



# Simulation analysis of thermal influential factors on crude oil temperature when double pipelines are laid in one ditch



Hongjun Zhu <sup>\*</sup>, Xiaolu Yang, Jiajia Li, Na Li

State Key Laboratory of Oil and Gas Reservoir Geology and Exploitation, Southwest Petroleum University, Chengdu 610500, People's Republic of China

## ARTICLE INFO

### Article history:

Received 2 September 2012  
Received in revised form 21 April 2013  
Accepted 21 April 2013  
Available online 10 June 2013

### Keywords:

Crude oil  
Double pipelines  
Temperature field  
Thermal influential factor  
Numerical simulation  
Computational fluid dynamics (CFD)  
Ambient temperature

## ABSTRACT

Crude oil pipeline laid with products pipeline in the same ditch is a new technology to save investment and protect environment. In order to provide reference to construction and operation optimization, the majority of this paper investigates the thermal influential factors affecting the crude oil temperature in double pipelines system using the computational fluid dynamics methodology. A two-dimensional rectangular region including the two pipelines is selected as computational domain in this investigation. Heat transfer models are proposed to obtain the temperature field distribution and the crude oil temperature drop. The impacts of pipeline interval, crude oil temperature at the outlet of heating station, diameter of crude oil pipeline and atmosphere temperature have been reasonably captured and analyzed in details.

© 2013 Elsevier Ltd. All rights reserved.

## 1. Introduction

In the last few years, a new pipe-laying technology, laying a crude oil pipeline and a products pipeline in one ditch, has been used in China in order to save excavation investment and protect environment [1,2]. In western China, more than one thousand kilometers of crude oil pipeline and products pipeline were laid in one ditch, which is the first and only application of this technology in long distance oil transportation in China until now. The main reason for restricting the promoted application of this technology may be the changes of temperature field distribution and crude oil temperature drop, which are key parameters for safe transportation, energy consumption and economic investment.

The majority of crude oil extracted in China is either waxy oil with high pour point or high viscosity oil, which brings about enormous pressure-drop consumption. One effective method adopted in transportation is heating the crude oil to a certain temperature at heating station. While the temperature of crude oil decreases along the pipeline due to heat transfer with external environment. So heating stations should be constructed in appropriate positions along the pipeline to keep the temperature of crude oil being above the pour point all the time. Great energy consumption and construction cost are the chief disadvantages of heating transportation [3–6].

If the new pipe-laying technology accelerated the crude oil temperature drop, higher temperature would be reached at heating station or more heating stations would be constructed. It may lose the original purpose of cost savings. Therefore, it is meaningful to investigate and gain a deep understanding of thermal influential factors on crude oil temperature drop when double pipelines are laid in one ditch, and it is important to provide technical support to ensure operation safety and at last, really save energy and investment.

Extensive studies have been carried out to investigate the thermal characterization of hot crude oil pipeline [7–12], while few researches are about double pipelines laid in one ditch. Ling et al. [13] and Yu et al. [14,15] had simulated the temperature field of double pipelines system and analyzed the effect of pipeline interval and diameter combination on thermal impact. However, there are several points in their studies that do not conform to the actual conditions. Firstly, coupled heat transfer presents between crude oil and soil, which includes convective heat transfer between oil and the inner wall of steel pipe, heat conduction between the inner wall and outer wall of steel pipe, heat conduction between the inner wall and outer wall of insulating layer, heat conduction between the inner wall and outer wall of corrosion protective covering, and the heat emission between the outer wall of corrosion protective covering and the soil. So neglecting the heat conduction in insulating layer is unreasonable, which plays an important role in temperature drop. Secondly, the physical characteristic of crude oil changes with temperature, especially the viscosity, which cannot be seemed as unchanged in transportation.

<sup>\*</sup> Corresponding author. Tel.: +86 28 83032206.  
E-mail address: [ticky863@126.com](mailto:ticky863@126.com) (H. Zhu).



متن کامل مقاله

دریافت فوری ←

**ISI**Articles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات