Experimental Study on the Peeling Characteristics of Wax on the Surface of Flexible Composite Pipe and Plastic Alloy Tube

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Abstract. In this paper, the wax deposition stripping experiment on the surface of flexible composite tube and the surface of plastic alloy tube was carried out by using medical paraffin. Under different temperature and different thickness of wax, the peeling force of wax on the surface of flexible composite pipe and the surface of plastic alloy pipe lining was discussed. The experimental conclusions of this study are specific guidance for wax cleaning technology in nonmetallic pipes and device design.

1 Introduction

Corrosion of metal pipelines has always affected the stable and safe operation of oil and gas field ground engineering, and is one of the important reasons that restrict the rapid development of the petroleum industry. Nonmetallic pipes has excellent corrosion resistance and hydraulic characteristics. It has the advantages of smooth inner wall, low friction, low energy consumption, no need for cathodic protection, long service life and good economic benefits. It has been widely used in the petrochemical industry at home and abroad.

At present, the non-metallic pipelines used in oil fields mainly include high pressure fiberglass pipes, steel skeleton polyethylene plastic composite pipes, continuous reinforced plastic composite pipes and plastic alloy composite pipes.

Although non-metallic pipelines play a major role in oilfield water injection and oilfield gathering and transportation production. Since crude oil contains a certain amount of wax, in the process of pipeline transportation, oil layer adhesion, wax deposition and scaling will occur on the inner wall of some non-metallic pipelines. resulting in the back pressure of the oil collection and single well pipelines increased, the crude oil production decreased, lack of injection of injection wells, and the maintenance cost increased.

Regarding the waxing mechanism and anti-wax technology of crude oil in metal pipes, many scholars have conducted in-depth research and obtained a lot of research results [1]-[10]. However, there are relatively few studies on the waxing mechanism and anti-wax technology of crude oil on the surface of non-metallic pipes. The existing researches focus on the research of wax coating on the inner surface of metal pipes [11]-[15]. Therefore, it is necessary to study the wax deposition characteristics of the inner surface of non-metallic pipes. Reasonable selection of pipes, improve the reliability and availability of pipelines, and ensure the normal production of oil fields.

The adhesion strength of a substance(coating) on a solid surface (surface of the object to be coated) is caused by the combination of the polar group (like carboxyl group, hydroxyl group) of the polymer in the coating film with the polar group on the surface of the object to be coated. Any factor that reduces the binding of such polar groups will result in a decrease in coating adhesion. Therefore, the factors affecting the adhesion of wax on the surface of non-metallic pipes are temperature, wax layer thickness, sample surface cleanliness, and surface roughness of sample, etc. This paper mainly explores the effect of temperature and wax deposition thickness on stripping strength (adhesion) of non-metallic pipes.

2 Experimental samples and conditions

2.1 Experimental sample

The experimental wax sample is medical sliced paraffin (melting point 52°C-54°C), thickness is 1mm, 2mm, 3mm, 4mm; the test piece is the lining surface of flexible composite pipe and plastic alloy pipe, the effective stripping area is 2.55cm^2.

2.2 Experimental temperature

Experimental temperature: 20℃, 25℃, 30℃, 35℃, 40℃, 45 ℃, 50℃.

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2.3 Experiment Instrument

Experimental equipment: ZQ-990LA electric tensile testing machine.

3 Experimental results and discussion

3.1 Effect of paraffin film thickness on stripping strength

The experiment used lining surface of flexible composite pipe and plastic alloy pipe as the test object, using different Paraffin thickness, tested the surface stripping strength change under different temperature conditions, as shown in Figure 1 and Figure 2.

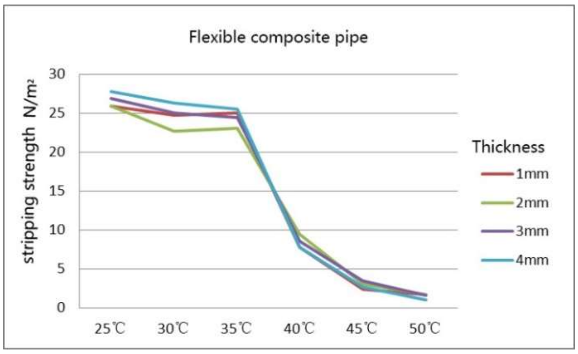

Figure 1. Relationship between peeling force of wax film with different thickness on the surface of flexible composite pipe lining with temperature

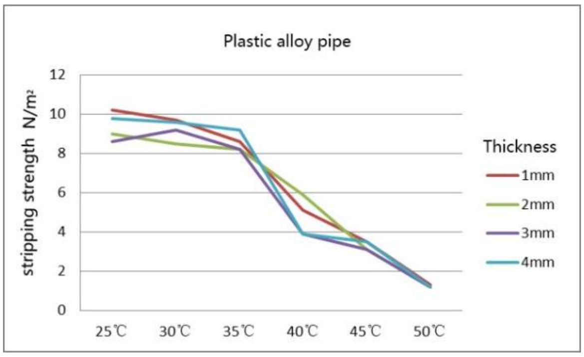

Figure 2. Relationship between peeling force of wax film with different thickness on the surface of plastic alloy tube lining with temperature

It can be seen from the figure that whether it is a lining surface of a flexible composite pipe or a plastic alloy pipe, the influence of different paraffin thickness on the adhesion of the paraffin is substantially the same at different temperatures, and the thickness is different, the adhesion difference is small. The above indicated the thickness has little effect on the adhesion, and after the temperature exceeds 43℃, the thickness of the paraffin film has almost no effect on stripping strength.

3.2 Effect of material properties and temperature on stripping strength

Figure 3 shows the stripping strength of paraffin film deposited on the inner surface of flexible composite pipes and plastic alloy pipes at different temperatures.

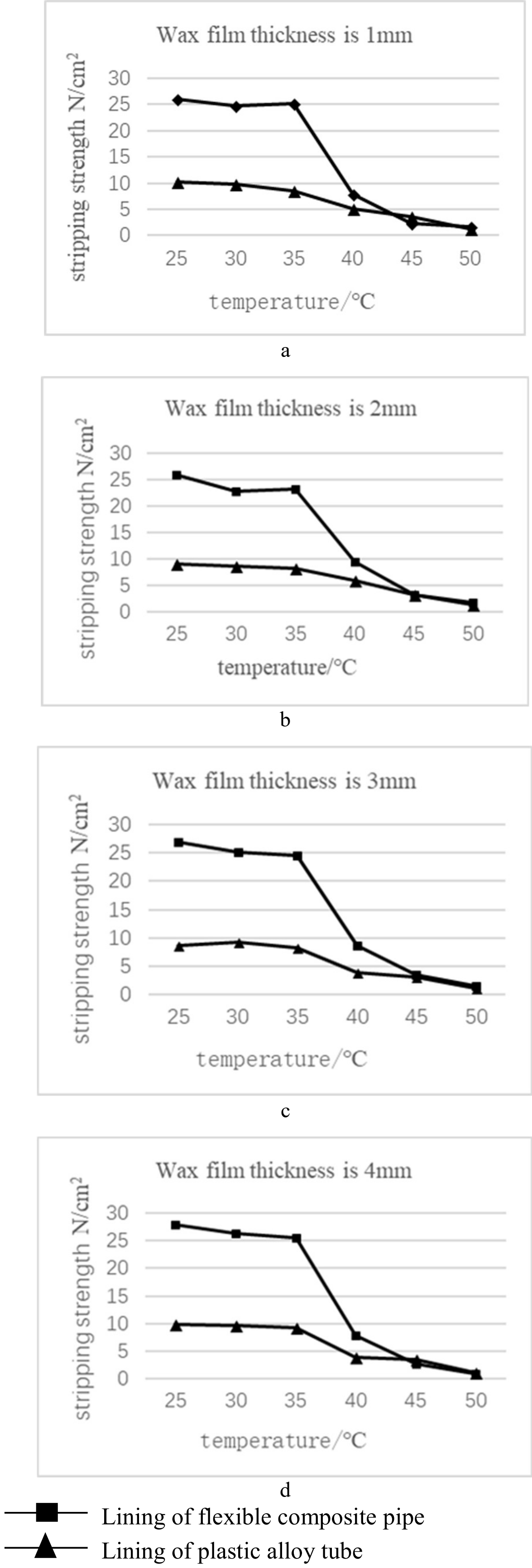

Figure 3. Relationship between stripping strength of lining surface of two non-metallic pipes and temperature

It can be seen from the figure 3 that for the same non-metallic material, the stripping strength of the paraffin and non-metal lining surface changes little between 25℃ and 35℃ under the same thickness. And between 35℃and 50℃,the stripping strength of the paraffin and nonmetallic lining surface drops rapidly. The melting point of the paraffin used in this experiment is between 52℃ and 54℃, indicating that the paraffin attached to the surface of the non-metallic pipe will rapidly drop when the temperature is close to the melting point.

The paraffin stripping strength on the inner liner surface of the flexible composite pipe is greater than the paraffin stripping strength on the inner liner surface of the plastic alloy pipe at 25℃ to 35℃; the different of the paraffin stripping strength on the surface of each non-metallic pipe between 40℃and 50℃ is small，and numerical value is small.

4 Conclusion

Through the wax stripping test, the influence of the thickness and temperature of the wax on the peeling force of the wax on the inner liner surface of the non-metallic pipe was obtained. The following conclusions were drawn from the experiment:

(1) Whether it is a flexible composite pipe or a plastic alloy pipe, the influence of the thickness of the wax on the wax stripping strength is almost the same at different temperatures. And the thickness is different, less difference in adhesion, indicating that the thickness has little influence on the adhesion.

(2) Under low temperature conditions, the stripping strength of the wax on the surface of the non-metallic pipe lining changes little，while the stripping strength of the wax decreases rapidly between 40℃ and 50℃. After the temperature exceeds 43℃, the thickness of the wax film has almost no effect to the stripping strength.

(3) Under low temperature conditions, the wax stripping strength on the surface of the flexible composite pipe lining is larger than that of the plastic alloy pipe.

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