarily the primary choice for buried applications, GPT's new EVOLUTION® gasket can help with unforeseen isolation issues. While resisting galvanic corrosion in dissimilar metals and allowing for proper isolation in Cathodic Protection systems and helping interrupt electrical current along pipelines, EVOLUTION® is the next advancement in flange isolation for pipelines.

The National Association of Corrosion Engineers released a study in 2016 called the "International Measures of Prevention, Application and Economics of Corrosion Technology" in which it estimated corrosion costs for the global economy to exceed an estimated $2.5 trillion. This astronomical cost is driving a need for further advancements in corrosion mitigation and an ever increasing understanding of the environmental and operational hazards that affect pipeline infrastructure. These efforts are essential in making the TAPS, and others pipelines like it, so successful. As engineers focus more on corrosion prevention and integrity management, we are able to extend the usable lifetimes for much of these transmission systems by providing a multifaceted approach in pipeline corrosion prevention. This 'robustness' is really the only way to ensure that "pipelines remain safe, cost-effect and efficient 20 to 50 years on" and as such, pipeline professionals should be looking at all aspects of their systems to look for technological improvements.

In the same way that integrity programs and corrosion prevention technologies have evolved, so too have sealing capabilities. Compared to alternative flange sealing methods, GPT's new EVOLUTION® gasket is capable of achieving extremely tight seals. In figure 2 and table 1 (tabulated data), one can see an extract of data taken from a custom Helium gas sealing test designed to measure the sealing performance of GPT's new Evolution gasket under a variety of operating conditions. While the 'springback' observed is somewhat common with other metallic seals as it is a more of a function of the entire flange assembly expanding and contracting due to changes in temperature, it is interesting to note that the system pressure is able to rebound and maintain integrity throughout the experiment.

Figure 2: Course of leakage curve for GPT's custom Helium sealing test.

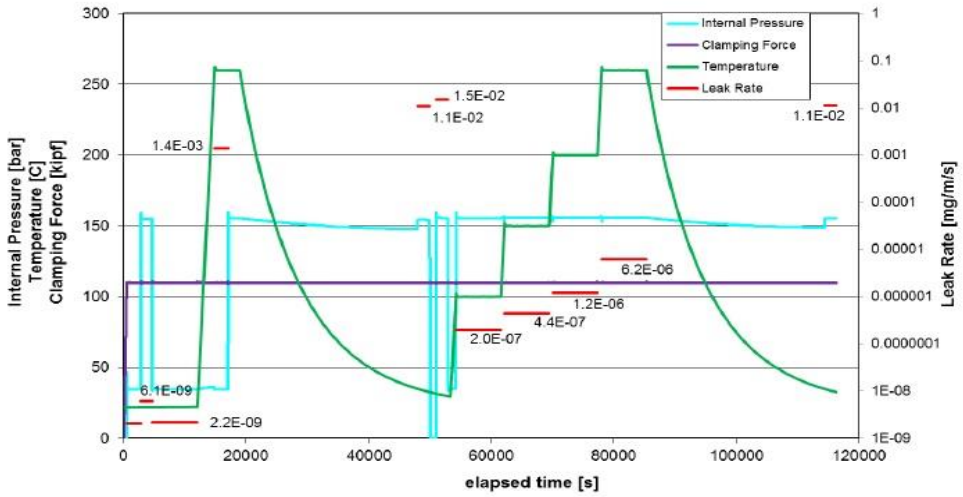

Table 1: Tabulated data for GPT's custom Helium sealing test.

Test: Leakage Test #	**17- 524** Pressure (Bar)	**Procedure 5** Clamping Force (kipf)	**Model F** Temperature (C)	Leak Rate (mg/m/s)
1	34.5	110	25	2.13E -09
2	155.1	110	25	6.1E -09
3	34.5	110	25	2.2E -09
4	34.5	110	260	1.4E -03
5	155.1	110	25	1.1E -02
6	155.1	110	25	1.5E -02
7	155.1	110	100	2.0E -07
8	155.1	110	150	4.4E -07
9	155.1	110	200	1.2E -06
10	155.1	110	260	6.2E -06
11	155.1	110	25	1.1E -02

Additionally, the EVOLUTION® gasket was subjected to the Chevron Fugitive Emissions Test (CFET) and passed with a maximum leak rate of 69 PPMv at 500F and a maximum leak rate of 16 PPMv at ambient temp. Not only can you help prevent corrosion and extend the life of your pipeline, but you can limit emissions while doing so.

As corrosion mitigation methods continue to evolve and advancements continue to be made with materials and integrity management, it is important to take a look at all aspects of your infrastructure and update components regularly. If a system is only as strong as its weakest link, don't let gaskets be that weak link! "By Coupling inspection, monitoring, mitigation, forensic evaluation, and prediction, a comprehensive corrosion-control program can be realised. Subsequent remedial actions can then be devised to counteract the effects of corrosion, thereby helping to assure the integrity of aging systems." As you upgrade all aspects of your piping and sealing programs, don't overlook the advancements taking place in sealing technologies to help increase the lifespan of your piping systems and equipment. GPT's

EVOLUTION® gasket can be an integral component in extending the life of your pipeline and equipment. As conditions become increasingly harsh, make sure that you are getting the best out of your materials and taking the appropriate steps to fight the threats facing your infrastructure.

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