



Review Article On Various Types Of Fluids

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Keywords :-

- Newtonian Fluid
- Non - Newtonian Fluid
- Casson Fluid
- Williamson Fluid
- Thixotropic Fluid
- Electrorheological Fluid
- Rheopectic Fluid
- Nano Fluid

Abstract :

The study of fluid dynamics, a subfield of physics, focuses on the Newtonian or non-Newtonian behaviour of fluids. Non-Newtonian fluids display a more complex behaviour than Newtonian fluids, which show a linear relationship between shear stress and shear rate. An overview of the several fluid types used in fluid dynamics is given in this review article, including viscoelastic fluids, shear-thinning and shear-thickening fluids, Newtonian fluids, and more. Each type of fluid's characteristics and uses are covered, with an emphasis on their significance in real-world fields like materials research, biomedical engineering, and the creation of consumer goods. The article emphasises how crucial it is to comprehend fluid behaviour in order to optimise procedures and create new materials and goods.

Introduction :

A subfield of physics called fluid dynamics examines how fluids—which are substances that may flow and adopt the shape of their container—behave. In many disciplines, including engineering, environmental science, and medicine, the study of fluid dynamics is crucial. Based on their behaviour and physical characteristics, fluids can be divided into many types, such as Newtonian fluids, non-Newtonian fluids, viscoelastic fluids, and more. For the development of new materials, the design of new technologies, and the optimisation of processes, it is essential to comprehend how these fluids behave. In this review article, we give a general overview of the different kinds of fluids used in fluid dynamics, their characteristics, and the different domains in which they are used. We talk about how it's crucial to comprehend fluid behaviour for real-world applications and how to apply that understanding to create technologies and procedures that are more effective.

The study of how gases and liquids behave under various conditions is known as fluid dynamics. In fluid dynamics, there are many different kinds of fluids, each with its own characteristics and behaviors. We will examine the various fluids studied in fluid dynamics in this review article.

(a) Newtonian liquids :

In fluid dynamics, the most frequently investigated fluids are Newtonian fluids. Because these fluids have a constant viscosity, no matter how much stress or shear rate is applied, their resistance to deformation does not change. The majority of oils, air, and water are Newtonian fluids.

(b) Fluids not Newtonian :

The viscosity of non-Newtonian fluids varies with the applied shear rate or stress. These fluids are more complicated and can be further categorized based on how they behave. Shear-thinning fluids like ketchup and shear-thickening fluids like cornstarch and water are two examples of non-Newtonian fluids.

(c) Incompressible liquids :

Incompressible liquids are liquids that can't be compacted, and that implies that their thickness stays steady under all circumstances. Examples of incompressible fluids include water and the majority of liquids. Because of their advantage of being incompressible, these fluids are frequently utilized in hydraulic systems.

(d) Compressible liquids :

Fluids that are compressible have a density that can change in response to a variety of conditions, such as changes in temperature and pressure. Examples of compressible fluids include gases. These liquids are much of the time utilized in aviation applications, where their compressibility considers effective impetus.

(e) Best fluids are :

Ideal liquids are hypothetical liquids that have zero consistency and are incompressible. There is no such thing as these liquids in nature, however they are many times utilized as a model for the way of behaving of genuine liquids. Because they simplify the equations that control fluid motion, ideal fluids are useful in the study of fluid dynamics.

(f) Genuine liquids :

Real fluids are those with a viscosity and the ability to compress or expand. The behavior of these fluids is frequently more challenging to predict because they are more complex than ideal fluids. In fluid dynamics, real fluids are studied to learn how they behave in real-world situations.

In conclusion, fluid dynamics is a huge field that deals with a wide variety of fluids with various properties and behaviors. Understanding the properties of various liquids is fundamental for the plan and investigation of numerous frameworks and applications, for example, aeronautic design, water powered frameworks, and synthetic handling.

(g) Quantum Fluid :

Due to their distinctive thermal properties, the relatively new category of fluid known as nanofluid has received a lot of attention from the scientific community. A nanofluid is a suspension of nanoparticles in a base fluid that typically have a size of less than 100 nm. A fluid's thermophysical properties, such as thermal conductivity, viscosity, and specific heat, are altered when nanoparticles are added, making it a promising fluid for heat transfer. The purpose of this paper is to provide an in-depth analysis of the most recent research on nanofluids, as well as their synthesis, characterization, and potential uses.

(h) Nano fluids :

The dispersion of nanoparticles in a base fluid, typically water or oil, is necessary for the synthesis of nanofluids. Nanofluids are synthesized using a variety of approaches, including one-step and two-step approaches. In the one-step method, the nanoparticles are added directly to the base fluid and agitated with ultrasonics to evenly distribute them. The nanoparticles are synthesized separately in the two-step procedure before being added to the base fluid. The thermal properties of the nanofluid are crucially affected by the quality of the dispersion in both approaches.

Details of various types of fluids :

1. Newtonian fluids :

1.1 Introduction:

One of the most basic categories of fluids in fluid dynamics are Newtonian fluids. Newton's law of viscosity states that there is a linear relationship between shear stress and shear rate. We will give an overview of Newtonian fluids, their characteristics, and their uses in a variety of sectors in this review article.

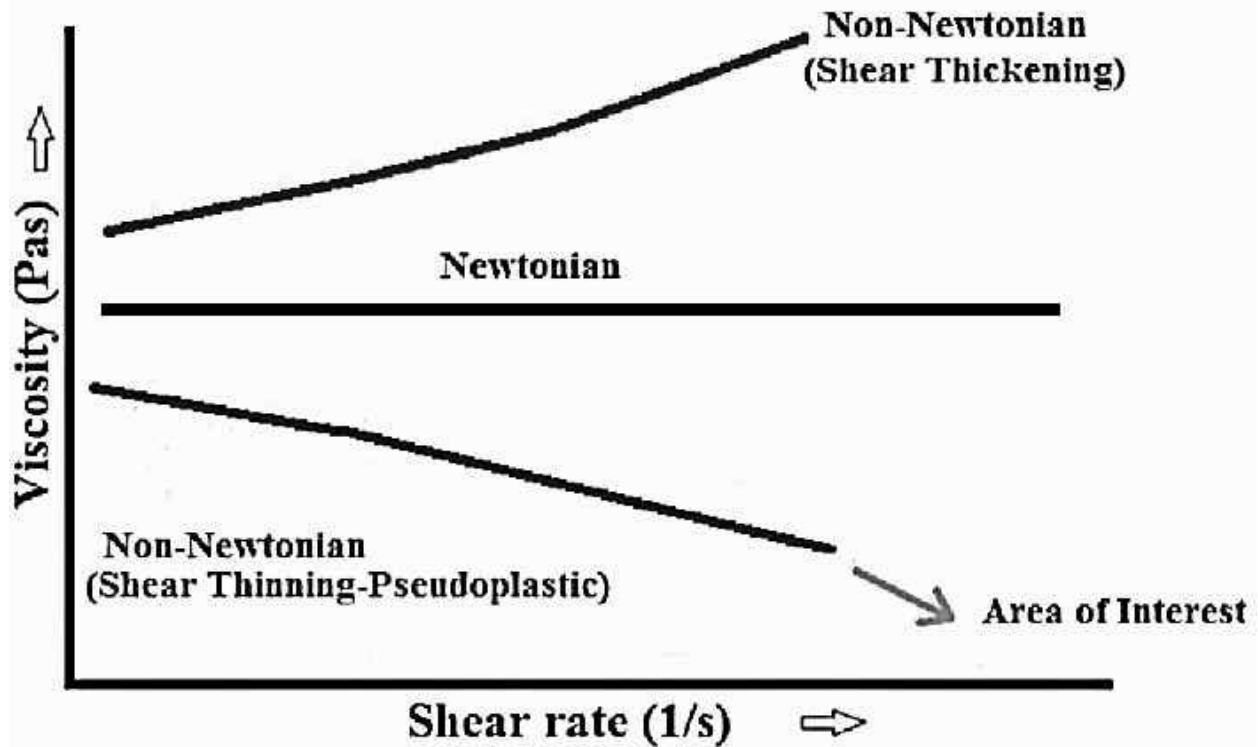
1.2 Definition and Properties :

Regardless of the shear rate, Newtonian fluids have a constant viscosity, or barrier to flow. This indicates that the shear stress, or force needed to distort the fluid, is inversely related to the shear rate. Shear stress and shear rate often exhibit a linear relationship in Newtonian fluids, as shown by the equation:

$$\tau = \mu * \gamma$$

where the viscosity, shear rate, and shear stress are three variables.

Viscosity, a metric of flow resistance, is one of the distinctive characteristics of Newtonian fluids. Newtonian fluids move predictably and are simple to model using mathematical equations because they have a constant viscosity. The density of Newtonian fluids, which defines their mass per unit volume, is another crucial characteristic.



1.3 Applications :

Many real-world uses for Newtonian fluids may be found in many disciplines, including engineering, medicine, and materials science. Water, air, as well as a variety of oils and lubricants, are typical examples of Newtonian fluids.

Newtonian fluids are used in engineering to build and improve fluid systems including pipelines, pumps, and turbines. Moreover, they are employed in the creation of coatings, adhesives, and other substances that need to have a regular and predictable flow behaviour.

Newtonian fluids are employed in a variety of therapeutic and diagnostic processes in medicine. For instance, blood plasma, a Newtonian fluid, is utilised in transfusions and blood testing. Other Newtonian fluids utilised in diagnostic and imaging procedures include saline solutions and contrast chemicals.

Newtonian fluids are used for polymers and other materials in materials research.

Newtonian fluids are employed in a variety of therapeutic and diagnostic processes in medicine. For instance, blood plasma, a Newtonian fluid, is utilised in transfusions and blood testing. Other Newtonian fluids utilised in diagnostic and imaging procedures include saline solutions and contrast chemicals. Newtonian fluids are utilised in materials research to create and test novel materials with certain qualities. For instance, scientists may employ Newtonian fluids to examine how polymers and other materials move, which can aid in the development of novel materials with enhanced properties.

1.4 Limitations:

Newtonian fluids are useful for simulating and forecasting flow behaviour, but real-world fluids, which might display more complex behaviour, are not always represented by them. Non-Newtonian fluids, for instance, can display shear-thinning or shear-thickening behaviour, meaning that the shear rate can alter the viscosity of the fluid. They may be more challenging to understand and anticipate as a result of this behaviour.

1.5 Conclusion:

A fundamental form of fluid in fluid dynamics is known as a Newtonian fluid, which is distinguished by a constant viscosity and a linear relationship between shear stress and shear rate. They have a wide range of real-world uses in many different industries, such as engineering, medicine, and materials research. Although they are helpful for simulating and forecasting flow behaviour, real-world fluids, which might display more complex behaviour, are not always represented by them.

2. Non-Newtonian

2.1 Introduction :

Certain fluids that do not adhere to Newton's law of viscosity's linear relationship between shear stress and shear rate are referred to as non-Newtonian fluids. As a result of their more complicated behaviour, such as shear-thinning or shear-thickening, these fluids' viscosities can vary with shear rates. We shall give an overview of non-Newtonian fluids, their characteristics, and their uses in many sectors in this review article.

2.2 Definition and Properties :

Fluids with viscosities that vary with shear rate or applied shear stress are said to have non-Newtonian fluids. As stated by Newton's law of viscosity, this indicates that the connection between shear stress and shear rate is not linear. Based on their flow properties, non-Newtonian fluids can be generally categorised into numerous groups :

Fluids that thin under shear: These fluids show a drop in viscosity as the shear rate is increased. Blood, paint, and ketchup are a few examples.

Fluids that thicken under shear: These fluids show an increase in viscosity as the shear rate rises. Examples include quicksand and solutions of cornflour.

Fluids with viscoelastic behaviour: These fluids can deform and then recover due to their combination of viscous and elastic activity. Gels and polymer solutions are two examples.

2.3 Applications :

Many real-world uses for non-Newtonian fluids may be found in many disciplines, including engineering, medicine, and materials science. Non-Newtonian fluids are frequently used in the following situations and examples:

Consumer goods and food: Many everyday items, like ketchup, toothpaste, and shampoo, are non-Newtonian fluids. For product development and manufacturing, it's critical to comprehend their flow behaviour.

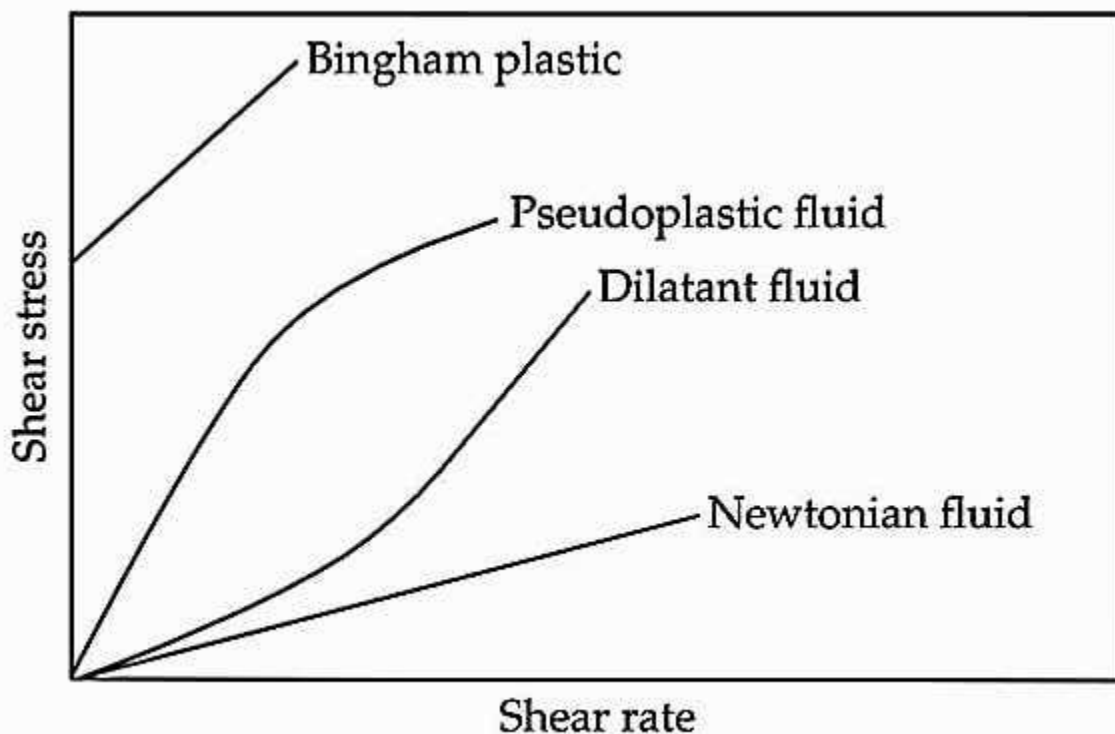
Industry for oil and gas: Several fluids used in this sector, like drilling muds and fracturing fluids, are non-Newtonian. It's crucial to comprehend how they flow in order to optimise drilling and production procedures.

Biomedical engineering: Because blood and other biological fluids do not flow Newtonianly, it is crucial to comprehend their flow characteristics while creating medical equipment and diagnostic procedures.

Non-Newtonian fluids can be used to create novel materials with particular qualities, like composites, coatings, and adhesives.

2.4 Limitations :

Despite the fact that non-Newtonian fluids have a wide range of useful applications, their complicated behaviour can make modelling and forecasting them challenging. For engineers and researchers dealing with these fluids, this can provide difficulties. Furthermore, generalising conclusions across many fluids and applications can be challenging due to the great diversity of non-Newtonian fluids and their distinctive flow behaviour.



In summary, non-Newtonian fluids are a vast class of fluids that display more intricate behaviour than Newtonian fluids, such as viscoelastic behaviour and shear-thinning and thickening. They have several real-world uses in many different industries, such as biomedical engineering, materials research, the production of food and consumer goods, and oil and gas. Understanding the flow behaviour of these materials is crucial for streamlining procedures and creating novel materials and goods, even if they can be challenging to model and forecast.

3. Casson Fluid

3.1 Introduction :

Non-Newtonian fluids like Casson fluid display viscous and elastic characteristics. It bears the name of E.W. Casson, a British rheologist who first put forth the concept in 1959. Casson fluid has a yield stress, which prevents it from flowing until a specific amount of shear stress is applied. We will give an overview of Casson fluid, its characteristics, and its uses in many fields in this review article.

3.2 Definition and Properties :

Non-Newtonian fluids like Casson fluid display viscous and elastic characteristics. The Casson model, which connects the shear stress to the shear rate, helps explain its flow behaviour. The following equation provides the Casson model:

$$\tau = \tau_0 + \mu C(\sqrt{\dot{\gamma}})$$

where the yield stress is τ_0 , the shear stress is τ , the Casson viscosity is μC , and the shear rate is $\dot{\gamma}$. A measure of a fluid's flow resistance, the Casson viscosity is influenced by the fluid's microstructure and intermolecular forces.

Casson fluid has a yield stress, which means that until a specific shear force is applied, it will not flow. The fluid starts to flow after the yield stress is exceeded and displays a nonlinear relationship between shear stress and shear rate. Moreover, Casson fluid has thixotropy, which implies that when it experiences continuous shear stress, its viscosity lowers with time.

3.3 Applications :

In a variety of industries, such as food and consumer goods, biomedical engineering, and the oil and gas sector, Casson fluid has numerous useful applications. Casson fluids are frequently used in the following applications:

Consumer goods and food: Many everyday items, like chocolate, ice cream, and mayonnaise, are Casson fluids. For product development and manufacturing, it's critical to comprehend their flow behaviour.

Biomedical engineering: Casson fluid is used in biomedical engineering to simulate how blood and other biological fluids flow. It's crucial to comprehend their flow behaviour when creating medical equipment and diagnostic procedures.

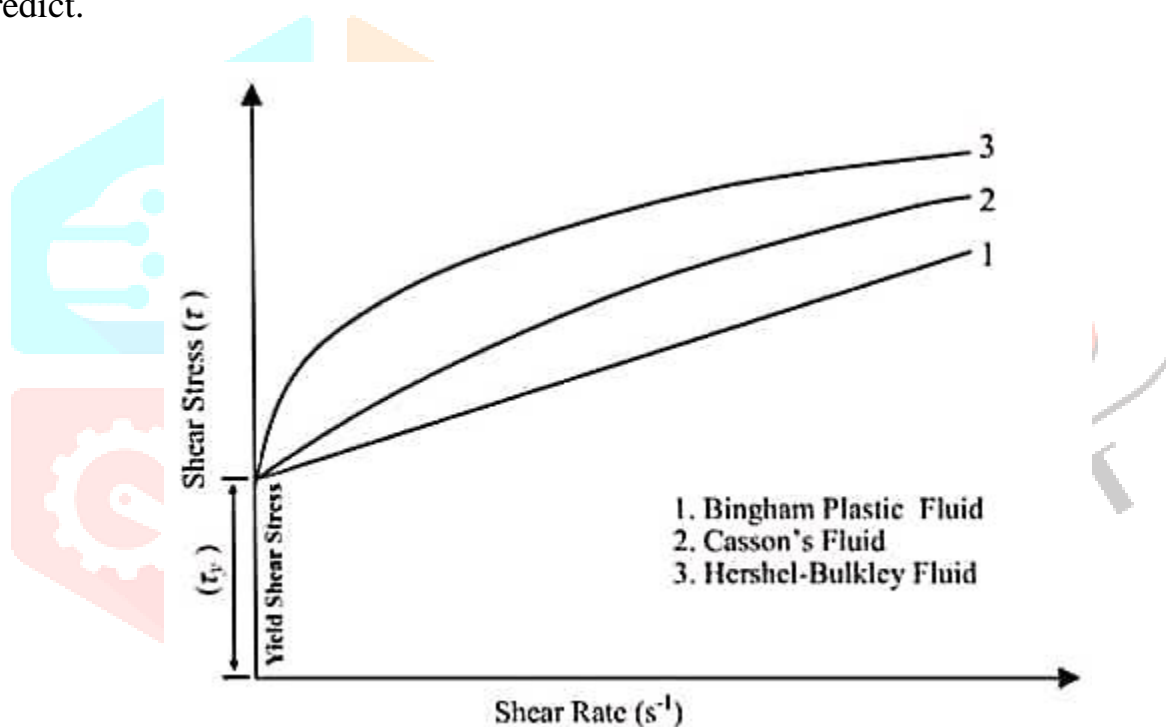
Oil and gas industry: Drilling mud and fracturing fluid flow behaviour is modelled using Casson fluid. It's crucial to comprehend how they flow in order to optimise drilling and production procedures.

3.4 Limitations :

Casson fluid offers a wide range of useful uses, but because of its complex behaviour, it can be challenging to analyse and predict. The Casson model also makes the assumption that the fluid is homogenous and isotropic, which might not be true in some real-world scenarios.

3.5 Conclusion :

Non-Newtonian fluids like Casson fluid display viscous and elastic characteristics. It has a yield stress that prevents it from flowing until a specific shear stress is applied. In a variety of industries, such as food and consumer goods, biomedical engineering, and the oil and gas sector, Casson fluid has numerous useful applications. Understanding its flow behaviour is crucial for optimising processes and creating novel materials and products, even though it can be challenging to describe and predict.



4. Williamson fluid

4.1 Introduction :

Non-Newtonian fluids that exhibit shear thinning characteristics are Williamson fluids. It bears the name of J.B. Williamson, a British mathematician who first put forth the model in 1960. Similar to other non-Newtonian fluids like Herschel-Bulkley and Bingham fluids, Williamson fluid exhibits a power-law relationship between shear stress and shear rate. Williamson fluid, its characteristics, and its uses in many fields will all be covered in this review article.

4.2 Definition and Properties :

Non-Newtonian fluids that exhibit shear thinning characteristics are Williamson fluids. The Williamson model, which connects the shear stress to the shear rate, helps explain its flow behaviour. The equation below yields the Williamson model:

$$\tau = K(\dot{\gamma})^n$$

where the shear rate is, the consistency coefficient is K, the shear stress is, and the power-law index is n. The fluid's resistance to flow is measured by the consistency coefficient, which is influenced by the fluid's microstructure and intermolecular forces. Lower values of the power-law index indicate stronger shear thinning behaviour, and it measures the degree of shear thinning.

Williamson fluid has shear thinning characteristic, which means that when the shear rate rises, its viscosity falls. This phenomenon is seen in a variety of real-world settings, including the processing of inks and polymers, where high shear rates are employed to encourage mixing and dispersion.

4.3 Applications :

Williamson fluid is used in a wide range of industries, including processing consumer goods, biomedical engineering, and materials science. Williamson fluid is frequently used in the following applications:

Materials science: The flow behaviour of polymers and colloidal suspensions is modelled using the Williamson fluid. For the creation of new materials and composites, understanding their flow behaviour is crucial.

The flow behaviour of blood and other biological fluids is modelled using the Williamson fluid in biomedical engineering. For the creation of medical equipment and diagnostic procedures, understanding their flow behaviour is crucial.

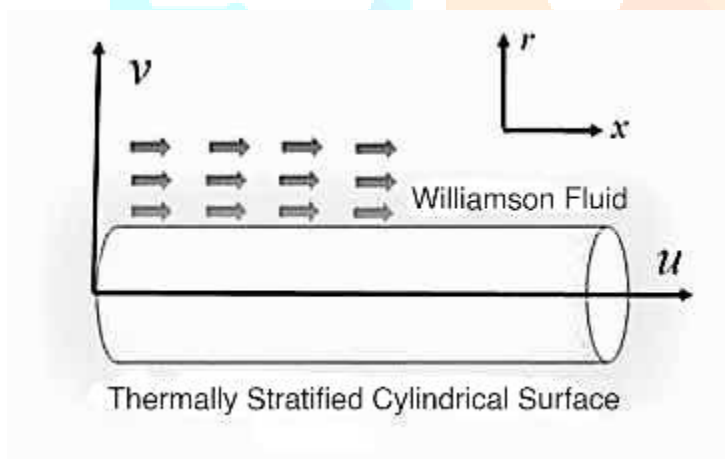
Many consumer goods, including inks, paints, and cosmetics, are processed with Williamson fluid. For product development and manufacturing, it's crucial to understand how they flow.

4.5 Limitations :

Williamson fluid offers a wide range of useful uses, but because of its complex behaviour, it can be challenging to analyse and forecast. The Williamson model also makes the assumption that the fluid is homogenous and isotropic, which may not be true in all real-world scenarios.

4.6 Conclusion :

Non-Newtonian fluids that exhibit shear thinning characteristics are Williamson fluids. Similar to other non-Newtonian fluids as Herschel-Bulkley and Bingham fluids, it exhibits a power-law connection between shear stress and shear rate. Williamson fluid has several real-world uses in many different industries, including as processing consumer goods, biomedical engineering, and materials science. Understanding its flow behaviour is critical for process optimisation and the creation of new materials and goods, despite the fact that it can be challenging to describe and predict.



5. Thixotropic fluid

A special family of fluids known as thixotropic fluids shows a reduction in viscosity over time with constant shear rates. The fluid returns to its initial viscosity as soon as the shear rate is halted. This activity results from the transient bonds that develop between fluid particles and dissolve under shear stress before reforming once the stress is removed. We shall talk about the characteristics and uses of thixotropic fluids in fluid dynamics in this review paper.

5.1 Properties :

Thixotropic fluids have a variety of intriguing characteristics that are advantageous in a variety of applications. Among the essential characteristics of thixotropic fluids are:

Thixotropic fluids show a decrease in viscosity over time when subjected to constant shear rates. The Bingham model or the Herschel-Bulkley model can both explain this pattern.

Behavior that Depends on Time: The behaviour of thixotropic fluids depends on time. The fluid's viscosity decreases as a result of the temporary bonds between particles dissolving under shear stress. The fluid regains its original viscosity when the stress is removed, causing the particles to re-form their bonds.

Temperature Dependency Thixotropic fluids are also temperature-sensitive, and as the temperature rises, so does their viscosity.

5.2 Applications :

Applications for thixotropic fluids in fluid dynamics include the following:

Thixotropic fluids are frequently employed as drilling fluids in the oil and gas sector. These liquids support the borehole and guard against formation damage.

Thixotropic fluids are used in paints and inks to increase flow and levelling characteristics, reduce settling, and prevent settling.

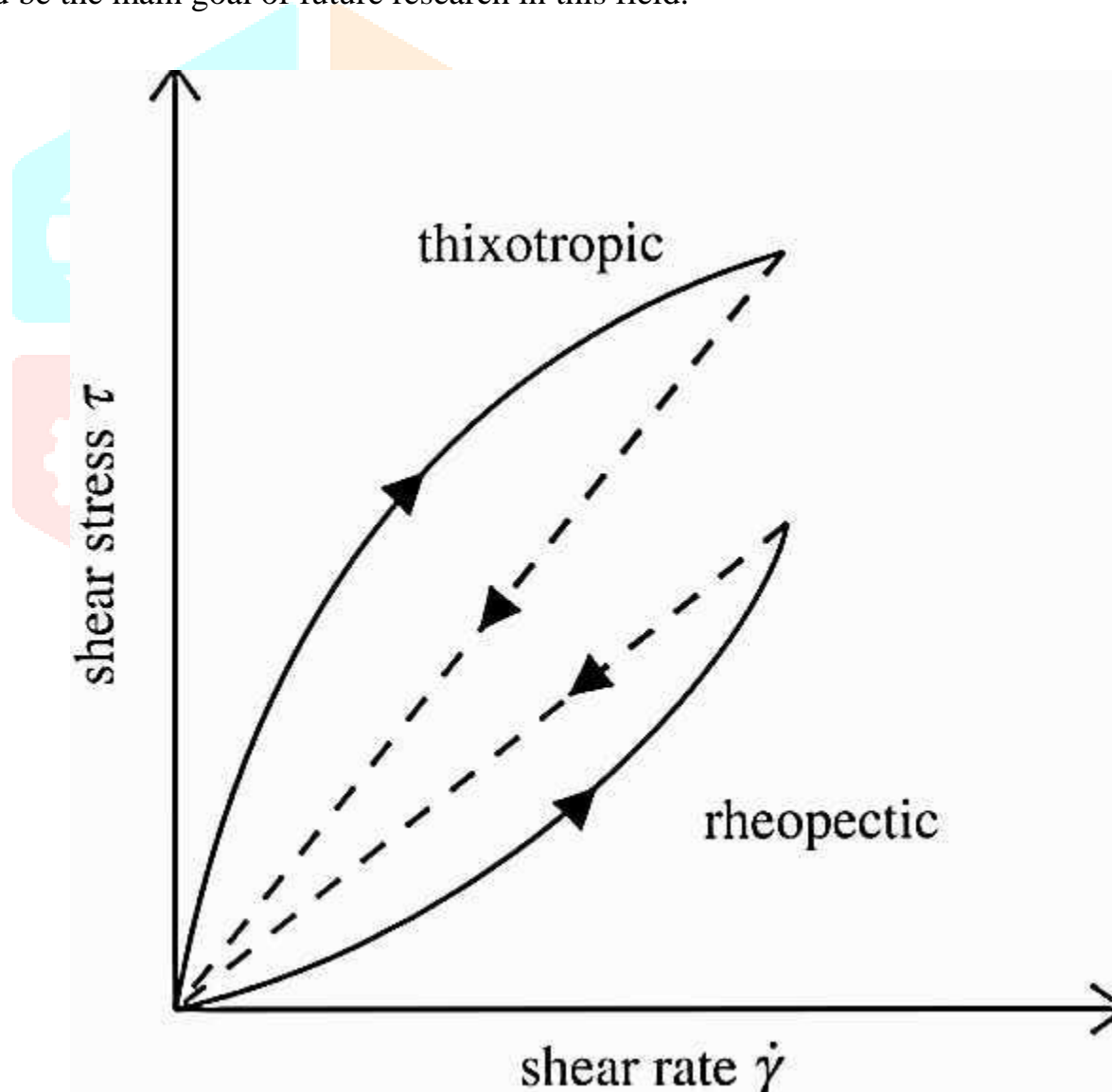
Thixotropic fluids are added to adhesives and sealants to enhance their application characteristics and stop sagging.

Food Processing: Thixotropic fluids are employed in the food sector to enhance consistency and texture.

Pharmaceutical Applications: To increase the stability and effectiveness of pharmaceuticals, thixotropic fluids are employed in drug delivery systems.

5.3 Conclusion :

A special family of fluids known as thixotropic fluids shows a reduction in viscosity over time with constant shear rates. These fluids are useful in a variety of applications, such as drilling fluids, paints and inks, adhesives and sealants, food processing, and medicines. They also exhibit a number of intriguing features. For processes to be optimised and new technologies to be developed, it is crucial to comprehend the characteristics and behaviour of thixotropic fluids. The development of new thixotropic materials with enhanced qualities for a variety of applications should be the main goal of future research in this field.



6. Electrorheological Fluid

Fluids classified as electrorheological (ER) display a reversible change in viscosity when exposed to an electric field. We shall talk about the characteristics and uses of ER fluids in fluid dynamics in this review article.

6.1 Properties :

ER fluids have a variety of intriguing characteristics that are helpful in a variety of applications. Among the essential characteristics of ER fluids are:

Viscosity: Under the influence of an electric field, ER fluids show a reversible change in viscosity. Depending on how strong the electric field is, the fluid's viscosity changes.

Time-Dependent Behavior: ER fluids exhibit time-dependent behaviour. Depending on how strong the electric field is, the fluid's viscosity changes.

Temperature Dependence: ER fluid viscosity is also temperature-sensitive, and it decreases as the temperature rises.

6.2 Applications :

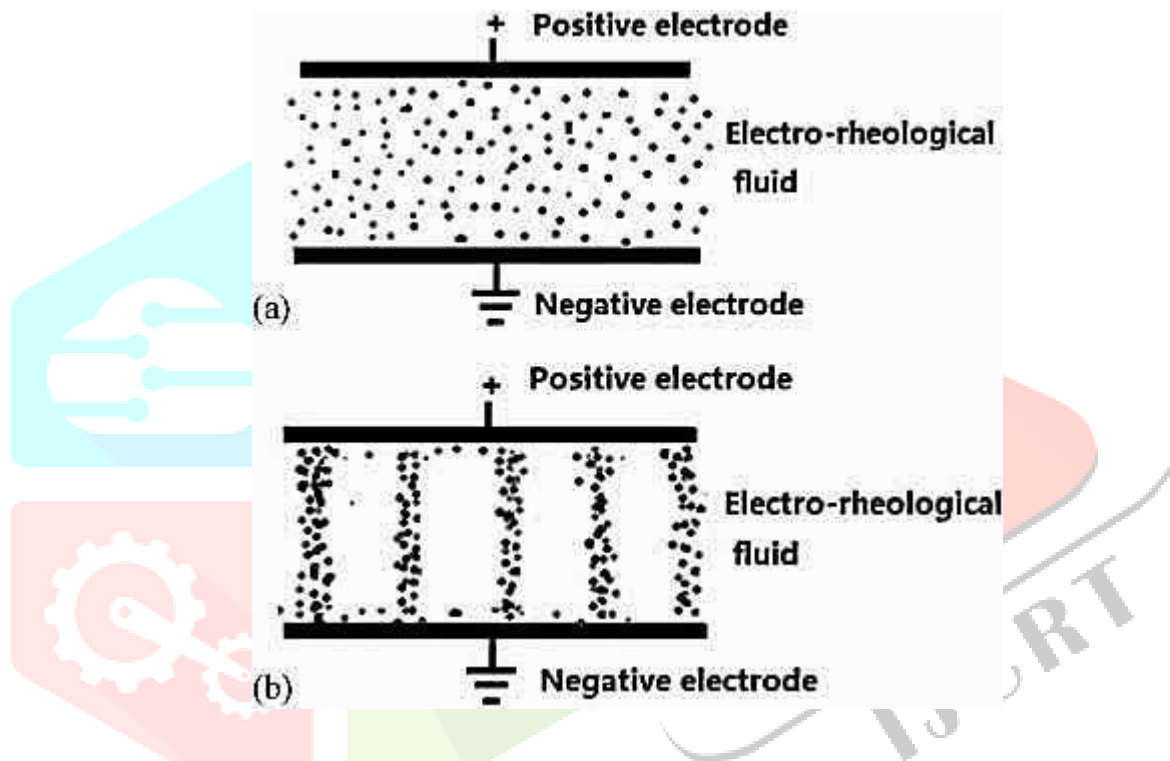
Applications for ER fluids in fluid dynamics include the following:

ER fluids are frequently employed in dampers to enhance the system's dampening capabilities. The damping force can be precisely regulated by modifying the electric field's intensity by altering the fluid's viscosity.

Brakes and clutches: To offer precise control of the torque transmission, ER fluids are also employed in brakes and clutches. The fluid's viscosity can be adjusted to change the amount of torque transfer.

Robotics and automation: To enable precise control of motion and force, ER fluids are utilised in robotics and automation systems. To give exact force and motion control, the fluid's viscosity can be adjusted.

Seismic Dampers: To enhance the dampening capabilities of buildings and other structures during earthquakes, seismic dampers utilise ER fluids.

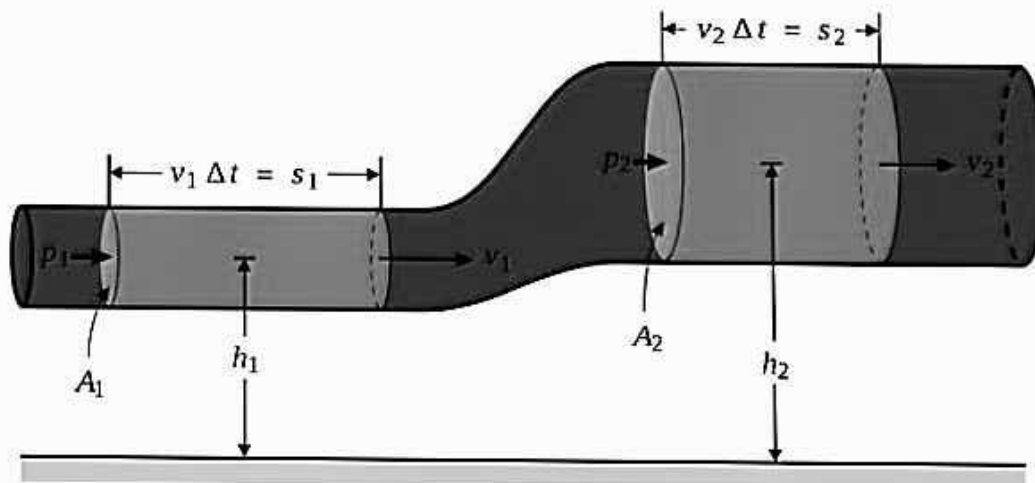


Medical Devices: To precisely control motion and force, ER fluids are also employed in medical equipment like prosthetic limbs.

6.3 Conclusion :

ER fluids are a special type of fluids that, when exposed to an electric field, exhibit a reversible change in viscosity. These fluids are useful in a variety of applications, such as dampers, clutches, and brakes, robotics and automation, seismic dampers, and medical equipment. They also have a number of intriguing features. For the sake of streamlining procedures and creating new technologies, it is crucial to comprehend the characteristics and behaviour of ER fluids. Future studies in this field should concentrate on creating new ER materials with enhanced characteristics for a variety of applications.

Electrorheological fluid



7. Magnetorheological Fluid

Smart fluids with the ability to be manipulated by an external magnetic field are known as magnetorheological (MR) fluids. We shall talk about the characteristics and uses of MR fluids in fluid dynamics in this review article.

7.1 Properties :

A number of intriguing characteristics exhibited by MR fluids make them valuable in a variety of applications. Among the essential characteristics of MR fluids are:

Viscosity: Under the influence of a magnetic field, MR fluids show a reversible change in viscosity. Depending on how strong the magnetic field is, the fluid's viscosity changes.

Behavior that Depends on Time: The behaviour of MR fluids depends on time. Depending on how strong the magnetic field is, the fluid's viscosity changes.

Temperature Dependence: MR fluids' viscosity is temperature-dependent, with viscosity reducing as temperature rises.

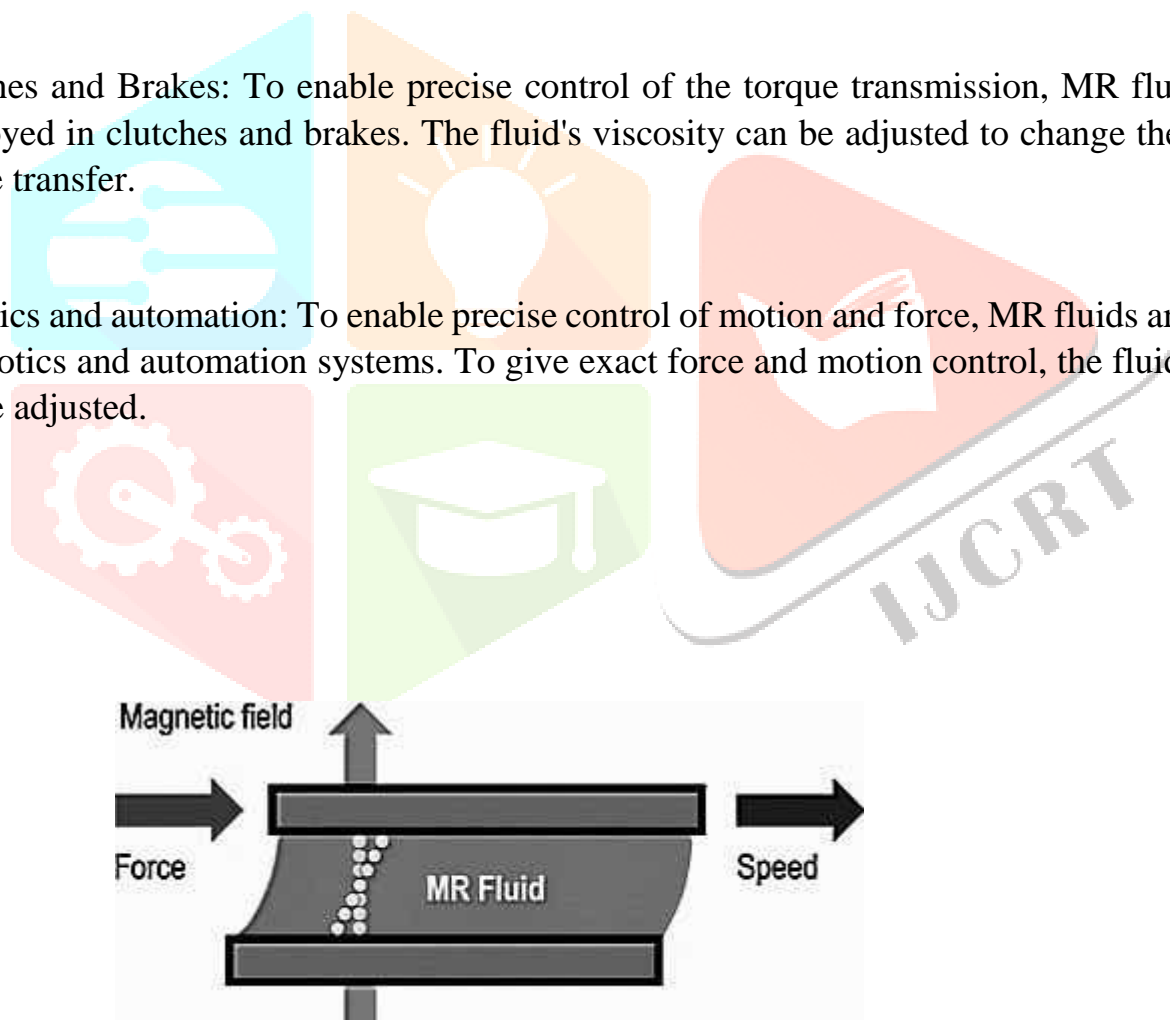
7.2 Applications :

Applications for MR fluids in fluid dynamics include the following:

MR fluids are frequently utilised in dampers to enhance the system's dampening capabilities. The damping force can be precisely regulated by modifying the magnetic field's strength by altering the fluid's viscosity.

Clutches and Brakes: To enable precise control of the torque transmission, MR fluids are also employed in clutches and brakes. The fluid's viscosity can be adjusted to change the amount of torque transfer.

Robotics and automation: To enable precise control of motion and force, MR fluids are employed in robotics and automation systems. To give exact force and motion control, the fluid's viscosity can be adjusted.

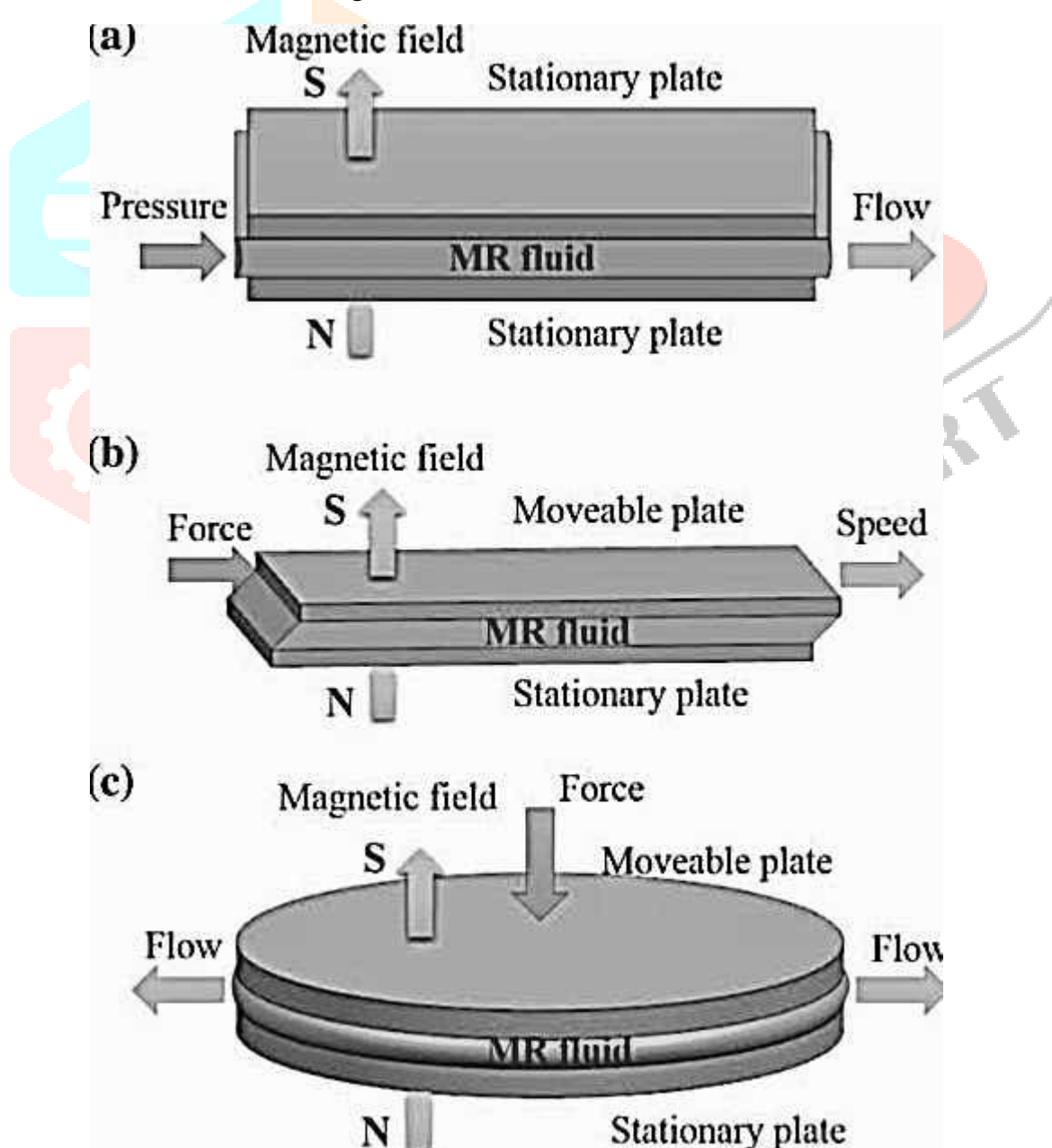


Seismic Dampers: To enhance the dampening capabilities of buildings and other structures during earthquakes, seismic dampers utilise MR fluids.

Medical Devices: To precisely regulate motion and force, MR fluids are also employed in medical equipment like prosthetic limbs.

7.3 Conclusion :

MR fluids are a special class of fluids that, when exposed to an external magnetic field, exhibit a reversible change in viscosity. These fluids are useful in a variety of applications, such as dampers, clutches, and brakes, robotics and automation, seismic dampers, and medical equipment. They also have a number of intriguing features. For processes to be optimised and new technologies to be developed, it is crucial to comprehend the characteristics and behaviour of MR fluids. The development of novel MR materials with enhanced properties for various applications should be the main goal of future research in this field.



8. Rheopectic fluid

Rheopectic fluids are a type of non-Newtonian fluid that exhibit an increase in viscosity with increasing shear rate. In this review article, we will discuss the properties and applications of rheopectic fluids in fluid dynamics.

8.1 Properties :

Rheopectic fluids have a variety of intriguing characteristics that are helpful in a variety of applications. Rheopectic fluids have a number of crucial characteristics, including:

Rheopectic fluids have an increase in viscosity as the shear rate rises. This indicates that when a fluid is subjected to a high shear rate, its viscosity increases.

Time-Dependent Behavior: Rheopectic fluids exhibit time-dependent behaviour. Under a constant shear rate, the fluid's viscosity grows over time.

Temperature Dependence: Rheopectic fluids' viscosity is likewise temperature-dependent, and it decreases as the temperature rises.

8.2 Applications :

Applications for rheopectic fluids in fluid dynamics include the following:

Printing: To control the flow of ink, rheopectic fluids are utilised in printing applications. Sharp, clean prints are produced because the fluid's higher viscosity at high shear rates prevents the ink from spreading out too much.

Oil Drilling: Rheopectic fluids are utilised to regulate the flow of drilling mud in oil drilling applications. The drilling mud is kept from flowing too quickly, which could pose issues while drilling, thanks to the fluid's higher viscosity at high shear rates.

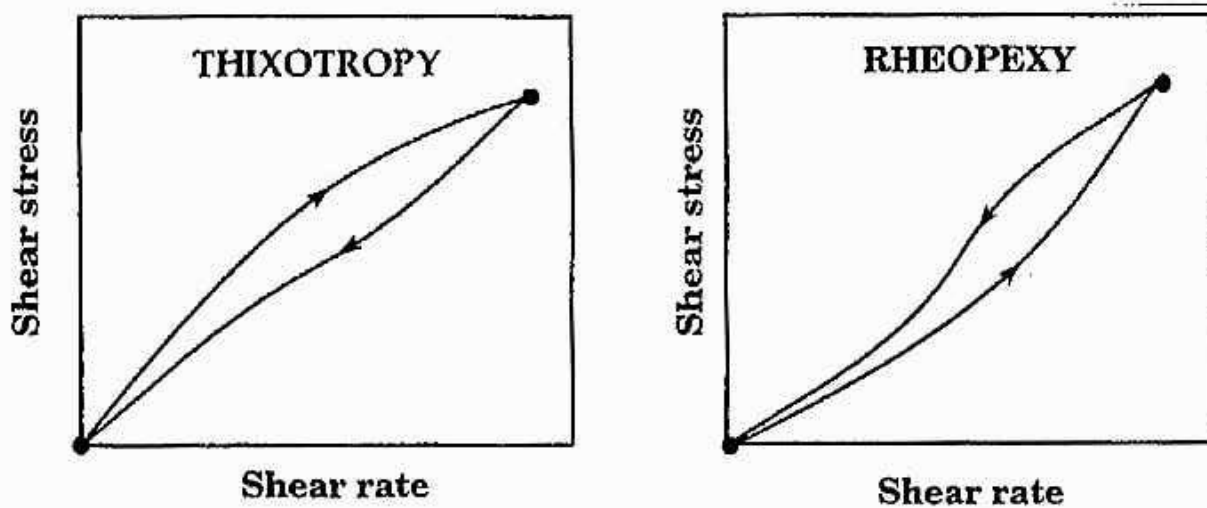
Food Processing: To manage the flow of different food items during food processing, rheopectic fluids are used. High shear rates increase the fluid's viscosity, which helps to prevent ingredient separation and enhance the overall texture of the finished product.

Pharmaceuticals : Rheopectic fluids are also employed in the pharmaceutical sector to regulate the flow of certain drugs. High shear rates cause the fluid's viscosity to increase, preventing the drug from flowing too quickly, which could impact the dosing and efficacy of the drug.

Paints & Coatings: To control the flow of the substance during application, rheopectic fluids are utilised in paints and coatings. A smoother, more even coating is produced as a result of the fluid's greater viscosity at high shear rates, which helps to reduce leaking and sagging.

8.3 Conclusion :

A special class of non-Newtonian fluid known as rheopectic fluids exhibits an increase in viscosity with increasing shear rate. These fluids are useful in a variety of applications, including printing, oil drilling, food processing, pharmaceuticals, and paints and coatings. They also have a number of unique features. For processes to be optimised and new technologies to be developed, it is crucial to comprehend the characteristics and behaviour of rheopectic fluids. The development of new rheopectic materials with enhanced qualities for a variety of applications should be the main goal of future research in this field.



9. Nano fluid

In order to improve the properties of a base fluid, nanoparticles are disseminated across nano fluids. We shall talk about the characteristics and uses of nano fluids in fluid dynamics in this review essay.

9.1 Properties :

A number of intriguing characteristics that nano fluids possess make them suitable in a variety of applications. Among the essential characteristics of nano fluids are :

Increased Thermal Conductivity: The basic fluid's thermal conductivity is improved by the inclusion of nanoparticles, making it more effective at transporting heat. When high heat transfer rates are necessary for cooling applications, this feature is especially helpful.

Increased Heat Capacity: Nano fluids are also more heat-resistant than pure fluids because they contain nanoparticles, which can absorb and release heat more efficiently.

Lower Viscosity: The lubricating effect of the nanoparticles causes nano fluids to typically have lower viscosity than the base fluid. In fluid flow applications, this feature may result in lower pumping power requirements and higher efficiency.

Nano fluids may be created so that they are stable throughout a wide range of temperatures and pressures, making them appropriate for use in a variety of industrial applications.

9.2 Applications:

Many fluid dynamics applications for nano fluids include:

Cooling systems: To enhance heat dissipation and prevent overheating, nano fluids are used in cooling systems for electronic equipment, such as computer chips.

Heat Exchangers: To improve heat transfer rates and decrease size and weight of the apparatus, nano fluids are employed in heat exchangers.

Nano fluids are utilised as lubricants in industrial machinery to lessen wear and friction.

Energy Storage: Due to their improved thermal properties, nano fluids are being investigated for use in energy storage applications, such as thermal storage systems.

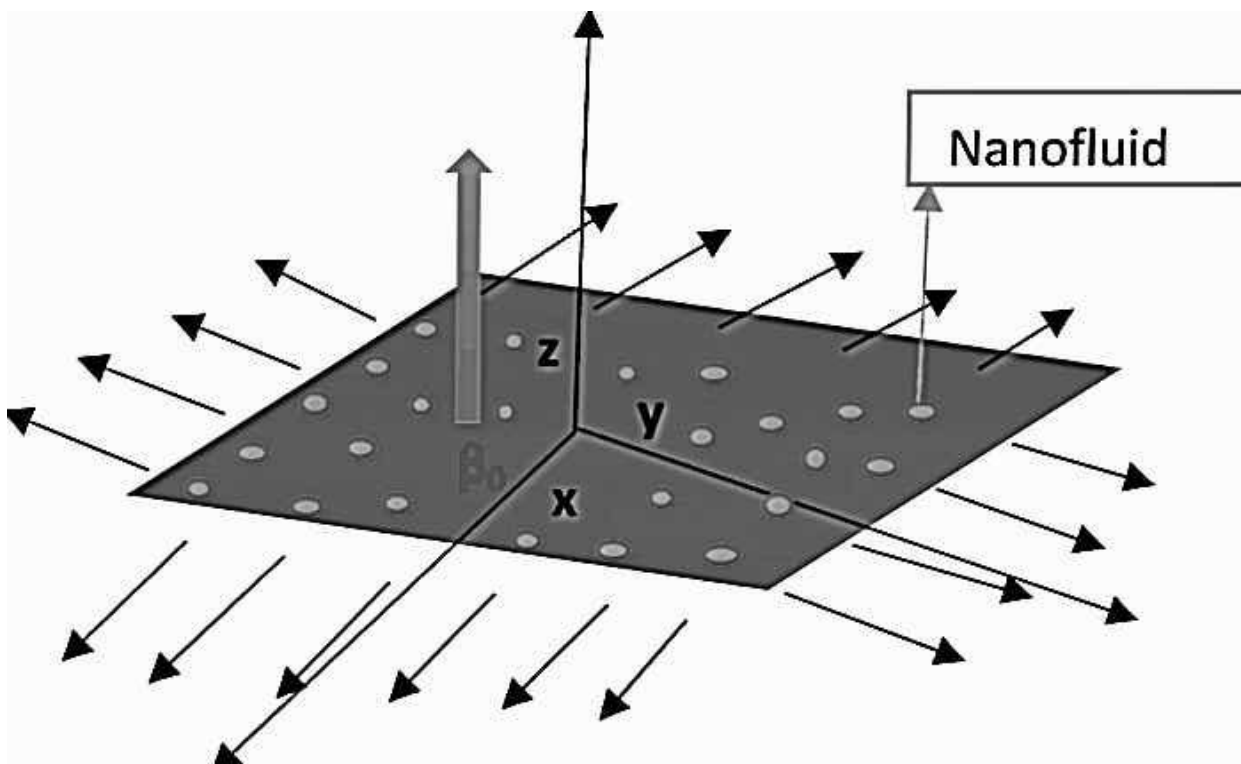
Nano fluids are being studied for use in drug administration, imaging, and therapeutic applications in medicine. Biomedical applications.

9.3 Issues and Upcoming Research

Despite the many advantages of nano fluids, there are still some difficulties in using them. The potential for nanoparticle aggregation, which might lessen the efficacy of the fluid, is one of the major problems. The development of novel methods for dispersing nanoparticles in the base fluid and enhancing the stability of the nano fluid under various conditions should be the main objectives of future research in this field.

9.4 Conclusion:

In order to improve the properties of a base fluid, nanoparticles are disseminated across nano fluids, a promising class of fluid. These fluids are used in a wide variety of fluid dynamics applications, such as lubricants, energy storage, cooling systems, heat exchangers, and biological ones. The development of novel methods for dispersing nanoparticles in the base fluid, enhancing the stability of the nano fluid, and enhancing their properties for particular applications should be the main objectives of future research in this field.



Review Article Discussion:

The review article gives a general overview of the several categories of fluids used in fluid dynamics, including viscoelastic, non-Newtonian, and Newtonian fluids. The paper emphasises how crucial it is to comprehend how these fluids behave in order to improve procedures, create new materials, and create new technologies. Newtonian fluids, which show a linear relationship between shear stress and shear rate, is one of the key themes covered in the article. These fluids, like air and water, are frequently encountered in daily life. The usage of these fluids in hydraulic systems, lubrication, and heat transmission are all covered in the article along with their characteristics and uses.

Non-Newtonian fluids, which behave in more complicated ways than Newtonian fluids, are another significant topic covered in the essay. These liquids consist of shear-thinning and shear-thickening fluids, whose viscosity varies according to the shear rate applied to them. The page addresses the characteristics and uses of these fluids, such as their use in biomedical engineering, consumer goods, and food processing.

The article also covers viscoelastic fluids, which exhibit both elastic and viscous properties. The behaviour of these fluids, which are present in biological systems including blood and mucus, is crucial for comprehending the workings of such systems. The article explores the characteristics and uses of viscoelastic fluids, including their role in tissue engineering and drug administration.

Overall, the review article offers a thorough summary of the numerous fluid types used in fluid dynamics, as well as their characteristics and uses. The paper emphasises how crucial it is to

comprehend how these fluids behave in real-world applications and how this understanding can be applied to create technologies and processes that are more effective.

Review Article Conclusion:

In conclusion, understanding fluid behaviour and its applications in diverse domains depends on the study of fluid dynamics. This review article has given a general overview of the several categories of fluids used in fluid dynamics, including viscoelastic, non-Newtonian, and Newtonian fluids. The essay has emphasised the significance of comprehending these fluids' behaviour for streamlining procedures, creating novel materials, and inventing cutting-edge technologies.

Newtonian fluids, which show a linear relationship between shear rate and shear stress, are frequently encountered in daily life and have many uses in a wide range of industries. Non-Newtonian fluids, which behave in a more complicated way than Newtonian fluids, have special qualities that make them valuable in the manufacturing of consumer goods, biomedical engineering, and food processing.

The presence of viscoelastic fluids, which behave both elastically and viscously, in biological systems has significant implications for medication delivery and tissue engineering. For the creation of more effective and efficient technologies and materials, it is essential to comprehend how these fluids behave.

In conclusion, this review article has given a thorough overview of the different kinds of fluids used in fluid dynamics, their characteristics, and their uses in a variety of sectors. The essay highlights the significance of ongoing research in fluid dynamics and underlines how understanding fluid behaviour is important for optimising procedures and creating new technologies.

Keypoints –

- Newtonian Fluid
- Non - Newtonian Fluid
- Casson Fluid
- Williamson Fluid
- Thixotropic Fluid
- Electrorheological Fluid
- Rheopectic Fluid
- Nano Fluid

References :

1. Bird, R.B., Stewart, W.E., & Lightfoot, E.N. (2002). *Transport Phenomena*, 2nd Edition. John Wiley & Sons, Inc.
2. Karniadakis, G., & Beskok, A. (2002). *Micro Flows: Fundamentals and Simulation*. Springer.
3. Bautista-Quijano, J.R., González-Trejo, E., & Gutiérrez-López, G.F. (2018). Review of rheological behavior of non-Newtonian fluids: Generalized Newtonian fluids, power-law fluids, and Herschel–Bulkley fluids. *Journal of Petroleum Science and Engineering*, 167, 1005-1017.
4. Bahramian, A., Sadrzadeh, M., & McKenna, T.F.L. (2019). Review of electrorheological fluids and their applications in soft matter devices. *Soft Matter*, 15, 1818-1841.
5. Jang, S.P., & Choi, S.U.S. (2011). Review of heat transfer and nanofluid. *Journal of Heat Transfer*, 133(4), 040801.
6. Sharma, R.K., & Kumar, R. (2016). A review of magnetorheological fluids and their applications. *Journal of Materials Science*, 51(21), 9683-9703.
7. Gao, S., Xu, W., & Li, D. (2018). A review of thixotropic behavior and its modeling in drilling fluids. *Journal of Petroleum Science and Engineering*, 169, 705-719.
8. Barnes, H.A. (1999). A review of the slip (wall depletion) of polymer solutions, emulsions and particle suspensions in viscometers: Its cause, character, and cure. *Journal of Non-Newtonian Fluid Mechanics*, 81, 133-178.
9. Saini, G., Chakraborty, S., & Das, P.K. (2019). A review of viscoelastic fluid flows: From theory to applications. *Journal of Non-Newtonian Fluid Mechanics*, 266, 72-116.
10. Ewoldt, R.H., Hosoi, A.E., & McKinley, G.H. (2017). New dimensions in microfluidics: Non-Newtonian fluids in microscale geometries. *AIChE Journal*, 63(7), 2538-2565.