Spectrum

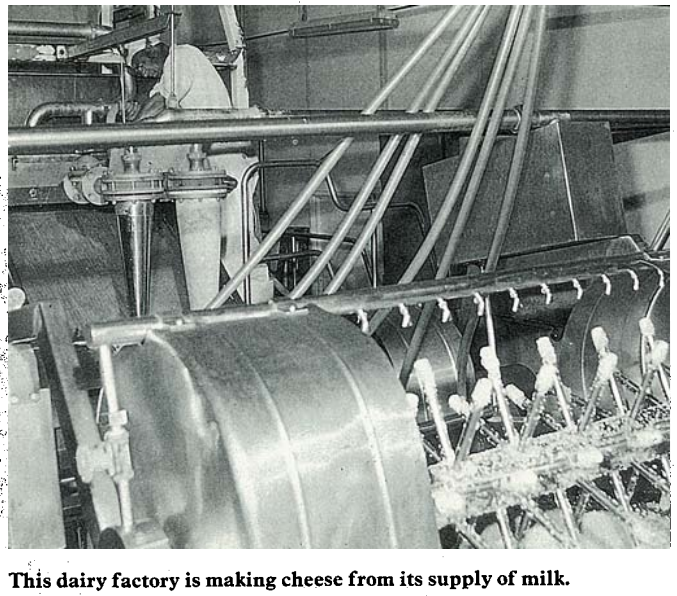
A decoy for toxic heavy metals

Why are heavy metals poisonous? Basically, reasoned Dr George Winter of the CSIRO Division of Mineral Chemistry, it is because they react with animal proteins. He therefore searched for a cheap animal protein that would remove heavy metals from industrial effluents before they are discharged.

His answer: casein, the protein fraction of milk. Casein is a by-product of butter factories. Butter is made from the butter fat in milk, and the remaining skim milk is either dried or turned into casein.

Experiments by Dr Winter have shown that casein more than meets the requirements of his initial search. As well as absorbing heavy metals at a pH around 7, spent casein can be rejuvenated by washing it in acid, just like a synthetic ion-exchange resin. However, unlike such resins, casein is much cheaper because it is a plentiful natural material. It currently sells at about $1000 per tonne, less than half the cost of synthetic resins.

Casein is attractive because it only absorbs heavy metal ions, like mercury, cadmium, nickel, zinc, and chromium ions. It doesn't exhaust itself by picking up the common light metal ions, such as those of sodium and potassium. One of its unusual (and attractive) features is that it can absorb both positive and negative ions. Thus it will absorb both the negative chromate ion as well as the positive chromium ion.



This dairy factory is making cheese from its supply of milk. Alternatively, it could be producing butter and casein.

One of the disadvantages of casein for Dr Winter's purposes is that it is soluble in water. This drawback can be simply overcome by dropping it into formaldehyde; the hard material which forms is cross-linked casein. If you think that sounds like a plastic, then you won't be surprised to learn that the first plastics were made in the same way.

Indeed, casein is still used for making quality plastics. The hard glossy buttons on high-fashion clothing are likely to be made of it, as are long-lasting knitting needles. Other uses for casein are industrial glues, boosting the protein content of dietary foods, and as a filler for sausages. However, Australian production is declining after a peak about 8 years ago, when 30 000 tonnes were made. Perhaps with this new-found use, the figure might rise once again.

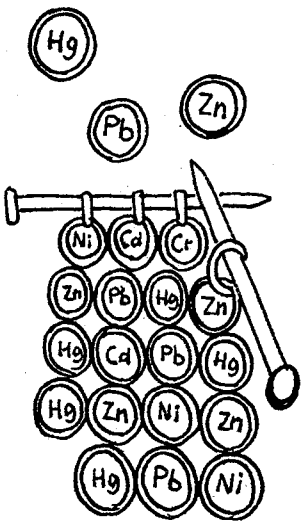
Dr Winter believes that removing the very toxic chromate ion from solutions will be an important application of his cross-linked casein. For example, there are many plating and anodizing works in the country which use chromate in the course of their processing.

One of these plants, a Melbourne plating works, is cooperating with Dr Winter in supplying samples of processing liquors for his experiments. The plant uses a very strong chromate solution in its electroplating bath, and washes each work-piece in a water tank after plating has finished. This tank steadily increases in chromate until a time is reached when fresh water is needed.

At this point, a chemical is added to the tank to reduce the chromate, which is then precipitated, using lime, as chromium hydroxide. The sludge formed is much less toxic than its mother material, and can be readily disposed of.

If Dr Winter's scheme is used, no waste disposal would be necessary. The chromium would be recovered from the casein and returned to the electroplating bath for further use. To date, laboratory trials are working well, with residual chromium levels consistently below 1 p.p.m.

Dr Winter has also looked at other aspects of the chemistry of casein and has found that its scavenging capacity for heavy metals can be improved by reacting the cross-linked material with carbon disulphide. The



product formed, a thiolate, also selects heavy metal ions more strongly than others and decreases the amount of residual ions.

But, taking into account the cheapness of the normal cross-linked casein, and the ease with which it allows heavy metal loadings to be reduced below current limits, we need look no further. According to Dr Winter, plain, cross-linked casein has a lot going for it. Not a new material, but an important new application.