

Application Report

Date: 10 March 2003

BEARING ALLOY OVERCOMES PROBLEMS ASSOCIATED WITH LUBRICATED STEEL BUSHINGS IN UNDERGROUND MINING EQUIPMENT

Underground mining is one of the most demanding applications for bearings. No matter how corrosive the environment in a salt mine, or how wet and aggressive in a coal mine, and regardless of whether or not a maintenance schedule is strictly adhered to, bearings need to fulfil their function by ensuring low friction and minimal wear. To solve a recurring problem with steel sleeve bushings on continuous mining machines, Joy Mining Machinery switched the bushing material to Brush Wellman's unique ToughMet[®] alloy. Since then, there have been no reported seizures, bearing failures, or premature wear of their equipment.

Continuous mining machines are substantial pieces of equipment used for mining salt, coal, Trona, Gypsum, Potash and other minerals. Typically, the dynamic linkage pins on the machines are mounted in bushings manufactured from steel, which provide the required strength with a complex lubrication system. Figure-of-eight channels are machined into the bushings to distribute lubricant. As long as the lubrication system is operating correctly, this design produces good results. However, underground mining is an environment where regular maintenance is difficult and, therefore, not always carried out at the appropriate intervals.

As a result, inadequate lubrication can occur, leading to galling between the steel bushing and the steel pin, and the two parts occasionally become inseparable due to a build-up of corrosion products.



Joy investigated several alternative materials for the bushings. However, none could match the strength of the steel bushing, which meant that a substantial redesign of the bearing would be required.

Brush Wellman's ToughMet[®] alloy, a spinodal alloy of copper, nickel and tin, offered Joy a material that has the strength of steel and the low-friction and lubricity associated with leaded bronzes. This means that a compact bearing arrangement can be designed, and that the bearing will continue to function even if starved of lubricant. For the dynamic pin bearing application, Joy Mining Machinery specified Brush Wellman's ToughMet[®] 3 CX105, a cast alloy with 15% nickel and 8% tin, with a yield strength of 105,000 psi (724 MPa). The mating component is a carburized steel pin.

One of the problems with heavy mining equipment is that the bearings are always loaded, so it is virtually impossible to get lubricant to the area where it is actually needed. This is especially so for oscillating joints, where heat can quickly build up and detrimentally affect bearing performance. ToughMet[®], with its inherent lubricity, negates this effect.

Because the fit between the pin and bushing is different for ToughMet[®], relative to steel, Joy developed a standardized pin-bushing fit that can be used in all cases where a ToughMet[®] alloy bearing must be designed. To date, Joy has concentrated on re-designing bearings that have traditionally proven problematic, but is now incorporating ToughMet[®] into new applications where it is believed to be more desirable than steel bushings.

Joy receives ToughMet[®] in standard sized cast tube to minimize machining and the resultant swarf. In the future, Joy aims to design all of its ToughMet[®] bushings so that they can be machined from just two customized sizes of tube, thereby optimizing the machining time (and swarf generation) and making it very cost-effective for Brush Wellman to produce casting runs to order. Typical Joy bushings range in size from 1.5-inch bore with 0.25-inch wall thickness to 6-inch bore with 0.625-inch wall thickness.

Although ToughMet[®] is more costly per unit weight than steel, savings are realized elsewhere. For example, steel bushings need complex machining operations to produce lubricant grooves.

These are not required for ToughMet[®] bushings. In the long run, it also may be possible for ToughMet[®] to be used instead of steel for large numbers of bushings, thereby reducing the size and complexity of the bearing lubrication system or, ultimately, to eliminate it altogether. The concept of a continuous mining machine that has lube-for-life ToughMet[®] alloy bearings also is attractive to mine operators who are aware of the high cost of underground maintenance in terms of both the maintenance procedures and the downtime.

Chris Stewart, Senior Engineer for Joy Mining Machinery's continuous miner development group, comments: "There have been no reported failures of our ToughMet[®] bushings and the test machines now in service have shown that the material is far superior to any of the alternatives currently available. The combination of high strength and low friction is very unusual and is just what we need for replacing problematic steel bushings. Moreover, the alloy's other properties – such as toughness, corrosion resistance and the ability to withstand particulate contamination – are also highly advantageous."

Mr Stewart goes on to praise the support that his company has received from Brush Wellman: "We were already using Brush Wellman's copper beryllium alloys when they introduced us to ToughMet[®]. The potential benefits for replacing some of the steel bushings were immediately apparent to us so we instigated a development program; the support we have received from Brush Wellman right throughout that project has been excellent. In addition, we have always been able to obtain the alloy in the correct grade, with no need to purchase large minimum order quantities. In summary, ToughMet[®] has exceptional properties and Brush Wellman has provided first-class support to enable us to make the best possible use of the alloy."