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Empirical Study of Dynamic Properties of Nano Oil in a Vertical Tube; Simulated as a Vertical Well

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Abstract

The operational conditions selected in the oil industry depend on the process oil features. Being aware of the oil flow behavior in different pressures and temperatures is necessary for oil producing from different fields. In fact, The Ferric dioxide (Fe_2O_3) is used for evaluation of dynamic properties of nano oil. The experimental set up includes mixing tank, adiabatic tube test section and electrical heater is used to survey the behaviour of nano crude oil. Ultimately, the Reynolds number, Prandtl number, Peclet number and Stanton number as basic equations are evaluated in this study. The experimental show decrease trend in Reynolds number is obtained for simple oil through the 0.3 m length of pipe from 1276 to 1164. For nano oil the decrease trend of Reynolds number is somehow slight from 1807 to 1789. Moreover, the decrease trend of prandtl number is obtained for both types of nano oil and simple oil. The values of prandtl of nano oil changes from 106 to 101 and for simple oil changes from 112 to 103. In addition, the values of peclet number for nano oil changes from 188431 to 177781 and for simple oil changes from 181034 to 166720 through the length.

Keywords

Rheology, Crude Oil, Heat Properties, Ultra-sonic, Nano Particles

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1. Introduction

These days' energy considered as one of the fundamental human requirements [1-3]. Energy taken into consideration as the vital requirement of an industry, production of foodstuffs, and agricultural productions [4]. So, that the human dependence on energy is unavoidable and that's while the major percentage of the world energy is supplied through the fossil fuels, the fuels that their utilization, unavoidably, on one hand has damages for the human health, and on the other hand has damages to the machinery and installation of the various applying industries [5-7]. Here it is useful to take a brief look at the types of the fossil fuels and their history [6-9]. The fossil fuels are the ones obtained from the fossils [10-12]. The fossil fuels are categorized to three major fuels, embodying coal, oil and natural gas [13-15]. All three groups started to forming hundred thousand years ago even prior to appearance of the dinosaurs, the time period that these fuels started to forming is the so-called "Carboniferous", which has been part of the Paleozoic period [16]. Carboniferous has taken its name from Carbon element, which is the most important constructing element of the coal and other fossil fuels [17-19]. The reason that they are called fossil fuels is that, in years gone by, the land was full of marshes, covered with the enormous trees, ferns, and other plants, once the trees and plants were dying, submerged deep in the oceans and were gradually being buried, therefor the sponge shape layer, the so-called peat used to be formed [20]. After

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hundred years, peat was covered by sand, soil, clay, and other mineral materials and these mineral materials used to gradually convert to the sedimentary rocks [21]. The more layers accumulated, the more would be the weight, and the peat would be pressed as far as its water would be draining and after millions of years converted into the coal, oil and natural gas [22]. The different types of the cited fossil fuels have had various application levels in the daily life, work, and industry, according upon the progression level of technological knowledge and mankind capability in the exploration, exploitation, and their utilization in different times [23]. But, obviously these days the utilization of oil and gas is far more and more extensive than coal [24]. Oil also is one of the fossil fuels, which has originated three hundred million years ago, some scientists believe that the origin of oil is aquatic organisms, each one in the size of needle tip and they can act exactly like the green plants, which means convert the sun light to the stored energy in their bodies [25]. These creatures submerge at the bottom of a sea and gradually buried under the sedimentary rocks, thereafter stones and rocks press these tiny creatures and therefore the energy in their bodies can't be exhausted, thus Carbon gradually converted to the oil through the heat and intense pressure [26-28].

The nano Ferric dioxide (Fe_2O_3) is used for evaluation of dynamic properties of nano oil. The experimental set up includes mixing tank, adiabatic tube test section and electrical heater is used to survey the behaviour of nano crude oil. The Reynolds number, Prandtl number, Peclet number and Stanton number as basic equations are evaluated in this study.

2. Materials and Method

The API of crude oil is about 30. therefore, the experiments are done with medium crude oil. Moreover, the Ferric dioxide (Fe_2O_3) is a transition metal oxide that has long been known to be active for hydrocarbon decomposition and has more recently shown to display high reforming activity for various long-chain Hydrocarbons. Researches showed that Fe_2O_3 is highly active for reforming isooctane via partial oxidation.

2.1. Experimental Setup

The experimental set up includes mixing tank, adiabatic tube test section and electrical heater is used to survey the behaviour of nano crude oil.

2.2. Investigation of Rheology of Stream

There are different methods and equipment for measuring the rheological properties of a fluid. For crude oil the most common way is by using a Fann 35 Viscometer.

2.3. Experimental Correlations for Calculating of Heat Transfer

The laboratory measurements have usually determined the relationship for heat transfer between a flowing fluid and a solid surface.

3. Results and Discussion

The obtained results are shown in this section. The Figures 1, 2, 3 and 4 illustrate the rheology of nano oil in the vertical tube.

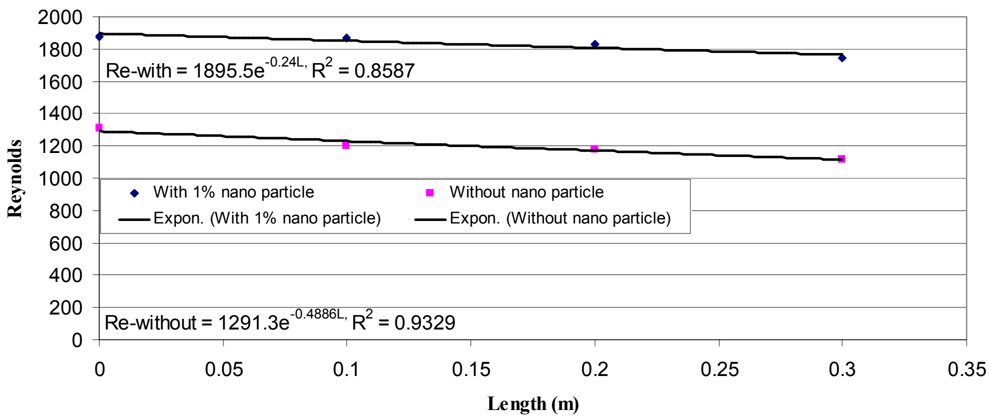

Figure 1. Values of Reynolds number through the length.

The Reynolds number is one of the important dimensionless numbers which is used extensively in hydrodynamic field. The total effect of nano ferric oxide on the velocity, viscosity and density of oil through the length is shown in the Figure 1.

The decrease trend in Reynolds number is obtained for simple oil through the 0.3 m length of pipe from 1276 to 1164. For nano oil the decrease trend of Reynolds number is somehow slight from 1807 to 1789.

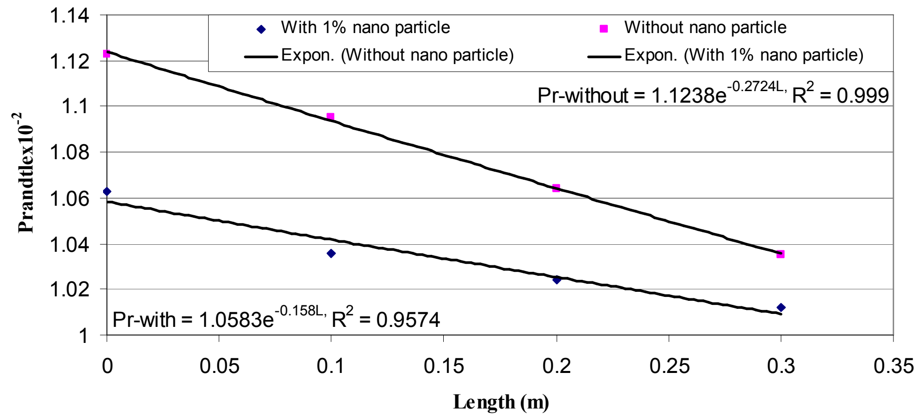

Figure 2. Prandtl number versus length.

The evaluation of thermo-physical properties of the fluid is easier with prandtl number to calculate heat transfer properties. Figure 2 shows the changes of prandtl number versus length. The decrease trend of prandtl number is obtained for both types of nano oil and simple oil. The values of prandtl of nano oil changes from 106 to 101 and for simple oil changes from 112 to 103.

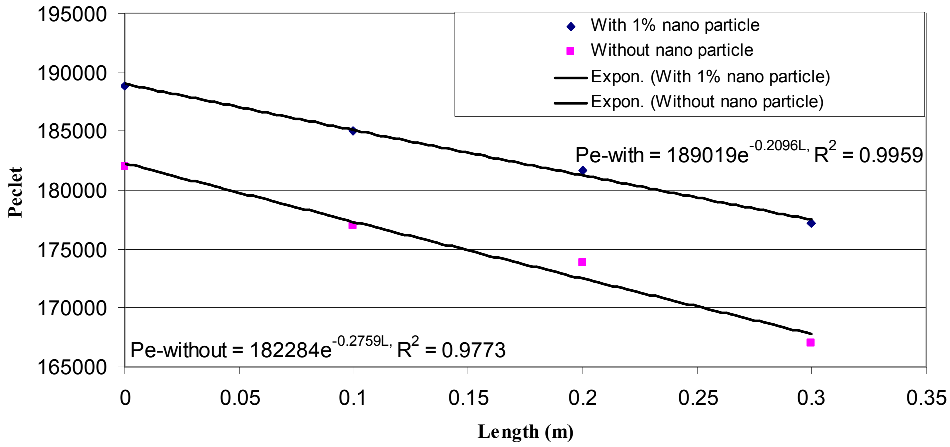

Figure 3. Peclet number versus length.

The Figure 3 shows the values of peclet number of nano oil and simple oil through the length. Values of peclet number for nano oil changes from 188431 to 177781 and for simple oil changes from 181034 to 166720 through the length.

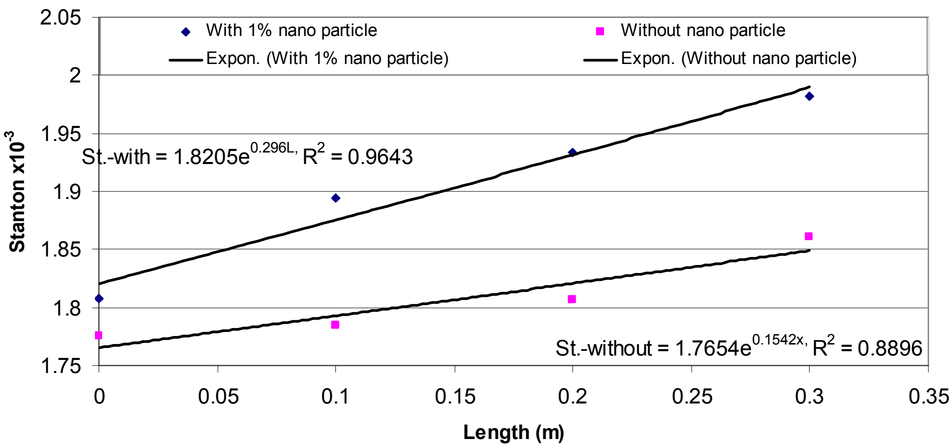

Figure 4. Stanton number values versus tube length.

Values of Stanton number versus length of tubes is shown in the Figure 4. The increasing trend is obtained for both simple oil and nano oil. Values of Stanton change from $1.77\times10^{+3}$ to $1.87\times10^{+3}$ for simple oil and from $1.8\times10^{+3}$ to $1.99\times10^{+3}$ for nano oil.

4. Conclusions

The operational conditions selected in the oil industry depend on the process oil features. Being aware of the oil flow behavior in different pressures and temperatures is necessary for oil producing from different fields. Application of nano ferric oxide in oil is studied in this manuscript. The effect of addition of different weight percentage of nano particle into the oil which flows vertically under different temperatures (ranges from 30-70 C, 25- 85 C, 30- 90 C) in a tube section is investigated, experimentally. The experimental show decrease trend in Reynolds number is obtained for simple oil through the 0.3 m length of pipe from 1276 to 1164. For nano oil the decrease trend of Reynolds number is somehow slight from 1807 to 1789. Moreover, the decrease trend of prandtle number is obtained for both types of nano oil and simple oil. The values of prandtle of nano oil changes from 106 to 101 and for simple oil changes from 112 to 103. In addition, the values of peclet number for nano oil changes from 188431 to 177781 and for simple oil changes from 181034 to 166720 through the length. Also, the increasing trend is obtained for both simple oil and nano oil. Values of Stanton change from $1.77\times10^{+3}$ to $1.87\times10^{+3}$ for simple oil and from $1.8\times10^{+3}$ to $1.99\times10^{+3}$ for nano oil.

References

[1] Fotoohi E., Farahbod F., Experimental evaluation of mercaptan removal process from liquefied petroleum gas, Mater. Chem. Phys, 2015, 1 (2), 202-206.

[2] Nasr Maher, Raymond Jasmin, Malo Michel, Gloaguen Erwan, Geothermal potential of the St. Lawrence Lowlands sedimentary basin from well log analysis, Geothermics, Volume 75, September 2018, Pages 68-80. https://doi.org/10.1016/j.geothermics.2018.04.004.

[3] Storm D. A., McKeon R. J., McKinzie H. L., Redus C. L., Drag Reduction in Heavy Oil, J. Energy Resour. Technol. 1999; 121 (3): 145-148. https://doi.org/10.1115/1.2795973.

[4] Riyahin M., Montazeri GM., Jamoosian L., Farahbod F., PVT-generated correlations of heavy oil properties, Petroleum science and technology, 2014, 32 (6), 703-711.

[5] Rached Ben-Mansour, Pervez Ahmed, Habib M. A., Simulation of Oxy-fuel combustion of heavy oil fuelin a model furnace, J. Energy Resour. Technol. 2015, 137: 032206. https://doi.org/10.1115/1.4029007.

[6] Loyola-Fuentes José, Smith Robin, Data reconciliation and gross error detection in crude oil pre-heat trains undergoing shell-side and tube-side fouling deposition, Energy, Volume 183, 15 September 2019, Pages 368-384. https://doi.org/10.1016/j.energy.2019.06.119.

[7] Shadi WH, Mamdouh TG, Nabil E. Heavy crude oil viscosity reduction and rheology for pipeline transportation. Fuel 2010; 89: 1095–100. https://doi.org/10.1016/j.fuel.2009.12.021.

[8] Motamedi Pouyan, Bargozin Hasan, Pourafshary Peyman, Management of Implementation of Nanotechnology in Upstream Oil Industry: An Analytic Hierarchy Process Analysis, Journal of energy resources technology, 140 (5), 2018, 052908-052908-7. doi: 10.1115/1.4038846. https://doi.org/10.1115/1.4038846.

[9] Elphingstone G. M., Greenhill K. L., Hsu J. J. C., Modeling of Multiphase Wax Deposition, J. Energy Resour. Technol. 1999; 121 (2), 81-85. https://doi.org/10.1115/1.2795072.

[10] Weissman J. G. Review of processes for downhole catalytic upgrading of heavy crude oil. Fuel Proc. Technol. 1997; 50: 199–213. https://doi.org/10.1016/S0378-3820(96)01067-3.

[11] Naseri A, Nikazar M, Mousavi DSA. A correlation approach for prediction of crude oil viscosities. J. Pet. Sci. Eng. 2005; 47: 163–74. DOI: 10.1016/j.petrol.2005.03.008.

[12] Bisht Harender, Shankar Balachandran Vijai, Patel Mitra, D. Sharma Girish, H. Yadav Ashwani, D. Biswas Dwaipayan, Pacharu Sreenivas, Mandal Sukumar, K. Das Asit, Effect of composition of coke deposited in delayed coker furnace tubes on on-line spalling, Fuel Processing Technology, Volume 172, April 2018, Pages 133-141. DOI: 10.1016/j.fuproc.2017.12.013.

[13] Alomair O, Elsharkawy A, Alkandari H. Viscosity predictions of Kuwaiti heavy crudes at elevated temperatures. In: SPE Heavy Oil Conference and Exhibition, Kuwait, 12–14 December 2011. p. 1–18. https://doi.org/10.2118/150503-MS.

[14] Yigit Ahmet S., Christoforou Andreas P., Stick-Slip and Bit-Bounce Interaction in oil-well Drillstrings, J. Energy Resour. Technol. 2006; 128 (4): 268-274. https://doi.org/10.1115/1.2358141.

[15] Barrufet MA, Setiadarma A. Reliable heavy oil-solvent viscosity mixing rules for viscosities up to 450 K, oil-solvent viscosity ratios up to 4 _ 105, and any solvent proportion. Fluid Phase Equilib. 2003; 213: 65–79. https://doi.org/10.1016/S0378-3812(03)00285-1.

[16] Wang Shumiao, Bhandari Siddharth, Chaitanya Chaduvula Siva, J. Atallah Mikhail, H. Panchal Jitesh, Ramani Karthik, Secure Collaboration in Engineering Systems Design, Journal of Computing and Information Science in Engineering, 2017; 17 (4): 041010-041010-11. doi: 10.1115/1.4036615.

[17] Luis F. Ayala, Doruk Alp, Evaluation of “Marching Algorithms” in the Analysis of Multiphase Flow in Natural Gas Pipelines, J. Energy Resour. Technol. 2008; 130 (4), 043003. https://doi.org/10.1115/1.3000103.

[18] Farahbod F., Farahmand S., Empirical investigation of heating and kinematic performance of ZnO nano fluid in a heat pipe for enhancing the energy transfer rate, Journal of nanofluids, 6 (1), 2017, Pages 128-135. DOI: 10.1166/jon.2017.1306.

[19] Yilin Wang John, Well Completion for Effective Deliquification of Natural Gas wells, J. Energy Resour. Technol. 2011; 134 (1): 013102. https://doi.org/10.1115/1.4005284.

[20] Liangyin Xu, Yunpeng Li, Sheng Zhang, Biaosong Chen, Efficient Visualization Strategies for Large-Scale Finite Element Models, Journal of Computing and Information Science in Engineering, 2018; 18 (1): 011007-011007-13. doi: 10.1115/1.4038315.

[21] Kazerooni MRM., Farahbod F., Experimental investigation of sulphur removal from LPG: new aspect, Journal of Environmental Science and Technology, 2016, 9 (1), 164-169.

[22] Chuan Lu, Huiqing Liu, Qiang Zheng, Qingbang Meng, Experimental Study of Reasonable Drawdown Pressure of Horizontal Wells in Oil Reservoir With Bottom Water, J. Energy Resour. Technol. 2014; 136 (3): 034502. https://doi.org/10.1115/1.4027405.

[23] Yamakawa Soji, Shimada Kenji, Feature Edge Extraction Via Angle-Based Edge Collapsing and Recovery, Journal of Computing and Information Science in Engineering, 2018; 18 (2): 021001-021001-18. doi: 10.1115/1.4037227. DOI: 10.1115/1.4037227.

[24] Junlai Wu; Yuetian Liu; Haining Yang, New Method of Productivity Equation for Multibranch Horizontal Well in Three-Dimensional Anisotropic Oil Reservoirs, J. Energy Resour. Technol. 2012; 134 (3): 032801-032801-5. https://doi.org/10.1115/1.4006573.

[25] J. Hagedorn Thomas, Krishnamurty Sundar, R. Grosse Ian, A Knowledge-Based Method for Innovative Design for Additive Manufacturing Supported by Modular Ontologies, Journal of Computing and Information Science in Engineering, 2018; 18 (2): 021009-021009-12. doi: 10.1115/1.4039455.

[26] Farahbod F., Investigation of gas sweetening by nanofluid in isothermal tower with consideration of thermodynamic equilibrium; experimentally and theoretically, Separation and Purification Technology, 2019, 211, 799-808.

[27] Rafibakhsh Nima, I. Campbell Matthew, Hierarchical Fuzzy Primitive Surface Classification From Tessellated Solids for Defining Part-to-Part Removal Directions, Journal of Computing and Information Science in Engineering, 2017; 18 (1): 011006-011006-12. doi: 10.1115/1.4038144.

[28] N. Bhuwakietkumjohn, S. Rittidech, Internal flow patterns on heat transfer characteristics of a closed-loop oscillating heat-pipe with check valves using ethanol and a silver nano-ethanol mixture, Exp. Therm. Fluid Sci. 34 (2010) 1000-1007. DOI: 10.1016/J.EXPTHERMFLUSCI.2010.03.003.

[29] Farahbod F., Farahmand S., Experimental and Theoretical Evaluation of Amount of Removed Oily Hydrocarbon, Aromatic and Bioassay of Drilling Fluid by Zinc Oxide Nano Coagulant, Journal of nanofluids, 7, 2018, Pages 223–234. DOI: 10.1166/jon.2018.1443.

[30] Hakimi A., Farahbod F., Experimental Evaluation of Dimensionless Groups for Scale Up of Sulfur Removal Process, Int. J. Chem. Biomol. Sci, 2016, 2 (1), 43-46.