Experimental study on the peeling characteristics of wax on the surface of plastic alloy pipe and glass steel pipe

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Abstract. Plastic alloy pipes and glass steel pipes are two widely used non-metallic pipes. In this paper, sliced paraffin was used to perform waxing and peeling experiments on the lining surfaces of two types of pipes, investigating the effects of temperature and wax thickness on the surface peeling force of two types of pipe line. This experimental study has certain guiding effect on the selection of non-metallic pipes and the design of the wax removal device.

1. Introduction

Non-metallic pipelines have excellent corrosion resistance and hydrodynamic properties, and have been widely used in domestic and foreign petrochemical industries, gradually replacing some steel pipes to become oilfield production pipelines. Plastic alloy pipe and glass steel pipe are two kinds of non-metallic pipes that are widely used.

In China, the development of glass steel pipes in oil fields started in the 1970s and has a long history of development. It is the earliest non-metallic pipeline that was put into oil fields in China. At present, it is mostly used in oil field drainage, single well gathering and long-distance natural gas transmission [1]. Although plastic alloy pipes started relatively late in China, the industry or enterprise standards related to plastic alloy pipes have developed rapidly in recent years, and related technologies have continued to mature and improve, taking Xinjiang Oilfield as an example, the length of plastic alloy pipes accounts for 58.68% of the total length of all non-metallic pipes, and it is applied to oilfield water injection and crude oil gathering and transportation [2]. It has been found in practical applications that the problem of waxing of pipelines is an important problem restricting the application of non-metallic pipes. Whether it is reducing the effective area to cause blockage or increasing the transmission pressure to make it difficult to restart the pipeline, it will have serious consequences and cause great economic loss [3, 4]. The study found that temperature, thickness of the wax layer, surface cleanliness of the sample, and surface roughness of the sample were the main reasons affecting the peeling force of the wax on the surface of the pipe [5-6]. At the same time, with the rapid development of plastic alloy pipes and glass steel pipes in recent years, the importance of selecting pipes according to different environmental and transport medium conditions on the field has also been valued. Therefore, this paper takes temperature and wax thickness as experimental variables, and discusses their influence on wax peeling force of two non-metal pipes, this experiment is conducive to the reasonable selection of materials in the oilfield, improving the on-site adaptability of the pipeline, increasing production,
reducing maintenance, extending the life of the pipeline, and maintaining efficient and safe production in the oilfield.

2. Experiment content
This article uses ZQ-990AL electric tensile testing machine, respectively, at 20℃, 25℃, 30℃, 35℃, 40℃, 45℃, on the plastic alloy pipe lining and glass steel pipe lining, with 1mm, 2mm, 3mm, 4mm sliced paraffin (melting point 52℃~ 54℃) for peeling force measurement.

The peeling force $\sigma$ (N / cm2) is the tensile machine load force $F$ (N) divided by the cross-sectional area of the wax layer when the wax layer on the surface of the material is damaged:

$$\sigma = \frac{F}{A}$$

3. Experimental results and discussion
The experimentally measured data of plastic alloy tube and glass steel tube at different temperatures and thicknesses are shown in Figures 1 and 2.

Figure 1. Peeling force of wax layer of plastic alloy pipe lining

Figure 2. Peeling force of wax layer of glass steel pipe lining
The influence of temperature on the peeling force of the wax layer of plastic alloy pipes shows different characteristics in different temperature ranges. Between 20°C and 25°C, the effect of temperature on the peeling force is small. Only the wax layer with a thickness of 3 mm shows a tendency to decrease with increasing temperature. Between 25°C and 35°C, the peeling force of wax layers of different thicknesses decreased with increasing temperature, and the decline trend was the same, with a faster decline rate. Between 35°C and 40°C, the peeling force of the wax layer hardly changes with temperature. Between 40°C and 45°C, the peeling force of the wax layer decreases slightly with increasing temperature.

The influence of temperature on the peeling force of the wax layer of glass steel pipes also shows different influence trends in different temperature ranges. Between 20°C and 25°C, the peeling forces of the wax layers with four thicknesses all decreased with increasing temperature, but the decrease was very small. Between 25°C and 35°C, the peel force of wax layers of different thicknesses decreased rapidly with increasing temperature. Between 35°C and 40°C, the peel force of a 1 mm wax layer decreases slightly with increasing temperature, and the peel force of other thickness wax layers hardly changes with temperature. Between 40°C and 45°C, the peeling force of the wax layer decreases slightly with increasing temperature. On the whole, under the same thickness, the temperature has the same effect on the peeling force of the wax on the two pipe materials, both of which have a downward trend with increasing temperature, and have a greater impact between 25°C and 35°C, and the effect is not obvious in other temperature ranges. The effect of the thickness on the peeling force of the wax layer of plastic alloy pipe is more complicated, showing different characteristics in different temperature ranges. Between 20°C and 30°C, the thicker the wax layer, the greater the peeling force. Between 30°C and 35°C, the relationship between the peeling force and the thickness of the wax layer is 4mm>3mm≈1mm>2mm, and the peeling force of the 4mm wax layer changed from slightly greater than 1mm wax layer, and gradually increased to slightly less than 1mm wax layer with increasing temperature. Between 40°C ~ 45°C, the relationship between the peeling force and the thickness of the wax layer is 4mm>3mm>2mm>1mm, and the peeling force of the 4mm wax layer changed from slightly greater than 1mm wax layer, and gradually increased to slightly less than 1mm wax layer with increasing temperature. Between 45°C and 50°C, the relationship between the peeling force and the thickness of the wax layer is 1mm>4mm≈2mm>3mm. The effect of the thickness on the peeling force of the glass steel pipe wax layer is relatively intuitive. Between 20°C and 30°C, the thicker the wax layer, the greater the peeling force. Between 30°C and 35°C, the relationship between the peeling force and the thickness of the wax layer is 4mm=3mm=2mm>1mm. Between 35°C and 45°C, the relationship between the peel force and the thickness of the wax layer is 4mm=3mm=2mm>1mm.

4. Conclusion
(1) At the same thickness, the effect of temperature on the peeling force of wax on the two pipe materials is similar, and both of them decrease with increasing temperature.

(2) Under low temperature conditions, the peeling force of the wax and the two non-metallic pipe linings changes little. The peeling force of the wax decreases rapidly with increasing temperature between 25°C and 35°C. After the temperature exceeds 35°C, the tendency of the peeling force to change with temperature becomes slow.

(3) At low temperature, the peeling force of wax on the inner surface of plastic alloy pipe is greater than that of glass steel pipe.

(4) For the inner surface of a plastic alloy tube, the effect of the thickness of the wax layer on the peeling force is more complicated and changes with temperature, indicating that the effect of temperature on the peeling force is greater than the thickness.

(5) For the inner surface of glass steel pipe, the thickness of the wax layer is proportional to the peeling force, and the effect of thickness becomes smaller and smaller as the temperature increases, indicating that the temperature has a greater effect on the peeling force.
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