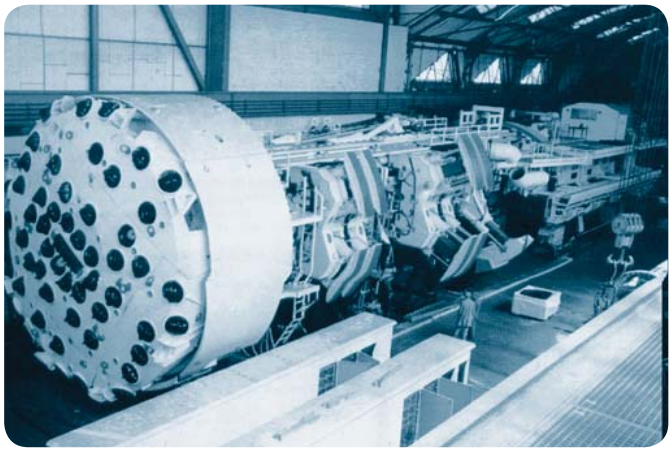
Industry: Mining
Machine Type: Boring Machine

History



Mining for chalk uses very large tunnel boring machines. The boring machine gears that drove the boring bits were getting loose consistently and quickly. Vibration showed nothing unusual.

Visual inspection showed nothing apparently wrong – gears were clean and smooth and shiny. Gears rapidly became loose, resulting in too much play in drives, backlash and broken equipment. The oil supplier was providing the most expensive, highest possible grade of gear oil with extra anti-wear additives. Oil supplier analysis showed excellent oil qualities.

Lubricant laboratory analysis

Laboratory analysis of oil and gears showed severe polishing wear on gear teeth – they were polished to a mirror finish. Oil had unusually high concentrations of phosphorous anti-wear compounds. Oil also had high levels of chalk dust.

Evaluation

Phosphorous is a sacrificial anti-wear compound that works by tarnishing the surface of the metal. Tarnish is a corrosion process. Tarnish films have lower shear strengths than the base metal, and so will act as a solid lubricant if the tarnished surface rubs against something. The tarnish is rubbed off. Tarnish also prevents two surfaces from welding together – it acts as an anti-seize compound. The high phosphorous content caused the gears to tarnish quickly. When the gears meshed, the fine chalk dust acted as a buffing compound to remove the tarnish. The oil immediately re-tarnished the surfaces of the gear teeth. The next time the gears meshed, the tarnish was buffed off by the chalk dust. The combination of high phosphorous and fine chalk dust created an extremely aggressive polishing wear environment.

Solution

Keeping dust out of a gearbox in an open mine is very difficult – and very expensive. A better solution was to use a cheaper grade of oil with no phosphorous additives. When the phosphorous was removed, the gear teeth did not tarnish and the polishing wear stopped.

Impact

Normal gear wear rates (without phosphorous additive in oil) were acceptable and dramatically lower than with the phosphorous additives.

Please contact:

SKF USA Inc.
Condition Monitoring Center – San Diego
5271 Viewridge Court · San Diego, California 92123 USA
Tel: +1 858-496-3400 · Fax: +1 858 496-3531

Web: www.skf.com/cm

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