INVESTIGATING THE EFFECT OF MAGNETIC FORCE ON THE FLOW BEHAVIOR OF PIPELINE

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ABSTRACT

Drag forces has been the main problem that occurs in pipeline and loss energy due to the water transmission along the pipeline. During the transmission of water in the pipeline, it needs high consumption of pumping power in the pipeline due to the fluids are flow in order of turbulent flow by against the fluid friction, which has been happened in the pipeline wall and results in drag forces of the pipeline. Consequently, the drag forces in the pipeline can be reduced by addition of drag reducing agent to improvise the fluid transmission in pipeline. The purpose of this research work is to study the effect of particle size and concentrations of suspended solid such as iron powder applied to magnetic force flow and ultimately investigate the flow behaviour in multi phase flow in the pipeline. In this study, the investigation is based on the role of ferromagnetic powder such as iron powder used as drag reduction agent to reduce the drag forces and less turbulent in the fluid transmission pipeline. In the experimental work, check the flow behaviour of pipeline when the iron powders add to the fluid transmissions with concentration of 100ppm, 300ppm and 500ppm and provided with and without magnetic force. Moreover, portable magnetic device has been used to apply magnetic force to the flow in the pipeline. The experimental procedures carried out in an experimental rig and obtain the pressure drop readings for drag reduction calculation. Iron powder particles are suitable and best method for drag reducing agent. In addition, smaller particle size at high concentration able to show the higher drag reduction compared to bigger particle size. The turbulence flow of the pipeline can be reduced by appliance of magnetic field and the high power of magnetic force able to reduce the drag reduction at higher Reynolds number. The average value of drag reduction for the pipe length of 1.5m was recorded for iron powder of particle size of 60µm is 25% and particle size of 120µm was achieved about 10% for concentration of 300ppm with the magnetic power of 720W.

ABSTRAK

Daya seretan merupakan masalah utama yang berlaku semasa pengaliran air sepanjang saluran paip yang boleh menyebabkan kehilangan tenaga dalam saluran paip. Semasa pengaliran air dalam saluran paip, ia memerlukan penggunaan pam yang berkuasa tinggi dan menyebabkan aliran gelora terhadap geseran bendalir, yang telah berlaku di antara dinding saluran paip dan daya seretan. Oleh itu, daya seretan boleh mengurangkan seretan dengan mengunakan ejen daya pengurangа untuk menambah baik pengaliran bendalir dalam saluran paip. Tujuan kerja penyelidikan ini dijalankan untuk mengkaji kesan saiz zarah dan kepekatan pepejal terampai sebagai contoh serbuk besi yang digunakan untuk menambah baikan saluran paip dengan menguji aliran daya magnet pada saluran paip. Dalam kajian ini, siasatan berdasarkan peranan serbuk feromagnet seperti serbuk besi yang digunakan sebagai agen pengurangan seretan untuk mengurangkan daya seret dan aliran gelora di dalam saluran paip untuk mengalirkan bendalir. Dalam kerja uji kaji, memeriksa terhadap pengaliran saluran paip apabila menambah serbuk besi semasa pengaliran bendalir dengan kepekatan 100ppm, 300ppm dan 500ppm dan mengalir dengan daya magnet. Selain itu, magnet mudah alih telah digunakan untuk memeriksa kuasa magnet terhadap saluran paip. Prosedur uji kaji telah dijalankan dengan menggunakan rig uji kaji dan mendapatkan bacaan perubahan terhadap tekanan untuk pengiraan pengurangan daya seret. Zarah serbuk besi adalah kaedah yang sesuai dan terbaik untuk menjadikan sebagai ejen pengurangan daya seretan. Di samping itu, saiz zarah yang lebih kecil dengan kepekatan yang tinggi mampu mengurangkan daya seretan yang lebih tinggi berbanding dengan saiz zarah yang lebih besar. Aliran gelora dalam saluran paip boleh dikurangkan dengan mengaplikasikan medan magnet dan juga mengurangkan pengurangan daya seret dengan kuasa tenaga magnet yang tinggi pada nombor Reynolds yang lebih tinggi. Nilai peratus pengurangan daya seret pada paip 1.5m telah dicatatkan bagi serbuk besi yang bersaiz zarah 60µm dengan pencapaian 25% dan saiz zarah 120µm telah mencapai kira-kira 10% bagi kepekatan 300ppm pada kuasa magnet 720W.

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LIST OF SYMBOLS

%	Percentage
°C	Degree celsius
min	Minute
ppm	Parts per million
µm	Micrometer
Re	Reynolds number
g	Gram
cm	Centimeter
W	Waat
Kg	Kilogram
m	Metre
s	Second
ρ	Density of water
V	Velocity of water
d	Diameter of pipe
µ	Viscosity of water
Q	Flow rates of water
Dr %	Drag reduction percentage

LIST OF ABBREVIATIONS

CTAC	CetylTrimethyl Ammonium Chloride
NaSal	Sodium Salicylate
MRI	Magnetic resonance imaging
PIV	Particle image velocimetry
AC	Alternative Current
P	Pump
T	Tank
PT	Pressure Transmitter
MV	Valve
PVC	Polyvinyl Chloride

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

In an introduction part, explains on the background of study of the drag reduction that occurs in the pipeline, continue with the problem statement, objective of the project, scope of study and rational and significance to improvise the turbulent flow.

1.2 BACKGROUND OF STUDY

Liquids and gases form known as a real or an ideal fluid. However, an ideal fluid contains property of incompressible and frictionless but a real fluid has viscosity and compressible property. There have two types of flow such as laminar and turbulent flow. Laminar and turbulent can occur in the pipeline. The first person distinguish the differences between the flows through experimentally is Osborne Reynolds (1842 – 1912) by using reynolds number.

The laminar flow will occur when the reynolds number is less than 2000. If the reynolds number is greater than 4000, the flow in pipe is known as turbulent flow. The two limits in between of reynolds number of 2300 until 4000 are called as transitional flow (Munson et al, 2006). Turbulent flow occurs when there is friction between the flow of fluids and wall of the pipe. The eddying motions which are varies with different size of motion in turbulent flow of pipeline and the large equipment part from mechanical energy in the pipeline flow goes into the formation of these eddies which eventually dissipate the energy as heat (Warhaft, 1997). The turbulent flow is affected from the roughness of surface. When increase the surface roughness it increases the drag in the pipeline.

Drag was the main reason for the loss of energy in pipeline for the transportation purpose. These energy losses are can be identified through the pressure drop, which will results in consuming high pumping power. Therefore, to reduce the drag should use the drag reduction effect in the turbulent pipeline flows, which was discovered by Toms. This phenomenon was known as Tom's phenomenon (Toms, 1948).

The main purpose of drag reduction is to delay the onset of turbulent flows and reducing the flow resistance especially in the pipelines, in order to improve the flow of fluid-mechanical efficiency in pipeline. Otherwise, the drag reducer will shift the transition from a laminar flow to a turbulent with higher flow velocity (Truong, 2001). Recebli and Kurt (2008) demonstrated that increasing the magnetic field intensity causes the local velocity of a two-phase steady flow along a horizontal glass pipe to decrease.

In addition, the turbulent friction factor can reduce by supplying electricity with magnetic force in pipeline. A charged particle passing in the presence of a current was experience a force from the current is called as magnetic force. This type of force is known as electromagnetic force. Moreover, the magnetic force can be expressed in terms of the magnetic vector or the magnetic field discussed in the electric induction force. Both the particles velocity and the magnetic field were perpendicular in the form of magnetic force.

1.3 PROBLEM STATEMENT

Drag reduction is not only applied in a chemical industries but also highly demand in an oil and gas refinery industries, medical, mining, marine, bio medical applications and jet cutting for fluid transportation in pipeline for the reason that moving fluid, energy will dissipated due to the drag friction. Widely used in most industries due to the purpose of drag reduction in order to reduce the energy loss in pipeline. Basically, in industry cost saving is the most high concern on limitation on power consumption. Reduce the turbulence flow in pipelines in order to power consumption saving and improve the flow. Instead that, water was supply into the pipeline with high flow rate but finally the water flow rate was become low due to the turbulent flow that occurs along the pipeline. Therefore, to increase the flows in pipeline by consume loads of power for the purpose of transportation in channel. Ultimately, the costs also will increase drastically.

Initially, the drag reductions in the pipeline have been studied, by addition of polymers, fibers or surfactant in order to reduce the drag reduction in a pipeline. Lately, the most comment material that used as drag reduction agent in the pipeline were polymers. However, the polymers have the characteristics as stretched along the axis and the elasticity supply the energy to reduce the drag in the pipeline but a fully prolonged chain of polymer cause a poor resisting degradation caused by the pumping shear power and degrade thermally at high temperature. Therefore, polymers were loosed their drag reducing ability permanently. Polymer as a drag reduction agent was able to cause a problem to the environment due to the toxic or environmental pollutant. Polymer also used at low concentration to avoid the toxicity.

Therefore, in this current study metal solid particle suspension used as drag reduction agent such as apply the magnetic force towards the pipeline was investigated by using an experimental approach.

1.4 OBJECTIVE

The aim of this investigation was studied to achieve this objective:

- To study the water flow behavior in pipeline with influence of suspended solid that can attract to the magnetic force.
- To study the effect of size and concentration of suspended solid in the magnetic force on the flow behavior in multi phase flow in the pipeline.
- To study the mechanism that controls the drag reduction experimental work for the pipeline.

1.5 SCOPE OF STUDY

Scope of this study was to achieve the objectives to study the effect of magnet device to the influences of the iron powder in the magnetic force and identifies the behaviour of the turbulent flow in the pipeline. The iron solid powders that tested are micron size particles with the size of 60 µm and 120 µm. Magnetic fields were applied using a custom made magnet device to study the influence of iron particles under the action of magnetic field on the turbulent flow of the pipeline. In this study water was used as transporting medium. At last, collect the pressure readings, calculate the pressure drop, followed by the percentage of the drag reduction, and finally calculate the Reynolds number and velocity by using the volumetric flow rate so that to make sure the flows are less turbulent in the pipeline.

1.6 RATIONAL AND SIGNIFICANCE

There have many benefit use of drag reduction. The significance of this study was to discover a new method to reduce the drag forces in the pipeline, in order to saving the pumping power consumption. Drag reduction able to enhance the flow rate of water in the pipeline by using the magnetic force as a flow improver. The presence of turbulence flow can be reduced under the influenced of magnetic field by adding the suspended metal solid particles towards the pipeline. Last time, use additive agent such as fiber, polymer and surfactant as a drag reduction agent has to reduce the drag force but now can use magnetic force in pipeline to improve the flow behaviour of water. The higher drag reduction performance of the metal obtains at the stronger magnetic field. These drag reduction can overcome the energy loss in pipeline. Moreover, the use of pump in plant will be reduced and the energy demanded for the pump is reduced too. Automatically, it saves the cost.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In a literature review, the theoretical particulars that will be covered are type of flow in pipeline, drag force in pipeline flow, turbulent flow in pipeline, and effect of magnetic force on the flow behaviour of water in pipeline. Finally, in the literature review discussed about the economical and commercial applications and benefits.

2.2 TYPE OF FLOW IN THE PIPELINE

In many fields, flow was distinguished by calculating Reynolds number. At low number of Reynolds, the viscous force is larger compared than the inertia force. The small changes in the disturbances in the velocity field, created perhaps by small roughness elements on the surface, or pressure perturbations from external sources such as vibrations in the surface or strong sound waves, damped out and not allowed to grow. The case for pipe flow at Reynolds numbers less than the critical values of 2300, which is based on pipe diameter and average velocity, and for boundary layers with a Reynolds number less than about 200,000 were based on distance from the origin of the layer and the free stream velocity (Warhaft, 1997).

The viscous damping action become less when the Reynolds number increases, and at the some point it becomes possible for small perturbations to grow. The flow of water can become unstable, and it can experience transition to a turbulent state where large variations in the velocity field can be maintained. The disturbances are very small, as in the case where the surface is very smooth, or if the wavelength of the disturbance is not near the point of resonance, the transition to turbulence will occur at a higher Reynolds number than the critical value. Therefore, the point of transition does not correspond to a single Reynolds number, and it is possible to delay transition to relatively large values by controlling the disturbance environment. At very high Reynolds numbers, it is not possible to maintain laminar flow since under these conditions even minute disturbances will be amplified into turbulence (Warhaft, 1997).

The Reynolds number, in the case of laminar flow in a straight pipe of the fluid particles travel in a straight pipes the particles travel in straight lines without losing their identify by mixing between layers. Thus, fluid particles between two adjacent layers do not mix except by molecular diffusion. If any disturbance in the form of velocity; hence the flow again comes back to laminar state. As the Reynolds number exceeds the limits of approximately 2300, the laminar flow in a pipe may become, leading to turbulent flow condition (Garde, R.J., 2000).

Moreover, it can be seen that the loss of pressure in a steady uniform laminar flow in a pipe is directly proportional to the first power of velocity and viscosity, and inversely proportional to square root of diameter. Laminar flow is between the parallel plates and flow through porous materials. In other hand, the inertial effects are neglected the pressure loss which is independent of the mass of density of the fluid. Another characteristic is the extreme no uniformity in velocity distribution. This gives an energy correction factor of two for pipe flow as against 1.05 to 1.10 for turbulent flow where the velocity distribution follows logarithmic law (Garde, R.J., 2000).

Lastly, it will pointed out the drag force experienced by the deformation of fluid is opposed by the viscous stresses that vary directly with the rate of deformation; there is continuous expenditure of energy. Therefore, in a steady uniform flow, there is a continuous transformation of mechanical energy into heat. The turbulent flow is formed based of intense mixing; there is much greater expenditure of energy in turbulent flow than in laminar flow (Garde, R.J., 2000).

2.2.1 Turbulent Flow in Pipeline

Thus, even in an otherwise steady turbulent flow the velocity at a given point will randomly fluctuate with time, whereas even in uniform turbulent flow instantaneous velocity at all time, whereas even in uniform turbulent flow instantaneous velocity at all points along a streamline would vary randomly. The flow is varied from parameters such as pressure, temperature, sediment concentration at flow point, or force on structures such as smoke stacks and suspension bridges for turbulent flow. The lateral movement of fluid particles in the case of laminar flow takes place due to molecular diffusion and it is very small indeed. In turbulent flow, lumps of fluid particles move laterally and longitudinally giving rise to the concept of eddy motion (Garde, R.J., 2000).

The flow behavior in pipeline is turbulent will be occurred when the behavior of flow contains the eddying motions of all the sizes, and the mechanical energy which is contain of large part in the flow will goes into the formation of these eddies which eventually dissipate their energy as heat. At a given Reynolds number exceeds a certain limit, disturbance breaks down into chaotic motion which is the drag of a turbulent flow is higher than the drag of a laminar flow. In addition, surface roughness is the main reason that affected in turbulent flow, in other word can said that increasing the roughness wills increases the drag in pipeline of flows (Warhaft,1997). Figure 2.1, shown of the turbulent flow for the pipeline.

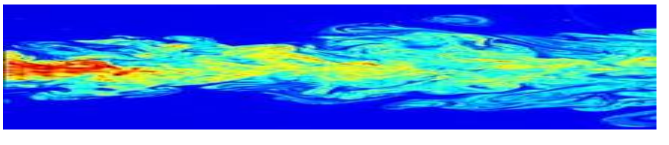

Figure 2.1: Turbulent flow

Source: Fukushima *et* al., 2000.

The fluid flow in pipeline was interpreted by the Reynolds number as the ratio of the inertia force to the viscous force. The turbulent flow was characterized for unsteady eddying motions that are in constant motion with respect to each other. Eddy can be defined as a large group of fluid particles which move laterally or longitudinally in the flow field; while undergoing this motion and eddy can change its shape or stretch, rotate or break into two more eddies. Eddies are generated in the region of high shear in the mean flow field that is the near the boundary in a pipe or channel flow, in the vicinity of interface between two streams flowing at different velocities and parallel to one another.

Therefore, turbulent flow can be considered to consist of the mean motion superimposed on which are the randomly varying components of velocity in all the three directions. A similar statement can be made about other variables. At pipeline flow, eddies that produce in fluctuations in the flow velocity and pressure. When measured the stream wise velocity in turbulent pipe flow, we would see a variation in time (Warhaft,1997).

2.2.2 Eddies

Eddies that formed in pipeline of water flow will be interacting with each other as they move to surrounding, and it will be exchange to the momentum and energy. An eddy that found in centerline of the pipe will have a relatively high velocity and move towards to the wall pipeline and interact with eddies that found in the wall, which is typically have lower velocities. As they mix, the momentum differences are smoothed out from the pipeline. This process is superficially similar to the action of viscosity, which tends to smooth out momentum gradients by molecular interactions, and turbulent flows are sometimes can said as to have an equivalent eddy viscosity. The eddy viscosity is in typical order of magnitude that larger than the molecular viscosity will form the turbulent mixing is such an effective transport process (Hunt, Morrison,2000).

At high shear, which is analogous to saying that at the high Reynolds Number, the size of larger eddies is governed by the size of flow and its geometry. At given time of flow contains eddies of various sizes. The largest eddy will be of the size of flows that is the pipe diameter or flow depth in a channel, whereas the smallest eddy will be very small, say of the order of millimeter. However, it may be emphasized that the size of the smallest eddy is still sufficiently large compared to the size of molecules of the fluid. These eddies are dimensional in nature, even though flow may be two dimensional. Eddies of various sizes are embedded in each other and are impermanent in nature. That is larger eddies, which are continually formed, break into smaller eddies until they are finally dissipated through viscous shear (Garde, R.J., 2000).

If the flow field, passage of smallest which is the small and large eddies through this point would induce velocity fluctuations of small magnitude and large frequency and of large magnitude and small frequency. This would yield a fluctuations velocity field. Since the turbulent eddies break into smaller and still smaller eddies which ultimately die out due to viscous dissipation, the kinetic energy associated with the eddy reduces. If this secondary motion of eddies is to be maintained at a quasi steady state, then there must be some mechanism which supplies energy to the secondary motion at the same rate at which its energy is dissipated. This energy supply is obtained from the mean flow through mechanism which requires existence of measurable mean shear. At last the turbulent flow is dependence of the eddying current which is cause from velocity and pressure (Garde, R.J., 2000).

2.2.3 Drag Force in Pipeline Flow

The liquids or fluids that pass through in a pipeline was experiences drag which is called as the net force in the direction of flow due to pressure and shear stress forces that forms in between surface of the object and the flow of fluids in pipeline. The transportable quantities related to flow, such as momentum, heat, sediment or other pollutants spread much more rapidly in turbulent flow than in laminar flow. This ability is several hundred times greater in turbulent flow than in laminar flow. Greater ability for diffusion is beneficial in many cases and harmful in others (Garde, R.J., 2000). Moreover, the suspended solids in water will cause the drag force in the pipeline because the flow behaviours of water were created eddies current which is can distract the flow of water in pipeline (Frank Kreith,1999).

2.3 DRAG REDUCTION

Drag reduction is the effect of turbulent flows. However, drag is an undesirable effect but it can also be desirable effect, because depending on the application. Drag reduction is closely associated with the reduction of fuel consumption in automobiles, submarines, and aircraft, improved safety and durability of structures subjected to high winds, and reduction of noise and vibration. The application is applied in parachute activity. Drag or known as frictional pressure drop is a result of the resistance encountered by flowing fluid being exposed to solid surface, example as pipe wall. Generally, there have two type of flow such as laminar and turbulent. Figure 2.2, shows the characteristics between the flows in the pipeline.

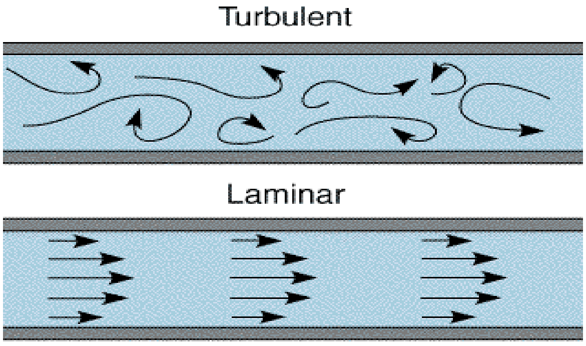

Figure 2.2: Characteristic of flows

Source: University of Cambridge, 2011.

Drag reduction is will highly observed in turbulent flow than laminar flow. In turbulent flow the fluid molecules are move in random manner, and formed eddy currents that caused from energy applied to them to be wasted. The structure of turbulent flow in the pipeline is important on understand the concept of how drag reducers decrease the turbulence. Drag reduction agent used to reduce the turbulent flow in pipeline.

2.3.1 Drag Reduction Agent

The drag reduction agent is the additives that used for reduce the frictional force in turbulent flow of pipeline with low concentration and pure solvent. The drag reduction agents are classified into three types of additives such as fibre, polymer, and suspended solids particle. These are the approach used to save the pumping power consumption in pipeline.

I. Fiber for Drag Reduction

Drag reducing fibers are the safest and cheapest drag reducing agent compare to surfactants and polymers. Moreover, some of the surfactant caused problem to the environment in high consumption. The solubility condition for any material to be classified as drag reducing agent is not dominating factor was proved in journal of Abdul Barri.*et.al* (2009).

Analysis of the fiber induced drag reduction in turbulent wall bounded flows using more sophisticated rheological models of fiber suspensions has become possible in less than a decade. Manhart, (2003) has proposed a direct Monte-Carlo solver for fiber orientation dynamics and used it in one-way coupled simulations of a turbulent channel flow to study the effect of Brownian diffusivity and fiber aspect ratio on the non-Newtonian stress generated by fibers.

Two ways coupled simulations have been performed for the first time by Paschkewitz et al. (2004, 2005) in turbulent channel and boundary-layer flows. They have used the moment approximation approach along with the hybrid and invariant based optimal fitting (IBOF) moment closure models. They have demonstrated that non-Brownian fibers lead to the highest amount of drag reduction as compared to Brownian fibers. This result is in favour of the conjecture that viscous effects are mainly responsible for drag reduction by fibers. Note that, in case of fibers, the elasticity is associated with the rotary Brownian motion (Manhart, 2004).

Later, Gillissen et al. (2007, 2007) have also performed simulations by using the moment approximation approach along with the eigenvalue-based optimal fitting (EBOF) closure model. It should be noted here that the moment approximation approach offers a computational reduction in comparison to the direct approach. However, it requires the use of a moment closure model. Thus, the accuracy of the simulation depends on the accuracy of the used moment closure model.

II. Surfactant for Drag Reduction

Many cationic surfactants with organic counterions such Salicylate are excellent drag reducers in aqueous systems. Organic anions are generally introduced as counterions by the addition of Sodium Salts such as Sodium Salicylate to quaternary ammonium salts. The counterion to surfactant concentration ratio has a major impact on drag reduction, rheological behaviour, and the microstructure of some cationic surfactant or counterion solutions. In dilute solution, drag reducing effectiveness increases with increase in counterion or surfactant ratio because longer thread-like micelles form after increased neutralization of the positive charges on the surfactant head groups by the negative charges of the counterion molecules. While equal molar counterion molecules are enough to neutralize all or nearly all charges, excess counterion increases the drag reducing effectiveness (Lin *et* at, 2000).

Hartmann et al. investigated the thread-like micellar systems of 0.05M CTAB with various concentrations of Sodium Tosylate (NaTos). Shear thickening occurred in a very limited domain when _<0.38. For higher concentrations of NaTos, they found a Newtonian domain followed by shear thinning. In the presence of high counterion concentration, branching or connection of the micelles can be expected due to electrostatic shielding of the repulsion between polar heads. Several groups have shown clearly the presence of branches of the thread-like micelles in such systems.

Lin et al., 1998, investigated the counterion to surfactant concentration ratio on the drag reduction, rheology and microstructure of the systems Arquad 16/50 (5 mM) with the 3, 4-dichiorobenzoate counterion at concentrations of 5, 7.5, and 10 mM that is, with values of 1, 1.5, and 2. With increase in counterion concentration, viscoelasticity as measured by the first normal stress value, decreased due to changes in microstructure from thread like micelles to vesicles and spherical micelles, although all systems showed good drag reduction over wide temperature ranges from 20°C to 70°C and from 20°C to 85°C.

Gonzales et al., 2011, proposed that, it had been studied the effects of a surfactant additive and its dissolution in diesel, on the tribological and rheological properties of water-based fluids (WBFs) formulated with two weighting materials such as hematite and calcium carbonate. The tribological properties were established by measuring the coefficient of friction in conjunction with optical surface profilometry used to evaluate the wear behaviour. The surfactant studied is a non-ionic/anionic mixture (80/20). The work presented has three important sections; first, the interactions between surfactant and the solids particles in aqueous media are discussed on the basis of conventional measurements, such as dispersion stability and zeta potential. Then, a brief description of the effect of surfactant on the rheological properties of the drilling fluid formulations is presented. Finally, the effect of surfactant on the tribological properties of water based fluids is discussed on the basis of friction reduction and wear behaviour.

During the last years, petroleum industry has increased the use of directional drilling techniques due to the need to reach new wellbores in order to maintain world's crude oil production. Additionally, there is a tendency to use drilling water based fluid instead of oil based fluid due to environmental restrictions (Orszulik, 2008 and Clark 1998). Therefore, it is necessary to develop new lubricant additives for water based drilling fluids with the following characteristic: high performance reducing friction at low concentration, compatible with drilling fluid additives, able to support drilling conditions, low toxicity and environmentally safe. It has been found that surfactants could accomplish this task.

The viscosity was determined as a function of shear rate in the interval 0.1–1000 s^{-1}. Additionally, light scattering techniques were performed to study the dispersion stability of solid particles of weighting materials in the aqueous surfactant solutions, and to correlate the solid surfactant interactions observed with the tribological and rheological properties of water based fluids. Based on the results, it was established that the evaluated surfactant additive can reduce significantly the coefficient of friction independently of the weighting materials used, and that suspended additives formulation has a superior performance in coefficient of friction reduction than dissolution in oil. Concerning the rheological properties, it was observed a viscosity increase in the polymeric water based fluids formulated with hematite and suspended additives, indicating strong interactions in the polymer surfactant solid system (Gonzales et al., 2011).

Ferhat and Sylvain (2010) are stated that, many surfactants and polymers are considered as excellent drag reducing agents. This is the phenomenon to induce a significant head loss reduction compared to the pure solvent. In this study, an aqueous solution of CetylTrimethyl Ammonium Chloride, (CTAC) and Sodium Salicylate, (NaSal) are used in turbulent pipe flow system. Drag reduction experiments were carried out for different experimental conditions using pressure drop measurements. At the same time, the spatial velocity distribution was measured and analyzed using particle image velocimetry (PIV).

III. Polymer for Drag Reduction

Toms on 1948 states that the drag reduction phenomenon and observed that the addition of a few parts per million of long chain polymers in a turbulent flow which is produced a dramatic reduction of the friction drag. Lumley (1969, 1977) postulated that in regions of the flow field where polymer molecules are elongated, viscosity is strongly enhanced. He further postulated that elongation of polymer molecules is due to strain flow of the elongation flow component, and that vortices diminishes polymer elongation because it reduces the relative time that the elongated polymer is aligned with the principal axis of the strain field.

Since in highly turbulent flow regions vortices and strain rate are not correlated, he concluded that stretched polymer molecules would be found in the overlap layer, but not in the viscous wall layer. Hence, increased viscosity will occur only in the overlap layer, enhancing dissipation of turbulent fluctuations, leading to suppression of