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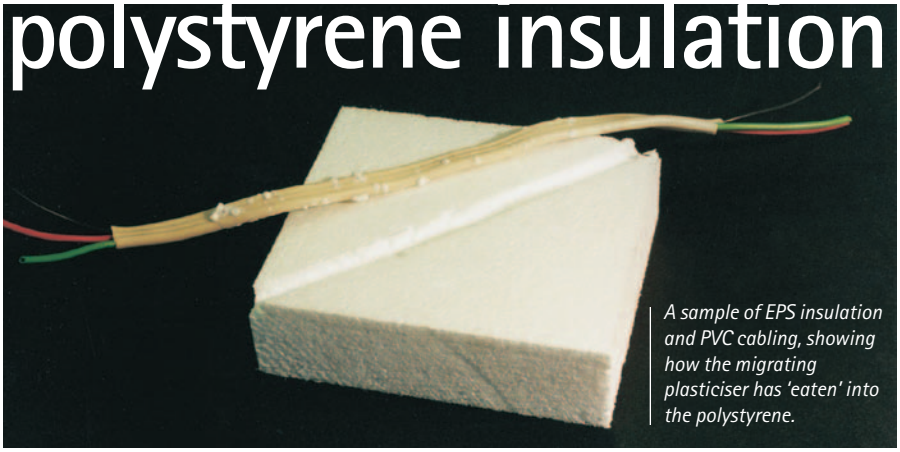
Electrical cable in polystyrene insulation



A sample of EPS insulation and PVC cabling, showing how the migrating plasticiser has 'eaten' into the polystyrene.

Questions are often asked about the suitability of electrical cables used in contact with polystyrene insulation. The answer is that there should be no problems if simple precautions are taken and electrical regulations followed.

The two main issues to look at when addressing this question are:

1. the temperature of the cables
2. interactions between cable sheathing and the building insulation.

All electrical cables generate heat when they carry electricity. The amount of heat generated is related to the current the cable carries and the thickness of the copper conductor. The actual temperature the cable and its sheathing will reach is governed by how quickly the cable can dissipate the heat to the surrounding environment. For example, when cables are bundled together or surrounded by insulation, the cable will get hotter than a single cable would when run through an empty wall cavity.

The New Zealand Electricity Regulations 1997 are designed to ensure that electrical cables installed in buildings operate within the temperature range of the relevant Standard to which the cables are manufactured. They take into account the anticipated electrical current, wire size, the effect of bunching cables and the effects of building insulation.

Chemistry of cable materials

The copper wires in electrical cables are insulated and sheathed to prevent short-circuiting, and to protect building users from electrical shock and fire. The most common sheathing material is PVC, which is a rigid material that needs to be plasticised to make it flexible.

A variety of compounds can be used to plasticise PVC, but the most commonly used are phthalate-esters. These are good general-purpose plasticisers that are also economical to use. This type of plasticiser is mixed into the PVC resin but is not chemically bound to the PVC. This means that under some circumstances the plasticiser 'migrates' (comes out) of the PVC. An example of this is the sticky surface associated with the PVC (or vinyl, as it is sometimes called) car seat covers of earlier years.

'Eating' polystyrene

The rate at which plasticiser loss will occur is dependent on the temperature of the PVC sheathing and the nature of the surrounding materials. Of the commonly used building materials, some phthalate-ester plasticisers have a particular affinity for expanded (or extruded) polystyrene. When left in contact with expanded polystyrene (EPS), the plasticiser slowly migrates out of the PVC into the polystyrene. The EPS is soluble in the plasticiser, so a sticky film develops on the outside of the cable sheathing, and the cable 'eats into' the polystyrene.

In theory, if enough plasticiser were lost, the cable sheathing would become brittle. If the cable was then flexed sufficiently, this could potentially result in a short circuit between wires in the core.

Prevention

There are two simple ways to avoid this problem completely:

1. use a cable with a migration-resistant plasticiser
2. prevent the cable contacting the polystyrene.

Cable manufacturers produce a range of cable types, and some high temperature products have sheathing that does not suffer from plasticiser migration. It is also possible to produce PVC-sheathed cables using migration-resistant plasticisers. While this costs only slightly more than standard PVC sheathing when produced in reasonable quantities, there is currently little demand from industry for it.

There are a number of ways in which PVC cabling can be separated from surrounding polystyrene. Ducting through piping is already used in some cases. Using a tape (e.g. polyester) to wrap the cable is another alternative.

Plasticiser migration from PVC cable in contact with EPS can also be effectively minimised. If the cable temperature can be kept relatively low (50–60°C for a 50% usage situation), the rate of migration will be slow and will not cause a problem over 50 years. One manufacturer has used this approach for a specific electrical design (for an individual building) in which the cable capacities, current loads and circuit breakers were such that temperatures were kept to acceptable levels.

Precaution checklist

Given the widespread use of EPS in buildings at the present time, there are some things that must be considered if the techniques described above are not used to limit plasticiser migration problems.

1. *Support horizontal cabling:* Running PVC cable horizontally through, or on top of, polystyrene must be avoided unless the cable is supported at regular intervals (600 mm maximum) with limited slack between supports. If the cable is not supported, it will continue to 'eat through' the polystryrene until all the slack is taken up.

2. *Fix vertical cabling:* Vertical cabling should preferably be fixed in position to prevent flexing. At a minimum, it should be installed in a manner that will reduce the potential for movement. With vertical and properly supported horizontal cable runs, contact between the polystyrene and the PVC sheathing will be broken as the polystyrene shrinks away from the cable. Samples of cable in contact with polystyrene taken from existing buildings have shown that plasticiser loss is minimal if contact is minimised.

3. *Don't use EPS beads:* Loose-fill EPS beads ('beans') must *not* be used as insulation since these could potentially maintain permanent contact with the cable (since gravity would keep moving new beads into contact with the cabling).

4. *Use correct cable size:* Electrical contractors need to ensure that they are installing the appropriate cable size for the length of run, electrical load and the anticipated cable temperature. If there is any doubt, the use of ducts or conduits as a barrier may need to be considered. Care must also be taken in the way cables are installed with regards to the spread of fire, such as the sealing of cable entries into switchboards. Another factor that electricians may need to take into account is that the increased use of air-conditioning has resulted in an increase in electrical loads in summer when ambient air temperatures are at their highest.

5. *Consider using migration-resistant cabling:* Where cables are carrying a load near to their rated capacity on a permanent, or near-permanent, basis contact with polystyrene should be avoided unless migration-resistant sheathing is used. An alternative is to have a specific electrical design done for that individual building by a qualified person, to ensure cable temperatures are controlled.