ViscoTec – Newsletter 10 / 2010
Basics for Dosing and Dispensing

Physics / Basics:

In order to provide customers with a perfect dispensing solution one of the essential things is physics and rheology. These rules cannot be switched of so we have to arrange the best design of the dosing equipment.

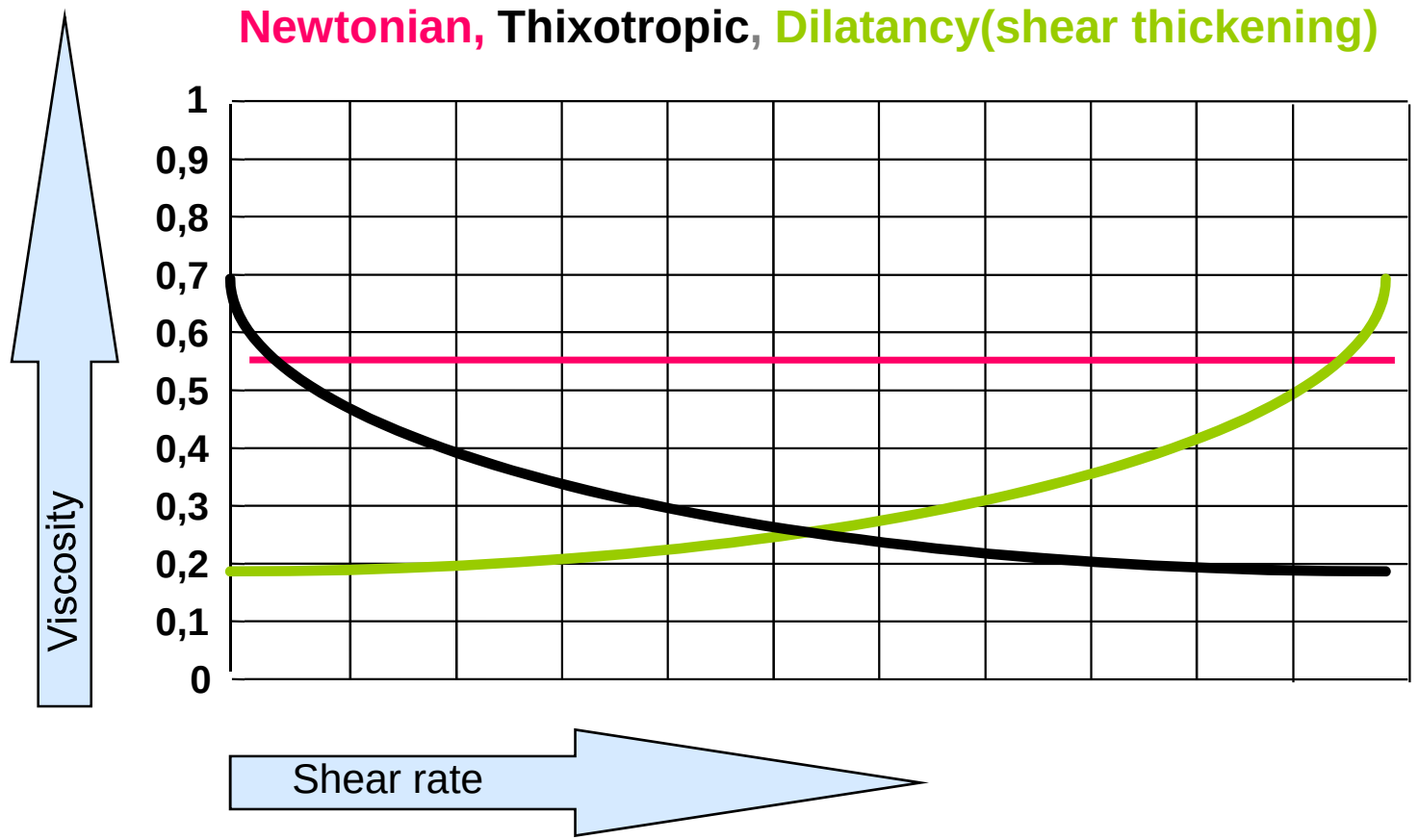
Rheology- definition:

Rheology (pronounced /ri□ɒlədʒi/) is the study of the flow of matter: primarily in the liquid state, but also as 'soft solids' or solids under conditions in which they respond with plastic flow rather than deforming elastically in response to an applied force.[1] It applies to substances which have a complex molecular structure, such as muds, sludges, suspensions, polymers and other glass formers (e.g. silicates), as well as many foods and additives, bodily fluids (e.g. blood) and other biological materials.

The flow of these substances cannot be characterized by a single value of viscosity (at a fixed temperature). While the viscosity of liquids normally varies with temperature, it is variations with other factors which are studied in rheology. For example, ketchup can have its viscosity reduced by shaking (or other forms of mechanical agitation) but water cannot. Since Sir Isaac Newton originated the concept of viscosity, the study of variable viscosity liquids is also often called *Non-Newtonian fluid mechanics*.[1]

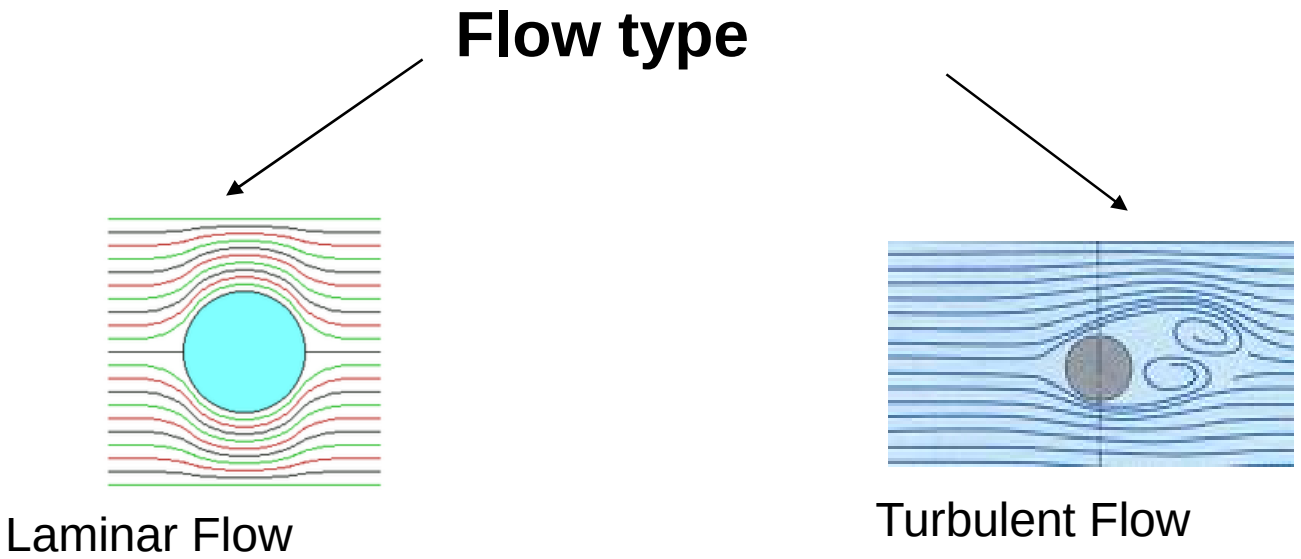
So mainly Non-Newtonian fluids appears at customers and have different features:

Overview of different behaviors of fluids:



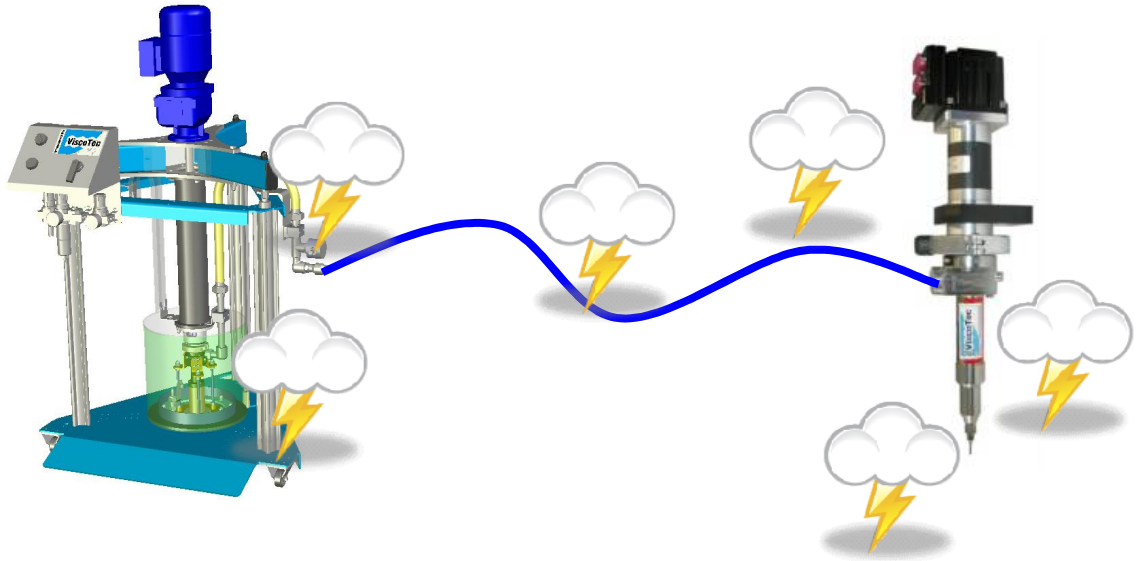
Fluid mechanics:

Regarding the flow of fluids there are two different types: laminar flow and turbulent flow. At dispensing technology we have to be in the area of laminar flow, because the turbulent flow is too difficult to control and handle.



Fluid mechanics / pressure loss:

One of the most important issues we have to consider and calculate is the pressure situation or pressure loss in the system (counter-pressure or inner pressure of the system). As ViscoTec-dispensing units are low-pressure systems it is necessary to have the lowest pressure possible in the system. Therefore all parts of the system (from the emptying system, hose to the dispenser itself) has to be analyzed regarding pressure situation.



Pressure loss:

There is only one main formula which describes everything and which could help for a better design and layout of the system:

Hagen-Poiseuille: $$\Delta p = \frac{128 \cdot Q \cdot \eta \cdot l}{\pi \cdot d^4}$$

Pressure loss at laminar flow

Q: flow rate in m^3/s
η: dynamic viscosity in Pas
l: length of tube/hose in m
d: diameter of tube in m

As the flow-rate, viscosity and length are linear, the diameter of the tube is the most critical parameter. So the hose or tube- diameter should be as big as possible in order to have as less pressure loss as possible in the system.

General rules:

1. Use short tubes / hoses but with the biggest possible diameter
2. The nozzle-diamter should be also as big as possible
3. Use conical / tapered nozzles instead of straight nozzles
4. It is always better to use a bigger dispenser with lower speed than a smaller sized dispenser with high speed

Successfull dispensing = keep rheological influences low!!