Industrial Pipeline Integrity Management & Remote Polyurea Pipe Lining Systems.

Aging pipeline infrastructure and industry's inability to evaluate and inspect has left many engineers and plant managers looking for solutions. Up until recenly pipeline integrity management has had a low priority while serious issues have been passed on for this generation of managers to solve. Responding to heightened awareness of the significant environmental, safety and economic consequences of corrosion and erosion of pipelines, industry has finally begun to look for answers. The good news is private companies have responded with some innovative and cost effective solutions.

Pipeline corrosion and failure is an environmental safety issue, it is an economic issue and it is a job retention issue. Pipeline Corrosion waste resources, results in environmental contamination and costs jobs. Companies find it less expensive to outsource overseas than to maintain facilities in the United States. Though there has been a great breakthrough the chemical engineering of adhesives and coating materials to extend and repair pipelines there has not been a practical way to apply these materials to pipelines while in service.

It has only recently has a remote relining system been developed to offer industry an effective way of delivering these new hybrid polyurea materials.

Deferred maintenance and poor planning has resulted in the current generation of plant managers and engineers having to deal with issues that were not thought about 30 years ago when pipelines were installed. Budget line items did not take into consideration the possibility of catastrophic failure or major breaks. Until just recently most industry has been in a band-aide mode, putting out fires when a serious problem finally forces action.

History

During the mid 1990's Polyurea application companies were very interested in changing their market strategy to focus on the pipeline rehabilitation. They were looking to develop a system that would provide improved performance characteristics over those of the leading treachless industry technology know as Cured in Place Piping, (CIPP). One of the first applications using polyurea lining involved a major automobile manufacturer in the Detroit area. Many of these older plants had old storm sewer systems with environmental concerns. Their primary concern was the infiltration of Polychlorinated Biphenyls (PCB's) from plant waste that had leached into the ground over the years. These storm systems contained reinforced concrete pipe (RCP) with diameters from 30" to 48". A number of these storm drains had been previously rehabilitated with CIPP. However due to the nature of the thermosetting resin used in the process radial shrinkage occurred during the curing process and created a void between the host pipe and liner. The existence of this annulus negated any beneficial effects of the CIPP lining process as it provided a path for the PCB's in the groundwater to backtrack between the liner and host pipe. This condition continued to allow PCB contaminated ground water to flow back into the uncontrolled environment.

In order to correct this condition, a methodology was developed to utilize a combination of a packing cord, stainless steel retaining bands and a semi structural polyurea in a multi layered configuration.

This method when implemented per the technical specification requirements successfully provided rehabilitation to effected storm drains and attenuated the infiltration of PCB's into the environment. This successful implementation of using Polyurea technology for pipeline rehabilitation is what spurred the initial ideas of Mr. Kent Weisenberg to develop the current remote lining device that Dallas 1 Rehabilitation Solutions calls "RASR", (robotically applied spray rehabilitation).

The CIPP installation companies were generating huge revenues for a system that basically had several intrinsic flaws and fundamentally did not work. Mr. Weisenberg's extensive background in polyurea and its versatile application potential, led to the possibility to develop a system that had the ability to rehabilitate pipelines without all the inadequacies of the current trench less methods.

Market Necessity

A 2002 study of the US infrastructure needs by the Environmental Protection Agency confirmed that the buried transmission and distributions pipeline system is in imminent and extensive need of rehabilitation. As the infrastructure reaches the end of its design life, renovation and replacement industries servicing this requirement shall continue to grow. *Currently $80 billion per annum is spent in the US on pipeline renovation.*

The cost of pipeline remediation is not just measured by the direct cost of the intervention, but additionally by indirect economic impact of disrupted traffic, plant close downs, reduced production and consequent cost to business. It is estimated that this economic impact is nearly twice as expensive as the actual remediation.

Pipeline infrastructure systems worldwide are starting to fail with increasing regularity. Over the last century, various support systems providing essential services such as drinking and wastewater have been developed. These pipelines have been buried under a growing surface of infrastructure and are now rapidly reaching the end of their design lives. Conventional repair or replacement of such systems results in significant disruption of surface facilities, such as road, building, and manufacturing plant closers.

The ‘Trenchless Technology’ industry came to prominence in the mid 1970’s when a British company Insituform invented a process called Cured in Place Pipe (CIPP). The process involves the insertion of a felt sock, which is impregnated with resin) polyester or epoxy). The resin sets, usually by using elevated temperatures and forms a structural composite pipe inside the original line. Since the mid 70’s CIPP has rapidly developed and is now estimated to be worth around $2 billion per annum.

Trenchless remediation is rapidly becoming the preferred solution, preventing excavation, saves money, takes less time, creates fewer community hazards and can significantly reduce indirect economic costs.

Trenchless remediation is growing its market share in a rapidly growing market and today over 50% of the pipelines are rehabilitated using Trenchless techniques. Remediation and repair is forecast to grow as municipal and industrial operations attempt to maximize the useful life of the original infrastructures.

With significant scientific advances in the polyurea technology a huge market place has been opened up for the remote lining of pipe. With considerable help from the Polyurea Development Association the new area of rehabilitation promises to solve many problems that were not anticipated when much of the current pipeline infrastructure was placed in service years ago.

Design considerations

Below is a summary of the design and challenges encountered in developing the “RASR” (Robotically applied Spray Rehabilitation) remote application system. Please note that this explanation was written to be easily understood as a non technical design and implementation review.

The coating industry is currently designing and utilizes several polyurea formulations in lining applications. The most commonly used formulation is for the structural rehabilitation of fully deteriorated pipe. The load design calculations for these liners are solely based on ASTM F-12 specifications. The current polyurea formulation’s flexural modulus is approximately 400,000 psi. Based on the load equation of this ASTM specification one can see that liners for full remediation of even small diameter pipe requires liner thickness in excess of 500 mils. Wall thickness can be varied according to desired results and life expectancy of the substrate.

The following is a list of current design capabilities.

1. The RASR unit can apply polyurea liners in pipe diameters from 5 inch through 72 inch.
2. RASR can apply any thickness of polyurea from 1/8 inch through 3 inches. This is not contingent on pipe diameter. It is simply controlled by proper calibration of flow/traversing speed/oscillation/reciprocation.
3. RASR can negotiate, while keeping articulating head center line to spray up to 45 degree bends or sages in pipe.
4. RASR can apply polyurea lining with traversing speeds of up to six feet per minute.
5. RASR can apply pure polyurea or hybrid at any desired thickness, with a get time from four to eight seconds.
6. RASR sends video signal for both forward and reverse viewing color cameras to maintain visual inspection of lining process.

7. RASR can facilitate start and stop functions for the application of structural or sealing “sleeves” when pipe is not to be full lined.
8. RASR has the ability to line any spherical pipe, elliptical pipe, CMP and concrete box pipe.
9. RASR can be calibrated to apply a symmetrical liner or can vary thickness on the top or bottom of pipe such as in the case of a severe hydrogen sulfide vapor/sulfuric environments in RCP.
10. Unit has the ability to remotely line stand pipes and vertical piping systems.

Summary:

It is hoped that this paper has provided an informative and interesting review of the current and future development of pipe lining with polyurea. While many challenges were overcame to provide the present level of achievement new ones will always be there as the industry continues to grow this technology in the future. The significant developments discussed in this paper provide the industry with several options with the use of robotics and polyureas as solutions to pipelining and maintenance problems.

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