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The Effect of Ultrasonic Oscillations of Pipe on Fluidity of Heavy Oil Products

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ABSTRACT

The phenomenon of statistically significant decrease in static limit of fluidity (normalized to background temperature) of heavy oil product M-100 is found in near-wall layer of rotating pipe. This effect is induced by shear ultrasonic oscillations of the pipe with the frequency of 25 kHz. The phenomenon is revealed by means of modeling laboratory installation where temperatures were in a range from -13^{o}C up to -17.5^{o}C. The value of the effect is about 19% under acoustic power of ultrasonic oscillations of an order 0.002 W/cm^2. This effect represents practical interest in decreasing extreme starting loads on pumps of technological pipelines especially in polar or pre-polar winter conditions. The result may be also important for crude mineral oil pipeline transportation from polar and pre-polar fields.

KEY WORDS: Heavy oil products, fluidity increase, winter temperature, pipeline transportation, ultrasonic influence, laboratory installation.

INTRODUCTION

Heavy oil products, in particular, furnace fuel oil, are transported in the technological pipelines of tank farms and thermal power stations. A problem is the weak fluidity of heavy oil products, especially at low ambient temperatures, when they become jelly-like. This problem is very important for polar conditions.

Special problems arise at starting modes when heavy oil products, at least, in a near-wall pipe layer undergo transition from elastic to fluid status. Usually a steam heating is applied to increase fluidity, however this technology is very energy consuming and ineffective owing to high insulating properties of heavy oil products.

A number of studies were devoted to investigation of mechanical oscillations influence on oil fluidity. Lionetto et al. (2007) observed decreasing oil gelation under increase in intensity of ultrasonic oscillations. Mironov et al. (2002) showed an effect of double decrease in flow resistance in oil at temperatures nearby -7^{o}C by means of creation of shear ultrasonic oscillations in wall of pipeline. Thus, the effect of acoustic influence on fluidity of mineral oil with a temperature of fusion up to 29^{o}C was confirmed experimentally.

The aim of the study is application of an acoustic method to heavier oil products (fusion temperature near 40^{o}C) at lower ambient temperatures of about -15^{o}C.

MATERIALS AND METHOD

Laboratory installation is developed according to Korenbaum and Tagiltcev (2011). It contains a capacity for oil product (Fig. 1). The rotating acoustic unit is suspended in it by means of an external support. This unit contains the metal branch of pipe with piezoceramic rod placed at its top end.

Figure 1. Photo of appearance of the laboratory installation.