Reduce Pipeline Maintenance Costs

Maintenance is a constant endeavor by pipeline owners and operators. Proper operation of a pipeline is necessary for safe delivery of crude oil and natural gas to processors and end-users. Internationally there are spills and leaks each year that hamper the timely transit, processing and delivery of crude and refined oil and natural gas product(s). Millions of dollars are then diverted away from operations for the purposes of remediation and regulatory compliance which otherwise could focus on delivery of product to end-users. There is now a better method to minimize the costs and maximize the benefits of routine pipeline maintenance.

Fused Amor's Super Steel protection system reduces overall maintenance requirements for pipeline operations. The unique nature of this protective system allows pipeline operators to lower routine maintenance costs by as much as 40%. Most of these cost savings relate to the inspection and reparation of pipeline integrity and pump relay stations efficiency compromised by leaks, spills or invasive corrosion.

Without sustained pressure within the inner walls of pipelines, the development of leaks or spills can be difficult to detect. Timely leak detection is needed to reduce down-time required for repairs and avoid a costly focus on remediation and public relations when an off-line event does occur. With transit costs of up to $1.50 a barrel, the disruption in flow for any length of time can be devastating to the bottom line of pipeline operators. In addition, capital costs related to ineffective maintenance protocols can dwarf the original construction costs associated with gas transit pipelines. For these reasons, the Super Steel maintenance plan offered by Fused Armor will effectively address these perplexing problems.

Innovative Market Entry

After years of research and decades in the coatings and manufacturing industries, the founders of Fused Armor incorporated in 2006. Fused Armor has developed a breakthrough that could change the way that companies deal with traditional corrosion, erosion, occlusion and degradation problems. The new approach involves cladding the external and internal walls of ferrous metals (such as steel pipelines) with a patented water-based silicon protective process. This nano-technology approach imbeds an armor cladding filling in all microscopic voids within the steel making it stronger than the underlying steel itself. The Fused Armor cladding takes place in a single step as compared to the multi-layered coatings in common protection methods.

Fused Armor permanently seals the metal substrate from corrosion and will prevent erosion from damaging inner walls of a pipeline. In contrast, the historic use of epoxies and urethanes are inherently flawed because they are softer "coatings" susceptible to wearing away or rupturing rather than a "cladding" which surrounds, insulates and protects the interior contents. The "contents" in this case calling for special treatment is the oil intended for the end-user, thereby the pipeline itself can return to its use as a dependable stable delivery platform.

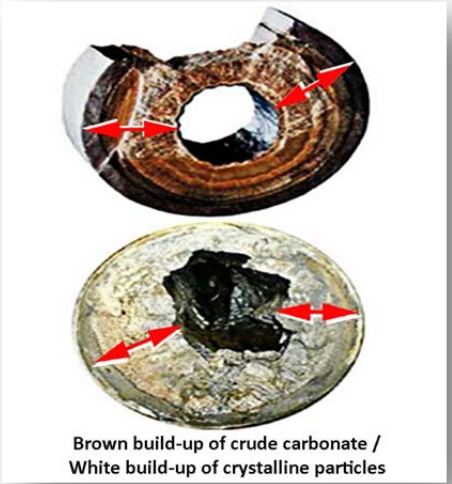
Reducing Equipment Repair and Pipeline Cleaning Expenses

The development of Fused Armor involved a substantial collaborative effort and numerous improvements bringing forth its current formulas designed for the caustic and corrosive environmental conditions of the petroleum industry. In providing this protection, Fused Armor also offers a high degree of lubricity which allows crude oil and natural gas to flow through the pipeline freely by greatly reducing static tension of liquids and gases flowing in the pipe.

The high lubricity feature of Fused Armor reduces the pressure of the pipeline internally taking the stress off of relay pump stations. Reducing stress of the pumps to create increased pressure to move the crude oil through the pipeline consistently extends the life of this equipment. The increased lubricity of the inner wall of the pipe can translate into faster through-put of the crude oil to the processor and end-users. The increased lubricity and reduced surface tension then decreases wax build-up on the inner pipeline walls (crude oil) and similarly will decrease hydration in natural gas transport pipelines. Added lubricity internally can consequently translate into decreased operating expenses and thereby, increased operating profits. In addition, the insulative properties of Fused Armor decreases heat loss in the flowing oil further reducing opportunities for internal build-up.

Crude oil contains varying amounts of paraffin wax which emerges from crude oil at 50^{o}C and as it cools, wax buildup may occur within a pipeline. When present in oil, waxes or asphaltenes (molecular crude oil components) can cause solubility issues and compromise flow. When obstructive buildup is present in transit lines, these pipelines are inspected and cleaned using pipeline inspection gauges or *pigs*. Cleaning Pigs not only scrape the wax off the wall of the pipe but cleans out the pits and corrosive impediments off inner walls. When impediments are removed, the pitted metal is exposed thereby accelerating the corrosive attack on the inner wall. Consequently, the thinner inner wall is weakened and will fail eventually creating leaks, spills or other disruption of flow in the pipeline. When the need to remove wax depositions (or plugs) is neutralized by consistent predictable flow, and oil temperatures in transit are maintained at higher temperatures, the enhanced operating efficiency of the pipeline is the natural outcome.

Cleaning Pig



Brown build-up of crude carbonate /
White build-up of crystalline particles

Thermal Properties

Sweet crude oil is a viscous liquid and is heated in order to be easily transported through a pressurized pipeline by relay stations along the length to maintain the proper pressure and heat properties. Heating crude oil in a buried or exposed steel pipe takes tremendous energy to move crude down the pipeline. Fused Armor's thermal conductivity will trap the heat used in shipment lowering the amount of energy to maintain the proper viscosity. The thermal insulation value is over 2 times that of the metal pipe. Heat loss is not a common problem when the pipe is protected by Fused Armor as the heat waves are refracted along the length of the pipe laterally as the oil continues down the pipeline (confirmed in tests by the automotive industry).

Heavier oils such as bitumen and oil sands must be diluted with a natural gas condensate, naphtha or synthetic oils to keep the bitumen from precipitating out of the crude oil. This mixture (diluted bitumen) must be used in order to comply with the order to meet viscosity and density requirements found in common carrier pipeline tariff rules. The diluted blend ratio may consist of 25 to 55% diluent by volume, depending on characteristics of the bitumen and diluent, pipeline specifications, operating conditions, and refinery requirements.

Dilbit contains a high amount of abrasive substances like shale, silica, quartz, etc. that wear away the wall of the pressurized pipeline when being transported to the processors. Fused Armor creates unparalleled abrasion resistance and impact resistance (up to 24,000 pounds psi) adding to the extended long life protection needed for the metal pipeline. Poly liners are soft and have a limited life time. Replacement of these liners can be expensive as the flow of the oil must be curtailed and the pipeline cut to replace liners

Metal Protection

The US Department of Transportation, Pipeline and Hazardous Materials Safety Administration identifies key performance characteristics in pipeline "coatings" which are needed to maximize safety and minimize needed maintenance (49 CFR 195.559). Among the required characteristics are that: (a) Coating materials are designed to mitigate corrosion; (b) Materials have sufficient adhesion to the metal surface to prevent "under-film migration of moisture"; (c) Be sufficiently ductile to resist cracking; (d) Have enough strength to resist damage due to handling and soil stress; (e) Support and supplemental cathodic protection; and (f) Have a low moisture absorption and high electrical resistance. Third party testing has proven that Fused Armor excels in each of these areas compared with all pipeline coating methods available.

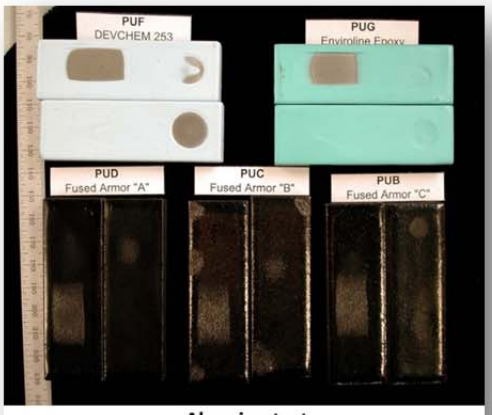
Fused Armor Clad Test Pipe Sample

Impacts (accidents), abrasion (heavy oil and oil sands, subsea oil instillations) and corrosion are the leading causes of pipeline failures internationally causing over 80% of all spills or leaks each year.

Since oil (extracted from Canadian oil sands and the Central States Bakken Formation) has been transported through North American pipelines, there have been tens of billions of dollars diverted from income to cleanup, with billions more spent on fines, remediation and regulatory compliance. Pipelines must now be stronger and more resistant to abrasion in order to transport the heavier thicker crude oil. Relay pumping stations must thereby increase pressure internally in the pipeline needed to move the thicker crude. Consequently, the needed characteristics for new pipelines today are much greater than those in the past in order to efficiently transport the more viscous crude coming out of Canada and the Central Plain States.

Fused Armor's Super Steel is the answer to meet and exceed all regulatory standards for pipelines. In the images to the right is chronicled evidence of third party testing on Fused Armor samples. The abrasion test pictured is a comparison conducted by the Canadian government between Fused Armor and typical epoxies used on pipelines. In this case, Fused Armor was applied at one-half the thickness of the epoxies with weight and volume loss in Fused Armor was negligible and epoxies breached in the same repetitive sampling. The corrosion test pictured was conducted by Ford Motor Corporation and shows the difference between a Fused Armor clad verses an unclad sample of 409 stainless steel. The lubricity and ductility test was conducted by independent labs serving the oil industry in Calgary, Alberta Canada. In the ductility test, a clad flat steel sample was bent in half without any negative impacts to the cladding. The strength test was conducted by independent labs in Houston, Texas who serve offshore oil drilling interests and demonstrated that a Fused Armor clad sample cut from a 21" pipe is 219% stronger than an unclad sample cut from the very same pipe.

Fused Armor's solid impermeable bond to the metal allows for a protective cocoon to be formed over the pipe wall becoming one with the metal. The combination of heat curing combined with nano-ingredients penetrate deep into the metal and this then changes the properties of the metal itself. When the metal is



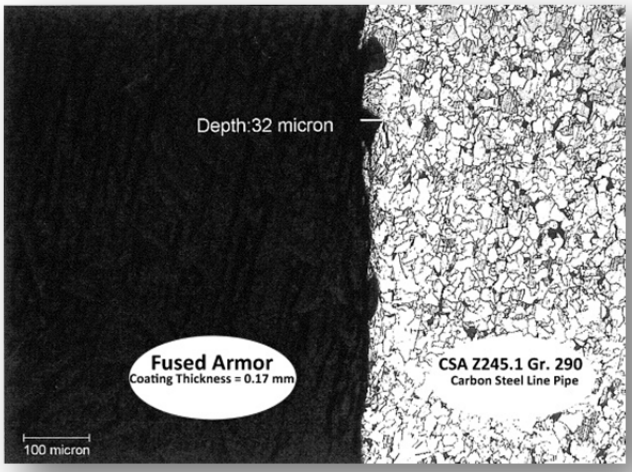
Abrasion test


Corrosion test


Ductility test


Strength test

heated, and imperfections in the metal are expanded the nano-components then fill all the spaces in the metal. Thereafter, when the metal is cooled, the voids are filled and the hard impermeable shell is formed which keeps the metal is under a constant state of compression. There is no other metal protection system available that offers this type of long term protection for metal substrates. The 100 times magnification photomicrograph to the right demonstrates that there are no voids between Fused Armor and the steel that is clad.



Pipelines owners and manufacturers should discuss and adopt best practices when maximizing the life and operating efficiencies of new pipeline routes and delivery methods.

Fused Armor, Inc. is selecting experienced and accredited applicators with whom to license its patented technology for use internationally. For those interested in additional information on third-party testing and application opportunities, please explore the Fused Armor website at www.fusedarmor.com.