Technical topic

Slideways Lubricants: Coolant separability and stick-slip

Energy lives here™

Introduction

Slideway lubricants can directly impact the productivity of machine tools. The selection of slideway lubricants can affect both machining precision and metalworking fluid service life, and is integral to the productivity of modern machine shops.

These are the characteristics of an optimum slideway lubricant:

☆☆☆ Superior Friction Control
This ensures high machining precision. To attain smooth and precise slideway operation, special attention to a lubricant's friction properties is required. The loss of frictional control could cause inaccuracies which would lower machine tool productivity.

☆☆☆ Excellent Separability
A slideway lubricant's excellent ability to separate quickly and completely from water-based coolants is important to avoid incomplete oil separation. Should oil separation be incomplete, higher operating costs and unscheduled machine downtime are to be expected.

How a Slideway works

With slideways, the two surfaces in contact are flat and motion is linear. Slides stop when reaching the end of the way, and move again in the opposite direction—operating in a stepwise manner.

Friction Fundamentals

The friction between lubricated surfaces is illustrated by the model plain bearing (refer to Figure 1).

1 While the system is at rest, the shaft and bearing surfaces are in direct contact with each other.

2 Force is applied to turn the shaft and must first overcome the interactions between the two surfaces. This is called static or break-away friction.

3. The shaft begins to rotate and dynamic/kinetic friction comes into play.

4 The lubricant is then "dragged" into the contact zone, reducing surface-to-surface interaction and causes friction forces to drop.

5 With increasing speed, the lubricant film in the contact zone increases too as friction drops.

6 When surfaces are fully separated by the lubricant, friction is reduced to a minimum.

7 If speed continues to increase, friction increases as the lubricant film grows and generates viscous drag.

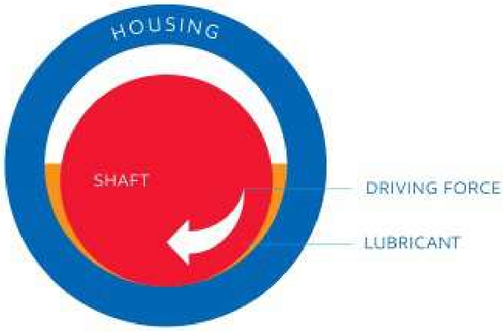

FIGURE 1

The relation between speed and friction in lubricated contacts can be described by the Stribeck-Curve (Figure 2). There are three different lubrication regimes:

- Boundary Lubrication: Friction is dominated by the properties of the surfaces
- Mixed Lubrication: Both the properties of the lubricant as well as the properties of the surfaces affect friction with a ratio depending on speed
- Hydrodynamic Lubrication: Friction is governed by the viscosity of the lubricant film

FIGURE 2

The Stick-Slip Effect

Slideways are very susceptible to stick-slip due to the large amount of time they operate in a mixed-lubrication regime. Stick-slip is a phenomenon that occurs when static friction exceeds dynamic friction, and when there is some elasticity in the system (refer to Figure 3).

Here is how it happens:

1. Driving force is applied.
2. High static friction prevents the slide from moving immediately.
3. The force loads the spring while the driving force exerted on the slide is gradually increased.
4. The force of the spring exceeds that of the static friction and the slide starts moving.
5. The spring force accelerates the slide and the spring unloads rapidly due to the change in friction from static to dynamic.
6. The completely unloaded spring then starts opposing the slide movement.
7. The slide slows down, while friction following the Stribeck-Curve model for mixed lubrication grows rapidly.
8. Finally, the slide comes to a halt.
9. The cycle starts over again.

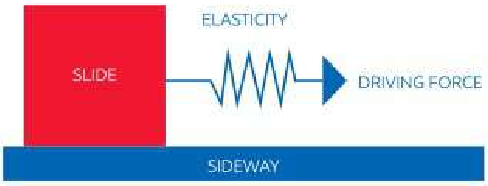

FIGURE 3

This jerky movement is what is often referred to as stick-slip.

Stick-Slip is undesired in most situations but especially for slideways where Stick-slip may cause jerky movements of the slide and the attached work piece or tool (refer to Figure 4). Such uncontrolled motion can result in:

- Inaccurate machining operations
- Unacceptable finished part quality
- Lost production

To combat this, modern slideway lubricants usually contain a synergistic mix of friction modifying additives that enable accurate and smooth operation over a range of operating conditions—allowing for better friction control.

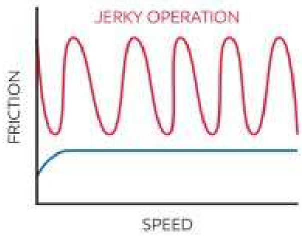

FIGURE 4

What is Coolant Separability?

The ability of the slideway lubricant to separate quickly and completely from water-based coolants. Figure 5 shows the separation between a slideway oil and aqueous coolant.

FIGURE 5

What is Tramp Oil?

"Tramp oil" is one of the primary contaminants found in such products and can adversely affect its working life. Because slideway lubrication is typically a total-loss and open system, coolant circulation system contamination and the formation of "tramp oil" is possible if aqueous coolants are being used.

High quantities of tramp oil in aqueous coolants can:

- Change the coolant concentration, making monitoring difficult
- Affect lubricity leading to tool wear and poor surface finish
- Increase the risk of bacterial growth and undesirable odors
- Reduce coolant pH levels, potentially causing corrosion
- Promote excessive coolant foaming

Emulsification through poor separation characteristics may result in:

- Reduced lubricity leading to increased friction
- Increased stick-slip and reduced machining precision
- Potentially higher energy consumption
- Wear of slideway contact surfaces or coating materials
- Corrosion of components and machines

Tips for Good Coolant Separability

Good Maintenance Practice
Periodically remove tramp oil and cover the coolant surface to prevent contact with oxygen and the growth of anaerobic bacteria.

Coolant monitoring
Use a refractometer for routine monitoring of coolant concentration so as to maximize coolant life.

Tramp Oil Removal
Tramp oil can be removed by automatic oil skimmers, belt skimmers or manually using an industrial vacuum cleaner. Offsite laboratory analysis can be used to quantify the presence of tramp oil.

Summary

- Consider separability characteristics during coolant/slideway lubricant selection.
- Good slideway lubricant/coolant separability properties provide optimal operational precision and help maximize. aqueous metal coolant life and performance
- A single supplier for both coolant and machine tool lubricants can limit compatibility issues.
- Good maintenance practices drive efficient machine shop operations.
- Good slideway oils provide smooth continuous transitions even under heavy loads.

mobil.co.in/business