Chapter 14

Installation of Mineral Insulated Cables

Mineral insulated (MI) cables have been in use for a sufficient number of years to have stood the test of time. These cables have an insulation of highly compressed magnesium oxide powder (MgO) between cores and sheath. During manufacture the sheath is drawn down to the required diameter; consequently the larger sizes of cable yield shorter lengths than the smaller sizes. Generally MI cable needs no additional protection as copper is corrosion resistant. However, in certain hostile environments, or if a covering is required for aesthetic or identification purposes, MI cable is available with PVC or LSF covering.

The advantages of MI cables are that they are self-contained and require no further protection, except against the possibility of exceptional mechanical damage; they will withstand very high temperatures, and even fire; they are impervious to water, oil and cutting fluids, and are immune from condensation. Being inorganic they are non-ageing, and if properly installed should last almost indefinitely.

The overall diameter of the cable is small in relation to its current-carrying capacity, the smaller cables are easily bent and the sheath serves as an excellent protective conductor. Current-carrying capacities of MI cables and voltage drops are given in IEE Tables 4G1A and 4G2A.

14.1 FIXING

The cable can be fixed to walls and ceilings in the same manner as PVC insulated cables. A minimum bending radius, of six times the bare cable outside diameter is normally applicable. This permits further straightening and re-bending when required. If more severe bends are unavoidable, they should be limited to a minimum bending radius of three times the bare cable diameter, and any further straightening and bending must be done with care to avoid damaging the cable.

All normal bending may be carried out without the use of tools, however, two sizes of bending levers are available for use with the larger diameter cables or when multiple bends are required. These levers are specially designed to prevent cable damage during bending.
When carrying out the installation of this wiring system, the sheathing of the cable must be prevented from coming into contact with wires, cables or sheathing or any extra-low voltage system (not exceeding 50V a.c. or 120V d.c.), unless the extra-low voltage wiring system is carried out to the same requirements as for a low-voltage system (1000V a.c.). This means that it must not be allowed to come into contact with lightly insulated communication or data cables.

**FIGURE 14.1** Control wiring in $3 \times 1.5\text{mm}^2$ PVC-sheathed MI cable (Wrexham Mineral Cables).

**FIGURE 14.2** Straightening up multiple runs of MI cable using a block of wood and hammer (Wrexham Mineral Cables).
Protection Against Mechanical Damage

Mineral insulated cable will withstand crushing or hammering without damage to the conductors or insulation. However, if the outer sheathing should become punctured, the insulation will begin to ‘breathe’ and a low insulation resistance will result. Therefore, it is advisable to protect the cable if there is a possibility of its being mechanically damaged.

Where cables are exposed to possible mechanical damage it is advisable to thread the cables through steel conduits, especially near floor levels, or to fit steel sheathing over the cables in vulnerable positions. Where cables pass through floors, ceilings and walls the holes around the cables must be made good with cement or other non-combustible material to prevent the spread of fire, and where threaded through holes in structural steelwork the holes must be bushed to prevent abrasion of the sheathing.

14.2 BONDING

Because of the compression-ring type connection between the gland and the cable, and the brass thread of the gland, no additional bonding between the sheath of the cable and connecting boxes is necessary although it is common practice for the terminating pot to have an earth tail fitted. The earth continuity resistance between the main earthing point and any other position in the completed installation must comply with IEE Tables 41.2, 41.3, 41.4 and 41.5.

A range of glands and locknuts is available for entering the cables into any standard boxes or casings designed to take steel conduit. The glands, which are

FIGURE 14.3  Bending and setting of MI cable. These operations can be more easily done by means of the simple tool illustrated (Wrexham Mineral Cables).
TABLE 14.1 Minimum Spacing of Fixings for MI Copper-sheathed cables. These Spacings are for Cables in Accessible Positions

<table>
<thead>
<tr>
<th>Overall diameter of cable (mm) of mineral-insulated copper-sheathed-cables</th>
<th>Horizontal (mm)</th>
<th>Vertical (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not exceeding 9</td>
<td>600</td>
<td>1800</td>
</tr>
<tr>
<td>Exceeding 9 and not exceeding 15</td>
<td>900</td>
<td>1200</td>
</tr>
<tr>
<td>Exceeding 15 and not exceeding 20</td>
<td>1500</td>
<td>2000</td>
</tr>
</tbody>
</table>

(a) Preparing cable end. Strip cable end by gripping the edge of the sheath between the jaws of side-cutting nippers and twist the cable off in stages, keeping the nippers at about the angle shown. (b) Then proceed in a series of short rips, pulling off the sheath in a spiral.

(c) An alternative method of stripping sheath to expose long conductors. A stripping rod, which can be easily made from a piece of mild steel is used in a similar manner to a tin opener. (d) The MI cable joistripper being used to start the cut to remove the cable sheath.

FIGURE 14.4 Mineral insulated cable – stripping the sheath.
slipped onto the cables before the cable ends are sealed, firmly anchor the cables and provide an efficient earth bonding system.

In some instances, it may not be possible to ensure bonding via the gland, e.g. when fixed into a plastic box. In these instances, a seal is available which incorporates an additional earth tail wire.

**Regulations on Sealing**

The ends of MI metal-sheathed cables must be sealed to prevent the entry of moisture and to separate and insulate the conductors.

The sealing materials shall have adequate insulating and moisture-proof properties, and shall retain these properties throughout the range of temperatures to which the cable is subjected in service. The manufacturers provide a plastic compound for use on the standard cold screw-on pot type seal.

Methods of stripping and sealing are given below. The tools required include hacksaw, side cutting pliers, screwdriver, special ringing tools and pot wrench.

**14.3 PREPARATION OF CABLE END**

To prepare the ends of the cable prior to sealing, cut the cable to length with a hacksaw. The sheath is then scored with a ringing tool to enable a clean end to be made when the sheath is removed. Tighten the nut of the ringing tool so that the wheels JUST grip the sheath and then give the nut a further quarter to half a turn. By rotating the tool through 360° or more, the sheath will be ringed. If the ring is made too deep it will be found difficult to break into it when stripping; if too shallow the sheath will be bell-mouthed and the gland and seal parts will not readily fit onto the sheath. If there is any roughness left around the end of the sheath from the ringing tool, remove it by lightly running the pipe
grip part of a pair of pliers over it. If the length to be stripped is very long, defer ringing until stripping is within 50–75mm of the sealing point.

After ringing at the sealing point, strip the sheath to expose the conductors. Use side-cutting pliers to start the ‘rip’. To do this, grip the edge of the sheath between the jaws of the pliers and twist the wrist clockwise, then take a new grip and rotate through a small angle. Continue this motion in a series of short ‘rips’ keeping the nippers at about 45° to the line of the cable, removing the sheath spirally. When about to break into the ring, bring the nippers to right angles with the cable. Finish off with point of nippers held parallel to the cable.

An alternative method of stripping, often employed for long tails, is to use an easily constructed stripping rod, as illustrated. This can easily be made from a piece of mild steel rod, about 10 mm in diameter, the end slot being made by a hacksaw. Start the ‘rip’ with pliers then pick up the tag in the slot at the end of

(a) A quick and accurate method of fitting the pot is by the use of a pot wrench. (b) Alternatively, a wrench can be used to fit the pot.

(c) Examine the inside of the pot for cleanliness and metallic hairs prior to filling with compound. (d) Overfilling the pot with compound. Use the plastic wrapping to prevent fingers coming into contact with the compound so as to ensure cleanliness of the seal.

**FIGURE 14.5** Sealing the cable end.
the rod and twist it, at the same time taking it round the cable; break into the
ring and finish as with the nipper method.

For light duty cables up to 4L1.5 in size the Joistripper tool is very efficient,
it is quick and easy to use, and will take off more sheath than any other tool of
its type, and is available from the manufacturers of MI cables, and their
suppliers. For other cables, large or small rotary strippers can be used, these are
also obtainable from the cable manufacturers.

14.4 SEALING CABLE ENDS

The standard screw-on seal consists of a brass pot that is anchored to the cable
sheath by means of a self-tapping thread. The pot is then filled with a sealing
compound and the mouth of the pot is closed by crimping home a stub cap or
disc/sleeve assembly. The components necessary are determined by the
conductor temperature likely to be encountered. They are as follows:

- 80 to 105 °C Grey sealing compound, stub cap with PVC stub sleeving or
  fabric disc with headed PVC sleeving, for standard seals.
- 20 to 60 °C Grey sealing compound, red/pink polypropylene disc with
  headed PVC sleeving, for increased safety seals.

Having ringed and stripped the sheath, slip the gland parts, if any, onto the cable.
To complete the screw-on seal, see that the conductors are clean and dry, engage
the sealing pot square and finger tight on the sheath end. Then tighten the pot
with pliers or grips until the end of the cable sheath is in level with the shoulder at
the base of the pot. In general the cable should not project into the pot but a 1 or
2mm projection is required for certain 250 °C and increased safety seals.
Alternatively the pot wrench can be used in conjunction with the gland body.
If the pot is difficult to screw on, moisten the sheath with an oil damped rag. To avoid slackness do not reverse the action. Examine the inside of the pot for cleanliness and metallic hairs, using a torch if the light is poor. Test the pot for fit inside the gland. Set the conductors to register with the holes in the cap. Slip the cap and sleeving into position to test for fit, and then withdraw slightly. Press compound into the pot until it is packed tight. The entry of the compound is effected by feeding in from one side of the pot only to prevent trapping air. To ensure internal cleanliness of the seal, use the plastic wrapping to prevent fingers from coming into contact with the compound (Fig. 14.5d).

Next slide the stub cap over the conductors and press into the recess in the pot. Finally, the pot must be crimped using a crimping tool and the termination completed by sliding insulated sleeves of the required length onto the conductors. New types of seal are becoming available with the sealing compound supplied as an integral part of the seal. These seals are easier to fit and information on their use may be obtained from cable manufacturers.

14.5 CURRENT RATINGS OF CABLES

Owing to the heat-resisting properties of MI cables and to the fact that the magnesia insulation is a good conductor of heat, the current ratings of these cables are higher than those of PVC or even PI cables.

Multi-core cables are not made larger than 25mm², and therefore when heavier currents need to be carried it is necessary to use two or more single-core cables which are made in sizes up to 240mm². Where single-core cables are run together their disposition should be arranged as shown in IEE Table 4A2. The current-carrying capacity of large single-core cables depends considerably upon their disposition.

IEE Tables 4G1A–4G2A are for copper conductor MI cables. When these cables are run under conditions where they are not exposed to touch, they are rated to run at a comparatively high temperature and the current rating is considerably more than cables which are exposed to touch, or are covered with PVC sheathing. For example, a 150-mm² single-core cable is rated to carry 388A if exposed to touch, but if not exposed to touch the same cable is rated to carry 485A.

When an installation is designed to carry these higher currents, due regard must be paid to voltage drop, and also to the fact that the high temperature which is permissible in these cables might be transmitted to switchgear, and which might be affected by the conducted heat from the cable.

14.6 SOME PRACTICAL HINTS

These cables are supplied in coils, and every effort should be made to ensure that the coils retain their circular shape. They are frequently thrown off the delivery lorry and the impact flattens and hardens them. Before despatch the manufacturers anneal the cables so they are in a pliable state, but during transit
and subsequent handling manipulation in excess of the manufacturers’ recommendations will harden the cable and could cause sheath fracture.

To measure the cable it should not be run out and recoiled as this tends to harden the cable. The best way is to measure the mean diameter of the coil and multiply by 3.14 which will give the approximate length of each turn in the coil.

Kinks or bends in the cable can best be removed by the use of a cable straightener. This is a device with pressure rollers that can be run backwards and forwards over the cable until the kinks are smoothed out.

The magnesium oxide insulation used in the cable has an affinity for moisture. There is, therefore, a need for temporary sealing during storage.

After sealing, an insulation test between conductors and to earth should be carried out, and this test should be repeated not less than 24 h later. The second reading should have risen, and be at least 100MV with a 500V insulation tester.

As the conductors cannot be identified during the manufacturing process it is necessary to identify them after making off the seals. This can be done by fitting coloured sleeves or numbered markers onto the core. Correct identification can be checked by the use of a continuity tester.

14.7 INDUCTIVE LOADS

Switching of inductive loads can cause high voltage surges on 230V and 400V circuits, and these surges could cause damage to MI cables. Protection from these surges can be achieved by the use of inexpensive surge suppressors. The manufacturers of MI cables will be pleased to give advice on this matter.