When Ointments Disappoint

The Viscosity Story

Have you ever experienced the hassle of taking a newly purchased ointment out of the box, opening the cap, puncturing the seal, ….. and the stuff just won't come out? Or the opposite situation where it squirts out more rapidly than a raging locomotive and half the tube is gone before you know it? These ointments can be expensive, especially the medical prescription type, and the flow behavior should be perfect if you're to use every last drop for the purpose intended.

Manufacturers are becoming more interested in the science of how ointments behave when customers use them. They are investigating test methods to quantify the flow characteristics of the material coming out of the tube and the behavior during application to the skin. This enables QC Departments to do a better job in guaranteeing consistent performance of the ointment as used by customers.

The first thing to understand about how materials flow is "shear rate". This relates to the shearing action of squeezing the ointment out of the tube and rubbing it on your skin. The ointment experiences a shearing action which causes a change in relative velocity of the molecules as they slide over each other. Figure 1 shows a scientific model of how shear rate is calculated for a fluid filling the space between two parallel plates; the lower plate is stationery while the upper plate moves at a given velocity. The molecular layers move at different speeds, depending on their relative position between the plates. Shear rate is calculated by the formula shown in Figure 1.

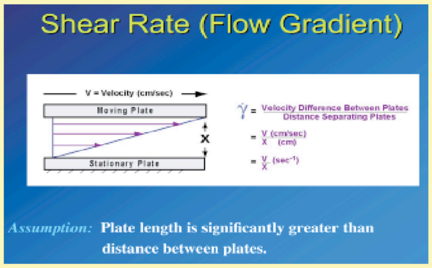

Figure 1: Definition of Shear Rate

R&D scientists can easily calculate the relevant shear rates for the situations described above. Rubbing the ointment on your skin may produce shear rates in the range of 500 to 5000 reciprocal seconds, depending on how fast you rub and the thickness of the layer of ointment that gets applied. This becomes the test spec for how to evaluate the ointment for optimal flow behavior.

Next comes the instrument that can generate shear rates of this magnitude so that the material can be tested correctly. Cone and Plate viscometers have this capability. (See Figure 2) The sample is placed on the plate, the cone spindle is brought down in contact with the sample, and the spindle is rotated at speeds equivalent to the shear rates of interest. The data from this type of a test will produce a flow curve similar to the information shown in Figure 3.

Figure 2: Brookfield RS-CPS Cone/Plate Rheometer

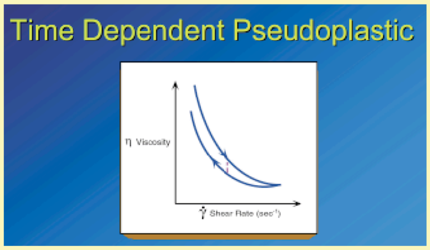

Figure 3: Illustrative Flow Curve for Ointment (Viscosity vs. Shear Rate)

Typical behavior for ointments is a shear thinning profile, which means that viscosity decreases as shear rate increases. Quality Control will either replicate this test method in totality or, depending on direction from R&D, choose one or two points on the curve and test to those specific shear rates. The objective is to verify that the ointment viscosity falls within defined limits.

One additional test that may help to determine acceptable squeezing action is to measure yield stress. This quantifies the amount of force needed to get the ointment out of the tube. Figure 4

Figure 4: Brookfield YR-1 Yield Stress Rheometer

shows the type of instrument that provides this type of test. The vane spindle is immersed in the material and rotated at a slow rotational speed until flow begins. Figure 5

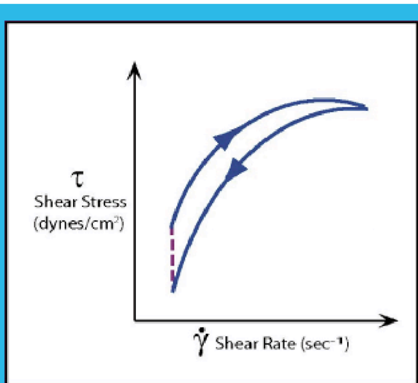

Figure 4: Illustrative Flow Curve for Ointment (Shear Stress vs. Strain)

displays the corresponding test data that gives a specific yield stress value for the ointment, which must fall between predetermined limits. These two tests are straightforward and easy to implement. They can improve the overall quality of the ointment by ensuring that every tube provides a consistently similar product. In today's competitive world, it's a must do for those who want to win the customer's continuing confidence.

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