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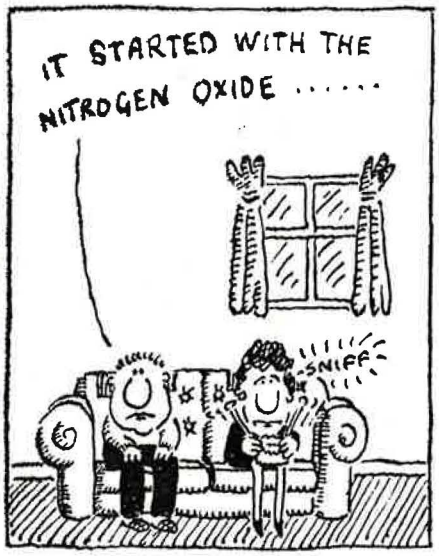
Housing the chemically sensitive

People spend most of their time indoors, and the quality of the interior environment is crucial to their health. This has been learned at great length since the North American media first reported the dangers of indoor air pollution by nitrogen oxides, radon and formaldehyde ten years ago. *David Olivier* explains the lessons that have been learnt.

Besides these three pollutants, and of course cigarette smoke, there is evidence that the concentrations of carbon monoxide, sulphur dioxide, ozone, pesticides and other chemicals inside buildings can all cause what is often called "environmental illness". Peoples' reactions range from mild discomfort through to life-threatening nervous system malfunction.

Application to the chemically sensitive

In Canada and the USA, the knowledge accumulated on energy-efficient houses is being used to help people whose home must be not just healthy in the sense of low concentrations of common pollutants, but virtually free of a list of chemicals numbered in the thousands. For anyone



who is ultra-sensitive to environmental chemicals, the sick building syndrome is just the tip of a very large iceberg.

Medical practitioners find that many of these people are sensitive to nearly all synthetic chemicals. Some cannot even deal with the naturally-occurring terpenes in softwood.

The aroma of a pineboard being cut, even the compounds emitted for years afterwards, will make them ill. Research suggests that earlier, massive exposure to pollutants; eg at work, may have sensitised such people to small doses of many different chemicals. Whatever the cause, these people simply must live in chemically-safe houses. This usually means that, as part of the design process, the client has to perform allergy tests on the wood, insulation, plasterboard, sealants, paint and even concrete which will be used in the building.

One soon comes face to face with the sheer variety of fire retardants, plasticisers, dyes, fixatives, bonding agents, wood preservatives, adhesives and pesticides which are added to modern building materials.

What materials are likely to be safe?

The growth of support groups for the chemically-sensitive, steady growth in the number of doctors specialising in the subject, and a growing pile of literature, are all helping builders to become more familiar with what is safe to use in new houses. Meanwhile, the following indicates what has generally proved acceptable, or not, in Canadian experience.

An airtight vapour barrier helps to keep any pollutants in the building shell out of the home. However, because of sensitivity to pine resin, some people cannot live in timber-frame structures, even made from non-treated wood. These people either need concrete/masonry construction or steel-frame buildings which have had the oil washed off the steel studs.

Canadian plywood, chipboard, hardboard, cork floor tiles and other processed wood products all contain much less formaldehyde than in the past, but hyper-sensitive people still cannot tolerate them. To clad frame walls, cement rendering or enamelled steel is usually acceptable, but aluminium off-gases and is sometimes ruled out. PVC cladding or window frames are rarely safe. Brick and other fired mineral products are acceptable — but note the comments below about cement.

Within the building shell, some mineral fibre products are satisfactory, depending on the amount and type of binding resins used. There is too little experience with plastic foams to say much about their applicability, but one would be very wary about using them, especially as internal insulation. Cellulose fibre may be safe, but only if the raw paper was free of problematic chemicals.

Inside the house, plaster is more likely to be acceptable than plasterboard. This choice does not just matter to the chemically sensitive; some years ago, a Florida plasterboard manufacturer was found to be using radioactive gypsum in its boards. However, in general, most plasterboard has slightly higher levels of radon than wet plasters.

Many sealants are no good. Mass-produced carpets, even hessian backed, are out of the question. Ceramic tiles are acceptable; however pvc tiles, normal tile cement, and Portland cement containing additives like calcium chloride, triethylcholimene and calcium formate, are unsuitable. Some parquet floors give no problems, but even the wax used to maintain the wood must be carefully chosen.

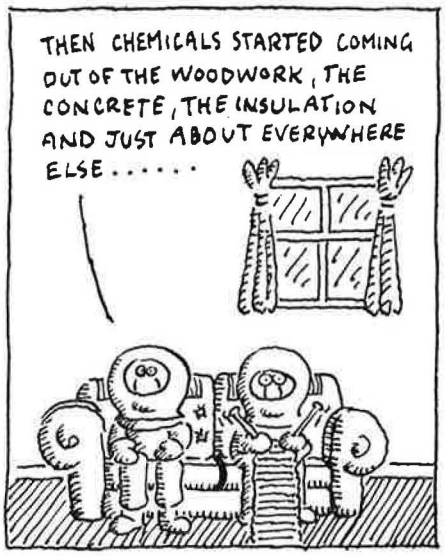
Often the only solution is a concrete or clay tile floor with cement mortar joints. Even then, any mould growth could be harmful. Hence the building must have effective ventilation. Care must be taken in the building's design to ensure that the internal surfaces are warm and dry throughout the year, which is more likely if they have high standards of thermal insulation.

The standard air-to-air heat exchanger may well need metal heat exchange plates, not plastic. It also needs to be upgraded by multiple filtration. Typically, this might include a coarse particle filter; eg

a loose-weave mineral fibre; an activated carbon filter, an activated alumina/potassium permanganate filter, and finally a fine particle filter. The activated carbon, which is better made from small pore coconut charcoal than the more common larger pore sources of carbon, adsorbs large gas molecules; eg benzene, toluene, ethers and ketones. The alumina filter removes lighter molecules; eg formaldehyde, hydrogen sulphide and carbon monoxide.

Since chemically-sensitive people react adversely to dust, pollen and mould, they must have clean homes. However, they may also react to detergents and common household cleaning products. Building the house tightly and ventilating mechanically eliminates much dust accumulation, but the dwelling still needs uncluttered interior spaces that are easy to clean. Water-based underfloor heating, or warm air heating using the ventilation ductwork, provide less dust-catching surface than hot water radiators.

Then again, materials selection is only part of the battle. Many practices on normal building sites, eg cleaning tools with solvents and dumping the residue into the



footing trench, promise to carry the dirty gas through construction cracks into the house.

What does it cost?

Designing and constructing North American buildings to house the population's most chemically-sensitive individuals turned out to be fairly inexpensive. Cost data on "clean" houses is rather scarce, but it seems to range from the same as any other custom-built house to 5-7% more.

This is much the same as North America's average 3% premium for "superinsulation". Taking both steps together may well cost below 5%, because many components of a good superinsulated design already contribute to making a healthier indoor environment, and need not be repeated.

The thousands of North American builders who have already mastered the art of building heavily-insulated, airtight houses with mechanical ventilation, and very low and predictable space heating costs, certainly have the edge when constructing chemically-safe buildings.

John Sams and his wife Marianne, who are sensitive to chemicals, built a 580 m² office in Atlanta, Georgia. This building achieved a 70% reduction in pollutant concentrations at little cost premium, just through John and Marianne being choosy about materials. Their efforts turned up at least one commercial latex paint free of synthetic chemicals, and an acceptable jointing compound.

The Toronto architects/engineers Allen-Drerup-White built several superinsulated, chemically-safe homes between 1984 and 1987. Average costs were 5% greater than normal dwellings, except for one sensitive client whose home required heroic measures to keep pollutants out.

Since 1977, Canadian and US research institutes have been at the forefront of energy-efficient housing technology. Helped by the federal government's R-2000 program, builders are learning how to maintain quality control and provide a comfortable, well-ventilated environment in their homes. In 1987 Canada's National Building Code became the second, after Sweden's, to require a mechanical ventilation system in all new dwellings (even in temperate British Columbia).

However, chemically-safe buildings demand still greater care and attention, and many questions still remain to be answered. In timber-frame structures, the polyethylene vapour barrier can emit gases that make the most sensitive people ill. Yet several countries, for example Sweden, have outlawed metal-foil vapour barriers because they can present an electrical hazard.

Does one rely on the approach of making the plaster-board/plaster layer airtight, as some builders in Canada and the USA have done, using "safe" sealants, or does one replace a timber-frame structure by masonry and/or *in situ* concrete, using additive-free cement and an aggregate which is low in radon-emitting elements?

Can low-formaldehyde plywood and chipboard be acceptable outside the airtight layer, or must one use softwood boards or even hardwood? Even though modern carpets are ruled out, can some hand-woven rugs be used to furnish the building and make the interior less Spartan? For each chemically-sensitive client, there have been new problems and new questions. More fundamentally, should this be a spur to make all new buildings safe for the worst-affected members of the population?

Fortunately, acceptable materials seem to exist. When the Masters Corporation, a house building firm in Connecticut, USA, found that its carpenters were all experiencing headaches, skin irritation and fatigue, it resolved to find out itself how to put up chemically-safe buildings. As a result, it uncovered about 250 apparently non-toxic building products, and set up the Environmental Building Products Corporation to advise other firms and individuals what to use in new buildings and renovation work.

Should UK building designers be concerned?

Almost certainly yes. Also, North American consumer protection laws impose full product liability on companies, a factor which keeps a few chemicals totally off the market. The UK situation could possibly be worse.

The UK has hardly begun to cater for the worst-affected people. If we can construct buildings which use less energy, arguably we should be able to produce buildings which are safe for virtually all the population to use. Let us hope that the move to energy-efficient buildings will accelerate and in turn make designers more aware of their ability — and responsibility — to produce a healthy indoor environment.

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