Non-newtonian fluids

By Vincent

This report about the uses, effects and explanations of Non-newtonian fluids will be really inspiring and understandable. I find this an interesting topic that is fascinating and involves a bit of thinking. Once I knew them, Non-newtonian fluids immediately caught my interest. If Humans can walk on something 'Liquid' that must be something special, and it kind of is. If it is so special, you might be wondering if it can also be used for other things. Non-newtonian fluids can save many lives in war struck areas, they can protect us from bruises and they can be delicious. Did you know that there are actually more Non-newtonian fluids than newtonian fluids(Marti Hendrichs). Find out more in the text below.

Non-newtonian fluids - What are they?

A non-newtonian fluid is a fluid who's viscosity depends on pressure applied on it. Viscosity is the regulation of the ability for a fluid to flow. The higher the viscosity, the slower the flow of the fluid.(For example water has got a lower viscosity than honey) In some examples the viscosity decreases with pressure, in others, the viscosity increases with pressure. An example of a fluid with increasing viscosity is Oobleck. (A suspension (mixture) of cornflour and water) Ketchup is an example with decreasing viscosity.

Shear thickening fluid

Definition- Experts say that shear thickening fluid is a fluid which when stress is applied instantly increases its viscosity. Stress is the pressure applied on the fluid on a certain point. Stress is followed by strain, Strain is the effect on the object.(If a metal is hit by a hammer, that that causes stress. The stress makes a dent. The strain is the amount of deformation (dent) in the metal.) A common example of shear thickening fluid is Oobleck(Cornstarch and water). If Oobleck is held in the hand without any pressure, it will run between the fingers. If it is under pressure it acts like a solid. If there is a pool filled with oobleck someone can run over it because the feet apply pressure.

But how does it work?

According to Ms. Greenland, in the example with oobleck, when a force is applied to the fluid by something suddenly (egs. hand), then the water between the cornstarch squirts out leaving a spot with nearly only cornstarch, a solid.

It is like a classroom with lots of desks. If someone would shove everyone out, they would bump into the desks and each other causing a jam of people. If someone would ask everyone nicely to leave the room, they would all find a way out, without getting stuck.

The Itai Cohen group from the Cornell University found out that the bigger the applied pressure the more the ‘second theory’ works.
The ‘second theory’ is that when we apply pressure, the particles get pushed together and touch each other. They form something called a ‘Hydro cluster’ as the name says, it is a group of molecules that move together. Because they touch each other, a force called the contact force works so we can’t move the fluid. The whole fluid gets blocked by friction.(Summary from the Itai cohen group cornell university) It’s like getting jammed.

According to a summary from Alice Greenland made from the recent studies from a team of the US National Institute of Standards and Technology (NIST) and Georgetown University, both theories work at different places at different times/stages of the process. Also, if the water leaves one place of the oobleck, it has to go somewhere else, so it goes to the rest of the fluid, making that more liquid.

Shear thinning fluids(Pseudoplastics)

Definition - A shear thinning fluid is a fluid with the characteristics of decreasing its viscosity with increasing pressure. The more pressure is applied, the runnier it gets. If a bottle is held the wrong way around then the Ketchup will stay in it… At least until it is shaken, hit or pressed. Which all act pressure of some kind to the Ketchup.
Shear thinning fluids are usually seen in suspensions(Mixtures) of some kind.

According to wikipedia a few examples of a shear thinning fluid are blood, ketchup, paint and whipped cream.

So… How does it work?

The information from Meredith Duffy claims that the reason for the behavior of shear thinning fluids is still not fully understood, not even by experts. It is believed that the pressure applied on the fluid rearranges the molecules so that they can flow over each other more easily. The easier molecules flow over each other the runnier it gets. The reason that liquids can flow because the cohesive force is weak enough to let the molecules flow over each other. How a liquid flows is that the rows of molecules slide over each other, so the fluid can change shape. The easier the molecules flow over each other the less the viscosity.

Uses of Non-newtonian fluids

Non-newtonian fluids have a variety of different uses. Most of them head in the same or similar directions. Some could save lives or protect us, others could stabilise buildings or make life more comfortable.

Shock Absorbers

Scientists have worked on a fluid that contains metal parts. This fluid has the properties of getting solid when it is near an electromagnet. Inventors used that fluid and a computer chip controlling an electro magnet to make extremely efficient shock absorbers. The computer chip changes the viscosity of the fluid within milliseconds to steady the car. The mechanics work so fast that the fluid changes within a bump. This enables a ride that

is comfortable. The military wants to use this mechanism.(Smart Materials (4 of 5): Magneto Rheological (MR) Fluid, Youtube)

Buildings and bridges

Engineers are planning to use non-newtonian fluids so that bad weather vibrations don't affect bridges so much and to make them more resistant. Probably, earthquakes will not make that much damage because buildings are getting planned using non-newtonian fluids.

Bulletproof and stab proof vests

Researchers from the 'Material research laboratory of the U.S. Army' claim that a shear thickening fluid made out of polyethylene glycol and silica powder, which is glass, can make a special fibre stab-proof. This is useful because they are definitely lighter than using many layers and are more flexible than many layers.

Sport shoes

According to real-science.ifs.hr non-newtonian fluids can be used to produce sport shoes that are really comfortable. Since they are 'liquid' they will fit the shape of the foot perfectly. But when running they are in a solid form in some places, that could help prevent injuries. Ideally they will feel like normal shoes.

Sport equipment

(Knee pads, motorcycle protection, Baseball Helmets, Skiing or snowboarding protection)

Non-newtonian fluids may be used in some sports equipment in the future.

Developers use non-newtonian fluids in sports equipment that can protect us. They are used in sports that have high risks of injury like Handball, skiing, mountain/B.M.X biking or motorcycling. They all have similar abilities of fitting to the body but turning solid on impact.

Other uses

Other usefull things are that shear thinning fluids like Ketchup or toothpaste stay in tubes and bottles. That is because they are very viscous until a pressure is applied like squirting(Pressing on the container), shaking or hitting it (Ketchup in a bottle).

Some Students from the Case Western Reserve University in Cleveland came up with the idea of using non-newtonian fluids(shear thickening fluids) as fillers of potholes. It is up to the perspective if that is a good idea or if it is a waste.

Many sauces are non-newtonian fluids. An example is ketchup(Shear thinning). Some tomato sauces are also non-newtonian fluids.[(Wikipedia)]

Fun!

It can be a lot of fun to play with non-newtonian fluids and to experiment with them. It is really easy to make oobleck at home. It is made out of cornstarch and water. According to Alice Greenland it should be a dose of 50:50.

Non-newtonian fluids may impact more or less on our world depending on how we accept them in our lives.

Effects on humans

Non-newtonian fluids can have effects on humans that can be shocking, but also plays an important part in our body.

Clay can be dangerous…

According to sciencelearn.org.nz if a house is built on a special type of clay(Shear thinning fluid) it can be verry dangerous. If there is a big force like an earthquake, the clay can start becoming less and less viscous, which would cause the house to start sinking in. It wouldn't be a nice surprise to come home and see no house…

Blood - a non-newtonian fluid?

Information from wikipedia claims that blood is a non-newtonian fluid(Shear thinning). It is well known that blood is the transport for oxygen and nutrients. Without blood our body wouldn't work, it is very important to us. Roland Feinäugle claims that this is useful as the blood can flow through tiny veins and would prevent blocks in the blood cycle.

Quicksand

According to the department of Physics of the University of Illinois at Urbana-Champaign, quicksand is a non-newtonian fluid(Shear thinning fluid [Wikipedia]). Although it seems like it, quicksand is not that dangerous.

There is a risk when getting stuck in quicksand by the beach because the high tide might flood the victim, which would cause the victim to drown.

In total non-newtonian fluids are very interesting. Researchers are still not 100% sure about the process but are getting further in achieving their goal of total understanding every day. Non-newtonian fluids can be fun to play with, useful and dangerous, but with the knowledge we can use them responsibly to bring the world a step ahead…

Think about them and get an idea!

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