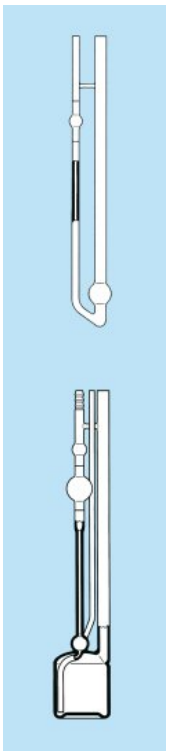
Glass capillary viscometers in food testing



The raw materials used in food industry, as well as its unfinished goods and end products show very different rheologic properties. While mostly non-Newtonian liquids, the flow behaviour of liquid foods is influenced by origin, temperature, water content, manner of mechanical processing, storage time and transport conditions. Many liquids in food production, however, have a Newtonian behaviour

The knowledge of viscosity is important for engineering purposes in several aspects, e.g. for

- Control of technical processes, e.g. in piping, valves and filters
- Quality assessment of products
- Design of food processing apparatus and handling devices
- Determination of the proportion of ingredients or additives that have an effect on viscosity (thickening agents, stabilizers, rheological additives, gelling agents).

Examples for measuring tasks in food industry

Viscosity determination of wort and beer

Beer varieties with a viscosity of > 1.7 mPas do require a longer filtration time and more filter material, thus limiting production output. On the other hand a higher viscosity is desirable for a full-bodied taste and stable froth. But regional tastes are different in this respect: German beer-drinkers prefer a longer-lasting froth than British ones.
A description is found in "Brautechnische Analysenmethoden" (Analysis methods in brewing technology) by the MEBAK Brewing Technology Commision in Freising-Weihenstephan, Germany (vol. 1 - 4.1.4.4.3).

Viscosity determination of fruit and vegetable juices

Rawly pressed juices with a high viscosity are difficult to clarify. Viscosity is mainly dependent on the pectin content in this case. In juice concentrate manufacturing, e.g. blackcurrant juice, the pectin content may reach very high levels involving the danger of gelling.

Specific pectinolytic decomposition may be used in the technical step of fining and purification of juices to adjust the pectin content to an optimum value. As the market demand shifts more and more towards naturally cloudy juices, the pectin content and the use of enzymes are considerations of growing importance.

Viscosity determination in the sugar industry

Knowledge of viscosity is of particular interest for the winning and technical processing of sucrose solutions. With increasing concentration, the viscosity of these solutions grows exponentially and is

thereby of decisive importance for the crystallisation disposition of treacle.
While the crystallisation disposition of a sucrose solution is favoured by increasing concentration (supersaturation), it is disfavoured by an increasing proportion of multiple saccharides. The viscosity grows with growing molecular mass of the solution components.

Glucose syrups of equal saccharification grade have different saccharide fractions and thus different viscose behaviour. As they are used as cristallisation inhibitors in the manufacturing of sweets, the viscosity is an important technological parameter here. After all, who wants his chewing candy to turn into a tooth-breaker within such a short time?

Viscosity determination in the dairy industry

The varying origin and composition of milk results in a very different rheological behaviour of milk and dairy products. The viscosity of milk, cream, condensed milk etc. is influenced by fat content, dry matter concentration and largely by the processing conditions.

The addition of hydrocolloids (thickening agents, rheological additives, gelling agents) and of stabilizers strongly increases viscosity. The viscosity measurement provides valuable information about their chemical structure and their interaction with the milk components. Or would you like your drinking yoghurt to end up sliceable within the bottle after just two days in the refrigerator?

The aims of viscosity measurement can be summarized as follows:

- Optimizing the mashability of beer
- Selecting filtration strategies and times
- Assessing the quality of malt and wort in beer
- Providing information for the design of industrial apparatus and equipment
- Characterising the gelling capacity of pectin by determination of the limiting viscosity number
- Acquisition of parameters for the conduction of the pectinolytic process for the optimisation of fining and purification of fruit and vegetable juices
- Supervising e.g. automatic dosing and bottling plants
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- Quality evaluation (taste, color stability, life)
- Developing formulations

Solution

After verifying whether the food liquid to be analyzed may sufficiently be regarded as a Newtonian fluid, all types of capillary viscometers can be employed. Difficulties may show up in the registration of the liquid meniscus. Dairy products for instance are hard to detect optoelectronically (via light barrier) in the viscometer because of their low transparence and their dripping effects.

Employing TC viscometers involves frequent thorough cleaning, as the thermistors tend to incrustations and fouling. Measuring the viscosity of beer, fruit juices etc., is an easier task. As these liquids tend to froth, Ostwald or micro Ostwald viscometers are recommended for automatic measurements. The standard deviation for viscosity measurements of beer wort with Ostwald/micro Ostwald viscometers was 0,004 mPas, compared to 0,02 mPas for measurements with the Höppler viscometer. Viscosity measurements of fruit juices have likewise produced good results.

Further Reading

Users manuals for glass capillary viscometers, by SCHOTT Instruments GmbH
Theory and Practice of Capillary Viscometry, by SCHOTT Instruments GmbH

DIN 1342 (2) Newtonian liquids
DIN 51 550 Viscosity determination basics
DIN 51 562 Measuring of cinematic viscosity with Ubbelohde viscometers
DIN 53 012 Capillary viscometry of newtonian liquids, error sources and corrections