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The Investigation of Internal Coating for Natural Gas Pipeline

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Internal coating applied on natural gas pipeline not only can prevent the pipelines from internal corrosion, but also can greatly decrease the roughness of internal surface of the pipeline so that the gas flowing resistance would be reduced and the gas transmission efficiency could be improved largely. In order to meet with the requirement of western gas pipeline projects, a internal coating material special for reducing transmission resistance of gas pipeline has been developed by my Institute. A stimulating test equipment show that transmission efficiency of pipe with special internal coating can be 15.3% more than that of steel pipe without coating.

Keywords : *internal coating, natural gas, pipeline, epoxy*

1. Introduction

Internal coating applied on natural gas pipeline not only can prevent the pipeline from internal corrosion, but also can greatly decrease the roughness of the pipeline internal surface so that the gas flowing resistance would be reduced and the gas transmission efficiency could be improved largely.

Since 50's the internal coating for natural gas pipeline has been used in many countries,[1] but by now not in China. Thought about economy benefit, internal coating for natural gas pipeline will be applied.[2] In order to meet with the requirement of West to East Gas Transmission pipeline project, a kind of domestic internal coating material special for reducing transmission resistance of gas pipeline has been developed by my Institute.

2. The development of coating

The action of binder is very important in any coating, and the epoxy resin is an excellent binder of internal coating for natural gas pipeline, as in most such foreign coatings, since epoxy resin coatings have some excellent properties, such as excellent adhesion, abrasion performance and anti-corrosion property, as well as low volume shrinking rate and thermal expansion. Therefore, we selected five kinds of epoxy resin with different molecular weight, and made comparing experiments. According to the results in Table 1, the 5# epoxy resin was selected to test the coating composition.

Since the type and dosage of curing agent could obviously affect the coating properties, especially the heat resistance of the common epoxy resin, one important way of the research is the selection of the curing agent. We chose three kinds of epoxy curing agent, including aliphatic amine' aromatic amine and polyamide. According to the results of comparing experiment shown in Table 2, the 3# curing agent was selected to test coating composition.

Table 1. The coatings properties of different epoxy resin

Property item	1#	2#	3#	4#	5#
Flexibility, mm	4	4	1	2	1
Adhesion, class	3	2	1	1	1
Impact resistance, cm	30	30	40	50	50
Resistance to water	Blister after 24h	Blister after 34h	Blister after 16h	Blister after 22h	Blister after 80

Table 2. The coatings properties of coating with different curing agent

Property \ Curing agent	1#	2#	3#
Flexibility (mm)	1	2	1
Adhesion (class)	1	0	0
Impact resistance (cm)	50	50	50
Thermal resistance (250℃, 30min)	Adhesion 0	Adhesion 1	Adhesion 0

Because the thickness of internal coating is very thin, commonly 50~80 μm, to ensure the smoothness of the coating, the standard requires the fineness of coating to be below 50 μm. To improve the quality and service life

of the internal coating, the abrasion resistance of the coating is a key property. After selecting some wearable filler and adjusting their size, the abrasion resistance of the coating is improved, without affecting the smoothness of the coating. The precipitation of pigment and filler in shelf time could directly affect the quality of the coating. Proper anti-sediment agent and deflocculating agent will help the coating keep stable in a long period, without changing the fineness of the coating obviously.

3. The physical and chemical properties of the coating

At last we developed the natural gas internal coating, named AW-01. The properties of AW-01 coating and film can meet with the API Standard RP5L2-87 "Recommended Practice for Internal Coating of Line Pipe for Non-Corrosion Gas Transmission Service". Because of the coating's heat resistance in short time, the internal coating can be applied both after external coating and before external coating.

AW-01 internal coating for natural gas pipeline is an air curing coating with two components. The cured coating surface is very smooth and very low profile. The physical and chemical properties of the coating are shown in Table 3.

Table 3 The physical and chemical properties of the AW-01 coating

Test item	Technical specification	Test standards
Solid content (%)	Min.50	GB1725
Surface dry time (h)	Max. 4	GB1728
Through dry time (h)	Max. 24	GB1728
Fineness (μm)	Max. 50	GB1724
Adhesion (class)	0	ASTM D3359
Impact resistance (cm)	50	GB1732
Bend (1.27cm)	pass	ASTM D522
Hardness	96	GB9275-88
Abrasion resistance ($10^{-3}m^3/\mu m$)	Min. 29	ASTM D968
Thermal resistance (250℃, 30min)	Intact	test
Salt fog resistance (1000h)	Intact	ASTM B117
Flexibility (mm)	1	GB1731
Gas blistering	pass	API RP5L2
Hydraulic blistering	pass	API RP5L2
Water immersion	pass	API RP5L2

4. The transmission efficiency evaluating test

The simulating test equipment was designed to evaluate the transmission efficiency of gas in pipes with different internal surface condition including titled special internal coating, common anti-corrosion coating and steel without any coating. The simulating tests have been done by the National on-flow Lab in Peking University, and it is the first time to test the transmission efficiency of gas pipeline coating in Lab. The test simulates the situation of field and measures the decrease of pressure and gas flowing velocity with some advanced test instruments, and the test results show that the average surface profile of special internal coating is 5.5 μm while that of steel surface without any coating is 45 μm. It has been shown that transmission efficiency of pipe with AW-01 internal coating can increase 15.3% compared with that of steel pipe without any coating, or increase 2.0% compared with that of steel pipe with common anti-corrosion coating. Correspondingly, the coefficient of friction decreases 26% and 3.9%. The following fig. 1 shows the test field in Peking University.

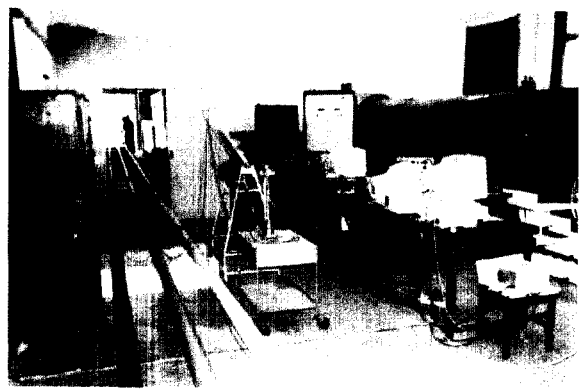

Fig. 1. The stimulating test equipments in Peking University

5. The application

To evaluate the transmission efficiency of gas in field pipeline with AW-01 internal coating, we are carrying out a industry test in Dagang-Changzhou gas pipeline, by comparing the efficiency between a pipeline segment with AW-01 internal coating and another segment without any internal coating. After the whole coating has been applied, we examined the performance of the coating, including adhesion, thermal resistance, bend, blistering, immersion and roughness. The results show that the quality of coating is excellent. Now the internally coated

pipeline has been transported to the field. The evaluation work of the transmission efficiency will be finished after the pipeline will be constructed.

6. Summary

Internal coating can greatly decrease the roughness of the natural gas pipeline internal surface so that the gas flowing resistance would be reduced and the gas transmission efficiency could be improved largely. In order to meet with the requirement of western gas pipeline projects, a domestic internal coating material special for reducing transmission resistance of gas pipeline has been developed by my Institute. The testing results showed the coating has excellent properties. The cured coating surface is very smooth and very low profile. Because of the coating's heat resistance in short time, the internal coating can be applied either after external coating or before external coating. With the accelerating development of natural gas exploration and utilization, the internal coating technology of pipeline will be used more and more in natural gas pipelines in China, such as in the project of West to East Gas Transmission Pipeline.

References

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