Rheology of polymers pdf

Studying the flow of matter, Primarily in Liquid State Part series onContinuum Mechanics Laws Of Conservation Mass Momentum Energy Inequality Clausius-Spirit (Entropy) Solid Mechanics Strain Elasticity Of Hook Act Stress End strain Infinite Voltage Compatibility BendIng Contact Mechanics Friction Material Theory Mechanics Fluid Principle Dynamics The Principle of Bernoulli Navier-Stokes Equation Poiseuille Equation (en) Pascal Viscosity Act (Newtonian and Non-Newtonon) Floating (en) Mixing Pressure Liquid Surface Tension Capillary Action Of Gaza Atmosphere Boyle Act Charles Gay-Lussac Law Combined Law Of Plasma Gas Reology Viscoelastity Reometer Reometer Smart Fluid Electroreological Magnetorological Ferrofluids Scientists Bernulli Boyle riːˈɒlədʒi Cauchi Charles Euler Gay-Lussac Hooke from Greek ῥέω re, Flow and -λογία-logia, study) is the study of the flow of matter, primarily in a liquid or gas state, but also as soft solids or solids in conditions in which they react with a plastic flow rather than deforming elastic in response to applied force. Reology is an industry of physics, and it is a science that deals with the deformation and flow of materials like solids and fluids. The term rheology was coined by Eugene K. Bingham, a professor at Lafayette College, in 1920 at the suggestion of colleague Marcus Reiner. This term was inspired by the aphorism Of Simply (often attributed to Heraclitus), the panta-rey (πάντα ῥεῖ, This refers to substances that have complex microstructures such as dirt, sludge, suspensions, polymers and other glass exes (e.g. silicates), as well as many foods and additives, bodily fluids (e.g. blood) and other biological materials , and other materials that belong to the class of soft matter, such as food. Newtonian fluids can be characterized by a single viscosity factor for a specific temperature. Although this viscosity will change with temperature, it does not change at the speed of voltage. Only a small group of liquids exhibit such constant viscosity. A large class of liquids, the viscosity of which changes at the speed of voltage (relative flow rate), are called non-Newtonian liquids. Reology usually explains the behavior of non-Newtonian fluids, characterizing the minimum number of functions that are necessary to link stress with the rate of voltage change or voltage rate. For example, ketchup may have its viscosity reduced by shaking (or other forms of mechanical arousal, where the relative movement of different layers in the material actually causes viscosity), but water can't. Ketchup is a liquefaction material like yogurt and emulsion paint (US terminology latex paint or acrylic paint), exhibiting thixotropy, where an increase in relative flow speed will reduce viscosity, for example, by mixing. Some other non-Newton materials show the opposite behavior, reobceptivity: viscosity increases with relative deformation, and are called haircuts or dilate materials. Since Sir Isaac Newton originated the concept of viscosity, the study of fluids with tension-dependent viscosity is also often called Non-Newtonian fluid mechanics. The experimental characteristic of the reological behavior of the material is known as reometry, although the term reology is often used synonymous with reometry, especially by experimenters. Theoretical aspects of reology are the relationship between the current/deformation of the material's behavior and its internal structure (e.g., the orientation and elongation of polymer molecules), as well as the behavior of the flow/deformation of materials that cannot be described by classical fluid mechanics or elasticity. In practice, rheology is mainly associated with the expansion of the continuum mechanics to characterize the flow of materials, which demonstrates a combination of elastic, viscous and plastic behavior through the correct combination of elasticity and (Newtonian) fluid mechanics. It also makes predictions of mechanical behavior (on a continuum mechanical scale) based on the micro or nanostructure of the material, such as the molecular size and architecture of polymers in the solution or the distribution of particle size in solid suspension. Materials with fluid characteristics will flow under stress, which is defined as strength in the area. There are different types of stress (e.g. haircut, torsion, etc.) and materials can react differently to different stresses. Most of the theoretical reology is related to the binding of external forces and torque with internal voltages and internal voltage gradients and flow speeds. The Continuum of MechanicsSy of The Physics of Continuous Materials Solid MechanicsSed physics of continuous materials with a certain form of rest. ElasticityDescribes materials that return to their form of rest after stress are removed. Plasticity Gives materials that are constantly deformed after sufficient applied stress. RheologySing materials with both solid and liquid characteristics. Fluid MechanicsIs physics of continuous materials that deform at an object of force. Non-Newtonian fluids are not subjected to loads proportional to the stress of removing flushes. Newtonian fluids are subjected to loads proportional to the stress exerted by the haircut. Reology unites seemingly unrelated areas and non-Newtonian fluid fluid Recognizing that the materials undergoing these types of strain are unable to maintain stress (particularly the stress of haircuts, since it is easier to analyze haircut deformities) in static equilibrium. In this sense, solid plastic deformation is a liquid, although this flow is not associated with the viscosity factor. Granular reology refers to the continuum of mechanical description of granular materials. One of the main objectives of reology is to empirically establish a relationship between strains (or the rate of deformation) and stress through adequate measurements, although a number of theoretical changes (such as framework-intaration) are also required before using empirical data. These experimental methods are known as reometry and are associated with definition with well-defined reological material functions. Such relationships are then replaced by mathematical processing by established methods of continuum mechanics. The characteristic of flow or strain originating from a simple stress field of a haircut is called rhubarb rona (or revere of a curlog). The study of elongated threads is called lengthened reology. The flow of lard is much easier to study, and thus there is much more experimental data on the flow of sl. Viscoelasticity Home article: Viscoelasticity fluid and solid nature are relevant for a long time: We consider the application of permanent stress (called creep experiment): if the material, after some deformation, eventually resists further deformation, it is considered solid if, on the contrary, material flows indefinitely, it is considered a transient liquid In contrast, elasticity and binding (or intermediate) : 9 if the strain of the material deformation increases linearly with increasing applied force, the material is linear elastic within the range it shows recoverable strains. Elasticity is essentially being independent processes as strains appear the moment stress is applied, with no delays in time. if the deformation rate of the material increases linearly with an increase in the applied voltage, the material is viscous in the Newtonian sense. These materials are characterized by the delay in the time between the constant load and the maximum voltage. if the materials behave as a combination of viscous and elastic components, the material is viscous. In theory, such materials can show both instant deformation as elastic material and deformation, depending on time, as in liquids. Plasticity is a behavior observed after a material is exposed to the stress of profitability: a material that behaves as hard at low applied loads can begin to flow above a certain level of stress called the stress of profitability The term plastic solid is often used when this threshold of plasticity is quite high, while exit stress fluid is used when the threshold stress is quite low. However, there is no fundamental difference between the two concepts. Deborah's immeasurable number number Home article: Deborah's number at one end of the spectrum we have inviscid or plain Newtonian fluid, and at the other end, hard solid; thus, the behavior of all materials falls somewhere between these two ends. The difference in material behavior is characterized by the level and nature of elasticity, present in the material when it deforms, which takes material behavior to the non-Newton regime. Deborah's immeasurable number is intended to account for the degree of non-Newton behavior in the stream. Deborah's number is defined as the ratio of characteristic relaxation time (which depends solely on the material and other conditions, such as temperature) to the nature of the time of the experiment or observation. The small Deborah numbers represent the Newtonian flow, while the non-Newtonian (with both viscous and elastic effect is present) behavior occurs for intermediate deborah range numbers, and Deborah's high numbers indicate elastic/hard solid. Because Deborah's number is a relative number, a number or denominator can change the number. A very small number of Deborah can be obtained for fluid with very little relaxation time or a very large experimental time, for example. Reynolds Room Home article: Reynolds Room In Liquid Mechanics, Reynolds' Number is a measure of the ratio of inertial forces (v s s s s'displaystyle v_'rho) to viscous forces (μ L displaystyle frac mu L) and therefore he quantifies the relative value of these two types of effect for the flow of this condition. At low reynolds, Reynolds is dominated by viscous effects and laminar flow, while Reynolds' high numbers are dominated by inertia and the flow can be turbulent. However, because rheology is associated with fluids that do not have fixed viscosity, but which can vary depending on flow and time, calculating Reynolds' number can be difficult. It is one of the most important non-changing numbers in fluid dynamics and is usually used along with other immeasurable numbers to provide a criterion for determining dynamic simuteity. When two geometrically similar flow patterns, perhaps in different liquids with possibly different flow speeds, have the same values for the corresponding non-measurements, they are said to be dynamically similar. Typically, it's given as follows: R e and u s 2 L μ u l 2 and u s L μ u s s s (display) {2} u_ Frak u_sL'{2} frac (frac) u_ with M s (u_) where: we are the average speed, flow, flow m s1 L - characteristic length, (m) μ - dynamic fluid viscosity, N s m2 or Pa s - kinematic viscosity of liquid: v μ Displaystyle vfrac (mu yohu) , m2 s1 - fluid density, kg3. Measuring reometers are tools used to characterize the reological properties of materials, usually liquids that melt or dissolve. These tools impose a specific stress field or fluid deformation, and control as a result of deformation or stress. Tools can work in a steady stream or oscillator streams, both in haircut and extension. The application of reology has applications in materials science, engineering, geophysics, physiology, human biology and pharmaceuticals. Materials science is used in the production of many industrially important substances such as cement, paint and chocolate, which have complex flow characteristics. In addition, the theory of plasticity is also important for the design of metal formation processes. The science of reology and the characteristics of viscous and viscous properties in the production and use of polymeric materials are crucial for the production of many products for use in both the industrial and military sectors. Studying the properties of fluid flow is important for pharmacists working in the production of several forms of dosage, such as simple liquids, ointments, creams, pastes, etc. Flow properties are used as important quality control tools to maintain product superiority and reduce batches to batch variations. Examples of materials science polymers can be given to illustrate the potential application of these principles to practical problems in the processing and use of rubber, plastic, and fibers. Polymers are the main materials of the rubber and plastic industry and are vital for the textile, oil, automotive, paper and pharmaceutical industries. Their viscous and viscous properties determine the mechanical characteristics of the final products of these industries, as well as the success of processing methods at the intermediate stages of production. In visco-elastic materials, such as most polymers and plastics, the presence of liquid behavior depends on properties and therefore depends on the speed of the load applied, i.e. how quickly the force is applied. The silicon toy 'Silly Putty' behaves quite differently depending on the speed of use of force. Pull on it slowly, and it shows a continuous flow, similar to that which manifests itself in a very viscous liquid. In addition, with a strong impact and directly, it collapses like silicate glass. In addition, conventional rubber passes a glass crossing (often called the rubber glass transition). For example, the Space Shuttle Challenger disaster was caused by rubber which were used well below the temperature of the glass on the Florida's unusually cold morning, and thus cannot be flexible adequately form proper seals between sections of two solid-fuel rocket boosters. Biopolimiers Linear Cellulose Structure is the most common component of all organic plant life on Earth. Note the evidence of hydrogen bonding, which increases viscosity at any temperature and pressure. This is an effect similar to a polymer cross, but less pronounced. Sol-gel Home article: Salt-gel polymerization process tetraethylortosylitis (TEOS) and water to form amorphous hydrated silica particles (Si-OH) can be controlled by reology using a number of different methods. With sol viscosity adjusted in the proper range, and optical quality glass fiber and fireproof ceramic fiber can be drawn which are used for fiber optical and insulation sensors, respectively. Hydrolysis and condensation mechanisms, as well as the reological factors that side with structure in the direction of linear or branched structures, are the most important issues of science and technology of salt gel. Geophysics Science Discipline geophysics involves studying the flow of molten lava and studying the flow of debris (liquid landslides). This disciplinary branch also deals with the Earth's solid materials, which are only manifested on an extended time scale. Those that exhibit viscous behavior are known as rheids. For example, granite can flow plastically with little yield stress at room temperature (i.e. viscous flow). Long-term creep experiments (10 years) show that the viscosity of granite and glass in the environment is at about 1020 equilibrium. Physiological physiology involves the study of many bodily fluids that have a complex structure and composition, and thus possess a wide range of viscous and viscous flow characteristics. In particular, there is a special study of blood flow called hemorrheuology. This is the study of the properties of blood flow and its elements (plasma and formed elements, including red blood cells, white blood cells and platelets). Blood viscosity is determined by the viscosity of plasma, hematocrit (a large proportion of red blood cells, which make up 99.9% of cellular elements) and mechanical behavior of red blood cells. Thus, the mechanics of red blood cells is the main determinant of the properties of blood flow. Nutritional reology Nutritional Reology is important in the production and processing of foods such as cheese and ice cream. Thickening agents, or thickeners, are substances that, when added to the aqueous mixture, increase its viscosity without significantly altering other properties such as taste. They provide the body, increase stability and improve the suspension of added ingredients. Thickening agents often as food additives and in cosmetics and personal care products. Some thickeners are gel-forming agents that form the gel. Agents Agents materials used to thicken and stabilize liquid solutions, emulsions and suspensions. They dissolve in the liquid phase as a colloidal mixture, which forms a loosely cohesive internal structure. Food thickeners are often based either on polysaccharides (starches, vegetable gums and pectin) or on proteins. The work of concrete and mortar of concrete and mortar is associated with the reological properties of fresh cement paste. The mechanical properties of hardened concrete increase if less water is used in the construction of the concrete mixture, but reducing the ratio of water to cement can reduce the ease of mixing and application. To avoid these undesirable effects, superplasticizers are usually added to reduce the apparent stress of yield and viscosity of fresh pasta. Their addition greatly improves concrete and mortar properties. Filled polymer reology Incorporating different types of fillers into polymers is a common means of reducing costs and giving the resulting material certain desirable mechanical, thermal, electrical and magnetic properties. The benefits that are filled with polymer systems should offer come with increased complexity in reological behavior. Usually, when using fillers, a trade-off is considered between improved mechanical properties in solid condition on the one hand and increased complexity in processing the melt, the problem of achieving a uniform filler variance in the polymer matrix and the economics of the process through an additional step of connection on the other. The reological properties of filled polymers are determined not only by the type and quantity of filler, but also by the shape, size and size of the distribution of its particles. The viscosity of the filled systems usually increases with the increase in the fraction of the filler. This can be partially improved by broad particle size distributions through the Farris effect. An additional factor is the transfer of voltage to the polymer filler interface. Interphacial adhesion can be significantly enhanced by a communication agent that sticks well to both polymer and filler particles. Thus, the type and volume of processing of the filler surface are additional parameters affecting the reological and material properties of filled polymer systems. It is important to take into account the walls of the slip when performing the reological characteristics of highly-filled materials, as there may be a big difference between the actual strain and the measured strain. A relogologist is an interdisciplinary scientist or engineer who studies the flow of complex fluids or deformation of soft solids. This is not an initial subject; there is no qualification of the reologist as such. Most reologists have qualifications in mathematics, physical sciences (e.g. chemistry, physics, geology, biology), engineering (e.g. chemical, materials science, plastic engineering and engineering or civil engineering), medicine, or certain technologies, in particular materials or food. Typically, a small amount of reology can be studied when obtaining a degree, but a person working in reology will expand this knowledge during postgraduate studies or by attending short courses and by joining a professional association (see below). See also Bingham Plastic Die swell glass transition liquid list of microreology relogology relogology welding for thermoplastic Reopexic solid slow-tropics Transport phenomena Viscosity Interracial Reology Links - b c W. R. Chauwalter (1978) Mechanic of non-Newtonian liquids Pergamon ISBN 0-08-021778-8 - James Freeman Steffe (January 1, 1996). Reological methods in the engineering of food processes. Freeman Press. 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