EUROPEAN INSULATION MANUFACTURERS ASSOCIATION

FACT SHEET

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CELLULOSE FIBRE INSULATION

1. Introduction

Cellulose Fibre Insulation is made from either pure cellulose waste, derived from paper production or from shredded newsprint. The product consists of small tufts of paper, dry mixed with powdered chemical additives which improve the fire properties of the product and prevent mould growth. These are frequently mixtures of borates or boric acid, cheaper alternatives such as aluminium and ammonium sulphate are sometimes used. Typically, it has a fluffy appearance and a greyish colour.

The insulation is often installed horizontally in attic spaces as a loose fill insulation. It can be poured out from bags directly into the loft or it may be blown into place.

Cellulose insulation can also be applied to walls. There are three methods.

- It can be blown into closed wall frames or behind a finely woven cotton (scrim) sheet. The installation technique in these applications is more critical than in horizontal constructions.

- In wet spray systems, cellulose fibre insulation is sprayed with a water based adhesive directly into the cavity between timber studs; the wet slurry remains in place without mechanical support until the interior wall finish is applied. Alternatively, the insulation may contain a dry mix water soluble binder, which makes it possible to add water just before the application of the material. Normally at least two weeks are required for drying out before the inner layers can be fixed.

- In the wet blown system, the insulation is blown with a water based adhesive behind netting installed to hold the insulation in place. As with the wet spray system, at least two weeks are required for drying out before the inner layers can be fixed.

2. Composition

Cellulose fibre insulation is made from approximately 80% fibre and approximately 20% by weight of fire retardant chemicals (inorganic salts) which if well dispersed in the product improve its fire performance. VITO (the Belgian Government Research Laboratory) says that some 20% by weight of the product is fire retardant salts.

Other measurements show that the figure varies between 5-25% for different products.

The fire retardant additives are usually boric acid and sodium borate. Cellulose fibre insulation will contain substances which were used in the preparation of the original newsprint that was recycled to make the product. viz. the dyes, resins, gums, talc, solvents and printing ink which contains a proportion of toxic heavy metal compounds which are used as pigments.

> NOTE: Published information points out that for every tonne of paper converted into cellulose insulation one tonne less is available for recycling into paper or as an energy source. As far as its use as a raw material for paper manufacture is concerned, every tonne of paper recycled must be replaced by one tonne of virgin paper from virgin wood pulp.

Mineral wool products are manufactured from inorganic materials (rock, glass and slag) with the addition of a small quantity of organic binder.

3. Thermal Performance

3.1 Thermal conductivity

The claimed thermal conductivity for cellulose insulation in the UK is 0.035 W/m2K for the product blown into lofts and 0.038 W/m2K for walls. This claim by the manufacturer is not supported by the results of the various international studies that have been published. viz.

> Norwegian studies have shown that thermal conductivity of cellulose fibre insulation at normal building moisture contents, of approximately 10% by weight, is 0.042 to 0.045 W/mK.
> In Sweden a thermal conductivity of 0.039 W/m2 K is normal for densities ranging from 30 kg/m3 to 70 kg/m3.

3.2 Settlement

Independent investigations in the seventies and eighties have shown that the settlement in attics to be 15 % to 25 %, the cellulose industry claim that newer products are in the range 10 % 15 %, however this has never been documented, also it is impossible for the authorities and consumers to determine whether they have a product of the new or old fiberising technology. The thermal performance loss due to settlement is increased by gaps in the insulation which appear as a result of the settlement.

In closed cavities settlement is not acceptable since inspection and topping up, in the case of settlement, is impossible. Cellulose manufacturers claim that provided a high density is installed the settlement is zero. The density needed to achieve this goal varies from manufacturer to manufacturer within the range 50 to 70 kg/m3, however these claims are not supported by independent field studies. In Germany official laboratories are issuing certificates on settlement based upon vibration tests. It is not documented how the vibration tests correlate to actual field performance.

4. Fire performance

Fires in cellulose fibre insulation, in the absence of fire retardant chemicals or if the retardents are only present at a low level, occur by insidious combustion (smouldering). This is a process which liberates exceptionally large levels of carbon monoxide.

Cellulose fibre insulation should contain between 20 and 25% of inorganic salts, by weight, to provide protection against this fire risk. In Finland 25% by weight is required and is strictly controlled. It is possible that the addition of these salts is subject to variable control, and that the proportion is affected by the application methods. It seems likely that in all its applications, some separation of cellulose fibres from the fire retardant salts will occur.

A review of fire incident data in the US revealed that greater than 80% of fires associated with insulation involved cellulose fibre insulation, and were started by overheated electrical light fixtures, other electrical sources and heated flues. Similar results were shown in Australia and other American studies. In Norway other studies have showed that localised heat sources, including 100 watt light bulbs, caused smouldering.

The UK Building Regulations lay down that the product should be kept away from hot flues, recessed luminaries and vent ducts. The fire performance of cellulose fibre products on the market must satisfy the requirements of BS 5803 Part 3, which specifies that fire tests are conducted in accordance with BS 5803 Part 4 for smouldering and flammability.

An American study has showed that smouldering cellulose fibre insulation is difficult to extinguish without flooding the sample in water and stirring it in. In a typical real life example, a fire started in a house in Maryland, USA in January 1992 from an overheated electrical cable in an attic. The fire department extinguished the fire only to be called out 20 hours later when the fire developed again from smouldering insulation that was not detected after the first fire. Similar examples are reported elsewhere.

In the UK the Property Services Agency (PSA) states that cellulose fibre loft insulation should not be specified on the grounds of its combustibility. A study for the Norwegian Government concluded that ‘ in view of the information we have today we can not recommend that the material be applied in buildings where people have to live’.

Conservative estimates have been made that in the USA cellulose insulation is the first material to ignite in at least 1500 - 2000 fires per year. The chairman of the US Federal Trade Commission testified that substandard cellulose fibre insulation was ‘like a time bomb waiting to explode’.

In Australia, a recent short survey uncovered 80 fires directly attributable to cellulose fibre insulation, and another study found 67 occurrences of house fires in a three month period involving cellulose fibre insulation.

Cellulose fibre insulation is combustible in accordance with BS476 Part 4. Independent tests commissioned by a Eurisol member company (Owens Corning) have shown that four brands of cellulose fibre insulation all failed ‘smouldering tests’ to BS5803 Part 4. In Australia , seven field research projects to determine the extent of compliance to fire safety regulations indicated a 55% failure rate for cellulose fibre insulation. An American study showed that

53% of samples tested failed an American standard smouldering combustion test, and the US Consumer Product Safety Commission reported a 65% failure rate for samples taken from manufacturing plants when tested for smouldering combustion and flammability.

In Palo Alto, California, in 1986 only 8 out of 133 houses with cellulose fibre insulation that were tested, passed the State of California tests for open flame spread and smouldering combustibility. To verify if the results applied to cellulose fibre insulation in general, the same tests were carried out to samples of attic insulation from across the USA. All samples of glass and rock mineral wool passed. However 15 of the 24 cellulose samples failed the smouldering test and 10 of the 19 samples tested failed the flammability test. This raised the question of whether the ageing of cellulose fibre insulation caused a degradation in fire performance. Laboratory tests were carried out, and revealed that fire resistance significantly declined with age. They also showed that boric acid sublimes from the top surface of the insulation and settled to the base. A study by the US Department of Energy found that 13 of 19 samples of cellulose insulation showed visible evidence of separation of cellulose and fire retardant chemicals, with the chemicals being found at the bottom of containers. This was backed up by the US National Bureau of Standards, who also identified a risk of chemical retardant sublimation.

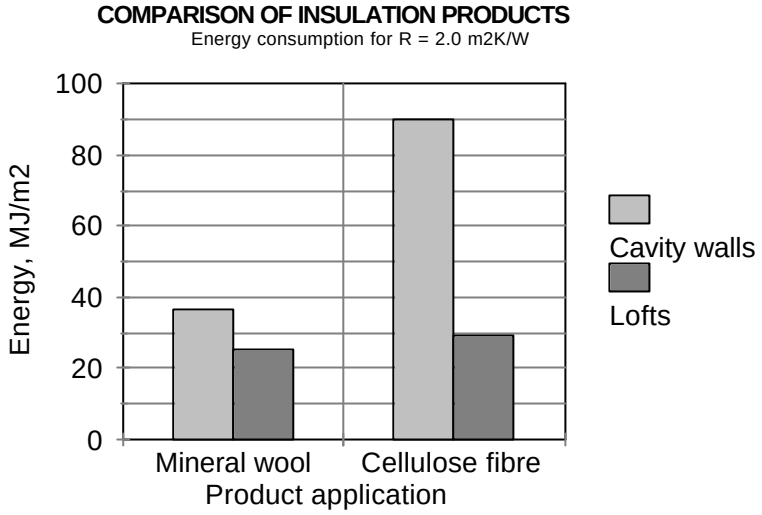
All mineral wool products perform well in fire and the large majority are classified as non-combustible.

5. Environmental performance

5.1 Embodied energy in cellulose fibre insulation

The energy embodied in cellulose fibre insulation (that is all energy consumed by the material from cradle to grave) has been given as 16.64 MJ/kg, in papers from the Danish Environmental Protection Agency. This figure is the sum of the energy used in the manufacture of the product, the additives and its installation i.e. 3.83 MJ/kg and the feedstock energy of the product, 12.81 MJ/kg.

Although it is claimed by cellulose insulation manufacturers that their product 'consumes an order of magnitude less energy in manufacture than all other insulation materials', the reality is different as the following histogram, based on the Danish EPA figures demonstrates:



5.2 Other environmental aspects

5.2.1 Use of resources

Cellulose insulation manufacturers claim that it is 'made from 100% waste newspaper, to save the world's finite resources'. Published information points out that for every tonne of paper converted into cellulose, one tonne less is available for recycling into paper, so one tonne of virgin paper is needed from virgin wood pulp. It therefore follows that the production of cellulose fibre insulation leads to the destruction of the world's forest resources rather than conserving them because of the ever increasing demand for paper and the need for more and more virgin product.

Boron in the form of its salts is not a widely available natural resource and as such the few concentrations that do exist constitute a valuable but limited resource

5.2.2 Disposal

At the end of its working life it seems likely that problems that will be encountered with the safe disposal of cellulose products because of the boron salts. The presence of these makes the material difficult to incinerate and other methods of disposal, such as soil burial, could cause seriously pollution to ground waters

A recent study has calculated that upon demolition of a building insulated with cellulose fibre, each cubic meter of insulation will typically contain 8 kg of soluble boron containing materials. It would therefore take 160 million litres of water to dilute the boron content of a house-lot of cellulose fibre insulation to a safe level.

One of the sources of boron containing minerals is in Turkey, where an important river running through the mining area has been rendered unusable for irrigation because of the mining discharges. At extremely dilute concentrations borates are essential trace elements for plant growth but at greater concentrations they are herbicides. In Norway, cellulose fibre insulation waste is classed as hazardous to the environment because of the presence of the boric acid.

6. Health aspects

Boric acid and sodium borate have been linked to testicular atrophy in rats, and high contents of boron in drinking water have been reported to reduce sexual function in men Similar effects have been reported for men working in boric acid production plants.

Published studies have found that boric acid causes infertility in mice, with the male sex being affected. The chemical reduces body and reproductive organ weight, increases the count of abnormal sperm, decreased sperm concentration and motility and causes sperminiferous tubule degeneration.

Cellulose fibres of respirable size occur in cellulose fibre insulation and these are released during installation (by pouring and blowing methods) in unacceptable quantities (50 fibres/ml with diameter < 3(m and 20 fibres/ml with diameter <1(m have been measured). Research in the United States involving animal inhalation exposure to cellulose fibre insulation has raised concerns about respiratory problems.

Tests in the USA on dust from a working situation have proved that cellulose fibre insulation fibres are not decomposed in the body, that they are associated with an increased risk of mesothelioma, and that they may be more active than asbestos.

Paper and cellulose fibre is derived from wood. Work published in the British Journal of Industrial Medicine states that wood dust is a known carcinogen causing nasal cancer, and has recently been reclassified and upgraded by IARC to a category 1 carcinogen. An excess of respiratory cancers have also been recorded in some populations of wood workers. Exposure to wood dust can cause other diseases, particularly asthma, loss of lung function and dermatitis. Significant excesses of cancers amongst paper industry workers have been found, as have increases in mortality from pulmonary disease and asthma
Air blowing of cellulose fibre is likely to maximise the generation of respirable dust. And occupational exposure limits are easily exceeded. Research indicates that worker exposure levels of both dust and borates during installation to be extremely high (over 40 mg/m3).

Several cases have been reported in the USA, where the installation of cellulose fibre insulation has caused severe health problems such as breathing problems, rashes, hair loss, skin discoloration, immune system suppression, hypersensitivity to pollutants in the atmosphere, upper respiratory infections, fatigue, severe mood swings, suicidal depression, weight loss, extreme fatigue, bleeding gums, abdominal and chest pain. Family pets have given birth to dead litters, suffered convulsions and even died. This has all led to the evacuation of homes and costly removal of the cellulose fibre insulation.

Mineral wool (glass and rock) is one of the most thoroughly tested and researched products made by man. There is no evidence of any link between exposure to fibres and cancer in humans.

7. Compatibility with other materials

Cellulose insulation manufacturers claim that their products are harmless to other common building components such as copper pipes, electric cabling and metal nail-plate fasteners. Some alternative observations are listed below:

Independent tests have shown that two out of four brands of cellulose fibre insulation caused corrosion of metals when tested in accordance with BS 5803 Part 3. This is likely to be enhanced by the hygroscopic nature of the product.

American studies showed that the presence of water in 16 out of 19 samples of cellulose fibre insulation caused unacceptable levels of corrosion of aluminium, copper and steel over a 26 day period, and that it produced severe corrosion of metal building components in conditions of high relative humidity.

Tests by the Oak Ridge National Laboratory in the USA showed that all samples of cellulose insulation produced corrosion of copper and steel. Moisture absorption appears to be the primary factor in causing corrosion.
Boron salts are expensive (50-55% of the cost of the insulation) and so some manufacturers replace them with cheaper alternatives such as aluminium and ammonium sulphate. When these compounds come into contact with water, they produce acidic conditions, which increase the risk of corrosion in constructions where moisture is present.

8. Moisture absorption and resistance to biological and fungal attack

Cellulose insulation absorbs moisture because the fibres themselves are hygroscopic. This can be increased by the replacement of non-hygroscopic boron salts with cheaper alternatives such as aluminium and ammonium sulphate, which are even more hygroscopic than the cellulose fibre. Manufacturers claim that their products are resistant to biological and fungal attack, and are treated against insects and unattractive to vermin.

Moisture contents of 20% by weight are the measured norm. This equates to about one litre of water per square metre in a 150 mm thick layer of 35 kg/m3 cellulose fibre insulation. In addition, in walls, cellulose fibre can be injected dry or sprayed. When sprayed, small amounts of water are added to activate the natural adhesives in the fibres.

Regarding resistance to biological and fungal attack, tests have shown that cellulose fibre insulation, under the conditions specified in BS1982, does not support fungal or mildew growth. However under more realistic conditions cellulose fibre has been observed to do so. The same studies, have confirmed that sodium borate, boric acid and sodium sulphate mixtures do not have anti-fungal properties. This is also confirmed by other published work. Experiments show a much higher content of micro-organisms in cellulose insulation than other insulants under similar conditions.

The user should be aware that the high moisture content of cellulose fibre insulation can expose timbers to the conditions which lead to dry rot attack.

Independent tests have shown that mineral wool insulation tested under conditions of BS1982 does not support fungal or mildew growth.