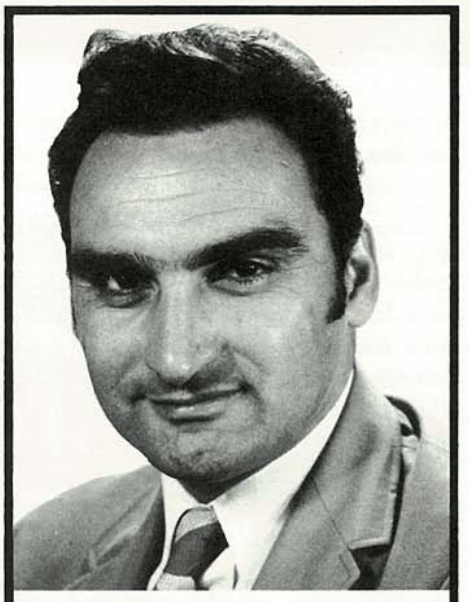
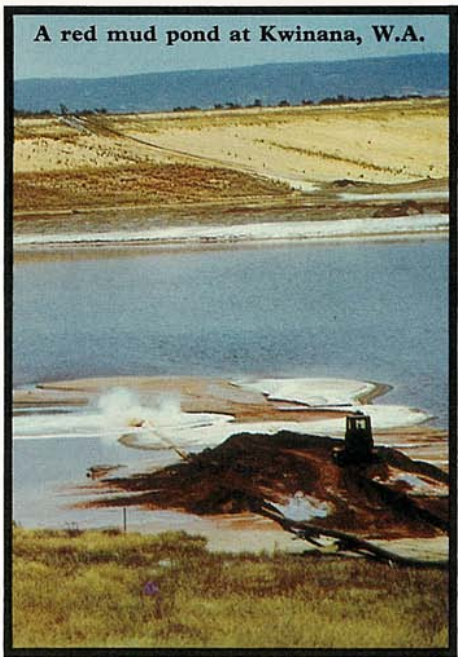
Outlook

Wastes: other people's raw materials

Mr Elijah Tauber



Mr Julius Beretka



A red mud pond at Kwinana, W.A.

Mr Elijah Tauber of the CSIRO Division of Building Research is no newcomer to waste recycling research. He began in 1964—well before it became fashionable. He can take credit for quite a number of building materials derived from wastes that are now used by the construction industry. His latest idea is a new extra-safe road-surfacing material made from, among other things, steel-plant slag and fly ash.

Like other industrial countries, Australia produces enormous amounts of wastes each year. Until recently, nobody seemed to have much idea just how big these quantities were. Statistics weren't available. So 3 years ago Mr Julius Beretka, a colleague of Mr Tauber at the Division of Building Research, carried out a survey. He wrote to 292 companies asking for information about the quantities of wastes they produced.

The response was remarkably good, especially from the larger companies. For this reason he feels that for many wastes his figures represent amounts close to the true totals being produced. The survey revealed the tonnages, locations, and current disposal methods or uses for more than 100 wastes and industrial by-products.

Some of the totals are very large. For example, each year B.H.P.'s iron and steel smelters at Port Kembla, Newcastle, and Whyalla produce some 4 million tonnes of blast-furnace slag and nearly 2 million tonnes of steel slag. Another 2½ million tonnes of fly ash come out of the electrostatic precipitators of our coal-burning power stations. Refining bauxite to yield alumina leaves an annual total of about 4½ million tonnes of awkward red mud accumulating in ponds, mainly at Kwinana, Pinjarra, and Gladstone.

Most wastes are dumped—either on land or at sea—or else are stockpiled in the hope that some use will be found for their ingredients at a later date. Both dumping and stockpiling cause obvious environmental problems—dust blows around, water-courses become polluted, marine life is affected, and the dumps themselves become eyesores.

Recycling wastes

So what else can be done about these wastes? Recycle them—use them as raw materials for some other process—is the fashionable answer. Slags, slimes, and other wastes and by-products often have no value to the works that produces them (the argument continues), and disposing of them can be expensive. So anybody that has a use for them will be doing the producer a favour by taking them away.

Not surprisingly, ore refineries, power stations, and other waste-producers are often located close to centres of population—and hence near to other industries. Mr Beretka's survey showed that almost 60% of the industries producing wastes are located within 50 km of our major cities. Thus many wastes have the advantage over natural raw materials that they don't have to be transported over great

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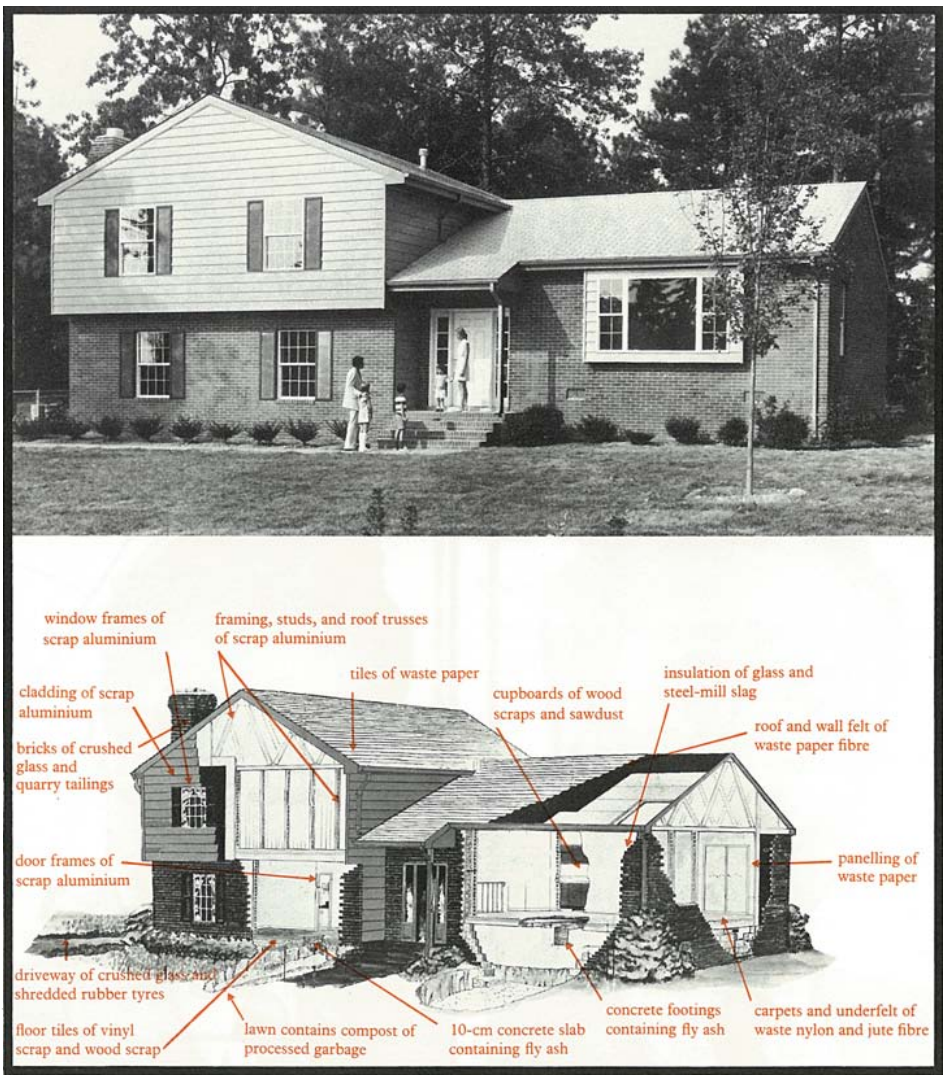
distances, at considerable cost.

However, wastes may require considerable processing before they can be used. Often, somebody has to invent and develop suitable processes, or even point out possible uses. This is where Mr Tauber has come in.

Mr Tauber is a ceramicist, an expert in producing fired products like bricks and tiles for use mainly by the building industry. He considers this industry as the obvious candidate as a user of wastes. It consumes vast quantities of raw materials.

For example, when he looked into it 8 years ago, the industry used 5·7 million tonnes of brick clays and shales, 506 000 tonnes of gypsum, 11 million tonnes of sand, and 46 million tonnes of crushed and broken stone—the sort of quantities needed to dent the growing amounts of industrial solid wastes and slurries.



This house in Virginia, U.S.A., was built almost entirely with recycled materials.

Basalt dust used

Mr Tauber's first success came in 1964, when he found a use for basalt dust. That's not the sort of material one commonly regards as a nuisance, but it was causing problems in Victorian quarries nonetheless. The basalt is quarried and crushed to make aggregates that are used for surfacing the State's roads, and for making concrete. The crushing process produces a fine dust, which represents about 10% of the quarries' production. Before the quarrying companies approached Mr Tauber this dust had no use, so it was piling up at the quarries, where it blew around becoming both a general nuisance and a health hazard.

By coincidence, Mr Tauber was approached at about the same time by the management of the power station at Bunbury, W.A. Very expensive imported cast-basalt linings used in the station's ash-sluices had failed. Perhaps Mr Tauber could find a more effective and cheaper local substitute for these linings?

As it turned out Mr Tauber was able to satisfy these two needs in one go. By mixing basalt dust with the right proportion of clay, and firing at the right temperature, he was able to produce a substitute lining tile that was hard enough to withstand the scouring action of the ashes in the sluice. The tiles could also be made in almost any required shape. Today, 11 years later, his original tiles are still in use at Bunbury.

By altering the mix and firing temperature, Mr Tauber also found that the waste basalt dust could be used for making bricks, blocks, and floor or wall tiles. Basalt tiles now adorn the floor of many a public building.

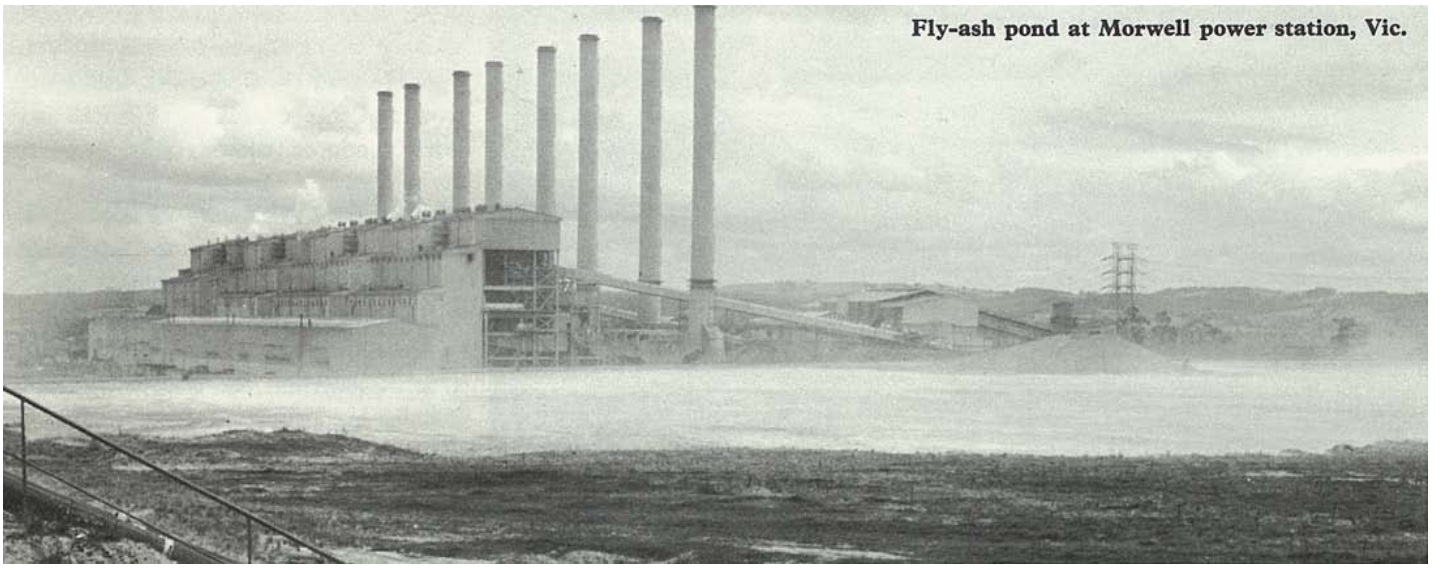
Four million tonnes of slag emerging from the nation's blast furnaces each year represents a far larger problem than basalt dust. Mr Beretka's survey showed that until now we have made little use of this material. Most is used as landfill, or just dumped. Small amounts also find use in road-making, as aggregates for concrete, and for making insulating wool, glass, or grit for sand blasting. Overseas, blast-furnace slag is regarded as very valuable. For instance, in Chicago and around Pittsburg in the United States there is actually a shortage of the stuff at present.

Blast-furnace slag is an impure glass. It's an ideal raw material for making ceramic products.

Safer road surfaces

Blast-furnace slag is an impure glass. It's an ideal raw material for making ceramic products. Mr Tauber uses it as an ingredient in his new, safer, synthetic road surfaces.

He began research into road-surfacing materials following an approach from the Country Roads Board in Victoria. The Board wanted a more reflective road surface than could be obtained using natural stones, to increase visibility at night. Natural stones with the right characteristics seldom wear well. Mr Tauber was able to come up with a synthetic material made from calcined pyrophyllite—a naturally occurring material from Pambula, N.S.W. It reflected much more light than



Fly-ash pond at Morwell power station, Vic.

naturally occurring stones, but didn't dazzle, and had satisfactory wear properties. Test patches of this stone have now been giving good service on North Road, Ormond, a Melbourne suburb, for more than a year.

Further discussions with the Country Roads Board and the New South Wales Department of Main Roads revealed that poor reflectance in natural stones is only one problem in making safer roads. More important is finding a skid-resistant surface that doesn't polish.

Research in the United Kingdom has shown that a very skid-resistant road surface can be made from calcined bauxite from Guyana. The Country Roads Board imported some of this calcined bauxite for use on a road-test panel in 1960.

Following an approach from Comalco, Mr Tauber and his research team investigated bauxite from Weipa to see if it could be used in the same way. Mr Tauber found that firing the bauxite at 1500°C produced a very skid-resistant material. Tests by the Country Roads Board, and more recently a 12-month trial on roads in the United Kingdom, rated calcined Weipa bauxite just as suitable as that from Guyana.

However, neither pyrophyllite nor bauxite are wastes. Where does blast-furnace slag come in? The ideal road stone would be one that was both more resistant to polishing and more reflective than naturally occurring stones. In addition, it would have to be at least nearly as cheap. Just recently, Mr Tauber and his team have once again come up with an answer. They have produced such a synthetic stone using as raw materials clay, limestone, whiting, silica, and two wastes—blast-furnace slag and fly ash. The stone certainly combines the properties of polishing less and being more reflective than any natural one. Even so, it can be made even more skid-resistant by adding calcined bauxite. It can be made at any brickworks.

Most likely the new safety stone will be between two and four times as expensive as natural ones. Nevertheless, Mr Tauber points out, there are other factors in the equation as well as the monetary cost. Safer roads save accidents and lives, which currently represent a considerable community cost. Mr Tauber has shown that it is possible to make safer road surfaces, but in the long run it's up to the community through its road-building authorities to decide whether it wants to pay for them.

Other waste materials that Mr Tauber has investigated include red mud from alumina refineries, and glass.

Red mud in acoustic tiles

As mentioned earlier, each year the refineries at Kwinana, Pinjarra, Gladstone, and Bell Bay in Tasmania between them produce some 4½ million tonnes of red mud. At present practically all of this is dumped in ponds and allowed to settle. At Kwinana these ponds are designed to take at least 10 years to fill. Hopefully, when they have dried out they can be used for light industry or covered with vegetation to prevent dust blowing about.

Waste chemical gypsum in a pond at Kooragang Island near Newcastle, N.S.W.

Three test panels of Mr Tauber's reflective road surfaces a year after they were laid.

On investigation, Mr Tauber and his team found that red mud from Gladstone improved the properties of a locally used brick-making clay when the two were mixed together. However, nobody has yet taken this up.

Mr Hank Pepplinkhouse, a member of his research group, has also very recently used red mud from Gladstone to make a lightweight acoustic tile. In fact the tiles are made from a mixture of red mud and broken glass—another problem waste. Most acoustic tiles used at present are made of cellulose and plastic. They are very flammable and can give off poisonous fumes when burning. Their use in supermarkets and other public places must add to the hazard of a fire. Tiles made of red mud and broken glass certainly wouldn't, since they don't burn. In addition they are weather-proof, so they could be used outside—beside highways, in courtyards, or in other appropriate places.

Waste glass, the other ingredient of the acoustic tiles, is by no means a useless material. Quite how much broken glass is available nobody seems to know. Mr Beretka's survey didn't reveal this. However, the arrival of the non-returnable bottle has meant that there is now a good deal around, especially in domestic rubbish. When ground, broken glass (or cullet as it's known by the trade) is a good source of raw materials for the ceramics industry.

Bricks and broken glass

Making those white-faced bricks now quite commonly used in homes and public buildings uses a fair amount of waste glass. They save the trouble of painting. Companies produce these bricks all over the country by a process known as engobing.

Many ceramic wares such as hand-basins, toilet bowls, pottery, and floor tiles are engobed. It means that they are covered with a thin, smooth layer that is harder than the baked clay or stoneware beneath. The process covers blemishes, and allows a considerable range of colours. Engobing is not the same as glazing, where the article is merely covered with a thin layer of white or coloured glass.

Making white-faced bricks uses a fair amount of waste glass.

Mr Tauber developed a mixture for making white engobed bricks 10 years ago. He used crushed cullet, kaolin, and quartz. Large quantities of bricks have been produced commercially using his technique. The mixture is applied to raw bricks and baked onto them. Adding chrome, cobalt, iron, or manganese oxides gives a variety of colours such as green, blue, or brown.

Australian tiles that incorporate crushed glass can also trace their origins back to Mr Tauber.

So far, Mr Tauber has come up with possible uses for basalt dust, blast-furnace slag, red mud, and waste glass. From his survey, Mr Beretka was able to pick out a number of other materials that could well find use in the construction industry. These other materials included coal-washery refuse, manganese mud and other tailings, 'chemical' gypsum, and fly ash. The CSIRO Division of Mineral Chemistry is looking into uses for coal-washery refuse, and Mr Beretka has himself successfully incorporated manganese mud and other tailings into manganese bricks as a pigment. (Articles about both these studies appeared in *Ecos* 1.)

Most chemical gypsum is a by-product of the processes used to make phosphoric acid. Plants at Newcastle and Yarraville that make the acid produce about 710 000 tonnes of chemical gypsum each year. Only about 20 000 tones of this are used; the remaining 690 000 tonnes are dumped either on land or at sea.

In fact, the by-product is very similar to naturally occurring gypsum, so it should be possible to use it in cement, gypsum boards, and the like. But it contains small quantities of impurities like calcium phosphate and calcium fluoride, which interfere with the setting of plaster made from it. Some countries. like Germany and Japan, have developed processes enabling them either to purify the gypsum by-product, or else to control the making of the phosphoric acid so that the impurities are kept to as low a level as possible. Here in Australia, the research team of which Mr Beretka is a member is looking into overcoming the problems with using chemical gypsum for producing building materials.

Mr Beretka also suspects that most of the 2·8 million tonnes of fly ash coming from the electrostatic precipitators of our coal-burning power stations could find a use. At present only about 10% gets used —mainly in Queensland and New South Wales as a substitute for cement. By comparison, France uses 85% of its fly

ash, and even imports large amounts from the Ruhr region of Germany. The United States uses 17% of its fly ash.

Great Wall of China

Like some naturally occurring volcanic ashes, fly ash is a pozzolana, which means that it can be made into a mortar when mixed with lime. Mr Beretka isn't sure how long such a mortar will last. But he points out that the ancient Chinese used a mortar made from lime and volcanic ash between the stones of the Great Wall of China, and so did the Romans when building the Appian Way. So a mixture of lime and fly ash may last 2000–4000 years or more!

Finding feasible uses for wastes is one thing. Mr Tauber and Mr Beretka have shown that for a number of our industrial wastes this can be done. But not all their ideas have been taken up, and the two scientists are not so naive as to believe that they necessarily will be. For this reason they have concentrated on developing materials that can be made using existing industrial plant.

When it comes to recycling materials, Australia's very richness in raw materials is probably her own worst enemy.

When it comes to recycling materials, Australia's very richness in raw materials is probably her own worst enemy. Why recycle wastes and by-products when you have abundant supplies of natural raw materials? In addition, many companies don't know what wastes, by-products, and processes are available to them. In Europe, several countries have set up 'waste pools' to try to overcome this problem. Companies enter the waste they produce on a central listing so that others can know what's available.

In recent years environmental regulations passed by our State governments have made it more difficult for many companies to dump their wastes, thus adding to the incentive to find alternative uses for them. Nevertheless, compared with the United States and a number of European countries, we still recycle a relatively small proportion of our wastes.

Finding uses and methods of using them is only a first step. Mr Tauber and Mr Beretka are well aware of the problems. Even so, they think it worth while to soldier on.

More about the topic

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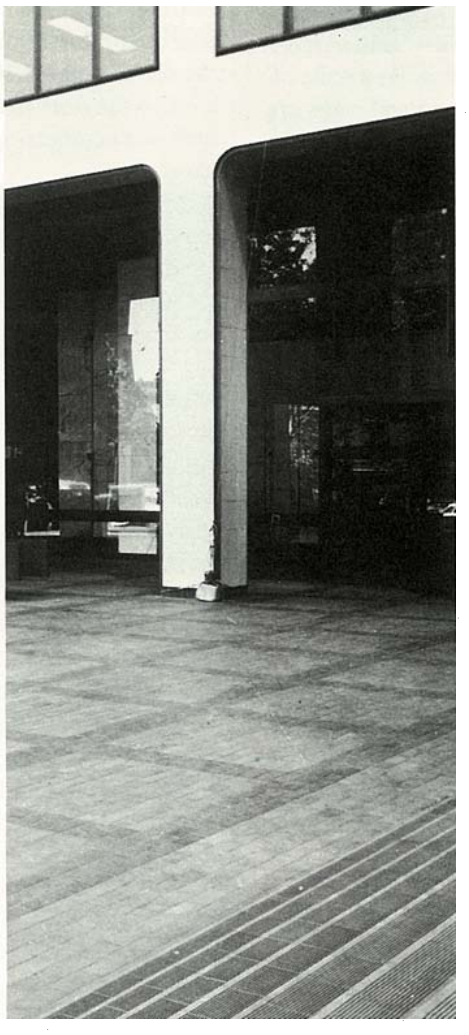
The white-surfaced engobed bricks in this building at Melbourne airport contain crushed waste glass.



Tiles made from basalt dust pave the forecourt outside this Melbourne building.