

Applications of Friction Measurements

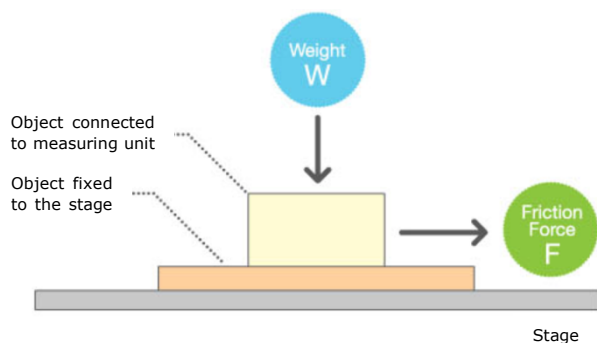
A Friction Analyzer or Friction Tester measures the resistance, or friction force, of two objects, which slide against each other. The magnitude of the friction and the abrasion, depends on factors such as material composition, contact geometry, load (normal force), sliding speed, temperature, humidity, surface roughness, etc.

The phenomena of friction are part of all kinds of industries and they may have both positive effects, which are being used, and negative effects, which are being avoided. Therefore, the control of friction and abrasion is subject of research and development for either their reduction, such as for energy-efficiency measures or for their enhancement, such as for safety measures.

The value of the Coefficient Of Friction (COF) " μ " is defined by the relationship between the required force " F " to slide an object and the load " W " perpendicular to the surface the object is resting on.

$$\mu = F / W$$

As the COF is a dimensionless scalar, it has no unit and the direction of the force does not change its magnitude.



Coefficient of Friction

When the stage with the fixed object moves, the load " W " of the object connected to the measuring unit generates the frictional force " F " between the two objects. The measuring unit detects this force and the software calculates the coefficient of friction " μ ".

When the static COF is overcome, the kinetic COF follows, so the COF " μ " can be 1) static or 2) kinetic.

- 1) The static COF " μ_s " describes the friction force between two objects when neither of the objects is moving.
- 2) The kinetic COF " μ_k ", also known as sliding or dynamic COF, describes the friction force between two objects if one object is moving, or if two objects are moving against each other.

Non-moving objects experience more friction than moving ones, requiring more force to put them in motion than to sustain them in motion. Thus the static COF is larger than its kinetic counterpart.

Coefficient of Friction (COF) for the Quantification of slip resistance

Whereas humans gradually evaluate the extent of magnitudes like the extensibility of cosmetics or the slipperiness of a sole subjectively, the coefficient of friction gives a reliable objective value by eliminating the human factor.

Evaluation of Abrasion and Durability

When fast-forwarding magnetic tapes, the sliding of the tape over the recording tape head leads to wear of the magnetic film coating little by little, gradually deteriorating the tape's recording performance.

With the use of a Friction Analyzer the durability of the coating film can be evaluated by sliding repeatedly over the same position of the tape's coating and observing the change of the coefficient of friction against the sliding repetitions.

Control of Friction

In automobiles, on the one hand, we have systems, such as for power distribution from the engine to the tires, where the lower the friction the better the efficiency. On the other hand, we have systems, such as the clutch or the braking-system, where the higher the friction the better the results.

In this example, controlling the friction in both directions means caring about people with higher safety and comfort and also caring about planet earth with better fuel efficiency, which will lead to less CO₂-emissions, preventing greenhouse effect and global warming.

Case examples of friction measurements requested from our customers:

Lubrication

1. Lubrication Oil

Reducing the coefficient of friction between oil lubricated metallic surfaces such as from bearings and joints, as well as evaluating wear-resistance and longevity of oil lubricated metallic surfaces.

2. Lubrication Powders

Functionality and effectiveness of powder lubricants.

3. Surface Treatment

Durability of slide-contact spots of precision components after surface treatment.

Drugs and Cosmetics

1. Extensibility, Touch and Texture of Cosmetics

Extensibility of foundations, creams and lipsticks on the skin; the feel of stickiness after applying cream; and the smoothness of hair before and after treatment with hairdressing.

2. Enhancing Productivity

Reducing the friction of surfaces from production machines, to improve flow properties of powders and prevent powder adhesion.

Films

1. Clear Files

Enhancing the friction between the paper and plastics, to prevent papers from slipping off.

2. Durability

Reducing the surface friction of polymer films, used for greenhouse coverings, to prevent damage caused by rain, snow or dust adhering to them.

3. Prevention of Film Blocking

Reducing the film-to-film friction to prevent blocking, the unwanted adhesion of two adjacent layers of film.

4. Abnormal Sound Prevention

Reducing the friction between films to each other, or between films and the film winding device in cameras to suppress the noise level.

Fibers, Fabrics

1. Touch and Texture of Fibers

Slippage and "touch" for fabrics after use of fabric softeners, as well as evaluating tactile properties and the sense of smoothness depending on weave textures.

2. Wear Comfort

Slippage of different kinds of fabrics on each other, as well as the slippage of stockings on insoles.

3. Safety

Slippage of stockings on different types of flooring and wax coatings.

4. Improvement of Productivity

Slippage of yarns, fabrics, etc. on surfaces of production equipment.

Printing, Coating

1. Printing Surfaces

Durability of and damage to papers or the surfaces of printing media during the printing process.

2. Plating

Strength of plating layer against scratching, continuous rubbing, sliding, etc.

3. Magnetic Tapes

Durability of magnetic film coatings when sliding over the recording tape head.

4. Thin Films, Thin Coatings

Adhesion properties of thin coatings on hard disks.

Machines

1. Noise Reduction/Elimination

Reducing or suppressing noise emission from sliding, rubbing or grinding parts by controlling the static and kinetic coefficient of friction, as well as the load to prevent the stick-slip effect.

Bureau Machines (Printer, Copier)

1. Feed Rollers

Durability and functionality of the rubber surface of paper-feed or pick-up rollers, as well as quality control measures.

2. Photoreceptor Drums

Slippage between the surface of the photoreceptor drum and rubber cleaning blades.

3. Paper Feeding

Evaluating the coefficient of friction between paper sheets to each other, and between paper sheets and each part of the printer's paper feed mechanism for its optimization.

Medical Devices

1. Catheters

Coefficient of friction of catheters submerged in water and durability of its coatings.

Automotive

1. Wipers

Evaluating the stick-slip effect between the wiper blades and the wet windshield.

2. Waxes

Extensibility of car polish or wax on the car body and their effectiveness after drying.

3. Car Seats Materials, Seat Belts

Sliding characteristics between clothing fabrics and seat belts, car seats materials.

4. Engine Oils

Coefficient of friction between engine oil lubricated metals against each other.

5. Tires

Coefficient of friction between tires and road surfaces as well as the caused tire wear.

Food

1. Productivity

Reducing the friction between production equipment and ingredients and/or food while being processed.

2. Transportability

Reducing the friction between materials used for product packaging to each other to prevent the collapse of cargo when stacking.

Daily Life

1. Writing Materials

Evaluating the writing feel or performance of a pencil (sense of resistance) by use of the kinetic coefficient of friction between pencil and paper.

2. Sports Gear

Functionality and persistence of waxes for skiers and rubbers for table tennis rackets.

3. Floor Materials

Safety and comfort of flooring by evaluating the coefficient of friction between soles and floor material.

4. Tiles, Bathtubs

Slip resistance of floor tiles, shower bases, bathtubs for safety reasons.

5. Shoes

Combining the coefficient of friction between soles and the underground with the sensory evaluation method to evaluate the comfort of walking.