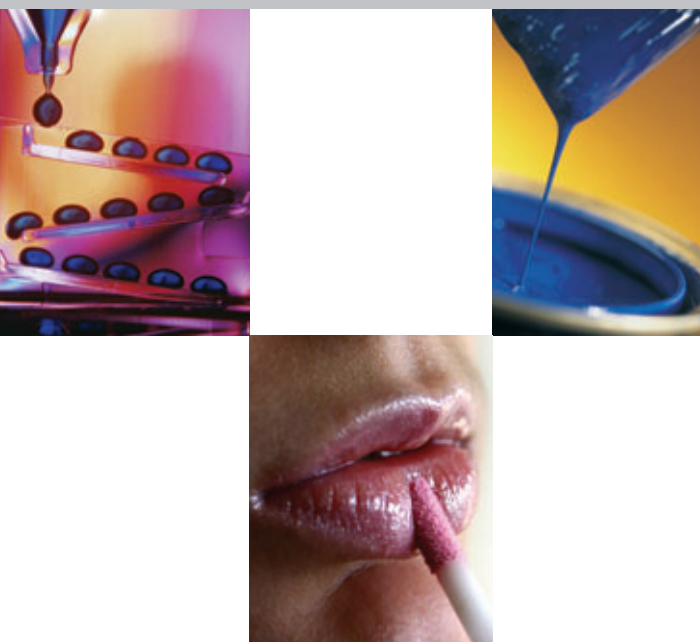


Many different experimental techniques for measuring the elongational properties of non-Newtonian fluids have been developed over the last 30 years. All these techniques were difficult to operate and generated complex flows and therefore confusing results. As a consequence, successful commercially available instruments did not exist. The HAAKE CaBER 1 (system CPG*) is the first instrument to change this.

HAAKE CaBER™ 1

Quantifying the extensional properties of fluids



Applications

- **Adhesives**
 - solvent loss or gain
- **Food products**
 - stringiness/strand formation
 - time to breakup
 - relaxation of doughs
 - elastic instabilities
 - mouthfeeling
- **Consumer goods**
 - filling of bottles
 - time to breakup
 - solvent loss
 - processability
- **Industrial resins**
 - relaxation time spectrum
 - constitutive modeling
 - spinnability
- **Printer inks**
 - stringiness/strand formation

Extensional Rheometry

Knowledge of the elongational behavior of fluids is important for both industrial and basic research purposes. Complex flows that contain strong extensional components occur in many industrial processes and applications. Some examples are extrusion flows, coating flows, contraction flows and fiber spinning flows. Materials that behave identical or similar in a shearing flow can behave completely different in an extensional flow. The thinning and breakup of a fluid filament that is analyzed with the HAAKE CaBER instrument provides valuable information about the material's physical properties that rotational rheometers simply cannot provide!

The Capillary Breakup Extensional Rheometer

The HAAKE CaBER, built by Thermo, was developed by Cambridge Polymer Group (CPG) based on the pioneering work of Russian scientists Entov, Rozhkov and co-workers in capillary breakup rheometry. The HAAKE CaBER system is an easy-to-use extensional rheometer for examining polymer solutions, suspensions, adhesives and a variety of other materials. The HAAKE CaBER system can be used as an analytical instrument, or as a quality control tool. With a footprint of 40 x 34 cm, the HAAKE CaBER is small enough to fit in a fume hood or to be used on a benchtop in the lab or on the plant floor.

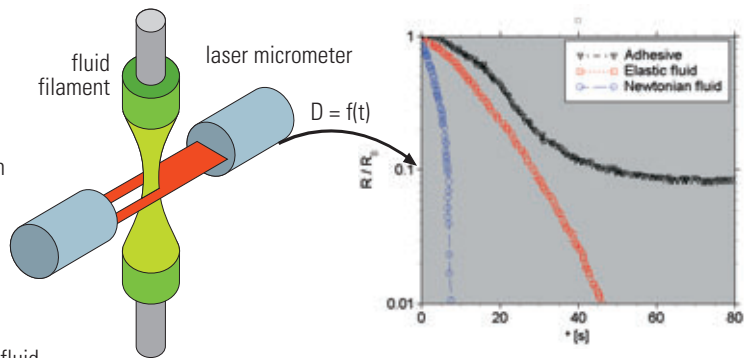
*) CPG = Cambridge Polymer Group

HAAKE CaBER™ 1



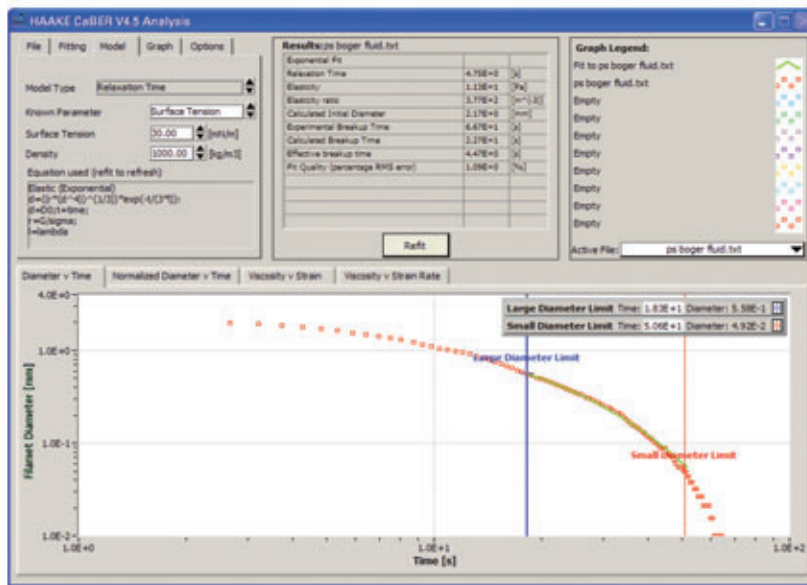
Principles of Operation

A small quantity of sample (< 0.2 ml) is placed between two circular plates. The top plate is rapidly separated from the bottom plate at a user-selected strain rate, thereby forming an unstable fluid filament by imposing an instantaneous level of extensional strain on the fluid sample. After cessation of stretching, the fluid at the mid-point of the filament undergoes an extensional strain rate defined by the extensional properties of the fluid. A laser micrometer monitors the midpoint diameter of the gradually thinning fluid filament as a function of time. The competing effects of surface tension, viscosity, mass transfer and elasticity can be quantified using the model fitting analysis included in the software. The automated experimental analysis and model comparison provides rapid determination of the following parameters: Viscosity, surface tension, elasticity, relaxation times and filament breakup time.



| Specifications | HAAKE CaBER 1 |
|-----------------------------|---|
| Hencky strains | up to $\epsilon_0 = 10$ |
| Strain rate range: | |
| Imposed strain rate | $0.01 < \dot{\epsilon}_0 < 300 \text{ s}^{-1}$ |
| Fluid strain rate | $10^5 < \dot{\epsilon}_0 < 10 \text{ s}^{-1}$ |
| Shear Viscosity range | $10^* - 10^6 \text{ mPas}$ |
| Plate diameter | $4 < D_{\text{plate}} < 8 \text{ mm}$, standard = 6 mm |
| Sample volume | < 0,2 ml |
| Sample rate | < 0,1 ms |
| Temperature range | 0 - 80 °C |
| Diameter resolution | 8 μm |
| System response time | 10 ms |
| Dimension (instrument only) | 40 x 34 x 60 cm |

*Depending on the elasticity of the sample.



Features

- Completely computer controlled
- Easy to operate
- Easy sample loading and cleaning
- Class 1 laser micrometer
- Linear motor drive with variable speed
- Automatic repeated testing
- Closed temperature-controlled sample chamber
- Exchangeable geometries
- User defined strains
- Small sample volume (< 0.2 ml)

Software

- Windows 95/98/NT/2000/XP compatible software
- Range of models for parameter extraction
- Data export to ASCII file

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