



Mine Hoist Rope Protection

Bill Bischoff & R.D. Barter, International Mining Magazine (February 1989 Issue)

The introduction of the wire cable marked a milestone in the development of mine hoisting. Prior to the use of wire, all hoisting has to be undertaken using natural materials, heavy in proportion to their strength, and of very limited loading capabilities.

Rope life was essentially short and the depths from which loads could be hoisted were also very limited.

The use of steel wire in the construction of hoisting ropes gave order of magnitude gains in rope life, rope loadings and hoisting depths. The years have seen many advances in the design of hoist ropes with different configurations being used for the various applications found in the mining industry. However, it is an inescapable fact that in spite of all of today's technology, there remains one basic problem that affects all steel winding ropes: corrosion.

The greatest development in rope making technology was the substitution of fiber by metal. By 1840, substantial lengths of wire 'selvagee ropes' were being made involving the winding of a continuous strand of wire between hooks set the required distance apart. These had to be manufactured in the lengths in which they were to be used since they could not be spliced. Even at this stage, the need for protection of the rope was recognized. A solution of india rubber with linseed oil, or a mixture of resin and tar, was rubbed between the wires. After the wires had been twisted into the required configuration, the solution was again applied. A woolen covet was wound on and once again was coated with the solution. The wire rope was now ready to be stored. This servicing having all been done by hand. It can be said that the practice of wire rope maintenance started from this period.

Because of the steel alloys used in the manufacturing of today's ropes and their subsequent use in both mechanically and chemically abrasive environments, it is necessary to provide hoist ropes with adequate protection against corrosion. This protection has to be omnipresent throughout the rope's manufacture, its storage and installation, but most importantly during its use whether that be in the hoisting of men and materials, of ore, or as a balance rope between cages or skips.

There are different methods of field dressing mine hoist ropes and there are various lay-up mixtures for protecting them ranging from petroleum-based to organic or inorganic compounds. These compounds include petroleum asphalts, oils and waxes, to which additives such as molybdenum disulphites, graphites as solids, and soluble extreme pressure additives can be applied while the use of soap thickened oil products (or greases) has recently seen a revival with good results.

Lay-up materials

The main function of a lay-up coating is to provide a rust inhibiting coating during storage and a base for subsequent field dressing materials. Several products are available, depending on the type of rope, its intended end use, and the cost limitations.

Traditionally, the most popular lay-up coating has been asphalt based, using a residue of crude oil distillation. During the laying-up of a rope, this asphalt (usually a solid at room temperature), is applied hot, at 80-100oC, so permitting the coating of individual wires. Upon cooling, the rope has a black coating, should be dry to the touch but not brittle, and the coating should stay intact for several years.

Another family of lay-up materials are the soap thickened oils, more commonly known as greases. These should be applied during stranding and closing of the rope, and since rope prepared with grease has had the voids between the wires and the strands filled in, it requires more grease than hot asphalt to prepare a rope for storage. However, the advantages are that greases stay pliable over a longer period than do asphalts while they also do not become brittle and do not permit water to condense inside the fully filled rope during storage.

Greases are usually reinforced with additives, the most acceptable being the sulphites of metals such as molybdenum and antimony. Graphite is also used as a blacking agent. Sulphur, phosphorus and chloride reacted fats and waxes can be used as extreme pressure additives. These are also used in open gear and bearing lubricants. The choice of grease depends on many factors: the end use, the condition of the shaft itself and the geographical/climatic conditions which prevail.

The superficial scale of water resistance for different greases varies markedly. Sodium soap greases are water soluble and are therefore not recommended for mine use. Calcium soap greases tend to emulsify a certain amount of water and their use in rope manufacturing is therefore questionable. Lithium soap greases are water resistant but tend to be rather buttery in texture and do not adhere to steel as well as some other greases. Aluminum soap greases are very water resistant, adhere well to metal and resist throw off.

However, lithium, aluminum and barium complex greases are best suited to mine rope maintenance. They are all very water resistant, fibrous in texture and are very resistant to chemical solutions such as acidic mine water. Their use is likely to increase in lay-up materials at the expense of the asphalt based materials.

It should be noted that lay-up materials for locked coil ropes are mostly of a waxy nature and are not related to the field dressings used on conventional stranded ropes.

Cut-backs and solvents

The correct storage of hoist ropes is of the greatest importance since storage in poor conditions or without regular inspection and maintenance can lead to progressive deterioration of a critical part of the mine's productive equipment.

Asphalt coated ropes should be stored inside a building and away from direct sunlight. The storage reel should be turned periodically to prevent the migration of lay-up material to the bottom of the reel. Upon being taken off the reel, a conditioning oil or solvent should be used to displace condensation moisture, to revitalize the aged lay-up material, to coat scraped areas and generally to prepare the rope for its first field dressing. It should be remembered that asphalt layed-up ropes are full of void areas which can extend to the core of the rope. This condition allows water to enter the rope so subsequent coatings will only help to entrap this water thus setting up perfect conditions for undetectable corrosion.

A further important point is that once a rope has been put into use, it should be given its first field dressing immediately because the potential for the onset of corrosion is always present.

Field dressing compounds are similar to the lay-up materials. In the case of greases, the same products are usually used for lay-up materials as for the field dressing. Greases are not cut-back with oils or solvents so pressure application is best suited when these materials are used as lay-up coatings or as field dressings.

To aid their application, asphalt base materials are cut-back with either chlorinated (inflammable) solvents or with oils. This has done away with the old-fashioned method whereby asphalts had to be heated in the headframe area before they could be applied to the rope. The chlorinated solvent cut-backs have the advantage that they soften the old lay-up material thus making the rope surface more receptive to a new field dressing. They will also penetrate into the rope's voids thus displacing any moisture. In addition, these solvents evaporate quickly allowing rope to be used shortly after dressing.

The drawbacks are that chlorinated solvents produce vapors that can accumulate in the lower parts of a downshaft. In hoist rooms, chlorinated solvent can reduce moisture in the air causing problems with electric motors so good ventilation is always necessary when using this type of material. Asphalts cut back with light oil can produce flammable oil vapors and also since they do not set very rapidly, some throw off will occur. Oil cut-backs do not penetrate a rope to the same extent as solvent cut-backs.

Overdressing can be a problem and as an aid to preventing this, a solvent-oil material should be used. Ropes should be inspected regularly. In the case of asphalt-based dressings, if sufficient coating is present, then a softening and conditioning agent should be used which will lead to shorter application times and the use of less coating material.

Polymers usually cause a heavy build-up on a rope and related equipment while waxes, either neat or as an additive to asphalt, reduce the adhesive nature of a lay-up or field dressing. Oils, when used as field dressings for stranded ropes, do not result in a marked improvement in rope life.

Coupled with the high rental cost of the equipment needed to preclean a rope and subsequently dress it with oil, this makes for rather a costly process. Very often the two most important factors in the success of any field dressing program are the attentiveness of the maintenance of the maintenance personnel towards the tedious task of maintaining a rope and allowing sufficient time for a field dressing to penetrate and become properly set.

Field dressing application

The methods of applying field dressings to hoist ropes vary greatly from mine to mine and even from shaft to shaft on individual mines. Techniques range from the simple to the sophisticated and it is thus not surprising that the recent introduction of 'cleaning devices' has gained some attention.

A method recently introduced by one of the large oil companies is probably the only one that is claimed to penetrate to the core of a rope. Using a light oil that is forced into the rope by a pressurized applicator, it washes out all contaminants, including the lay-up materials. But as mentioned before, the cost of this type of service is rather high and it has not yet been established that an oil coating will improve overall rope life.

A second method involves the use of a two-sectioned collar which is fastened to the rope and which, with the aid of internal plastic seals, endeavors to clean the rope as it applies a new dressing. This works reasonably well if one bears in mind that it is mainly an applicator and that new material rarely penetrates to the actual core of the rope.

One point of importance here is the consistency of the dressing. The lighter a field dressing, the more likely that it will be forced into the core of the rope. At a rope speed of about 46m/minute (150ft/minute) and a grease pump pressure of about 2 atmospheres (30 psi), it is rather doubtful that anything penetrates a rope that is under load. Indeed, it may not be desirable to force a lubricant into the rope by this method since the old dressing together with rock dust and water could be forced into the center of the rope.

What these devices will do, however, is to simplify the job of dressing a rope and reduce the time needed for set up and consequently clean up. At a mine site in the Sudbury (Canada) area, a grease spray system was installed at a sheave wheel on one of the hoists to dress a stranded rope continuously. This system proved to be successful. The rope cannot be overdressed and since the dressing is done whilst the rope is in operation, there is no down time for maintenance.

The bottom line

The correlation between the size of rope, its speed of operation and whether its use is in hoisting or skipping, all affect the type of coating required. The larger diameter, faster traveling rope needs a heavier coating. Tail or balance ropes should be layed-up with a complexed grease rather than with an asphalt product, as this prevents water from entering the rope and since grease is flexible, can prevent the entanglement of ropes in the shaft bottom area.

There is no escaping the fact that all mine hoist ropes need regular maintenance in the same way that any other piece of equipment must be cared for in order to ensure that it operates at its optimum performance level. The use of the correct type and amount of lay-up material and field dressing will help to ensure that the hoist rope gives of its best while protecting it from core to outer wires from the corrosive conditions frequently encountered in mine shafts. As with any piece of equipment, good levels of preventive maintenance will help reduce the amount of emergency repair work that is required, since in the case of hoist ropes, failures incur heavy costs.

In conclusion, the conditions and duties required of each rope can vary widely whilst the levels of moisture and acidity in a particular shaft will dictate the type of field dressing required. It is for this reason that no single product or method can satisfy the needs of this demanding and important maintenance sector so a wide range of rope coatings and field dressings will continue to be needed.

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