Analysis on different types of viscometers, design, materials and technology

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Abstract

Viscosity is a potential quality control parameter for quick and rapid fluid evaluations as a responsive measure of fluid changes. As a potential thermodynamic biomarker, viscosity measurements are essential to ensure the consistency of liquid products or to calculate the viscosity of clinical liquids. However, traditional viscometers and their micro-fluidic equivalents usually rely on bulky and costly equipment and cannot measure viscosity easily and in-field. Viscometers, for instance biochemical optimization, biomedical diagnostics and medication products, and various defilement detections are commonly used in a wide range of applications for sensing and monitoring. In general, viscometers can be used in an integrated and detailed healthcare setting when understood in a microfluidic setting. Although several improvements have been made, the best production method, especially in relation to easier processing, costs and time, is one of the ongoing challenges of developing microfluidic devices. We present a 3D viscometer (EMV) here. By measuring the sample fluid transit time with respect to the reference fluid, the EMV measures its viscosity below the laminar flows. We ignore various kinds of viscometers, principles, materials and technology in this article.

Key words : viscometer ,materials ,3D printing ,technologies

1. Introduction

Science and technology advances are increasing rapidly and sophisticated. In addition to the accuracy , reliability and eco-friendliness of measures for obtaining the characteristics of an object, the needs of researchers are growing. This may be in the setting of research on macro-scales and research on micro-scales. One of the measurements that play a role in measuring micro-scale was Brownian movement, a spontaneous motion phenomenon of a number of particles observed under a microscope objective that was caused by particle collisions, as well as by surrounding fluid molecules[1].

Brownian Motion is commonly used in many research projects, including biology , medicine and physics. In microrheology, high-resolution camera assemblies and optical microscopic systems are especially used to analyse the viscosity values of micro-dielectric balls or micron balls in a fluid; and then micro-bead movements. The Brownian movement-based system produces a tool to measure the viscosity of a liquid using minimal amount of liquid (microliters) in an easier and simpler way than conventional methods. Several studies were performed on the Brownian motion-based method, as observed in the short time scales of Brownian motion, measure the speed and transformation from a ballistic to a delusive Brownian fluid motion of the gas particle. The study also explores the capacity for medium-square displacement analysis (MSD) to reliably obtain D values when localization uncertainty in a single brownish motion particle is demonstrated on an isotropic medium. A liquid viscosity analysis using optical tweezers was observed in article [2-5].

Not every fluid is the same, some are thin and quick to flow, some are sluggish or dense. Viscosity is called the property which accounts for these fluid variations. Viscosity is referred to as its deformation resistance measurements at a defined rate consistent with the informal thickness concept. The viscosity unit is synonymous with Newton seconds per sqm, Ns / m2 passcal seconds (Pas), is determined by international unit systems (SI). In pounds-force seconds on foot, viscosity is determined by imperial units ibfs / ft2[6]. The study of this material feature is called rheology. This property is measured with a viscometer that gives data useful when manufacturing a wide range of products in quality control applications, including inks, paints, motor oils, foodstuffs and cosmetics[7]. G. Dharmaiah et al [18] discussed the effect of viscous dissipation on free convective features of heat and mass transfer. Sivaiah et al[19] performed numerical investigations on the MHD boundary layer flow of visco-elastic fluid on a porous plate in the presence of thermal radiation.

In the world of science, viscosity calculation is very important. Hydraulics, lubrication, building, refrigeration and manufacturing are some of these areas where viscosity measurements are relevant. In lubrication, lubricating oils are of various grades and their viscosity greatly influences these grades. The viscosity is also

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regarded as an essential function of lubricating oil, according to[8]. For quality control in the painting industry, viscosity computation is important in the construction sector; the self-leveling and pumping behaviour of a concrete blend is determined by adhesive performance and viscosity. For measurements of viscosity, viscometers are used and seven different classes are present. These include: capillary viscometers, viscometers for the aperture, high-temperature heat strength viscometers, rotary viscometers, viscometers for drop balls, vibration viscometers and ultrasonics. [9-11] The widely used viscometers were proclaimed to be the type of capillary flow, type of orifice and rotational viscometers. Viscosity measuring methods that are generally most widely used enable the liquid to come into contact with a solid object. For very thin liquids, this approach is impracticable in most situations. One of these widely used viscosity measurement techniques [12] is the falling sphere viscometer. The impact of bioadditives on the viscosity and flow of heavy crude oil water was investigated by Manoj Kumar G et al.[20]. Naga Santoshi et al.[21] observed the transfer of heat and mass of a variable viscosity nano-fluid.

In the solitary Y-shaped micro-tube, the one was a reference fluid and the other a test fluid, there were two immiscible fluids which were moving under laminar flow. Owing to both fluids' viscosity, it was found that the width occupied by both fluids varied [13]. This has been demonstrated by modelling, simulations and experimental processing methods for various Applications such as monitoring biodiesel, milk adulteration and fuel defilement [14]. Microscopic photographs have been taken and analysed for determining the fluid’s diameter. Because of the need to capture images, the drawback of this solution was a bulky device. Elsewhere, with the aid of a mobile phone and an additional accessory of 4 lenses [15-16], this approach has been slightly updated and expanded.

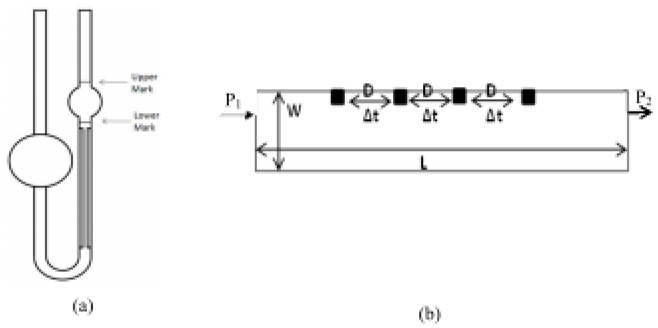

Fig.1. (a) Schematic of a typical Ostwald viscometer. (b) Schematic of the proposed micro fluidic device

Nonetheless, the need for image capture and analysis continues. In addition, during image capturing, With the variation of the orientation of the camera, viscosity values have been found to change. The purpose of this approach is the development of a micro-fluidic viscometer to prevent image acquisition requirements resulting in an integrated, miniature, robust and automated viscosity-calculating micro-fluidic device a simple and inexpensive 3-DP using microelectronics.

2. Literature review

2.1 General study

In the world of science, viscosity calculation is very important. Hydraulics, lubrication, building, refrigeration and manufacturing are some of these areas where viscosity measurements are relevant. In lubrication, lubricating oils are of various grades and their viscosity greatly influences these grades. Consequently, the viscosity of lubricating oil is considered to be a major property. Viscosity calculation is important in the construction industry in the paint industry for quality control, adhesive manufacturing the self-levelling and pumping action of a mixture influences viscosity in concreting. For measurements of viscosity, viscometers are used and seven different classes are present. These are: capillary viscometers, opening viscometers, high temperatures , high shear rate viscometers, rotating viscometers, drop-ball viscometers, vibration viscometers, and ultrasound viscometers.

2.2 Designing of viscometer

Mr. Joseph Michael Derrick,2018: In order to make available existing laboratories used for undergraduate engineering courses cost-effective, acquisition boards and the necessity for students to write information extraction code from these resources can be enforced. Programming is performed before the laboratory session and the code is reviewed. This paper explains one of the Indiana University Purdue Universities experimental experiments in Indianapolis. The key aims were to build a prototype viscometer (1) with substantially lower purchase costs compared to the present model and (2) to develop the viscosity and drag definition comprehension for students. The system is being introduced for use in the fluid mechanics laboratory of the IUPUI Mechanical and Energy Engineering Department. Because of the method of research, current acquisition costs are seen to be costly and can yield unreliable results. Growing results quality would allow students to feel more positive about the basic idea that they are teaching. A prototype has been produced which meets the sponsor 's requirements, the technical requirements and met the ASTM viscometer measurements. The fully developed and assembled prototype offers students an economical opportunity to efficiently and accurately determine the viscosity of various oils. The newer model showed a 30-40 percent error reduction relative to the older model. An appraisal research is a work in progress to assess the cumulative effect on student performance by redesigning and programming.

Ekele Ogwu Augustine, 2019: In the field of science and engineering, viscosity plays an important part. In liquids, knowledge of viscosity and flow parameters is crucial for their manufacturing, quality control and production. For various applications the building industry uses various liquids. The liquids used in the construction industries are plasters, sealers, bond breakers and coatings for liquid flooring and more. Good measurements will draw results concerning their processing properties, pump strength, longevity of the spray system, as well as flow capacity and application characteristics. It is necessary therefore to perform pertinent measurements with less expensive and reliable equipment. This paper presents a viscometer design, development and testing which, due to its flow rate through a discharge aperture, measures fluid viscosity. In the design of the viscometer, the following factors were used; corrosion resistance for material selection, ease of manufacture and use. For measuring kerosene, ethanol and plasma, the manufactured viscometer was used and obtained the following findings were respectively 0.00134, 0.0011 and 0.0034. These values are in strong accordance with various literatures and an average error of significant 5.9%. This demonstrates the reliability, standard-setting and use of the established viscometer for laboratories, building, food processing and educational purposes.

I P Kondrashov,2020: In the paper on rotary viscometers the topic of measuring the viscosity of a newtonian liquid was taken into consideration. For the measurement results, the least-square method is recommended. Conversion factors are proposed for electrical sensor measurements. The method to determine the conversion between the torque moment and the sensor current is the measurement tool. The formulas suggested are useful to produce an algorithm for a thorough data processing to measure a rotary viscometer.

Zulfahmi,2019: In micro-scale measurements, there is one research method, namely Brownian motion, since the advances in science and technology are increasing rapidly. Brownian movement is a spontaneous movement of multifaceted particles which can, because of collisions between the particles and the liquid molecules around them, be observed under the objective lens of a microscope. The author will discuss how the Brownian movement technique is used to assess the importance of liquid viscosity by the relationship between displacement of polymer particle size and the size of the particulates to be detected in various solution concentrations. The Brownian movement device was developed to calculate the viscosity of a liquid with an equipment that is simpler and cheaper using the minimum liquid quantity (in microliters) in place of traditional methods than using a viscometer, which has a large quantity of liquid (in millilitres). The measurement was based on optical systems like the sensor (Zeiss Axiocam 105 Color) and the objective microscope lens (50 magnification). The algorithms of MATLAB process image are used to capture the movement of particles through the optical system and process image recording effects. By using the correlation function before collecting data for each frame on particle displacement, particle movement direction can be traced. It indicates that the measured glycerin viscosities are not more than 10 percent accurate with the errors from the experiments performed using 10-40 percent glycerin concentrations and 1-micron particle. It also shows that for measured NaCl viscosities with concentration fluctuations of 0 percent, there is reasonable precision with errors of up to 7 percent; 50 percent, and 100 percent using 1 micron particle.

2.3 Material required for viscometer

S. A. Anjorin,2019: This article explains the design and testing of a locally manufactured viscometer. The need for a locally fabricated viscometer to measure the viscosity of lubricants is underpinned by the prohibitive cost of imported laboratory equipment such as the viscometers. The kinematic viscosities ofSAE 40, Palm oil and Soybean oil were measured using the fabricated viscometer. Experimental results showed that the viscosity of Palm oil and Soybean oil at 40 oC was40.87 mm2 /s and 32.01mm2 /s respectively. The viscosity of SAE 40 (Engine oil) was 13.65 ± 0.013 mm 2 /s (90% confidence level) at 100oC.

Mohammad Quqazeh,2016: It is now urgent to develop the measurement method and general-purpose control equipment that will allow us to analyse fluid rheological properties and to determine the dependence of the sample stress tensor on the deformation tensor over a wide range of strain rates. At the same time, it is a matter of practise to ensure that product properties are constantly monitored under the conditions of high precision and measurement automation.

Gokce Sevim Sariyerli, 2018: The present study was carried out using capillary viscometers to measure the Stabinger viscometer SVM 3001 and reference liquid viscosity with viscosity intervals varying between 1 and 5000 mm2 / s at 20 ° C to 80 ° C temperatures. The viscosity values are measured and the two results are compared based on our different estimates of liquids. The aim of this research is to compare the results of TUBITAK UME primary viscosity measurement and stamping viscometer and to contrast the measurement results based on the traceability of TUBITAK UME Stabinger Viscometre. Viscometer calibration fluids with a wide viscosity range are provided with a number of institutes and accredited national metrology laboratories. Standard practise is the use of water viscosity as the metrological basis of viscosity. A series of ubbelohde viscometers covering a kinematic viscus measurements range of approximately 0.5 mm2 / s to 100 000 mm2 / s is included in the TUBitak UME national viscosity standard. The key parameters which are calibrated directly by water are long capillary viscometers with a lower viscosity.

Ochei Emeka Stephen,2020: Viscosity plays a major role in the field of science and engineering. In liquids, knowledge of viscosity and flow parameters is crucial for their manufacturing, quality control and production. For various uses, the building industry makes use of various liquids. Building industry fluids include plasters, sealers, bond breakers, liquid floor hardeners, coatings, etc. From the proper measurements, conclusions can be made about their pumping power processing functions, spray shelf life as well as flow ability and application properties. It is necessary therefore to perform pertinent measurements with less expensive and reliable equipment. This paper demonstrates how a viscometer is developed, made and tested, by virtue of its flow rate through a discharge orifice, measures fluid viscosity. In the design of the viscometer, the following factors were used; corrosion resistance for material selection, ease of manufacture and use. The following results were obtained for measuring kerosene, ethanol and plasma: 0.00134, 0.0011 and 0.0034, respectively. The viscometer was used. These values compare favourably with various literatures and with an average error of 5.9 percent. This demonstrates the reliability, standard-setting and use of the established viscometer for laboratories, construction, food processing and educational purposes.

2.4 Analysis on types of viscometers

Tenison Basumatary,2017: A fibre optic sensor has been documented in this paper to measure the viscosity of Newtonian liquids. The sensor comprises a rectangular channel and two separate optical multimode fibres that are correctly inserted through the provided hole at the ends of the rectangular channel. The two optical fibres have a declad zone in order to allow the optical power to go away from regions when light is coupled into the fibre. As the right liquid type flows through the tube, liquid comes into contact with deluded zones reducing the optical leakage from the declad zones. In this case, the optical level available at the fibres' output ends varies one by one with a time delay. The time delay is proportional to the liquid viscosity and the inclination of the channel into which the liquid flows.

Sehyun Shin,2002: An revolutionary method for mass detection is a newly developed capillary viscometer that continuously tests the viscosity of non-Newtonian fluids at a range of shear speeds. The flow or pressure drop measurement normally required for capillary tuber visco metres can be replaced by a single measurement of liquid mass variance with time. We calculated changes in the mass flow rates by a capillaries cell and capillary using the time m(t), from which viscosity and shear rate were determined mathematically. An excellent deal for aqueous polymer solutions has been found between the findings of the mass capillary viscometer and the findings of the commercially available rotary viscometer. The limitations of traditional capillary visco metres measuring non-Newtonian fluid viscosity are overcome by this new method. First, the capillary viscometer detecting mass can calculate non-Newtonian viscosity reliably and continuously the other Provides convenience and low expenses with a wide variety of shear rates that are as low as I S-I (e.g. ease of use, no moving parts).

Rafael M. Digilov,2011: We describes an unstable capillary viscometer powered by pressure where liquid occurs being measured is pushed by compressed-air pressure through a capillary tube. The operating theory includes calculating the driving pressure versus time that gradually decays as the fluid flows and in a single calculation continuously covers a wide shear rate range. By the curve adjustment of experimental data for clear expression of the transient strain, the viscosity is determined in accordance with time. The theoretical viscosity technique of Newtonian and non-Newtonian liquids is illustrated by a laboratory bench test.

S.K. Kawatra,1996: A viscometry device consisting of a rotating vibratory viscometer and rotational viscometer for line viscosity measuring and rheological characterization of mineral slurries is formed in Newtonian or non-newtonian slurries. The viscosity of the settling mineral suspensions was measured with special attention. The viscosity measurements were as low as one centipoise, and the water viscosity at room temperature was measured. Both instruments could calculate the shear rate dependence of the viscosity together as the vibrating field viscometer worked much more marginally than the rotating viscometer. Soil silica was suspended in water by 80% to 65 pp and used for the preparation of slurries with different solids percentage points. The viscosity was simultaneously determined by both viscometers of each slurry and rheological properties of the slurry were compared. This method showed that all the silica gauze samples in the Newtonian fluid regime were in the defined size distribution (up to 70 wt percent solids).

2.5 Designing technologies

Sein Oh,2018: Viscosity is a possible quality control metric for a easy and fast evaluation of the quality of frying olive oil as a reliable measure of material changes. However, for widespread quality control applications, classical viscometers require enhanced performance, portability, reliability and usability. We have a 3D multi-canal viscometer, which is designed to measure viscosity clearly , effectively and multiplexed. The multichannel viscometer allows multiple fluid streams to be passed in parallel and their relative volumes are explicitly measured with the naked eye. by pushing the viscometer via the side. Consequently, unknown viscosity test fluids will simultaneously calculate the volume ratios between known viscosity reference fluids and unknown viscosity test fluids. The Viscometer has been shown as useful in quickly analysing the deterioration of vegetable oil while frying pipelines deeply, and recovering used frying oil following the application of an adsorbent in order to remove by-products of the frying phase with the 4-plex version of the multi-canal viscometer. The results of the multi-channel viscometer measurement were closely associated with the results of the commercial oil study. The multiplexing capability of the viscometer was demonstrated, 10-plex viscometer was developed and viscosity of 10 test liquids was simultaneously measured. These findings together demonstrate that the 3D multi-channel viscometer represents an effective tool to research the consistency of frying oil in resource-limited environments.

Puneeth S. B.,2018: Viscometers, for instance biochemical optimization, biomedical diagnostics and medication products, and various adulteration detections are commonly used in a wide range of applications for sensing and monitoring. In general, viscometers can be used in an integrated and detailed healthcare setting when understood in a microfluidic setting. Although several improvements have been made, the best production method, especially in relation to easier processing, costs and time, is one of the ongoing challenges of developing microfluidic devices. Here is a 3D electro viscometer (EMV) imitating the conventional viscometer in the East Forest. By measuring the transit time of the sample liquid relative to the referring fluid, the EMV checks for its viscosity under the laminar flow. The EMV was manufactured in a single step, using four electrodes fused on the 3D printer module base desktop. In order to assess viscosity it has been integrated and automated the entire network, the microfluidic unit, pumping system, data acquisition subs systems and signal processing subsystems.

Sungyoung Choi , 2018: Viscosity measurement as a potentially hemodynamic biomarker is critical for liquid substance quality control and clinical fluid viscosity testing. However, traditional viscometers and their micro-fluids usually depend on spacious and expensive equipment and cannot measure viscosity easily and in-field. We define 3D capillary circuits (3D-CCs) to address these problems and to calculate the viscosity of Newtonian fluids free from calibration. To address these problems, 3D-CCs are described. A syringe calibrated into a pressure buffer air chamber creates and retains constant pressure to move stressed fluids from the test fluids to 3D-CCs. The 3D-CCs fluid gradation chambers are a flux metre which allows for convenient measurement of fluid levels of test fluids flowing through the 3D-CCs. The viscosity in the test fluids can easily be determined by the flux rate in a fixed pressure setting without peripheral equipment and calibration. We illustrate the multiplexing ability of the 3D-CC system by measuring several Newtonian fluid specimens at the same time. In addition, reliance on the viscosity of a fluid other than Newtonian can be simultaneously investigated with the 3D-CC platform under different shear rate conditions.

Tuan D. Ngo,2018: Additive processing (AM) or 3D printing has main advantages: design independence, mass personalization, waste reduction, and the ability to manufacture complex structures, as well as rapid prototyping. Systematically evaluating the principal 3D printers, materials and performance in trend applications. Like bio-health, aerospace, buildings and defence systems, AM applications have been demonstrated. The current status of metal alloys, polymer composites, ceramics and cement production has been discussed. This paper also

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addressed key processing issues such as formation of voids, anisotropic behaviour, device design constraints and layer-by - layer appearance.

Ganzi Suresh et all[17] introduced different 3D printing technologies that define automotive , aerospace and medical applications. In general, this paper provides an overview of various types of viscometers, their architecture and materials, including an analysis of their benefits and disadvantages as benchmarks for future development and research.

Conclusion

In this review we disuses about different types of viscometers, design, materials and technology. The viscometer is often used for high-performance viscosity calculation by measuring various Fluid flows without interference from channels. The proposed 3D multichannel viscometer provides cost-effective, accurate, high-performance and field-specific fluid viscosity measurement. A simple and inexpensive 3-DP has been developed to build the mication system with a micro channel and integrated electrode interfaces desktop in one single step. Consisting of a micro fluid unit, microcontroller, and pumping mechanism, the EMV platform mimics the traditional Ostwald viscometer, allowing the fluid viscosity to be measured in a minute. The platform, which is similar to the bench top structures, was used to test the viscosities of three distinct fluids. Viscometers, for instance biochemical optimization, biomedical diagnostics and medicine products, and various adulteration detections are commonly used in a wide range of applications for sensing and monitoring. In principle, viscometers can be used in an integrated and detailed healthcare setting when understood in a microfluidic setting. The best production method is also one of the constant challenges, especially for simpler process, cost and time after so many developments, in the development of microfluidic devices.

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