The Rheological Behaviour of Shower Gel - What makes a product acceptable for aspecific target customer?

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Introduction

Shampoos are based on complex systems of surfactants having the function to cleanse the hair. Because of their everyday use it is not surprising that the shampoo market comprises approx. 12% of the total personal-care industry [1]. These products are complex systems consisting of about 80 wt.% water, 10wt.% surfactants, 5wt.% viscosity modifiers, 2wt.% preservatives, fragrances and colorants and about 3wt.% of performance additives [2]. Few things are more important to customers than using a thick (rich) shampoo product correlating this directly with value and concentration. A shampoo is not only expected to be easy to use but to meet also sensory criteria that will appeal to the customer. One main rheological parameter that correlates with the thickness and flow properties of a shampoo is the viscosity. The viscosity affects both the cleansing efficiency and the user perception of a shampoo product. In addition to that it also influences the foaming properties, production filling, packaging, storage and long-term stability of the product. Viscosity is a quite important parameter! As was mentioned already, customer perception is one of the most important parameters, however who is the customer and what does he expect? The three different customer groups Female, Male and Children (Infants) have different views on the same product class because they usually put different amounts of energy into a shampoo when they i.e. squeeze it out of the bottle or distribute it on themselves. This is due to the fact that the different processes will happen at different stress levels (as the customer groups apply different forces) and thus result in different shear rates. As no customer wants to experience the viscosity the product has at rest (rich and creamy) when they actually use the product, a shampoo has to be a non-Newtonian or better shear-thinning fluid. To induce non-Newtonian flow and thus modify the flow behaviour towards the specific customer groups, water-soluble polymers are used as modifiers.
This contribution is to show how products for those different customer groups differ rheologically and how easy it is to absolutely determine the parameter viscosity with the help of the new Thermo Scientific™ HAAKE™ Viscotester™ iQ.

Fig. 1: Thermo Scientific HAAKE Viscotester iQ

Experimental Results and Discussion

Three different commercial shampoos have been tested on the Thermo Scientific HAAKE Viscotester iQ at RT with 35 mm plate/plate geometries (see Figure 1). One of them was a shampoo for men, one for women and one for children (infants).
After carefully filling the shampoo on the lower plate and manually adjusting the measuring head to a pre-determined gap of 1 mm the testing procedure was conducted as can be seen in Figure 2.
With the described procedure the shampoo products have been tested in a shear rate range of 1 to 100 1/s, the results can be seen in Figure 3.
As can be seen in Figure 3 the rheological fingerprint for the three products is quite different. At low shear rates around 1 1/s the shampoo for men and the shampoo for

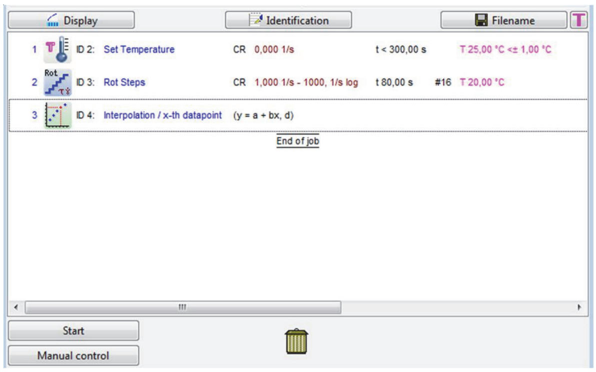

Fig. 2: HAAKE RheoWin Measuring Routine to determine the viscosity as a function of shear rate on the Thermo Scientific HAAKE Viscotester iQ

Right now many users of viscometers, especially in an industrial QC/QA environment, are working with concentric cylinder measuring geometries ("cup and bob"). However, the use of plate/plate measuring systems is preferable because less sample volume is needed. This directly leads to two main advantages, namely that cleaning will be easier and temperature control will be faster. However do both measuring geometries yield the same result? To answer that question, Figure 4 shows the resulting viscosity for the "soft" shampoo measured at RT with the concentric cylinder system CC25Din in comparison to a 35 mm plate/plate geometry.

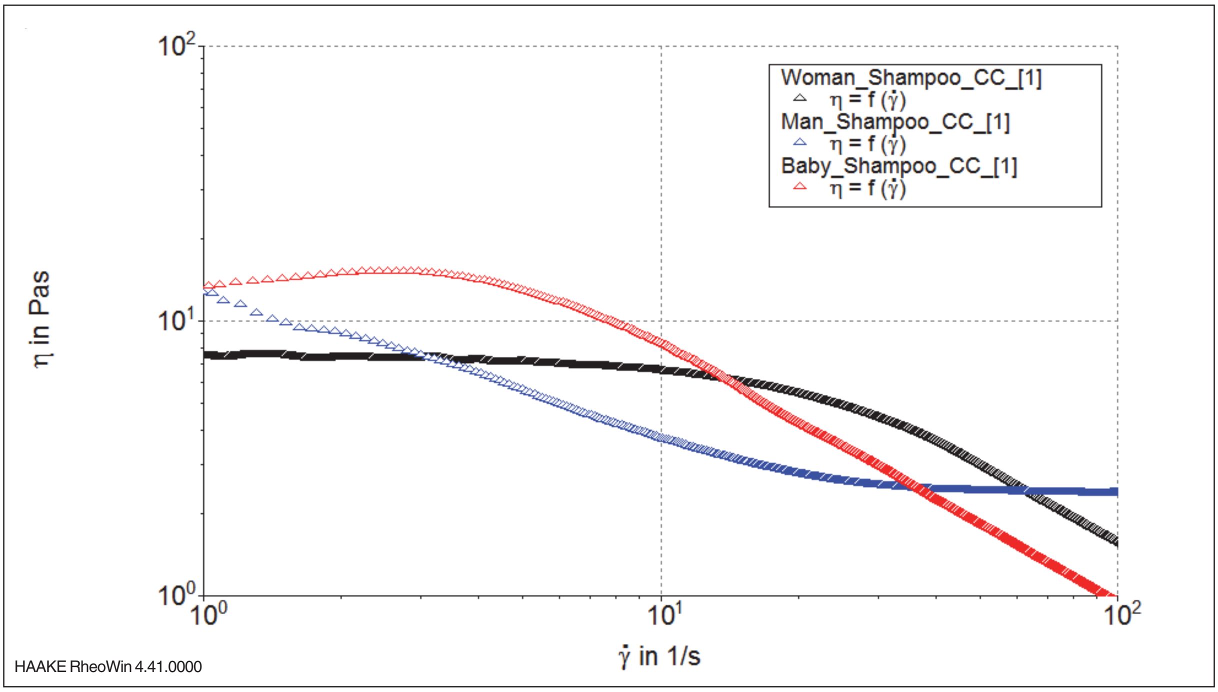

Fig. 3: Viscosity as a function of shear rate for three different shampoos at RT.

children (infants) have about the same viscosity of about 12 Pas. The shampoo for women has a considerably lower viscosity of about 7.5 Pas. Male customers usually want to have an even richer (higher viscous) product than female customers that prefer slightly "creamier" (lower viscous) products. For child products more functional aspects have to be taken into account as a child usually does not choose a shampoo according to its viscosity. However, the parents that buy the product intuitively "know" that a high viscous product will stay longer in the child's hand when using it in the bathtub.

When applying higher shear rates the behaviour differs between the products. Whereas the "male" product goes into non-Newtonian flow directly because of the higher molecular weight polymer additives that have been used in formulation to achieve a higher base viscosity, the "female" and "child" product show Newtonian plateaus. However whereas the "female" product leaves Newtonian flow at around 4 1/s to achieve lower viscosities when being used the "child" product maintains a constant viscosity for much longer (up until about 20 1/s) so that less product is lost before starting in the washing process.

As can be seen in Figure 4, the measured viscosity is the same, independent of the measuring geometry.

Conclusion

Determining the viscosity of a shampoo (or shower gel etc.) formulation is of utmost importance to understand if a product meets customer expectation. Additives have to be chosen wisely to formulate a product for a specific customer group. The Thermo Scientific HAAKE Viscotester iQ is a powerful tool to let you conduct those tests easy and reproducible, no matter if you test with concentric cylinders or plate/plate geometries.

Literature

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[2] H. Leidreiter, U. Maczkiewitz, Utilizing Synergistic Effects in Surfactant Mixtures, Th Goldschmidt AG, 1996, Essen

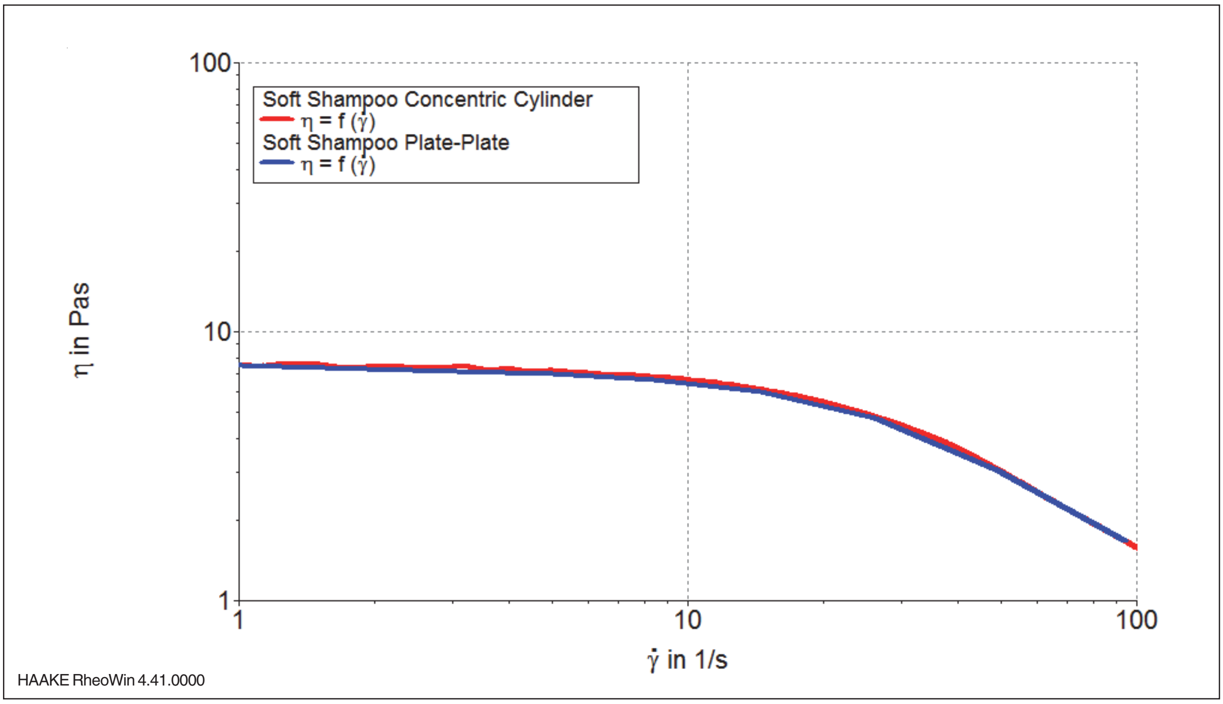

Fig. 4: Viscosity as a function of shear rate for a shampoo measured with concentric cylinders and plate/plate geometry at RT.

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