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Theory of Operation

Coefficient of Friction (COF) Testing is used in product development or quality control to measure the coefficients of starting and sliding friction of plastic film and sheeting when sliding over itself or other surfaces at specified test conditions. The procedure permits the use of a stationary sled with a moving plane, or a moving sled with a stationary plane. Both procedures yield the same coefficients of friction values for a given sample.

Coefficient of friction is defined as the ratio of the frictional force, to the force, usually gravitational, acting perpendicular to the two surfaces in contact. The static (or starting) COF is related to the force measured to begin movement of the surfaces relative to one another. The kinetic (or sliding) COF is related to the force measured to sustain this movement.

Friction is the opposite of slip, where slip is a term that denotes the lubricity of two surfaces sliding in contact with each other. A high coefficient of friction denotes low slip and low coefficient of friction denotes high slip.

Slip properties are generated by additives or coatings in some plastic films, for example, polyethylene. These additives have varying degrees of compatibility with the film matrix, and therefore some of them bloom, or exude to the surface, lubricating it and making it more slippery. Blooming action may not be uniform on all areas of the film surface.

ASTM and International Standards

The Oakland Instrument Series FX-7000 and FX-7100 Coefficient of Friction Testers are designed to meet the testing requirements of ASTM D-1984 “Test Method for Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting”.

Oakland Instrument manufactures several coefficient of friction tester models that meet the various testing methods specified by ASTM standards. The Model FX-7000 is an analog tester with a fixed-speed drive system operating at 150 millimeter (6 inches) per minute platform speed. The Model FX-7100 is a digital tester, also with a fixed-speed drive system.

The FX-7000-VS and FX-7100-VS add a variable-speed drive to allow testing at speeds between 1 and 20 inches per minute. The FX-7100-VSC is a combination tester, with the addition of sample grips and a reversible drive, to allow peel, seal, and low-elongation tensile testing in addition to COF testing.

All models come with a 200 gram Sled (with dimensions of 63.5 mm or 2.5 inch square) and flexible cable, with weight and foam density specifications certified to meet the requirements of the Standards.

Our Model FX-7200 Quality Control Software records, graphs data, calculates COF values, and provides reports for quality control record keeping.

Preparing Film or Material Samples

Test specimens preparation varies slightly depending upon sample thickness. The test specimen that is attached to the plane is cut to approximately 250 mm (10 inch) in the machine direction, and 130 mm (5 inch) in the transverse direction when such extrusion directions are identifiable.

A film sample attached to the sled is cut to approximately 120 mm (4.5 inch) square. Film is defined as sheeting have a thickness of not greater than 0.254 mm (10 mil) as indicated by ASTM Standard D-883. A sheeting specimen (greater than 0.254 mm thickness) or other material that is to be attached to the sled is cut to 63.5 mm (2.5 inch) square.

Sheeting specimens shall be flat and free of warpage, with the edges of specimens rounded smooth.

Five specimens are typically tested for each sample.

Loading Film or Material Samples

Care must be exercised when handling sample specimens. The test surface must be kept free of dust, lint, finger prints, or any foreign matter that may change the surface characteristics of the specimens.

Plastic films and sheeting may exhibit different frictional properties in their respective principal directions due to anisotropy or extrusion effects. Specimens may be tested with their long dimension in either the machine or transverse direction, but it is common practice to test specimens with its long dimension parallel to the machine direction.

Tape the 250 by 130 mm specimen to the plane. Smooth the film specimen to eliminate wrinkles if necessary, taking care not to alter the specimen surface through finger oils, etc. For some samples, it may be necessary to tape only the leading edge of the specimen to the plane.

For film specimens, tape the edges of the 120 mm (4.5 inch) square film specimen to the back of the sled, using adhesive tape and pulling the specimen tight to eliminate wrinkles without stretching it. For sheet specimens, tape the 63.5 mm (2.5 inch) square sheet specimen to the sled face with double faced tape. Keep the machine direction of the specimen parallel to the length of the sled.

Running the Coefficient of Friction Test

The measurement of static coefficient of friction is highly dependent on the rate of loading and on the amount of blocking occuring between the loaded sled and the platform due to variation in time before motion is initiated. Therefore, a uniform operating procedure should be established and adhered to.

Place the sled lightly and gently on the plane to prevent any unnatural bond from developing. A high starting COF may be caused by undue pressure on the sled when mounting it onto the plane.

Start the drive mechanism to provide a plane vs. sled speed of 150 mm/min. No immediate relative motion may take place between the sled and the moving plane until the pull on the sled exceeds the static frictional force acting at the contact surfaces. Record this initial, maximum reading as the force component of the Static COF.

Record the visual average reading during a run of approximately 130 mm (5 inch) while the surfaces are sliding uniformly over one another. This is the kinetic force required to sustain motion between the surfaces and is normally lower than the static force required to initiate motion. After the sled has traveled over 130 mm, stop the apparatus and return to the starting position.

Remove the film or sheeting specimen from the sled and the horizontal plane. The apparatus is now ready for the next set of specimens.

Measure and record the average thickness of the test specimens in the area of testing.

Recording Your Data

During the test, record your data on a standard data form as shown, or collect the force vs. time graph and statistical data with appropriate chart recorder or software.

If following ASTM or other standards, you are typically required to record: product (specimen) description, sample conditioning procedure followed, instrument configuration and setup, testing technique used, specimen thickness, surfaces tested, principal directions tested, approximate age of sample after manufacture, date and operator name, average static and kinetic coefficients of friction, together with the standard deviation, and number of specimens tested for each COF.

Reporting Your Data

After recording the test data, determine and report the calculated Static and Kinetic Coefficients of Friction, together with the standard deviation.

Static COF is calculated as follows: Static COF equals initial (maximum) motion scale reading divided by sled weight. Kinetic COF equals average scale reading obtained during uniform sliding of the film surfaces divided by sled weight. COF is a unitless number or coefficient.

The force and weight values stated in SI units are regarded as the standard.

Oakland Instrument provides standard Data Forms with its testers, which can either be filled out manually, or used in a computer-assisted manner with 3rd party Statistical Software packages such as Microsoft ExcelTM.

Oakland Instrument also offers Quality Control Software packages for Coefficient of Friction data collection and reporting that meets the Standards.