

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

pitting in many other types of electro-plated surfaces, which may also be roughened by organic solvents and embrittled by chlorides. When anodising aluminium, chlorides and sulphides are generally undesirable; silica, in particular, impairs the hot water sealing process, and hardness salts may dry out on the work.

In the paint industry, the demand for pure water is even more rigorous, and the water used in electrophoresis must approach theoretical purity if salts are not to be deposited with the paint, or the finished surface stained on drying out.

REMOVING UNWANTED SOLIDS

For years the conventional method of purifying water has been distillation in a still. It requires that large volumes of raw water be boiled, condensed and collected into a separate vessel. The effect is to transfer a great deal of water by means of heat slowly from one vessel to another, in order to leave a small amount of solids as precipitate in the still. Such a process is, clearly, uneconomic where high throughputs of water are required. Moreover, there is the maintenance problem of defurring the still and consequently shutting down the plant.

By contrast, the ion exchange method of water purification merely acts on the dissolved solids, allowing all uncontaminated molecules of water to pass through without further ado. The deioniser employs both cation and anion resins, so that all ionic impurities are arrested, even trace metals. But perhaps the greatest advantage of the ion exchange method is that mains water can be processed through its resins at very large throughputs, piped directly to process areas, and does not require intermediate storage vessels such as carboys, which are heavy and cumbersome.

The economic advantages of deionisation are three-fold. First, is the greater degree of production control which it allows. Secondly, the pollution problem of letting unknown contaminants pass into the drainage system is minimised; this in turn may reduce local authority charges for treating the effluent, or make it possible to design a purpose-engineered system to deal with effluent at the plant before discharge. Thirdly, both production efficiency and pollution control can benefit by recirculating back to the deioniser mildly contaminated water, especially from rinsing operations, so that purified water is again available without drawing a fresh supply from the mains.

It should also be noted that deionising units are produced in various forms to suit the particular application. For a large metal-plating works or paint factory, the deionising unit would normally be equipped with an automatic system of maintenance, whereby the resins are periodically washed with acid and alkali solutions to restore and regenerate their capacity. Such deionisers, referred to as *in-situ* regeneration types, are normally capable of delivering 1 000 litres/hour or more of purified water. For applications requiring lower throughputs a popular unit is the cartridge deioniser which, when the resins are exhausted, is simply exchanged for a new one. The cost is merely that of returning the cartridge to the manufacturer or his agents, who regenerate the resins in bulk. Such cartridges are available with capacities from

30 litres/hour up to 1 000 litres/hour to suit the requirements of electronics processors, printed circuit manufacturers, and many precision metal-coating industries.

THE PLATING INDUSTRY. PURIFIED WATER FOR CLEANING

In the plating industry, while the use of purified water for laboratory tests and the preparation of electrolytes is recognised, its value in making up other chemical baths and especially rinses is often overlooked. The normal sequence in wet finishing operations is cleaning, rinsing, the finishing process itself, and then a final rinse. At each stage in the finishing operations, there is a case for using good quality water.

A cleaner can be used hot or cold, be acidic or alkaline, anodic or cathodic or a combination of these types. Cleaners prepared with deionised water are free of random solids which would otherwise be concentrated by evaporation and the subsequent topping up operation. Similarly, 'drag-out' from the cleaner, taken into a further rinse, will only introduce cleaning solids to the rinse, thus minimising its solids content and increasing its working life because there is no waste caused by precipitation reactions. When cleaners are used anodically or cathodically, the use of deionised water improves their performance because there are no undesirable electrolytes in the cleaner to interfere with the process.

When cleaners are used hot, calcium salts, whose solubility decreases on heating, precipitate as scale on the surface of heaters, thus impairing efficiency, and on the walls of tanks, creating a cleaning problem. Some proprietary cleaners are available with water-softening chemicals added in order to precipitate the hardness salts. Not only are these products more expensive than 'straight' cleaners, but the precipitated salts may have to be filtered out or the cleaner decanted into another tank. The use of deionised water enables cheap or basic cleaners to be used and eliminates the filtering or decanting operation.

RINSING

Among the advantages of purified water at rinsing stations is the prevention of salt precipitation when a hot rinse is used. The number of rejected components is reduced and also the need for wiping, buffing or other labour-consuming operations. This is particularly true if the rinse is the final stage in the process. One internationally known car manufacturer found that the number of rejects on one plating line, previously as high as 30 per cent, fell to zero when deionised water was used for rinsing.

Where the work is rinsed before entering a finishing solution (normally an electrolyte), the use of deionised water prevents the carry over of dissolved solids into the electrolyte. Similar considerations apply when a rinse is followed by a dye or chemical colouring operation.

FINISHING SOLUTIONS — A PARTICULAR PROBLEM IN PRINTED CIRCUIT MANUFACTURE

The arguments against using unpurified water for making up finishing solutions are well known — con-

centration, via evaporation, of unwanted solids in hot solutions; chemical imbalance of the solutions; high current loadings, especially when plating out metallic impurities; the pernicious effect of the ever present chlorides; reduction in the throwing power of the electrolyte.

Reduction in throwing power can be critical in precision processes such as printed circuit plating. One U.K. manufacturer has recently overcome this problem by installing a cartridge deioniser near the through-hole plating line. Through-hole plating provides a copper coating on the walls of the holes drilled in a printed circuit board. Unless the coverage is controlled and even, inclusions in the surface will interfere with the electrical performance of the final product. By keeping the density of the electrolyte low, deionised water permits penetration of the electrolytic action into any minute crevices and irregularities.

The output from the deioniser unit in this plant is also piped upstairs to a small laboratory where the edge connections of the printed copper circuits are gold flashed to ensure perfect connections and complete electrical transmission. Since the presence of magnesium and calcium in raw water easily upsets the balance of solutions for precious metal finishing, the company had earlier used distilled water in carboys. But this method had proved expensive and it was

difficult to transfer the water to where it was needed.

Now, deionised water is simply drawn off into a bucket and used to top up the 'drag-out' rinse bath. Since the plating bath is hot and the water evaporates, the losses are made up by adding an occasional cupful of water from the 'drag-out' bath.

Deionised water is also used here in the gold plating of the connector pins. These are put, together with electrodes, in a plastic cage. The cage is dipped first in the plating bath, then in the 'drag-out', and finally in the rinse. The cage is revolved to ensure an even treatment of each pin.

A SIMPLE CHOICE

The choice of a particular deionising equipment is usually quite simple. Before recommending equipment, the manufacturer needs to know the solids content of the local water supply; the purpose for which purified water is required; average weekly volume and peak requirements. Cartridge units are generally recommended for a weekly requirement up to 10 000 litres — up to 22 000 litres if the raw water contains few solids. Above these rates, the capital cost of *in situ* regeneration plant is usually offset quite quickly by improved product quality, water savings and sometimes the recovery of valuable materials.

Sixteenth International Refractory Colloquium 1973

This colloquium will be held at Aix-la-Chapelle (Aachen) on 25th and 26th October, 1973.

The main theme is: 'Refractory building materials for electric steel furnaces'.

This theme covers all problems arising from the production of refractory building materials and their use in electric, resistance, and induction furnaces.

Anyone wishing to contribute papers should submit details and abstracts before 1st March, 1973. Further particulars may be obtained from:

Instituut für Gesteitenshüttenkunde der RWTH
Aachen,
D-5100 Aachen,
Manerstr. 5.

The Institution of Engineers (India)

National Seminar on Materials Science and Technology - February 1973

This seminar will be held on the occasion of the 53rd Annual Convention of the Institution, in Madras.

Further particulars may be obtained from:

Organising Secretary (Seminar 1973),
c/o The Institution of Engineers,
8 Gokhale Road,
Calcutta 20,
INDIA.