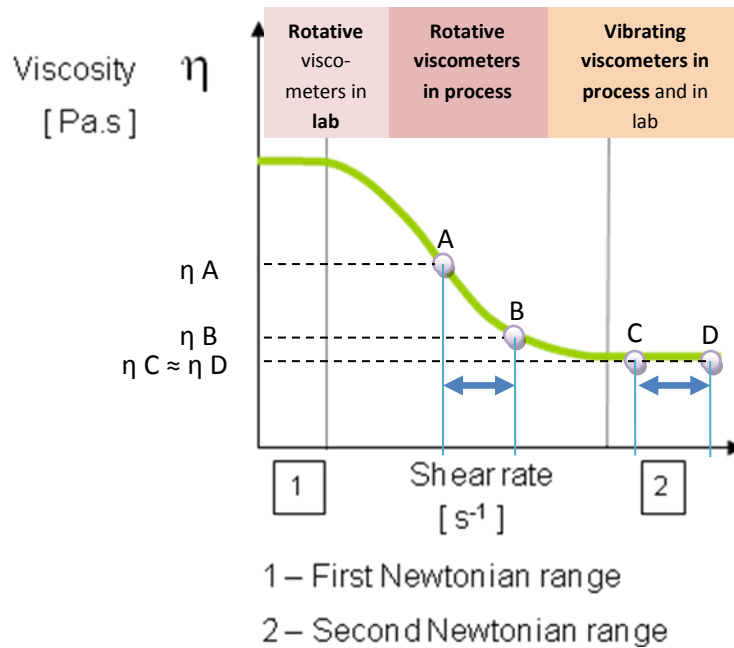


SHEAR RATE AND NON-NEWTONIAN PRODUCTS

Influence of shear rate in process for Non-Newtonian products

- ⑤ In general for pseudo-plastic fluids in process, sensors with high shear rate are less affected by process flow variations than sensors with low shear rate. This is due to the behavior of these fluids.
- ⑤ In process, as shear rate is never perfectly known, all sensors measure relative information of viscosity (and not an absolute viscosity); this is why a correlation with lab measurement (rheometer) on reference values must be done.
- ⑤ High shear rates viscometers work in the Second Newtonian range, where viscosity does not vary with shear rate



- ⑤ As shear rates sum up, a process shear rate variation (flow rate, stirring, pumps) will have less impact on viscosity value with high shear rate (viscosity variation from C to D)
- ⑤ Proportionally, a flow variation will have less impact on the viscosity value at high shear rates than at low shear rates (viscosity variation from A to B)

Measurements at low shear rate show big differences in viscosity among two similar products, whereas the difference in viscosity is low at high shear rates

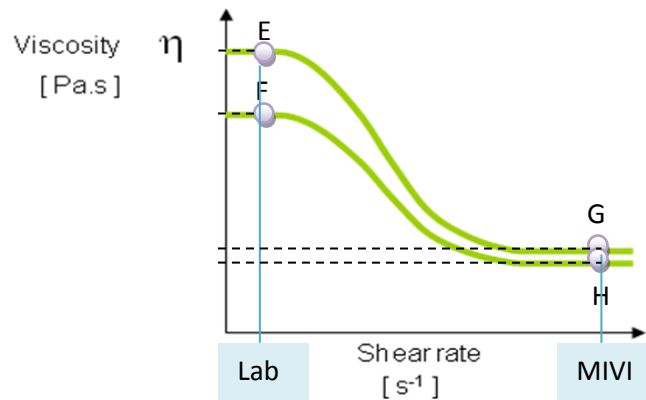
Recapitulative table:

Generally, in process:	Viscometer Shear rate	Influence of flow on shear rate	Influence of global shear rate on viscosity measurement	If flow rate changes:
Rotative viscometer	Low	High	High	Viscosity changes (difference between A and B is important)
Vibrating viscometer	High	Low	Low	Viscosity does not change (difference between C and D is negligible)

- Ⓢ This is the reason why the use of vibrating viscometers has to be privileged in pseudo plastics fluids measurement in process.

How to use shear rate to select a viscosity range with pseudo-plastic fluids?

- Ⓢ At high shear rate, viscosities are much lower than at low shear rate and so are the differences to be measured.
This explains why it is important to select the correct viscosity range according to shear rate.



- Ⓢ In order to be able to see this low difference, the viscometer needs a very good resolution in order to discriminate low viscosity differences
- Ⓢ The MIVI viscometer provides repeatable measurement ($\pm 0.2\%$ of reading according to process specifications) which is the best repeatability available for process viscometers today.
- Ⓢ The MIVI has the best sensitivity of the market.

Key points for pseudo-plastic fluids

- Whatever the viscosity measurement to be used, in process, a correlation to a lab value is essential
- At high shear rate, the influences of process variation are less important
- A good selection of the instrument range according to shear rate allows a better viscosity