THE BASIC PRINCIPLES IN THE WETTING OF POROUS INSULATION MATERIALS

INTRODUCTION

The molecules of a liquid are attracted to one another by intermolecular forces or bonds. In the case of water, these bonds are very strong. Within the body of the liquid the forces cancel one another out and the molecules are free to move around. At the surface where the liquid meets the air, the attraction between the liquid molecules greatly exceeds their attraction to the widely spaced air molecules resulting in a net inward force on the molecules at the surface, which acts like a skin over the surface of the liquid. This effect is known as surface tension.

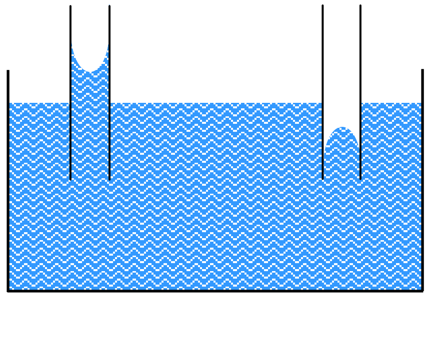
The surface tension at a water/air interface is exceptionally strong and is responsible for many phenomena in the natural world; insects walking on water, water forming droplets etc. The smaller the scale the more significant the surface tension force becomes. Thus a tiny water droplet may be a perfect sphere, held tightly together by it's surface tension skin. As the droplet size increases, the surface tension forces become relatively less dominant and the droplet's shape less well defined. Larger droplets are likely to divide into smaller, more stable droplets.

The effect when water comes into contact with a solid surface will depend upon whether the interaction between the solid and the water molecules is greater or less than that between the water molecules themselves. If the force of attraction is greater, the solid is said to be hydrophilic and the solid is said to have an affinity for water. Water will tend to maximise its area of contact with the solid by readily soaking into it. A classic example of a hydrophilic material is blotting paper. If the interaction between the solid surface and the water molecules is less than that between the water molecules, the solid is said to be hydrophobic. The water acts as though it has an aversion to contact with the surface. The classic example is "water off a ducks back".

These characteristics are demonstrated by the capillary effects produced when a vertical tube of the solid material is dipped into a reservoir of water - see figure l.

Figure 1

Hydrophilic material Hydrophobic material



In the case of hydrophilic material the meniscus is concave, and the water level in the tube is raised above that in the reservoir by the greater attraction that the water molecules have for the solid material. This is the mechanism behind 'rising damp'.

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In the case of the hydrophobic materials, the meniscus is convex and the water level is depressed below that in the reservoir, as the water "tries to avoid contact" with the solid walls of the tube.

THE WETTING PROCESS

Porous materials consist of a solid lattice of material surrounded by interconnected air gaps. This structure accounts for the insulation properties of the material and also means that capillary wetting can occur if the material is hydrophilic. The finer the pore structure of the material the more efficient the process will be. In coarse porous materials, such as typical glass fibre insulation, the size of the voids is too great for the liquid to bridge. Thus the capillary wetting effects are very limited in such materials, and the liquid will tend to flow freely downwards through them. The surfaces of the individual fibres may be wetted if they are hydrophilic, but they will be exposed to the open-air voids where air/liquid surface tension effects also apply.

SURFACTANTS

Chemicals that can affect the surface tension effects are called surface active agents, or more commonly, surfactants. The effect most required is to increase the affinity between water and solids to ensure thorough wetting for cleaning or other process purposes. Such surfactants are commonly called wetting agents or detergents. Surfactants increase the affinity of water to solid materials thus making less hydrophobic and more hydrophilic, and thus more readily wetted.

Astrip contains a non-ionic surfactant, which increases the affinity of the liquid for the fibre.

The temperature of the liquid also has a significant bearing on surface tension effects. At higher temperatures the increased energy of the liquid molecules may overcome adverse surface tension effects which apply at lower temperatures. When the liquid cools, however, the normal temperature situation is likely to be re-established.

WETTING ASBESTOS CONTAINING MATERIALS (ACM'S)

Chrysotile (white) asbestos is hydrophilic and can be wetted by water. However, the presence of a good surfactant will speed up and improve the efficiency of the wetting process. The amphibole forms of asbestos, amosite (brown) and crocidolite (blue), on the other hand are hydrophobic and tend to repel water, they are therefore difficult to wet. If these materials are to be effectively wetted in a controlled manner, appropriate surfactants will need to be used.

With the exception of sprayed coatings and products such as asbestos rope, which can contain high proportions of pure asbestos, the majority of asbestos insulation applications consist of asbestos and other materials.

These other materials were added to act as fillers etc. and may form the greater part of the insulation with the asbestos a minor component. These other insulation materials will also need to be effectively wetted during controlled wet removal operations.

Insulation materials basically fall into two categories, namely:-

1. applications where the outer surface is unsealed and porous, e.g. unsealed sprayed coatings, asbestos rope windings or structural asbestos insulation boards, and

2. applications where the outer surface is sealed, covered or armoured; the majority of commercial applications will fall into this category

In the first case, controlled wetting can be achieved by carefully spraying the surface with a suitable liquid. This tends to be a slow and inefficient process compared to injection. In the latter case, an injection technique must be used to introduce liquid into the porous materials behind the outer surface barrier.

BASIC PRINCIPLES FOR CONTROLLED WETTING

For effective controlled wetting of porous insulation materials to be achieved, a number of basic rules and principles need to be obeyed, namely:-

a) The objective is to wet the insulation all the way through. Over-saturation should be avoided since it increases the risk of run-out or uncontrolled delamination and can slurrify the waste material and make it more difficult to handle.

b) It is important to know the type and construction of insulation to be wetted. This information should, preferably, be available prior to contract and should be obtained by full-depth core sampling.

c) **Penetrant liquid should only be applied at a rate at which it can be absorbed by the insulation. Excessive feed rates will only result in wasteful run-off**

d) The factors which will determine the rate of natural absorption of the liquid into and penetration through a porous solid, are surface tension, gravity, time and temperature.

e) Insulation does not form a pressure-resisting or sealable system and thus the scope for applying external pressure to enhance rates of penetration during injection procedures is limited. Moderate pressure (1 to 5psi), provided that an effective seal can be achieved at the surface of the insulation, will enhance natural penetration rates by overcoming liquid flow resistance in the immediate vicinity of the injection point. The application of high pressures, e.g. 2000+psi, as supplied by positive displacement pumps is likely to result in the liquid cutting through the insulation and escaping along the line of least resistance and the release of significant numbers of fibres.

f) Natural wetting is not an instantaneous process. It takes time for liquids to penetrate through porous materials. It will normally be beneficial to allow a soak time after injection or spraying to allow the liquid to spread out uniformly, avoiding dry spots and excessively wet areas. It is useful to be able to monitor the progress of the liquid as it penetrates into the insulation. The objective is to produce a firm, putty like, 100% wetted material, and not an uncontrollable, expensive to clean up slurry.

g) Although suitable penetrants can spread upwards under capillary action, in general, faster penetration will be achieved <u>downwards</u> when gravity and surface tension effects combine to promote penetration rather than opposing each other.

h) The rate of liquid penetration from a single starting point will increase as the area of the advancing "wet front" increases in size. Multi-point injection and the facility to increase the flow rate at the injection point, as is possible with the Safestrip System, enables the operative to take advantage of this effect.

i) Where the liquid can be sprayed directly onto an exposed, porous surface such as 'floc' or spray applied asbestos, the "wet front" will be able to advance uniformly provided that an adequate amount of liquid is applied. Several applications may be required.

PRACTICAL IMPLICATIONS

The practical implications of the above principles are as follows:

i. For sprayed applications of liquid onto unsealed 'floc' or sprayed asbestos coatings

a) The liquid should be applied using wide angle fan shaped nozzles (maximum 45psi-3bar) to avoid over vigorous impingement of liquid onto the surface (which could release dust). Excessive pressure should be avoided.

b) A preliminary (at lowest possible pressure) damping spray should be applied to break down any initial surface resistance.

c) Subsequent sprays may be at higher application rates PROVIDED THAT THE SURFACE DOES NOT BECOME SO WET THAT EXCESS LIQUID IS RUNNING OFF.

d) The application should be in the form of repeat passes over clearly marked areas (to ensure uniformity of application). Experience will dictate the number of passes required.

e) The rate of application should be monitored to ensure penetration right through to the substrate.

f) Sufficient 'soak-time' should be allowed for the liquid to disperse through the insulation.

ii. For injection applications into insulation or pipe work

a) Injection should normally be from the top so that gravity assists penetration.

b) The greater the number of injection points, the more likely it is that uniform penetration will be achieved.
c) The larger the surface area exposed to free liquid at the injection point the less the bottle- neck effect.
d) Injection should normally be into a blind hole, which terminates <u>within</u> the insulation material to avoid short-circuiting of liquid via gaps between the insulation and the pipe etc. below.

e) The rate of injection should preferably be adjustable to maximise the rate of penetration without causing run-out. This is particularly important when time is critical to the work programme.

f) Allow a 'soak time' after injection has ceased so that the liquid can penetrate throughout the insulation matrix. Trials and experience will determine the length of time required. This will also enable the Astrip to penetrate into any corrosion on the surface of the steel or copper pipe.

g) The effectiveness of penetration should be checked at positions furthest from and/or above the injection positions.

h) Where pipe work insulation has become cracked or damaged, wrapping with light gauge polyethylene sheet will contain the liquid within the A.C.M.

i)Vertical pipes, depending on diameter, thickness of insulation and time available for wetting purposes, are injected with a number of units inserted around the highest level possible.

iii. Calorifiers and boilers

With so many sizes, shapes and insulation thickness', these have to be dealt with on an ad hoc basis. Points to note are that this insulation is usually multi-layered and that liquids do not always readily transfer from one layer to the other. Injector units should be set at uniform spacing at the highest levels possible.

It is of course, not possible to inject into a board containing asbestos **-** Asbestolux, but it is possible to spray from above.- Ceiling tiles. Astrip (diluted 10:1) will penetrate through 3/8", l0mm thick ceiling tiles in about 15 minutes. Where electrical installations are present, Asbestostrip Innovations have a penetrant, which is non-conducting (dielectric). This non-volatile penetrant is also stable at temperatures far exceeding the boiling point of water, thus enabling A.C.M.'s to be removed from hot water, steam and hot process pipe work.

In either case, contractors should build up a database of successful applications, detailing as appropriate:

- types of insulation, thickness etc.
- method of liquid application used
- rates of application
- pattern of injection points (where appropriate)
- time taken for successful wetting
- dust exposure level, if any, arising (where monitoring is carried out)