Liquid Applied Internal Flow Coatings for Oil Transmission Lines

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This paper will examine more closely the benefits to the Industry by lining Oil Pipelines.
Introduction

The application of high performance two component epoxy coatings to internals of pipes, has a track record of over 40 years. Within the Oil and Gas Industry it is taken as standard to internally line any Sweet/ Sour Gas Transmission Lines. The arguments for lining have been won and the sound economical benefits are agreed by everyone. However the same reasons for lining a gas pipe can be made for Oil pipelines as well. In fact, under close scrutiny, these same arguments could be made more vociferously as oil pipelines are transporting a higher viscosity fluid with more friction and abrasion within the pipeline.

Over the next few pages I aim to set out a coherent argument setting out the reasons for internally lining Oil Pipelines.
**The Product:**

There are many different types of lining materials on today’s market –

- Single Coat Epoxy – Solvent Based or Solvent Free
- Multi Coat Epoxy – Solvent Based or Solvent Free
- Polyurethane – Solvent Based or Solvent Free

The most cost effective and efficient product to apply is a **Single Coat Solvent Based Epoxy**. Through experience gained in the gas markets and through testing by independent engineering consultants, a single coat would appear to meet the requirements of the oil industry –

- High Abrasion Resistance
- Teflon like finish
- Ease of Application
- Impact Resistance
- Flexibility
- Good chemical resistance
- Good corrosion resistance

Multi Coat Epoxy – expensive multi handling in pipe coating mill, risk of inter coat contamination, risk of solvent entrapment during coats, increased wastage of product.

Polyurethane – single coat and offers good flexibility, poor impact resistance and low chemical and corrosion protection.
The argument for Lining:

**Improved Flow Efficiency**

Independent testing has shown that an increase in flow efficiency of up to 20% can be achieved by lining an Oil Pipeline. Essentially we are applying a smooth, Teflon like finish to the internal surfaces of the pipe. The measured surface roughness of an applied internal coating ranges from 5 to 15 microns. The surface roughness of an unlined pipe ranges from 35-85 microns. The velocity of the oil being transported, typically 2mtr per second to 2.5mtr per second on an unlined pipe creates turbulence within the product. As the oil becomes more and more agitated by the roughness of the internal surface of the pipe, friction is created. The smooth finish of a lined pipe reduces the friction and helps to smooth the flow of oil.

For example –

NEL (National Engineering Laboratory)
This company performed an independent study on the flow efficiency that could be gained by internally coating an oil pipeline.

The study covered the following areas –
Two viscosities of crude were used
Pumped through a length of pipe at a typical velocity of 2.5 metres per second
The coated pipe was classed as hydraulically smooth
The unlined pipe was commercial steel with an approximate surface roughness of 50 microns
The testing showed that on the lined pipe an increase in flow of 11% was achieved

Conclusion of the report –
NEL assessed the results and concluded that a flow increase ranging from 6% to 20% could be achieved. The test was performed on zero elevation pipe, but even with length and geography of a constructed pipeline taken into account, 6% flow increase was a conservative estimate.
Reduced Pumping Costs
As the friction within the pipe is reduced, the work carried out by the pumping stations is reduced. Through independent studies it has been shown that two options are open to the client when pumping oil through a lined pipe. Reduce the pumping power of the station to achieve the same flow rate of an unlined pipe. Or keep the pumping station at the same pumping rate to achieve a higher throughput of oil.

For Example –
Fell Associates, carried out an independent study on the cost saving on using lined pipe.

Peak Throughput of Oil Pipeline, 500,000 barrels per day
Length, 200km
Diameter, 24 inch
Steel Grade, X70
Elevation, zero elevation change along the pipeline.

Cost of lining the pipe $1 million

The modelling shows clearly the cost savings available to operator and transit country.

- The total power requirement for such a pipeline would be 28MW
- The fuel cost would be $8.5 million per year
- Flow efficiency saving of 6%
- Saving on fuel cost $510,000 per year

(6% flow increase is the lowest figure calculated)
Alternatively,

- Peak throughput of oil pipeline 500,000 barrels per day
- Increase in flow 6%
- New Peak throughput of oil pipeline 530,000 barrels per day

This higher throughput will result in quicker payback for the operator, as more oil is being transported to the customer for the same power consumption of an unlined pipe.

Also, if the pipeline is transporting oil through several countries, a typical charge of $0.20 per barrel is paid to the transit country. A 6% flow increase will result in an extra payment of $6000 per day or $2.19 million per annum.

**Reduced Corrosion During Storage**

Unlined pipe normally has many miles to travel to the construction site. Typically purchased from mills in Japan or Germany. Once purchased it is transported to the pipe coater, where it may sit for many months before being externally coated. Through work in the gas Industry we have seen that it is in this period where the internal surface of the steel pipe can be open to heavy corrosion. If left unlined this corrosion has to be dealt with during commissioning time of the pipeline. An unlined pipe can produce up to 150 tonnes of corrosion debris every 200km. This debris prolongs the commissioning time of the pipeline and the debris has to be disposed of in an expensive and eco-friendly manner. Lined pipe eradicates this problem.

In fact, within the Gas Transmission Line industry many state this reason more than any other, as the main benefit to lining steel pipe. Commissioning time can be reduced by up to 4-6 weeks. This can produce significant savings when looking at pipes pumping 200,000 barrels per day.
Effective Pigging and Scraping
A constant problem during the operation of an oil pipeline is the wax and hydrate build up. This reduces the diameter of the pipe and causes friction between the oil and pipe surface acting as a drag on the flow of product. The Oil industry uses expensive pigging operations to remove the build up of film of these contaminants.

Lined pipe eradicates the reason for removing the wax and hydrate as they are not allowed to build up on the internal surface. Furthermore, the smooth finish of the internal lining has shown to the pipeline operator that they can achieve faster pigging and less frequent scraping, reducing the operating costs of the pipeline.

No need for use of additives and inhibitors
Because a smoother finish has been achieved on the internal surface, the pipe operator can reduce the volume of drag reducing additives into the oil. The benefits to the operator include, reduced running costs for the additives involved, reduced monitoring and reduced pollution problems from the chemicals used and no contamination of the crude oil, which maybe problematical for some refineries.
Summary

The benefits highlighted on the previous pages show that lining Oil pipelines has to be taken seriously by the industry.

Not only does lining offer economic and financial incentives to the pipeline operator/owner but the environmental issues it covers can also be seen to be major benefits.

Reduced energy consumption from reduced pumping costs, which in turn lowers CO2 emissions, can be seen as ways a large multinational company is taken environmental issues seriously. Furthermore through lining an oil pipeline and reducing corrosion debris and its method of disposal, this not only speeds up commissioning time and saves money for the client, but eradicates the headache of what to do with the large corrosion build up. A reduction in use of chemicals such as additives and inhibitors can again been seen as an environmental benefit, the quantity manufactured, used and disposed of will in time and during the duration of the pipes life, been seen as operating costs saved + cleaner environment.

The future for the Oil and Gas Industry is not only to be measured in cleaner hydrocarbons and delivery of these new products, but in the greener methods adopted to deliver these products into the market place. Lining an oil pipeline may not be the answer to the industries prayers, but put together in a collective of greener measures, lining does deliver, a faster, safer, greener and a more efficient product to the market.