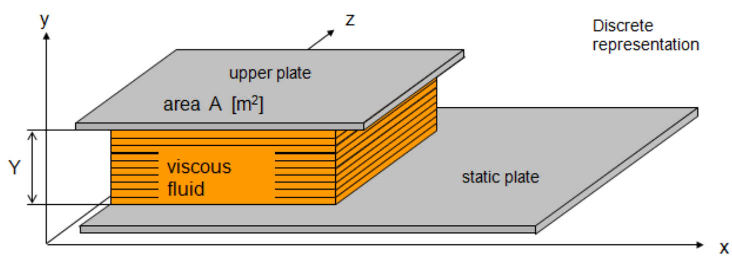
SOFRASER
Pioneering viscometry since 1972

TECHNICAL INFORMATION

VISCOSITY - NEWTON LAW
NEWTONIAN and NON-NEWTONIAN PRODUCTS

Viscosity according to Newton law – Definitions

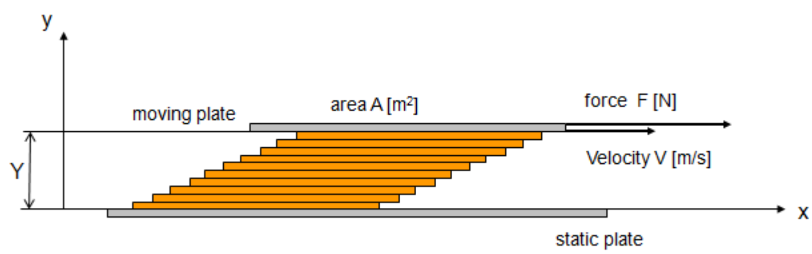


Before instant t_0 the fluid is contained between two large parallel plates of area A, separated by a very small distance Y

Shear stress $\tau = \frac{F}{A}$ in N/m^2

Shear rate $\dot{\gamma} = \frac{V}{Y}$ in s^{-1}

Newton law explains that shear stress is proportional to shear rate $\tau = \eta . \dot{\gamma}$



At instant t_0 the upper plate is set in motion in the x-direction at a constant velocity V

At instant $t >> t_0$ steady flow: final velocity distribution

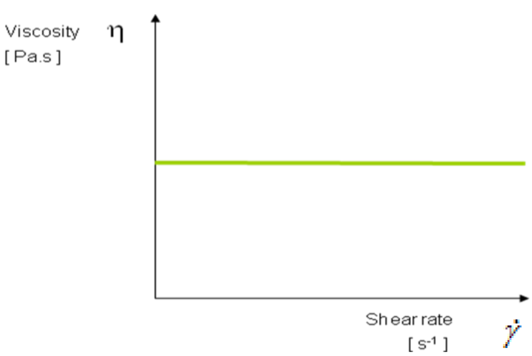
Dynamic viscosity units: η

S.I. Unit:	**Pa.s**	pascal-second
	m P a.s	millipascal-second
C.G.S unit	**P**	poise
	cP	centipoise

Conversion factor: *1 mPa.s = 1 cP*

Using a MIVI viscometer on Newtonian products

A Newtonian product is a fluid whose viscosity value is the same at all shear rates



Viscosity is constant.

The shear rate generated by the MIVI sensor and process conditions have no influence on viscosity

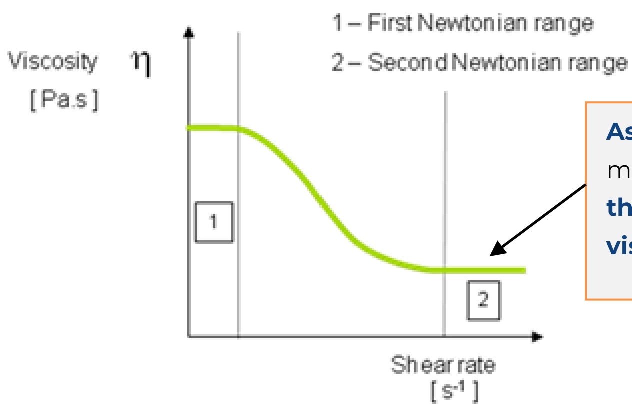
Examples of Newtonian fluids: water, most salt solutions in water, molasses, kaolin – clay slurry, bitumen, high viscosity fuels, gasoline, kerosene, most motor oils (without additives), most mineral oils

MIVI viscometer on Non-Newtonian products

- **A Non-Newtonian product is a material whose viscosity changes as shear rate changes**
- A precise characterization of the influence of shear rate and time must be measured with a laboratory rheometer

- There are different categories of Non-Newtonian fluids. Pseudo-plastic fluids are the most usual met Non-Newtonian fluids in process (the vast majority of the Non-Newtonian)

Pseudo-plastic fluids or shear thinning fluids



As the MIVI induces a rather high shear rate, it works most of the time in the Second Newtonian range, where **the variation of the process flow has no impact on viscosity**

- Viscosity decreases when shear rate increases

  - In area 1, called the first Newtonian range, shear rate is in theory stable (In process, it is usually difficult to observe this range).
  - In the middle area, there is a big influence of shear rate on viscosity
  - In the area 2, called the second Newtonian range, viscosity is stable according to shear rate

- The MIVI sensor is a vibrating viscometer inducing a high shear rate.

- In the case of pseudo-plastics fluids, most of the time **it works in the Second Newtonian range (or end of the middle area). The viscosity reading is not influenced by process shear rate fluctuations.**

- **This makes the MIVI working easily with pseudo-plastic fluids, behaving in this range as Newtonian fluids. Thus it provides a reliable information.**

Examples of pseudo-plastic fluids: most emulsions, suspensions, dispersions, sewage sludge, paper pulp, grease, soap, paint, printing ink, starch, latex solutions

Other Non –Newtonian fluids:

- Dilative fluids
- Thixotropic fluids
- Rheopectic fluids
- Bingham fluids
- Yield pseudoplastic fluids
- Yield dilative fluids

Sofraser has experience among many types of fluids and on a case by case basis will study with you the difference measurement possibilities with the MIVI sensor.