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1 *Test loop developed by the Paint/Lacquer Technology at Fraunhofer IFAM.*
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DETERMINATION OF SHEAR STRESS IN PAINT/LACQUER SYSTEMS USING TEST LOOPS

The industrial painting of cars, rail vehicles, aircraft, machinery, and other large objects usually involves supplying the paint via paint circulation systems, so-called "loops". The paint/lacquer system is subjected to considerable shear stresses in the valves, pumps, and mixer units.

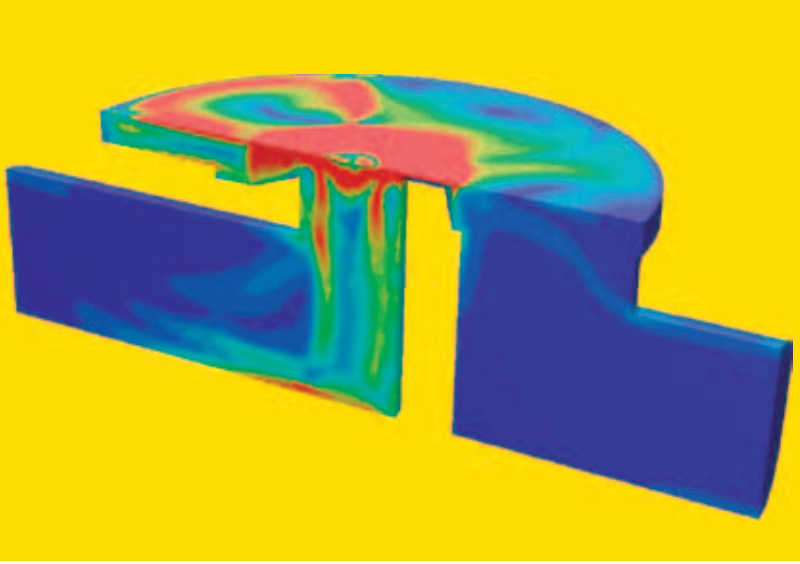
The resulting shear can lead to changes in the complex paint/lacquer system and can impact the technical as well as optical properties of the paint. In some cases this may necessitate complete emptying of the loop – associated with high costs for the paint/lacquer manufacturers and users.

Shear stress in loops

Liquid paint/lacquer systems are held in loops in order to supply a wide range of different applicators with a constant flow of paint and in order to keep the paint in motion. The paint in a loop is subjected to mechanical loads, for example, due to compression and decompression, as well as due to transport, and dosing.

Test loop developed by Fraunhofer IFAM

The Paint/Lacquer technology experts at Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM have developed a test loop for paint/lacquer and coating materials especially for paint manufacturers and users (Fig. 1). This 20 meter long test loop models large industrial plants. Despite the shorter length, the paint/lacquer is subjected to exactly the same stresses as in large industrial plants.



The paint/lacquer can be passed through this loop system either continuously or intermittently. The test loop can be heated up to 40 °Celsius.

Data acquisition

During the tests, the temperature, pressure, flow rate, and shear rate are measured inline at different places and documented. This allows, for example, viscosity changes due to a new batch of paint or due to too long circulation in the loop to be directly measured. The test loop can be operated either at low pressure or at high pressure.

Simulation via CFD

Simulation via Computational Fluid Dynamics (CFD) allows the shear in plants of conventional size to be quantified. The results of these simulations are compared to the process data acquired from the 20 meter loop (Fig. 3).

PolyShear – The miniature test loop developed by Fraunhofer IFAM

The "PolyShear" test loop developed at Fraunhofer IFAM is a laboratory plant that only requires one liter of paint/lacquer. However, it subjects the material to shear following a test protocol – and thereby simulates a complete loop (Fig. 2 + 4).

The PolyShear method is being declared as a patent by Fraunhofer IFAM (DE 102009001157 A1; "Device and method for testing the behavior of fluids, and in particular polymeric liquids"). It is able to simulate the shear stress in a paint/lacquer on a laboratory scale and to hence indicate whether the tested paint system is suitable for a specific industrial loop.

Benefits of PolyShear

- Rapid information about the shear and storage properties of paints/lacquers
- Laboratory-scale, thus low space requirements
- Minimal use of resources and environmentally friendly
  - Only small quantities of paint/lacquer required
  - Short cycle times
  - Short rinsing times
- Very good reproducibility of actual processes in large industry standard loops

3 *Result of the simulation of paint shear stress in the back-pressure regulator of a loop.*

4 *PolyShear – the 1 liter miniature test loop developed at Fraunhofer IFAM.*