Drag reduction by hydrophobic nano - particles adsorption process

Poondla Vishnu Vikas

Abstract--This paper proposes a mechanism for Identifying hydro phobic capability of nano particles. Distinguishing the affinity capability of these particles and then coming to a conclusion on best hydrophobic nano particles. Creating a 2-D or 3-D model of a reference body on which the coating is done . Induce suitable conditions such as heavy water flow over the surface of the body after coating, the hnp. Measuring drag by calculating drag force, viscosity, density and reference area.The drag reduction technology by nanoparticles adsorption method has been developed to effectively reduce the water injection pressure, enhance the injection rate and partially protect the formation from damage during water flooding processes of low permeability reservoirs. However, there is a lack of an effective method to simulate the drag reduction effects on the scale of oilfields. In this work, the slip velocity model in the reservoir micro-channels caused by nanoparticles adsorption onto the porous wall is firstly presented based on fluid dynamics. The relationship between the effective permeability of water phase and the slip length is established by combining the slip velocity model with Darcy's law, then, a two phase with three-dimensional model (water, oil) is developed to simulate the drag reduction effects.

Index Terms— Hydrophobic , Adsorption , Drag , Grid , Aerodynamic , Ahmed Body , Fluctuations , Permeability.

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1 Introduction

The adsorption of hnp's onto the porous walls slow down the formation damage to some extent. This work may serve as an efficient tool for understanding drag simulation reduction effects owing to the adsorption of hnp's on the oil field scale. Slip velocity model in reservoir micro channels caused by hnp's adsorption is presented. A 3d two phase model is developed to simulate the drag reduction Effects[10]. Effective permeability of water phase after hnp's adsorption increases by 130%. Water injection pressure after nano particles adsorption decreases by 12.5 mpa. Nano particles adsorption onto the porous wall can slowdown the decay of surface as well.

The main objective of this work is to develop a novel simulation method to evaluate the drag reduction effects of the nanoparticles adsorption method on the scale of oilfields. We first briefly described the mechanism of the drag reduction effect caused by nanoparticles adsorption onto the porous wall, and then the relationship between the

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Corrosion resistive coatings of particular ferrous and ferric oxides can be viewed in different strategies[7].Conductive , resistive and semi-conductivity of graphene mixer of silicone rubber are used for graphical comparisions[9].

effective permeability of water phase and the slip length was established[9]. A three-dimensional, two-phase model (water, oil) was developed to simulate the drag reduction effects. Based on a water injection well pattern in China's Jiangsu oilfield, a series of experiments were firstly conducted to validate the mechanism, and then the drag reduction effect of the injection well was simulated through the proposed method[8]. Comparing hydrophobic to super hydrophobic coatings under various conditions such as laminar and turbulent were extracted[5].

2 Literature review

Applying the body fluid strategies to automotive industries are the basic ideas that are taken.Cocepts related to hydrophobic surfaces with multi-layered coating are deeply observed[2].Correlating bio-science with mechanical engineering was extracted from this.

Usage of chemicals and their suitable reactions with specific nano-particles for the scientific observations of drag reduction are studied.

Providing various distributions of ahmed body testing in both air and water are evaluated specifically[2].Under high pressure zones during floods , calculation of velocity and acceleration with minor surface energy losses are compared.

Polymer and its derivatives mainly co-polymers with dispersions in water are provided in detail.

Multidisciplinary, innovative and high values development of high performance, cost-effective and environmentally acceptable separation systems is highly desired to tackle the sustainability challenges that facing current desalination technology[8].

As membrane transports are inherently nanoscale where the transport of water and salts across the membrane primarily depends on the chemical properties as well as physical structures of the membranes at nano- to microscales[6].

The application of nanotechnology knowledge in the fabrication of so-called nano-enabled membranes is anticipated to counter the limitations of current materials and processes as well as optimize the performance of processes used in desalination[4].

Reconciles the underlying issues of membrane desalination technology and carries the benefits by sustainably promoting improved desalination system and providing greater return across the sectors;[3] but at the same time may also call attentions to multifaceted social and environmental pitfalls with unintended consequences.

3 Proposed method

The main aim is to implement the drag reduction technology by nano particles adsorption method for the reduction of water injection pressure,enhance the injection rate,and protect the damage during water flooding[4]. Experimental tests on the adsorption behaviour of hydrophobic nano particles ,the wettability changes on the core surface,and the core displacement as well as the numerical simulation of the drag are conducted. The effective permeability of the water phase increases by 130% after the nano paricles are adsorbed onto the porous walls of the core samples micro channels[1].

The bottom hole pressure, the reservoir pressure and the saturation of oil and water phases in water flooding process can then be obtained. After injecting the nanoparticles, the effective permeability of water phase increases. In this case, if the effective permeability of water phase after the nanoparticles adsorption is known[3]. Thus, a core displacement experiment must be conducted firstly to test the changes of the water phase permeability before and after the nanoparticles adsorption, and then the drag reduction effects of the nanoparticles adsorption method in water flooding process can be simulated. In addition, as the water flooding process is a continuous process, the simulation before and after the HNPs adsorption should be linked up. Therefore, the grid-refinement and restart

techniques are introduced to take the nanoparticles adsorption area and the effective permeability changes of water phase into account in the water flooding process[7].
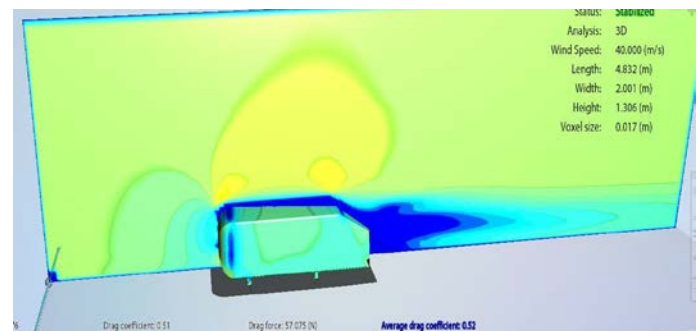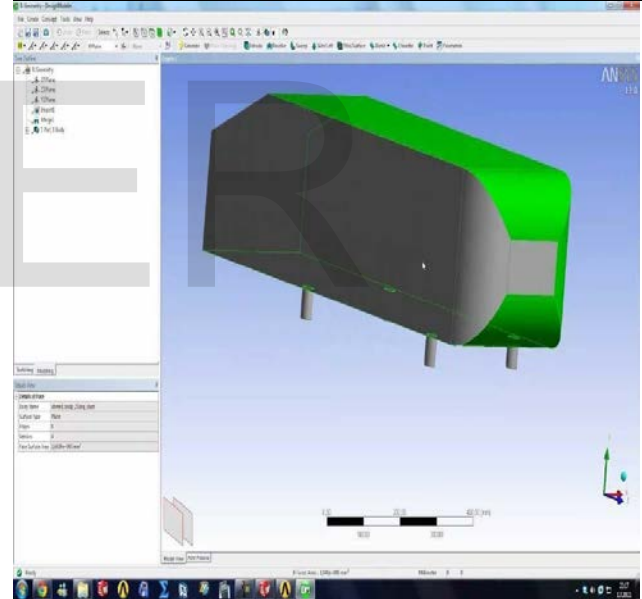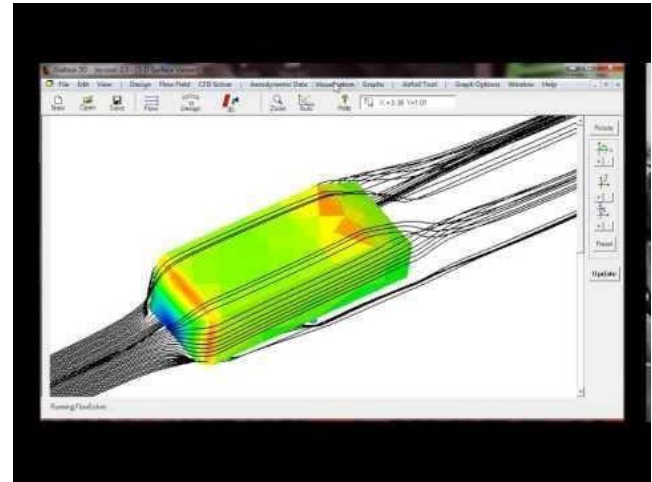
4 Results

fig:1,2,&3 represent the flow simulation of ahmed body under wind tunnel test with calculations on wind speed and dimensions.

Creating a 3-D model of ahmed body in solid works and importing that model to ansys software for further simulation to understand the different flow characteristics over it.The parameters such as length , width , height and voxel size are mentioned above.
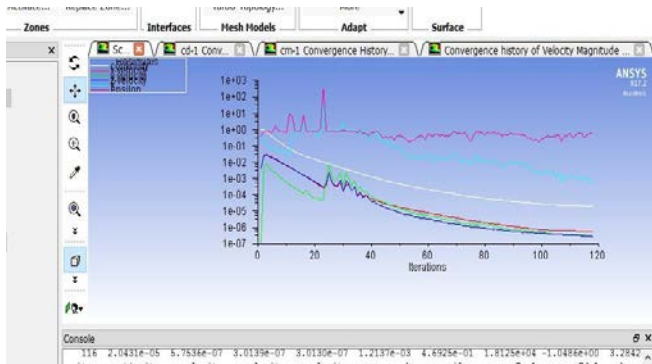

fig:4 deals on x- axis number of iterations per second with the evaluation of velocity of the ahmed body at those input intervals.These iteration include the mesh grid is divided into how many micro level grids as this number is directly proportional to accuracy and efficiency.
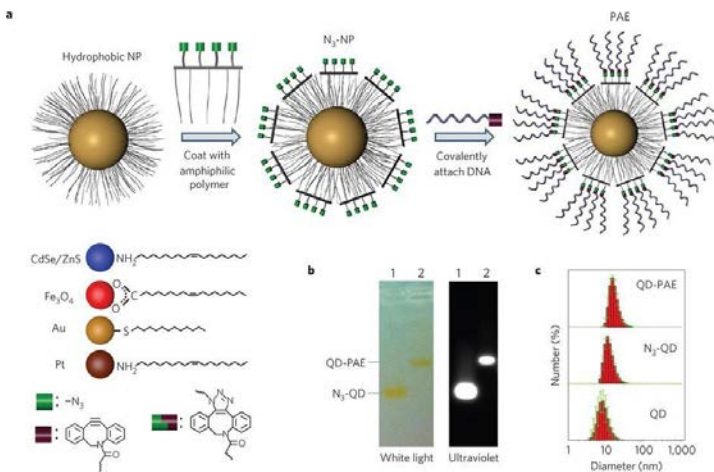

fig5: is analyzing why there is a sudden reduction in drag after coating with hydrophobic nano particles with water repellant properties acquired whreas this is not the case of actual body.

Representing the various structural analysis of commonly used experimental nano coatings.Simulation of ahmed body for flow varying characteristics under different frequencies of light with diameter of atomic particles.
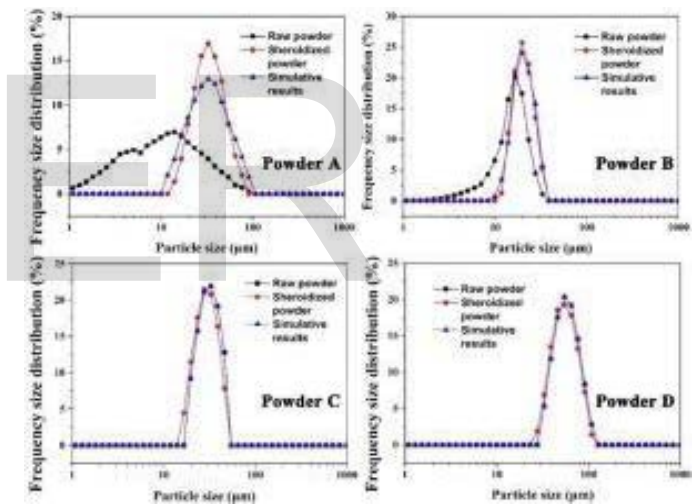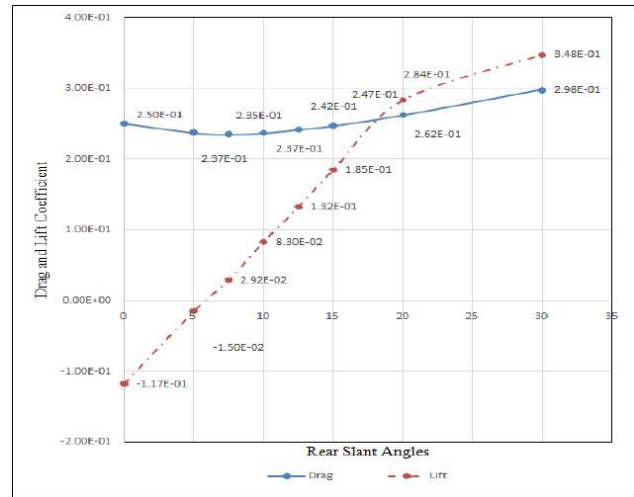

fig:6&7 deals with the coefficient of drag mainly depends on the type of powder which we used for coating.If the the particle size is more adsorption dominates absorption, causing surface phenomenon more feasible while if the particle size is of micro to nano level absorption dominates adsorption causing the sinking power variations in frequency distribution.The lift coefficient of drag varies predominantly with angle of attack even for small fluctuations.
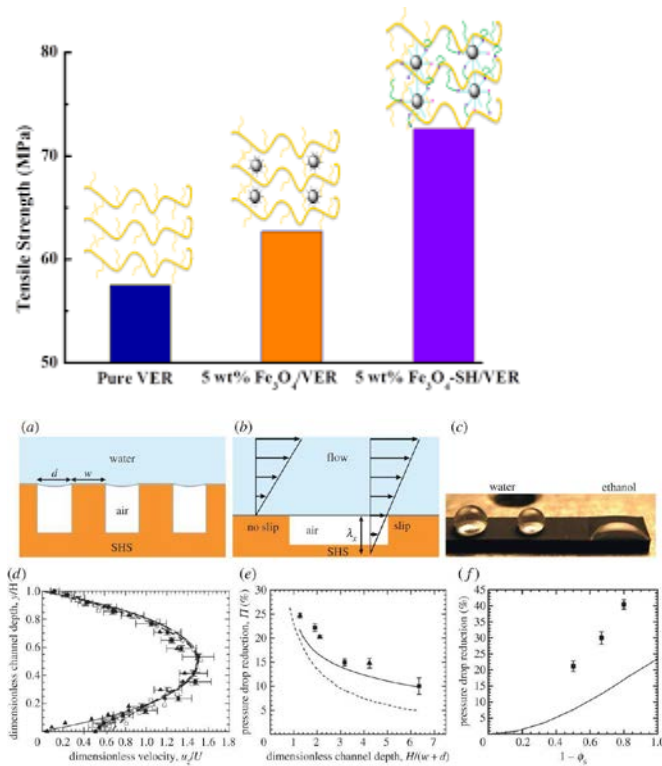
fig:8&9 describes about Surface tension and tensile strength criteria obeying no slip boundary condition creating the actual boundary layer profile.The area of the above triangle represents the intensity of slip. The structure on rear part and under carriage of ahmed body can be designed in such a way that it causes flow separation inducing pressure drop causing wakes formation.
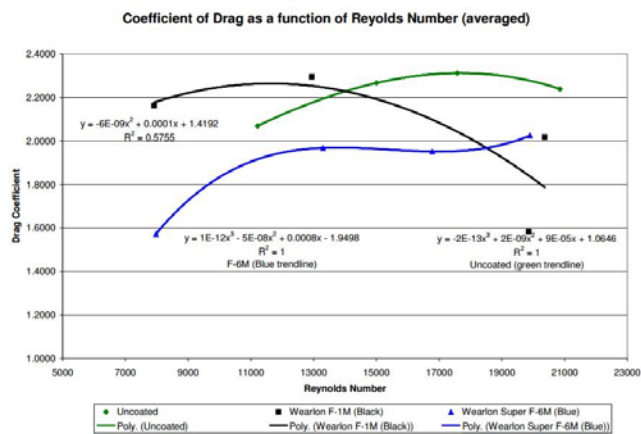

fig:10 gives the comparision between uncoated and nano coated simulations.The non-coated body offers more drag causing more fuel usage and maintanance costs wheras poly wearlon super F-6M blue is the most efficient nano coating powder.

Creating the aerodynamic structure of ahmed body with side fins and top holistics having streamlined body makes the flow turbulent to laminar causing the reduction in drag.This input gives the mathematical equation of the parabolic curve when solved in matlab.

5 Conclusion

In future the experimental results show that HNPs could be adsorbed tightly onto the surface of the core slice, and the wettability of the sample surface changes from hydrophilic to hydrophobic after HNPs adsorption. The effective permeability of the water phase after injecting the nano-fluid into the micro-channels is increased and the increased ratio is about 130%.

The Wearlon F-6M coating showed a clear reduction in drag for the entire range of Reynolds Numbers tested (roughly 10,000 – 20,000). There is an interesting change in the data as the Reynolds number increase. Above a Reynolds number of about 15,000 the F- 6M increases its drag reduction relative to the control group. We would recommend that further experimentation be designed to test drag reduction for laminar flows, i.e. a wider and lower range of Reynolds numbers. To reduce possible avenues of error such as wall effect.

6 Acknowledgements

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