

Fundamental studies of the flotation process: The work of the National Institute of Metallurgy

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AUTHORS' REPLY TO DISCUSSION

In his contribution to our paper Dr Lloyd makes two criticisms: The first criticism, as we interpret it, is that the agglomerate flotation process that we described is not really necessary because previously described processes effect almost the same results or could be made to give the same results by including sufficient paraffin in the reagent combination. We believe, however, that the agglomerate flotation process is a distinctive one: firstly because in using the process the concentrate is produced in the characteristic form of large oily flocs, considerably different from the normal frothy concentrate; and secondly because the results obtained are significantly better than those obtainable by other methods, particularly as regards flotation of the very fine particles. Dr Lloyd quotes an oleic acid flotation test that gave a recovery of 48 per cent of the uranium in the -10 microns fraction. We submit that the recovery of 97 per cent of the uranium from a similar size fraction that was quoted in our paper is sufficiently different from 48 per cent to justify our belief that the agglomerate flotation process is different. Dr Lloyd is wrong in suggesting that we have not presented evidence for our supposition that an agglomeration mechanism must be central to the process. On the other hand, it appears that we were wrong in thinking that the point needed no labouring. There are good grounds, both theoretical and practical, for believing that there is a lower limit to the size of particle that can make fruitful contact with an air bubble and, hence, be floated. Thus, when particles smaller than this limit appear in a flotation concentrate, they must either have been entrained mechanically or have been subject to agglomeration before being captured by the bubble. The fact that the $<12\ \mu\text{m}$ material is recovered selectively with high efficiency is the evidence that Dr Lloyd is seeking.

Dr Lloyd's second criticism deals with the economic value of attempting concentration of uranium ores prior to acid leaching, which he has rather quaintly called the 'recovery' step. He makes several calculations to show that preconcentration has little, if any, place in our uranium industry. It is with the greatest reluctance that we find ourselves drawn into this discussion. The strategy for the processing of Witwatersrand ores is an extremely complex matter. It is certainly too complex to be expressed in a couple of elementary formulae and a few assumed costs, and to be debated adequately within the confines of the discussion columns of this Journal. Furthermore, we feel it unfair to the readership of the Journal that they be subjected to a sort of blind-man's-buff debate on which, because some of the essential

evidence is kept secret, they can make no independent judgment.

Dr Lloyd's calculations show that, under the conditions presently governing the uranium industry, it will be difficult, in general, to apply concentration economically. With this conclusion we have no quarrel. Even the fact that Dr Lloyd chose to ignore our clear statement that the reagent dosages we quoted had not been optimized (later work suggests that the additions can be reduced considerably) does not really affect the issue. However, we believe that the case that Dr Lloyd has presented is both over-simplified and over-generalized.

The model he uses is over-simplified, because it does not make provision for many of the factors that could, in particular situations, influence the economics and because it cannot assess the less direct benefits that can arise from concentration — such as the recovery of gold when a tailings dump is treated or a possible decrease in the costs of regrinding. The conclusion he draws is over-general because it rests on assumptions that do not cover a number of situations — either industry-wide or confined to individual operations — that would operate in favour of preconcentration and might make it profitable. For example, the justification for preconcentration is critically dependent on the uranium market and the price of uranium. The possibility cannot be ignored that the marketing situation may remain tight and that the price might fall in the face of stiffer competition. In such a situation our calculations indicate that preconcentration could become economically attractive.

As a second example, let us consider a cyanide residue dump containing 20 million tons of material at a grade of 150 p.p.m. U_3O_8 . Such material is clearly well below the limit for direct leaching and must be concentrated if it is to be exploited. A process such as flotation or magnetic separation could reasonably recover 60 per cent of the uranium in 20 per cent of the mass, i.e., the grade of the concentrate would be 450 p.p.m. U_3O_8 . Our calculations indicate that it would be economic to produce such a concentrate if the total cost of concentration is of the order of 30c per ton, which is not an unreasonable figure for the processes being investigated. (Obviously, agglomeration flotation with the large reagent additions assumed by Dr Lloyd would not be applicable, but we have already pointed out that flotation can be more economical than that.) Furthermore, it is probable that the concentrate would contain 1.5 to 2 g gold per ton, of which at least half should be recoverable after the acid uranium leach. Even if the value of the pyrite contained in the concentrate is disregarded, it seems that the possibility of applying preconcentration with profit in this case cannot and should not be ruled out.

Other examples can be presented but this seems to us *notto* be necessary. What is important, we think, is the conclusion that we are trying to bring home: that there are so many complicating factors that each case must be considered on its own merits. It is this conclusion, together with our feeling that there are reasonable possibilities that the conditions that favour preconcentration may arise in the medium term future, that has led us to pursue our studies of concentration.

We have been encouraged in this work by the knowledge that the mineralogical characteristics of the ores are such that good recoveries with useful ratios of concentration are not precluded. Furthermore, it seems to us to be not irrelevant that concentration of uranium has, in fact, played a part in uranium production in South Africa from the earliest days and is, at present, used on a considerable scale. We need only mention the heavy medium plant at Vaal Reefs and the flotation operations at Zandpan and Virginia. Dr Lloyd may argue that, where concentration is being used, it involves the recovery not only of uranium but also of gold and pyrite, but how can it be otherwise when these three components are so intimately associated? Can it be said that we have learnt all that we need know about

the way that gold (and, with it, uranium) can be concentrated to provide a product for intensive treatment? Such treatment could be used to increase the recovery of gold and uranium so that an increased overall recovery can be obtained at conventional grinds, or conventional recoveries can be obtained from coarser grinds. Can it also be said that all methods of concentration have already been tested?

Descriptions of new processes for flotation of uranium appear fairly regularly and one of the latest (C.S.A. Pat. 70/2389) claims that quite remarkable increases in recovery are obtainable by using a sulphonate in conjunction with a 'booster'. Surely Dr Lloyd would not recommend that the many suggestions for improved processes should not be investigated? And, will he not concede that, if experimental work is necessary, the fundamental aspects of it should not be neglected?

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Growing use of deionised water in surface coating techniques

by W. F. LORCH

SYNOPSIS

Production engineers in the metal plating, paint, plastics-coating and printed circuit industries are increasingly aware of the cost of sub-standard or blemished items which have been poorly processed. An area where quality control can quickly produce higher efficiencies is in the choice of suitably purified water for making up solutions, for rinse baths and 'drag-out' baths, for cleansing lines and electrophoresis tanks, for maintaining electrolyte density and hence consistency, and for facilitating the recovery of valuable minerals. The author of this article examines the general problems of using non-purified water, and shows how purified water has become accepted by the principal surface coating industries to improve processes and effect economies.

INTRODUCTION

Although water is an essential element in most surface coating processes, surprisingly little attention has been paid in the past to the quality of the water used, with the possible exception of the preparation of electrolytes. Yet, unlike the other materials used in metal finishing, water is not supplied to an agreed specification but is variously drawn from streams, rivers, wells or from the public supply. Even if raw water from these sources is suitably filtered before use, it still contains dissolved chemicals which are undesirable when preparing cleaners and electrolytes, and in certain rinsing operations.

Water from the public supply, carefully treated so that it emerges from the tap as a potable source which is perfectly suitable for all household uses, nevertheless contains dissolved solids which can be harmful in many coating operations. Chemicals likely to be present in all

raw water include calcium, magnesium, sodium and the salts of heavy metals such as iron, manganese, copper and lead. Other impurities may include silicic acid, carbonic acid, some organic substances and anions such as chlorides, nitrates, sulphates and bicarbonates.

In the plating industry generally, various cleaning processes may be impaired by the concentration through evaporation of dissolved solids; by their presence as undesirable electrolytes; and by the precipitation of calcium salts as scale. Random solids carried over to hot rinse water cause pitting and staining, and may pass to the finishing solution where they concentrate to contaminate the electrolyte.

Contamination of the electrolyte for through-hole plating of printed circuits can critically reduce its 'throwing power', while gold-plating solutions are easily upset by the presence of calcium, magnesium and other heavy metals. The same contaminants can cause