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Investigation of Thermal and Acoustical Properties of Hybrid Nanofluid (Ag-SiO_2)

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***Abstract:** In the present investigation, ash from agriculture waste i.e., sugarcane bagasse was used in the synthesis of silica. Nanoparticles were followed by using leaching and acid treatment. The required ash from agriculture waste(sugarcane bagasse)are subjected to sintered at 700°C at 5hours in order to reduce the residuals from the ash. The obtained powder was treated with1M of NaOH for leaching and then acid treatment with 0.5M H_2SO_4 to precipitate pure SiO_2 Nanoparticles powder. The synthesized silica were charecterized by XRD,FTIR).*

Using neem leaves extract, extraction of silver(Ag) nanoparticles was obtained. These plant extract (neem leaves) can be act as capping agent and reducing agent. Charecterization were done for this process i.e., XRD and FT-IR. This procedure requires 15min for conversion of silver ions to silver nanoparticles, without any harmful chemicals. Nanofluids were prepared by synthesized Ag-SiO_2 nanoparticle dispersed into water i.e.,base fluid using ultrasonication method. These nanoparticles were characterized by zeta potential, FT-IR and Ultrasonic Inferometer. Nanofluid with volume fraction of 0.04% and 0.06% at different temperature are using for the measurement of ultrasonic velocity(v),then predict the adiabatic compressibility(β), intermolecular free length(Lf), Accoustical Impedence(Z) and thermal conductivity(k) of nanofluids.

This experiment mainly concluded that agricultural wastages, converted into a valuable product, reducing environmental impact of disposal problems. Increase the thermal conductivity of metal by adding metal oxides for nanofluids.

Keywords: Silica, Nanoparticles, sugarcane bagasse, Neem leaves, Ultrasonic inferometer

I. INTRODUCTION

Developed countries have followed that the concept of “no waste” and all such materials are termed as “new resources” for new material development through value addition. Silica, the industrial materials and the precious inorganic chemical compounds. Most commonly silica found in nature as quartz, sand or flint, and also can be formed in the crystalline and amorphous in nature. There are natural reservoir of silica from agricultural waste i.e., sugarcane bagasse, bamboo leaves ,rice husk. They have a great possible and capacity for eco-friendly and economically practicable for ‘green’ synthesis of silica. Silica were used in several industries like rubber industry, in cosmetics , an anticaking agent in salts , in tooth pastes, chromatography and soon. The burning of agriculture waste(sugarcane bagasse, coconut coir, bamboo leaves) ash contain extensive SiO_2 content with 10 to 20% of carbon contents and other organic components depends upon the burning conditions, climate, furnace type and geographical area. Silica will obtained in the amorphous in nature. In industrial application, usage of purity silica are high in cost due to its high melting point of 1700 °C . Silica from agricultural waste is one of the way to reduce the cost and can be utilized high content of silica. These ashes(sugarcane bagasse, coconut coir, bamboo leaves, rice husk) were used to extract the pure form of silica by several chemical methods. Acid leaching for the agriculture wastes(sugarcane bagasse, coconut coir, bamboo leaves, rice husk) were carried out to get rid of impurities and to improve pure form of silica content. These ashes can be decomposed under sintering conditions.

A. SILICA

Silica is the basic material, it is attracted for scientist because of its numerous technology applications like photonics, optoelectronics, bio-engineering. It occupied a major role in biological field due to its non-toxicity and biocompatibility of silica nanoparticles. The biological applications are DNA delivery, cancer imaging, biosensors etc., Many methods are developed to synthesized silica nanoparticles. The silica source is a silica precursor, this method is effective to synthesized different silica with controlled morphology, particle size and porosity. The main disadvantage with silica precursor is cost and sustainability. Silica is a very prominent role in industrial materials. The silica particles are synthesized from the natural sources used for advanced scientific field.

B. Sugarcane Bagasse ASH

Sugarcane bagasse ash, a cellulose fibre after extracting sugarcane juice from sugarcane. It is a cellulose and fibrous waste from the sugarcane industry. Bagasse is the waste material from the sugarcane industry. During, sugar processing, its bagasse is used as a fuel to generate the steam. This sugarcane bagasse will cause a serious environmental problems. So that scientist researched that, through physically and chemically method, to find out the possibility of their usage in the industry.

II. CHARECTERIZATION OF NANO PARTICLES

A. Synthesis Of Silica Nanoparticles By Sugarcane Bagasse

Collect the sugarcane bagasse from the sugarcane shop (or) sugarcane industry. Bring sugarcane bagasse and washed with distilled water to remove dust and dirt which are present on it, then dried it. The washed and dried sugarcane bagasse is then burnt in a muffle furnace at 200°C/hr to become a sugarcane bagasse ash. The ash should be sintered at 700°C for 5hours, to remove explosive gases, it should be converted into ash powders. Silica nanoparticles should be equipped using dissolution and precipitation process. Acid leaching is the process, to dissolve material, 1M of sodium hydroxide is used.

The required sodium silica was filtered and dried for 24 hrs at required temperature. The precipitation silica nanoparticle by sodium silicate solution by 0.5M sulfuric acid at pH=11.8 and ageing for 12hrs.The required material should be centrifuge and washing the precipitate with hot water. Then, precipitate should be dried at 80°C for 24hrs.

B. Synthesis Of Plant Extract (Neem Leaves)

1) *Preparation of Plant Extract:* Due to its ease of availability, cost of effectiveness and its medical property, these neem leaves were used. Fresh green leaves were collected and wash it with a water to remove dirt and dust from the leaves, and dried at room temperature. About, 10gms of green leaves were kept in the beaker with 100mL of double distalled water for about 30min. The plant extract (neem extract) were cool down and filtered with whatman paper and were stored at 4°C for other use.
2) *Green Synthesis Of Silver Nanoparticles:* This method is used by using two-step method. Wet chemical method is used to synthesis of the silver nanoparticles. In this procedure, 0.01M of silver nitrate and 0.02M of $NaBH_4$ with 30ml of double distalled water. The 0.02M of $NaBH_4$ will be added to the solution by drop-by-drop with continuous stirring at room temperature. Then, the colour was turned from grayish black to brown. This process will be incubated at closed chamber. Then colour will changes to reddish brown. This indicates that reduction of silver ions to silver nanoparticles. This ,method is easy to use, easily available, cost effectiveness.
3) *XRD*

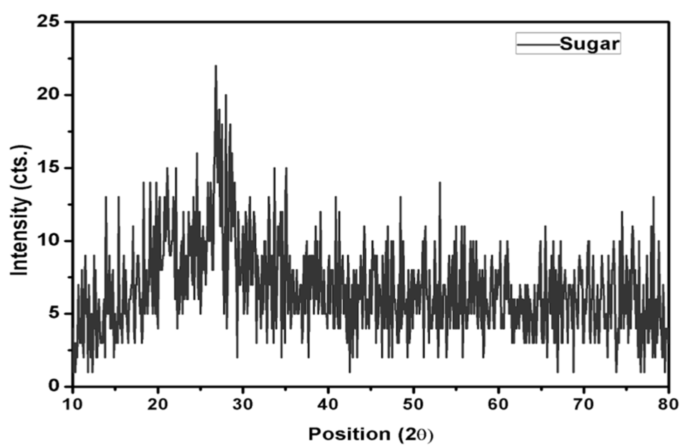

Fig.2.1. XRD of silica nanoparticle by sugarcane bagasse

After the synthesis of silica, characterization will be done i.e., XRD was done to the silica. The peak will be formed at around 28° as per the XRD results. It shows the shape of quartz and crystobalite phase respectively. According to the literature survey, it was confirmed. The peak will be observed at around 20° and 28°, it indicate the presence of calcite as per the literature survey. This XRD will shows, pure form of silicate without any sodium and magnesium contaminants. In this sample, aluminium and magnesium can be observed in the silicate network. Hence, pure silica can be obtained in amorphous form from the sugarcane bagasse which is an environmental contaminants.

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4) *FT-IR:* It is used to find out the absorbance changes and bands of the material. It gives us greater accuracy, reproducibility.

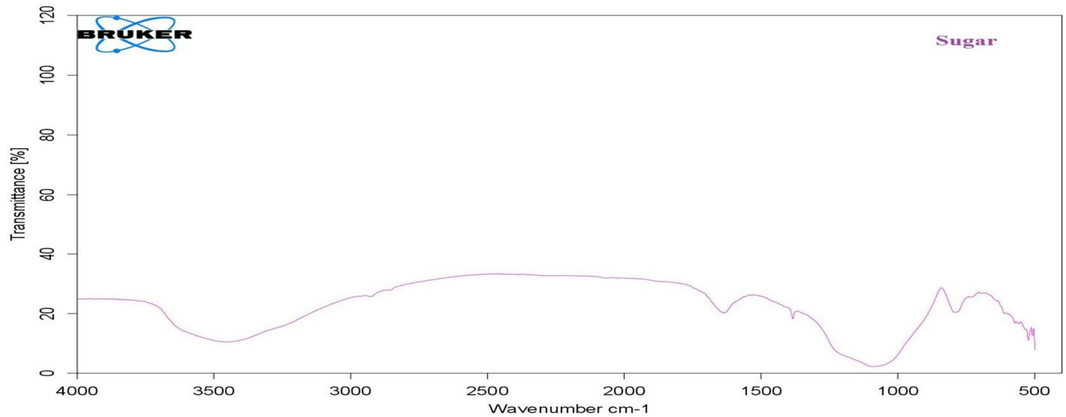

Fig.2.2. FT-IR for silica nanoparticle by sugarcane bagasse

This silica sample were characterized by the FT-IR process. The vibrational band rings of the silica will be observed at 770cm^{-1}. The bands will be observed at the 820cm^{-1}. The decreasing peak will be obtained at the 3500cm^{-1}. The bands are 770, 820, 3500cm^{-1} are obtained. The broad band will be observed at 3300-3800cm^{-1}, because of its absorption gap. At the bands of 3400 and 1450, their will be a vibrations and bending stretching molecules. Strong band at the 800 and weak band at 750cm^{-1} approximately at the asymmetric stretching vibrations. The intense band will be observed at the 500cm^{-1} approximately.

5) *Preparation OF Ag-SiO$_2$:* To measure the velocity, we have to use multi-frequency ultrasonic Inferometer. Its construction is simple in design and it gives very accurate results. It measures the sound velocity in the fluids with great accuracy. Several frequencies can generate ultrasonic waves from 1MHZ to 12MHZ. To prepare the Ag-SiO$_2$nanofluid, pour the medium (or) liquid in the beaker consist of double distalled water. This preparation is done in two-step method for hybrid nanofluids. Present study focused on the preparation and analysis of (Ag-SiO$_2$) nanofluid to increase thermal properties and suspension time of nanoparticles in fluid. Also nanofluids of different volumetric concentrations used and various testing was done to have through understanding of thermal and acoustical properties of nanofluid. For volume fraction 0.04% and 0.06%; 0.0328gm, 0.0492gm of Ag-SiO$_2$ nanoparticles respectively are added to 20ml of distalled water separately. Both the samples are do sonication under Homonizersonicator for 1hr. Then the samples are kept for stirring and ultra-sonication for 2hrs the sample obtained are Ag-SiO$_2$nanofluid with volume fraction 0.04% and 0.06% respectively. The prepared sample will get stable and it is used for the effective nanofluid applications. This technique is used to detect and evaluate strong and weak molecular interactions in fluids. By measuring the ultrasonic velocity, it gives valuable information about the liquid and particle-liquid. This device is used to measure density (ρ) and acoustical properties.

6) *ZETA Potential for Ag-SiO$_2$ Nanofluid*

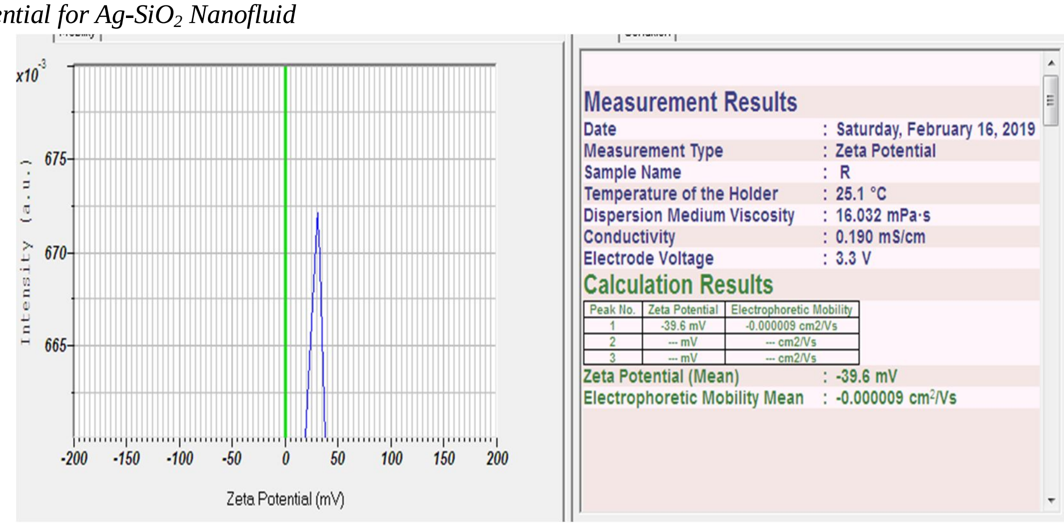

Fig.2.3. Zeta potential for Ag-SiO$_2$ nanofluid

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Zeta potential and pH to nanoparticle concentration. At volume concentration of 0.04% and 0.06% , the absolute value of zeta potential increases by enhancing the volume fraction of Ag-SiO_2 nanoparticle respectively. It is considered that, if the zeta potential is over 30mV, then it become stable. If the zeta potential cross over 60mV, then the stable of nanoparticle are to be good.In SiO_2 case, the value of zeta potential will be over 30mV. Then, it certify that, SiO_2nanofluid can be considered as good.

7) Particle Size Analyzer: PSA (particle size analyser) for Ag-SiO_2

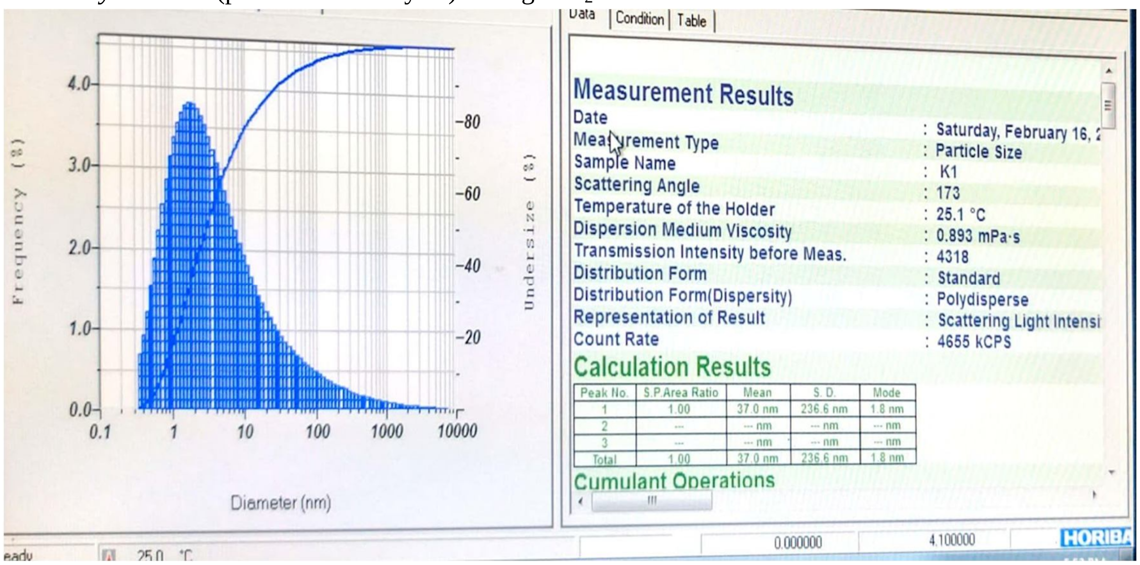

Fig.2.4. PSA for Ag-SiO_2

Using Dynamic light scattering , it is used to find out the particle size distribution ,(or) to analyze small particles in suspension., When light hits the particles in all the directions then observe time fluctuations in scattering intensity. These fluctuations are caused by interference effects, which is related to Browian movements

8) FT-IR OF Ag-SiO2

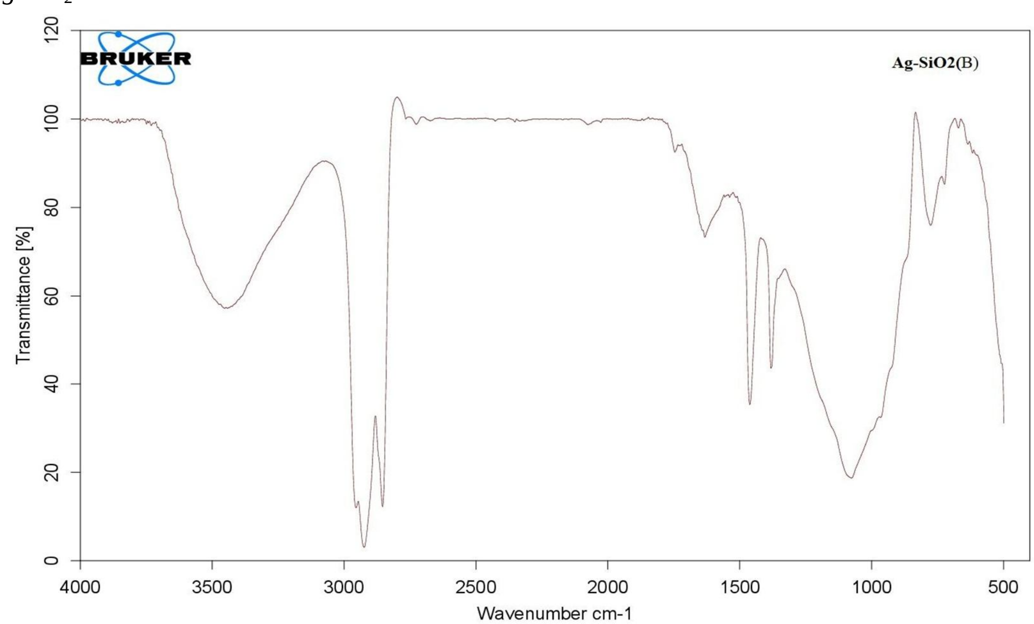

Fig.2.5. Charecterization of Ag-SiO_2 nanofluid

It provide an accuracy and reproducibility. It is used to find absorption band and broad band. Broad band will be observed at 3455cm^{-1} and the decreasing peak will be obtained at the 2785$cm^{-1.}$

9) *Ultrasonic Inferometer:* Ultrasonic velocity, acoustical parameters and thermal conductivity measurement for Ag-SiO_2 hybrid nanofluid at 0.04% concentration.

Table.2.1. Accoustical parameters and thermal conductivity measuring for Ag-SiO_2nanofluid at 0.04% concentration; for measuring the values,At 0.06% concentration of Ag-SiO_2nanofluid

SiO_2nanofluid*:*

S.No	Temperature °C	Ultrasonic velocity U (m/s)	Adiabatic compressibility $\beta*10^{-1}$ (m^2N^{-1})	Inter molecular free length $L_f*10^{-10}m$	Accoustical impedance z	Thermal conductivity $k*10^{-2}W/m$
1	30	1489	3.51	3.71	1908.22	1.77
2	40	1492	3.49	3.77	1917.22	1.895
3	50	1496	3.48	3.82	1922.36	2.017
4	60	1500	3.46	3.87	1927.5	2.135
5	70	1503	3.44	3.93	1931.35	2.255
6	80	1512	3.41	3.95	1942.92	2.370

Table. 2.2. Accoustical parameters and thermal conductivity measurement for Ag-SiO_2nanofluid at 0.06% concentration

S.No	Temperature °C	Ultrasonic velocity U(m/s)	Adiabatic compressibility $\beta*10^{-10}(m^2N^{-1})$	Inter molecular free length $L_f*10^{-10}m$	Accoustical impedance z	Thermal conductivity $k*10^{-2}W/m$
1	30	1493	3.51	3.71	1918.50	1.99
2	40	1495	3.49	3.78	1921.07	2.13
3	50	1505	3.48	3.83	1933.92	2.127
4	60	1513	3.46	3.87	1944.20	2.249
5	70	1522	3.43	3.94	1955.77	2.453
6	80	1520	3.41	3.72	1953.20	2.567

10) *Variation Of Ultrasonic Velocity With Temperature In Ag-Sio_2 Nanofluid:* At 0.04% and 0.06% concentration

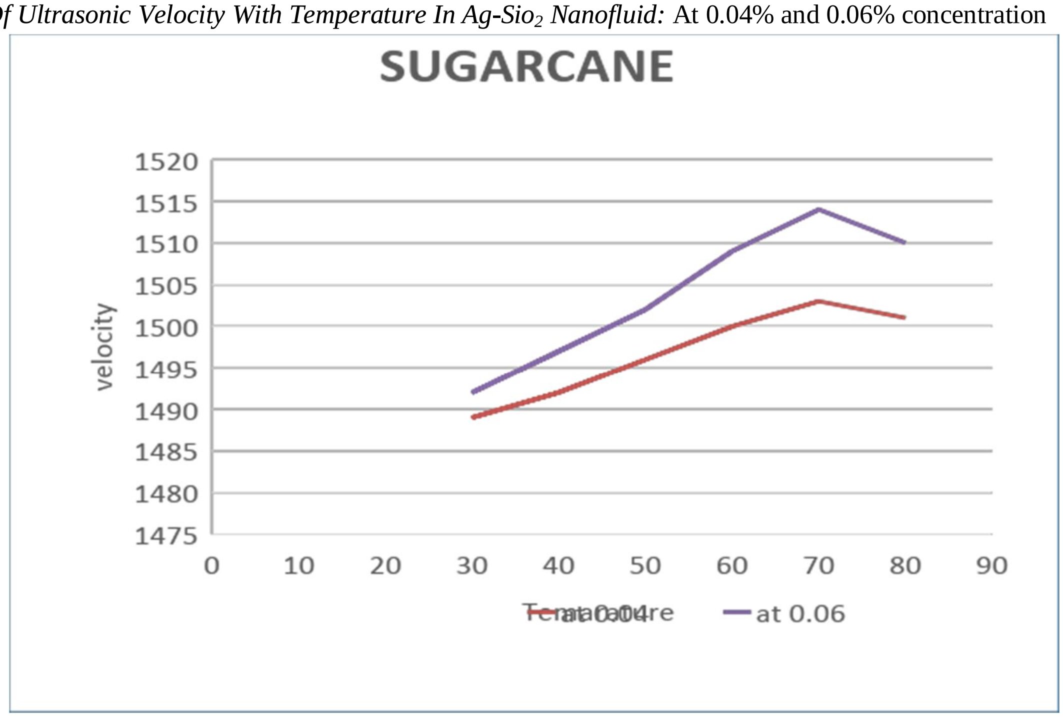

Fig.2.6. Variation temperature of Ag-SiO_2 nanofluid

Variation can be observed at different concentrations i.e., at 0.04% and 0.06% at different temperatures respectively.

It is clear from the table and figure that Accoustical impedance and inter molecular free length increases with increasing the concentration and temperature respectively. Similarly, the adiabatic compressibility decreases when increasing the concentrations. As per the Brownian motion, it will attributes the molecular force of attraction will be decreases. At different concentration, ultrasonic velocity and thermal conductivity increases rapid. Temperature increases ultrasonic velocity increases ,but at the temperature 80°C, it decreases. Whereas thermal conductivity increases. it concludes that when ultrasonic velocity increases with increase of concentration, but when the temperature increases, velocity slightly decreases because of viscosity decreases, therefore there is an increase in thermal conductivity.

III. RESULTS AND DISCUSSION

Sugarcane bagasse, a waste material, was produced high purity silica (SiO_2) content, by using leaching process.Under temperature of 700° C, the sugarcane bagasse ash will be obtained amorphous nature and forms white colour. After, leaching process, 68% of silica obtained from sugarcane ash.This method suggests that sugarcane is an alternate method for amorphous silica. For preparation of silica from waste material is the promisingly low cost.XRD results confirmed that, an average crystalline size of silica nanoparticle size is 23nm.FT-IR results found that the broad band can be observed at 3300-3800cm^{-1}.Using Ag nanoparticles from neem leaves is a eco-friendly method.This method can minimize the reducing agent/stabilizers.Using plant extract is a cost-effective, can minimize environmental problems and can be used in the bio-medical applications.By increasing the thermal conductivity of metal by adding metal oxides.Ultrasonic inferometer is used for achieving the acoustical and thermal properties respestively.At different temperatures, at 0.04% and 0.06% concentrations, we find out the ultrasonic velocity and acoustical parameters.In this experiment, it proves that when fluid interaction increases, then there will be increase in the velocity.

IV. CONCLUSION

Though Silica and Silver nano particles have various usaes together when SiO_2 + Ag Nano fluid added to paints it provides good surface finish as well as anti boils effect.The paint with SiO_2 + Ag nanoparticles can be painted below water tanks, pipe lines and building roofs to protect from algi / bacterial growth and improving structural life The paints mixed with SiO_2 + Ag nanoparticles can be used for equipments and structures installed in costal environment as silica nano particles provide weather shield and silver nano particles will prevent biological growth on surface.Ag and SiO_2nano fluid when added to epoxy paints it can be used for Painting below water tanks, pipe lines and drain lines.Ag and SiO_2nano fluid can be used for medical equipment coatings. Studies of Ag and Sio_2nanofluid reveals high surface spread / deposition and anti boil action.

REFERENCES

[1] Nguyen et al. (2008),” viscosity data base for Al2O3-water nanofluid”, Advances in Mechanical Engineering 2,91:220-24
[2] ParitoshGarg et al. (2009),” pseudoplastic non-Newtonian behavior and follow the Power Law viscosity model”, 128:249-58.
[3] LePing Zhou et al. (2010) “On the Specific Heat Capacity of CuONanofluid”, Advances in Mechanical Engineering 2,100:324-46.
[4] Mandeep Singh and LalKundan (2013) “Experimental Study on Thermal Conductivity and Viscosity of Al2O3-Nanotransformer Oil” Journal of Thermal Analysis and Calorimetry. ;128:249-58.
[5] NabeelRashin and Hemalatha (2014) “CuOnanofluids: Particle-fluid interaction study using ultrasonic technique”, Journal of Chemical and Pharmaceutical Research, 7(8):313-326
[6] Behnaz Tajik et al. (2015),” Preparation Techniques of TiO2 Nanofluids and Challenges: A Review”, Journal of Chemical and Pharmaceutical Research, 8(9):413-416
[7] KanjirakatAnoop et al. (2016),” characteristics of SiO2-mineral oil nanofluids at elevated temperatures and pressures”, Applied Thermal Engineering. 2014; 103:356-64.
[8] Salma Halelfadl et al. (2017),” Influence of particle concentration and temperature on the viscosity of water based CNT nanofluids”, Thermal transport in nanofluids 1. Annu Rev Mater Res; 34:219-46.
[9] Laura Fedele et al. (2018),” Investigation of dynamic viscosity of water-based nanofluids containing TiO2 nanoparticles”, Thermal and Fluid Science;32:397-402