Commercial rotational rheometers are based on two measurement approaches. These are controlled rate and controlled stress. The controlled rate approach was the basis for the earliest commercial rheometers and is adequate for characterizing industrial materials in the 1 to 1000 s\(^{-1}\) shear rate range. However, the controlled stress approach is better for working with more stress sensitive materials where a small change in stress can create a measurable rotational motion, thus providing useful information such as apparent yield stress. In addition, since many processes are stress-driven (e.g., gravity), controlled stress represents a more direct correlation. Hence, the controlled stress approach is quickly becoming the method of choice for characterizing most materials. Nevertheless, the large volume of historical controlled rate data as well as the need for correlation with control rate processes make it desirable to have both approaches available. The TA Instruments CSL\(^2\) Rheometer answers this need by providing both controlled stress and controlled rate capabilities in a single cost-effective unit. The high responsiveness of the CSL\(^2\)’s torque motor and associated electronics makes this unique combination possible.

**SPECIFICS**

The schematic for a typical controlled rate system is shown in Figure 1. Obviously, one of the key components in such a system is the drive system used to create rotational motion. There are two types of drive systems which have been used in controlled rate instruments.

1. Early instruments used synchronous motors driven from AC power. These were true constant speed (constant rate) instruments in that the motors operated at defined speeds regardless of load. These systems are now largely out of use.
Later instruments replaced synchronous motors with DC servo motors, which are not inherently constant speed, but which can be made to operate at constant/controlled speed by virtue of a closed loop control system. Initially, this control system was a DC tachogenerator providing a control signal to analog electronics. Currently, this control loop is based on an optical encoder and fast digital electronics. This is, in fact, how the TA Instruments’ Weissenberg Rheogoniometer, a controlled rate instrument works.

The CSL uses a similar optical encoder / high speed digital loop approach ("type 2" approach) to achieve controlled rate capability. The presence of a second on-board processor provides the fast electronics required to make this approach work. Figure 2 shows comparison results from a traditional “type 2” controlled rate rheometer and the CSL for a non-Newtonian sample (hand cream). The curves essentially superimpose.

![Figure 2. COMPARISON PROFILE (Hand Cream)](image-url)