Spectrum

A use for mud, slag, and slime

Many people like to build these days with bricks that are brown or grey rather than the usual red or cream. A pigment commonly used to give the bricks their colour is 'industrial manganese dioxide', which sells for about $80 a tonne.

Each year in Australia about 3500 tonnes of 'manganese mud' are produced as a by-product of electrolytic separation of zinc and dumped or stockpiled for possible future use. Research by Mr Julius Beretka and Mr Trevor Brown, of the CSIRO Division of Building Research, has shown that almost identical bricks can be made if the industrial manganese dioxide is replaced by the same amount of this at-present useless and valueless manganese mud.

'Steel-plant slags' are industrial wastes on a grander scale. Some of them, including about 800 000 tonnes produced each year at Port Kembla, contain considerable amounts of manganese dioxide and can also be used instead of industrial manganese dioxide as brick colourers. So can 'slime residue', a picturesquely named waste from the production of concentrates used for extracting lead, zinc, and silver.

Research is going on around the world to find uses for industrial by-products now regarded as wastes. The quantities are immense and the problems of disposing of them in a non-polluting manner become harder to solve as production increases and stockpiles grow. Utilization offers the environmental double advantage of saving natural resources and reducing the risk of pollution.

Scientists at the Division of Building Research have been working on the development of new materials using solid mineral and industrial wastes since 1964 and have come up with some notable successes. Examples include processes developed by Mr Elijah Tauber for using broken glass in white brick facings and waste basalt pieces in floor tiles.

Last year the Division conducted a survey of industries to obtain a general assessment of the types, quantities, and locations of wastes and by-products in Australia. More than half the companies approached, including most of the larger ones, provided information. The list prepared by the Division and published in the December 1973 issue of the *Proceedings of the Royal Australian Chemical Institute* probably accounts for the major proportion of solid wastes generated. The table above is derived from the list; it gives the stated annual production figures for the wastes shown as being produced in the greatest quantities.

Annual production of wastes

	tonnes
red mud	4 550 000
blast furnace slag	4 098 700
coal washery refuse	2 960 000
fly ash	2 540 000
steel-plant slag	1 970 000
chemical gypsum	710 000

Setting aside economic considerations, Mr Beretka sees the following as the most promising wastes for conversion to useful materials:

- slags from blast furnaces
- dust, including fly ash, from electrostatic precipitators used to remove fine particles from smoke
- coal-washery refuse
- red mud, a by-product from the extraction of aluminium
- chemical gypsum

Large quantities of these are stockpiled, and their composition is fairly uniform.

However, he chose wastes containing manganese dioxide for the first detailed investigations following the survey, largely because of the commercial prospects. The industrial manganese dioxide employed in brick-making now is fairly expensive and large quantities are used throughout the country.

Dried manganese mud is a coarse black powder with some larger lumps, and contains 80–90% manganese dioxide. Industrial manganese dioxide, by comparison, contains only about 66% manganese dioxide. The steel-plant slag used in the experiments came from Port Kembla. It is a black, brittle material, comes in irregular

The top two bricks are coloured with industrial manganese dioxide, the others with waste manganese mud.

lumps, and contains about 7–8% manganese dioxide. Slime residue, a light grey powder, contains 9%.

Bricks were made using a range of quantities of the three pigments and different firing temperatures, and tested for strength, shrinkage, and light-reflecting characteristics.

Also, as manganese mud contains a fairly high percentage of lead (6·2%), it was necessary to find out whether much of this would evaporate during firing. If it did, it could harm the kiln lining and the final product. Tests removed any worries on this score, as the lead forms compounds with constituents of the clay.

Manganese mud also contains some zinc (about 1–2%) in compounds that could be harmful in brick-making. However, the small quantity involved—and earlier research showing that these compounds react to form stable compounds with clay constituents—led to the conclusion that the zinc also would not be a problem.

Manganese mud was found to have virtually the same colouring effect as industrial manganese dioxide when used in the same quantity; commercially made coloured bricks normally contain about 3% industrial manganese dioxide. Steel-plant slag and slime residue showed up as inferior colouring agents, but each did a satisfactory job if it made up 10% of the brick's ingredients.

The Division tested the physical properties of bricks containing these percentages of the wastes. The differences among them, and between them and industrial manganese dioxide bricks, proved to be insignificant.

Mr Beretka concludes that, considering the price of industrial manganese dioxide, all three wastes have great potential as substitutes, manganese mud being the most promising. It is available in fairly large quantities in Tasmania, and he believes it could be used economically either locally or after transportation to any of Australia's major cities.

Slime residue is produced at Broken Hill. This fact, with the need to use about 10% of the mixture, could restrict its economic use. The steel-plant slag has to be ground finely and has to make up at least 10% of the ingredients, so its use may be uneconomic far from Port Kembla.

Bricks containing steel-plant slag developed a shiny, smooth surface and low porosity when fired at 1170°C; the normal firing temperature for bricks is about 1000–1100°C. Mr Beretka believes it may be possible to put this effect to use in the production of acid-resistant ceramics and self-glazed tiles. He plans to investigate this possibility further.

Industrial wastes and by-products generated in Australia: the results of a survey. J. Beretka. *Proceedings of the Royal Australian Chemical Institute*, 1973, **40,** 357–62.

The utilization of manganiferous industrial wastes and by-products in the manufacture of coloured bricks. J. Beretka and T. Brown. *Journal of the Australian Ceramic Society*, 1974, **10** (in press).