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A REVIEW ON SHOCKABSORBER CONTAINING NANOFLUID

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ABSTRACT

In a vehicle, shock absorbers reduce the effect of traveling over rough ground, leading to improved ride quality and vehicle handling. Shock absorbers also serve the purpose of limiting excessive suspension movement by damp spring oscillations. It does this by converting the kinetic energy of the shock into another form of energy (typically heat) which is then dissipated. Shock absorbers use oil and gasses to absorb excess energy, but conventional shock absorber fluids and magneto rheological fluids have their own advantage and disadvantages. Hence in this paper, a reviewed method and composition, to use nanofluid in shock absorber has been decribed from a old patent, which shows improved viscosity index and thermal conductivity than other shockabsorber fluids.

Keywords: Carbon Nano-structure, Dispersant, Nano-fluid, Shock absorber, Shock-absorber fluid

I. INTRODUCTION

In transportation, a vehicle is required to run on different types of road conditions such as even, uneven, rough etc. Suspension system is mounted between the passenger compartment and axle, which isolates the vehicle chassis from the road conditions, thus avoids the undesirable effects safeguarding passengers against road shocks and providing riding comfort. Most vehicles are provided with additional dampers which serve to control the amplitude and frequency of spring vibration, known as shock absorber. A shock absorber is a mechanical or hydraulic device designed to absorb and damp shock impulses. A shock absorber consists of mainly two parts i.e. 1] tube or cylinder filled with oil, 2] piston. The piston slides up and down within the tube, pushing its way through the oil which acts as a hydraulic fluid. When a vehicle runs on worst roads, jerks or damps condition of road causes up and down motion, which forces hydraulic fluid through some orifices holes in piston. These orifices allows only little amount of oil to enter through the piston and therefore provides resistance to the movement of the piston hence slows spring and suspension movement. This is because the oil cannot itself be compressed.The process also converts kinetic energy into heat, which needs to be dissipated through the surrounding, otherwise it will heat the damping fluid inside the absorber thus changing the damping fluid characteristic and decreasing the absorber performance. Another important loss is the dissipation of vibration energy by shock absorbers in the vehicle suspension under the excitation of road irregularity and vehicle acceleration or deceleration.

In order to overcome this problem, a substance that has a high thermal conductivity and high viscosity index must be added inside the absorber. The reason for using a high viscosity index for shock absorber oil is that a lot of heat is generated when the shock absorber is functioning. High viscosity index of shock absorber oil can be achieved by Nano-fluids which does not allow too much change in viscosity with temperature, therefore improving shock absorber functionality and prevents from rough rides.

During the literature survey, none of the papers have provided a process for dispersing and maintaining nanostructures in suspension comprising a lubricant additive, for use in a shock absorber nano-fluid composition. The present paper provides a method which is reviewed from US patent 7,470,650, which disperses nanostructures, preferably carbon nanostructures into a liquid medium and adds same to a shock absorber fluid. Thus a nanofluid composition is made containing nanostructures which can be utilized in shock absorber applications. To form stable carbon nanostructure fluid dispersions a method is adopted by dispersing the nanostructures together with at least some preferred surfactants, which can disperse carbon nanotubes in petroleum liquid medium, with selected dispersants and mixing methods.

II. LITERATURE REVIEW

Title 1: Experimental study of damping characteristics of air, silicon oil, magneto rheological fluid on twin tube damper

Journal: Science Direct- Procedia Materials Science 5 (2014) 2258 – 2262

Author: Avinash B, Shyam Sundar S and K V Gangadharan

In this paper the damping rate of the different fluid medium of a damper was compared. The twin tube damper was designed to conduct the experiments and to analyze the dynamic behavior under these conditions. The results show that MR fluid has good damping characteristics than that of the other fluids (i.e. silicon oil, air) due fluid-particle interaction and friction near fluid-structure interface. In addition it can provide high damping rate under the influence of magnetic field.

Title 2: Characteristics of Ferro fluid

Journal: Indian Journal of Science and Technology

Author: Satish B. Purohit, S. R. Lapalikar, Sachin Pare and Vikas Jain

This paper focuses on the synthesis and characterization of Ferro fluid (smart fluid). The colloidal mixtures of magnetite in carrier fluid were made by different chemical processes. The characteristics like particle size, turbidity, density, viscosity, and damping were studied. The average particle size after repeated filtering measured to 12 nm. The turbidity variation was found to be almost negligible. Such smart fluid could be used in a shock absorber where semi-active suspension is desirable. The use of the Ferro fluid with coupling (c = 0.8348 N –sec/m) and decoupling(c = 0. 2418 N –sec/m) with the magnetic field for the instant change in damping coefficient is recommended. It is thus possible to get the instant change in the viscosity and therefore the instant change in the damping characteristics of the viscous fluid.

Title 3: Concept of Electromagnetic Shock Absorber using Magnetorheological Fluid

Journal: International Advanced Research Journal in Science, Engineering and Technology

Author: Wasnik A.R., Bhosale V.P., Aswar S.K., Birange V.B. and Bodhale M.M.

This paper deals with electromagnetic shock absorbers which uses magnetic energy which can be actively controlled according to requirement. In this case Magnetorheological fluid is used for controlled damping which has the ability to change its viscosity according to the surrounding magnetic field. Magneto rheological fluid is composed of nonmagnetic particles which are suspended in a carrier fluid like oil. It concludes that magneto rheological dampers have better shock absorbing property than passive hydraulic dampers. Hence, electromagnetic shock absorbers can be used as mono suspension in motorcycles to improve handling and stability of the vehicle.

Title 4: Experimental Analysis and Heat Transfer Study of Damping Fluid in Shock Absorber Operation

Journal: IJEDR | Volume 2, Issue 3 | ISSN: 2321-9939

Author: Jignesh Rana, Swastik Gajjar and Ankit Patel

The aim of this research work is to Study the Heat Transfer using the different working fluids in Shock Absorber body.To complete this objectives Shock Absorber test Rig was constructed. Most of shock absorber contained the air gap inside the shock absorber between internal cylinder and outer body. As Air gap has lower heat transfer rate so problem of overheating will effect of damping fluid characteristics and decrease shock absorber performance. To improve heat transfer air gap is filled by fluid substance like ethylene glycol, propylene glycol and glycerol which showed increase in heat transfer by 52%, 39% and 64 % respectively. With increase heat transfer rate from inside absorber to surroundings, problem of overheating of damper fluid could be decreases and shock absorber performance could be maintained for long time

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Title 5: Magneto-Rheological Dampers in Automotive Suspensions

Journal: International Research Journal Of Engineering And Technology (IRJET)

Author: Atmiya K. Bhalodi, Jaikit Patel, Raj Patel and Krutik Shah

The paper consists of experimentation to show the efficiency of using MR Fluids on conventional shock absorber of the automobiles. The MR dampers provided a more stable ride and reduce instability of suspension geometry, than that of the OEM shock absorbers by downgrading the settling time, suspension displacement and suspension oscillations. It was found that the efficiency of damper used in this study increased by using MR Fluids since viscosity of fluid can be varied with the applied current on the MR damper.

III. NANO-FLUIDS

Nano-fluids are stable colloidal suspensions of Nano-materials in common, base fluids. This system consists of two phases: liquid phase (base fluid) and solid phase (nanoparticles). The term “nanostructure” refers to elongated structures, tubes, particles, rods, spheres, strands, and combinations thereof having a cross section (e.g., angular fibers having edges) or diameter (e.g., rounded) less than 1 micron. The structure may be either hollow or solid. Nanostructures can be dispersed in an oil based medium such as natural and synthetic based oil products. The liquid medium can be a petroleum distillate, petroleum oil, synthetic oil, vegetable oil and/or any other oil.

IV. EXPERIMENTAL METHODOLOGY

The paper provides a method of preparing a stable dispersion of a selected carbon nanostructure in a liquid medium, such as water or any water based solution, or oil, with the combined use of surfactants and agitation (e.g. ultra sonication) or other means of agitation. The nanostructure can be either single-walled, or multi-walled, with typical aspect ratio of 500-5000; and may comprise fibrils, nanotubes, nanoparticles or their combinations. Preferably, the nanostructures used in the present paper has diameter less than 0.05 micron.

The term 'surfactant' means a chemical compound that reduces surface tension of a liquid. It is a broad term that covers all materials that have surface activity, including wetting agents, dispersants, emulsifiers, detergents and foaming agents, etc. 'Dispersant' refers to a surfactant added to a medium to promote uniform suspension of extremely one solid particle, often of colloidal size.

In this paper, method for making a stable particle-containing dispersion includes physical agitation in combination with chemical treatments.

The physical mixing includes high shear mixing, such as with a high speed mixer, homogenizers, micro-fluidizers, a Kady mill, a colloid mill, etc., or a high impact mixing, such as attritor, ball and pebble mill, etc., and ultra-sonication methods. The mixing methods are further aided by electrostatic stabilization by electrolytes, and steric stabilization by polymeric surfactants (dispersants).

The chemical method includes a two-step approach: dissolving the dispersant into the liquid medium, and then adding the selected carbon nano-structure into the dispersant liquid medium mixture with mechanical agitation and/ or ultra-sonication. The liquid medium can be a petroleum distillate, petroleum oil, synthetic oil, vegetable oil and/or any other oil. The dispersant for the oily liquid medium is a surfactant with low hydrophile-lipophile balance (HLB). The chemical treatment and the use surfactants/dispersants are critical to long term stability of the nanostructure fluid mixtures. Base oil for the dispersion of the nanostructures in shock absorber fluid applications is conventional shock absorber fluid such as VISTA LPA 210, in an amount of up to 95% and more preferably up to about 80% by weight based on the total weight of the composition.

The uniform dispersion of nanostructures is obtained with a designed viscosity in the liquid medium. The dispersion of nanostructures may be obtained in the form of a paste, gel or grease, in either a petroleum liquid medium. This dispersion may also contain a large amount of one or more other chemical compounds, preferably polymers, to achieve thickening or other desired fluid characteristics.

V. WORKING

The method of forming a stable suspension of nanostructures in a solution consists of two primary steps.

First select the appropriate dispersant for the carbon nanostructure and the medium, and dissolve the dispersant into the liquid medium to form a solution. Secondly add the carbon nanostructure into the dispersant containing solution while strongly agitating, ball milling, or ultra-sonication of the solution.

Carbon nanostructures, particles, fibers or their combination are most readily available nanostructures which can be utilized as is from the production. In this paper, carbon nanostructure product obtained from CARBOLEX at the University of Kentucky which contains amorphous carbon particles and which is believed to utilize an activated carbon treatment to improve the level of hydrophilicity, is utilized as commercial product straight from a commercial production process. The CARBOLEX carbon nano structures comprise single walled nanostructures, multi-wall nanostructures, and its combinations which also can include small fractions of the carboneous materials made up of partially disordered spherical particles and/or short carbon nanostructures.

VI. PHYSICAL AGITATION

For mixing carbon nanostructures, physical agitation with high shear and high speed is carried out. In this paper, a preferred physical method is Ultra sonication as it is less destructive to the carbon nanostructure structure than the other methods. For better homogeneity sonication is carried out for at least 10-20minutes at medium or high instrumental intensity. This process can be either done in bath-type ultra-sonicator or by the tip-type ultra-sonicator (which is usually applied for higher energy output).

The dismembrator used for preparing in this experiment is a Model 550 Sonic dismembrator manufactured by Fisher Scientific Company. The convertor is fed with 20 kHz electrical energy by generator from a conventional 50/60 Hz AC line power supply. The most important part of the convertor is a lead zirconate titanate (Piezoelectric) crystal which when subjected to an alternating voltage, expands and contracts. The convertor vibrates in the longitudinal direction and transmits this motion to the horn tip immersed in the liquid solution. These results in cavitation, in which again microscopic vapor bubbles are formed momentarily and implode, causing powerful shock waves to radiate throughout the sample from the tip face. Horns and probes amplify the longitudinal vibration of the convertor; higher amplification (or gain) results in more intense cavitational action and greater disruption.The larger the tip of the probe, the larger the volume that can be processed but at lesser intensity. The convertor is tuned to vibrate at a fixed frequency of 20 kHz. All horns and probes are resonant bodies which are also tuned to vibrate at 20 kHz.

Any one of dry or wet grinding method can be used to pulverize the raw material mixture. The grinding method includes pulverizing the raw material mixture in the fluid mixture, to obtain the concentrate, and the pulverized product may then be dispersed further in a liquid medium with the aid of the dispersants. But pulverization or milling reduces the carbon nanostructure average aspect ratio.The dispersant contains a hydrophilic segment and a hydrophobic segment which surrounds the carbon particles thereby providing a means for isolating and dispersing the carbon particles. The selection of a dispersant having a particular HLB value is important to determine the dispersant characteristics such as rate and the degree of stabilization over time.

SAMPLE 1

Components	Description	Weight percentage

Carbon nanostructure	Surface untreated, aspect ratio 2000, diameter 25 nm, length 50 µm	0.1
Dispersant	Lubrizol TM 9802A	4.8
Liquid	Poly(a—olefin), 6 cSt	95.1

SAMPLE 2

Components	Description	Weight percentage
Carbon nanostructure	Surface untreated, aspect ratio 2000, diameter 25 nm, length 50µm	0.1
Dispersant	Lubrizol TM 4999	4.8
Liquid	Poly(a—olefin), 6 cSt	95.1

SAMPLE 3

Components	Description	Weight percentage
Carbon nanostructure	Surface untreated, aspect ratio 2000, diameter 25 nm, length 50µm	0.1
Dispersant	OLOA 9061	4.8
Liquid	Poly(a—olefin), 6 cSt	95.1

SAMPLE 4

Components	Description	Weight percentage
Carbon nanostructure	Surface treated	0.1
Dispersant	Igepal TM CO-630	5.0
Liquid	Water	94.9

VI. METHODOLOGY

The method for preparing a stable dispersion of carbon nanostructures into the shock absorber fluid is a multi-step process.

Firstly dispersant liquid medium is prepared, by dissolving a dispersant in an amount of 0.001 to 30.0 % which also comprises of a surfactant having a low hydrophile-lipophile balance (HLB) value of 8 or less, into a major amount of a liquid medium consisting of a mineral oil, hydrogenated oil, a vegetable oil, a synthetic oil or their combination.

It then includes pulverizing the solid material into micro –powders, by adding carbon nano material having an aspect ratio of 500 to 5000, in an amount of 0.01 to 10.0 % by weight into said dispersant liquid medium with ultra sonification.

It is then followed by wet-milling the micro-powders with the solvent used in shock absorber oil (a typical example is VISTA LPA 210) for several hours, and then adding the viscosity modifier into the mixture and continuing the milling for another several hours. The Final mixture is a paste, which is diluted by the solvent (such as VISTALPA 210) and treated by small amounts of other additives (Such as defoamer, seal sweller, antiwear agent, etc.)

TABLE 1: COMPOSITION OF CONVENTIONAL SHOCKABSORBER OIL

Ingredient	Percent by Weight
VISTA LPA 210	62.40
LUBRIZOL 7720C	36.87
LUBRIZOL 5186B	0.30
Tricresyl phosphate	0.22
F-655C defoarner	0.20
Blue Dye	0.01

TABLE 2: COMPOSITION OF NANOFLUID SHOCKABSORBER OIL

Ingredient	Percent by Weight
Graphite nanostructures	2.14
VISTA LPA 210	78.80
LUBRIZOL 7720C	18.55
LUBRIZOL 5186B	0.21
Tricresyl phosphate	0.15
F-655C defoarner	0.14

VII. BENEFITS OF NANOFLUID IN SHOCKABSORBER

Nano structures provide significant surface area when incorporated into a structure because of their size and shape. Moreover, such fibers can be made with high purity and uniformity hence possess a higher viscosity index than a conventional viscosity modifier typically used in lubricating oils.

Nano-fluids have high thermal conductivity, which is beneficial when it is used as shock absorber oil. Normally solid materials have higher thermal conductivity than liquid materials. The higher thermal conductivity enables the fluid to handle the temperature change better when the shock absorber is actively functioning.

VIII. CONCLUSION

The utilization of nanostructures in shock absorber fluids provides a composition of nanofluid which is having improved performance capabilities such as heat transfer, electrical properties, viscosity, and lubricity. Conventional shock absorbers fluid has low viscosity index and magneto rheological fluids require current for its operation. But use of nanostructures in a nanofluid composition enhances the viscosity index as a function of temperature, when utilized as a lubricant additive in shock absorber oil. In this paper, stable dispersions of nanostructures are described and surfactants/dispersants are identified which can disperse nanostructures in petroleum liquid medium. It also gives a appropriate method for preparing a uniform suspension of the carbon nanostructure in a liquid medium, forming a nanofluid which can be used as shock absorber fluid.

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