CADMIUM RECOVERY
BY ION EXCHANGE

The production of refined cadmium from sinter-plant fume using weak sulfuric-acid leaching followed by ion-exchange purification and concentration.

The Cockle Creek Works of Sulphide Corporation Ltd. is located approximately 100 miles due north of Sydney in New South Wales, Australia. Part of the Works consists of an Imperial Smelting Process plant for the simultaneous treatment of zinc and lead sulfide flotation concentrates produced by associated mining companies at Broken Hill, some 780 miles by rail from the smelter site.

The raw feed for the smelting operations consists of a mixture of about three parts by weight of zinc concentrate (averaging 52.2% zinc and 0.20% cadmium) to one part of lead concentrate (averaging 77.0% lead and 0.02% cadmium), together with a small proportion of finely-crushed limestone. These materials are first mixed with about five times their total weight of recirculated sinter fines and roasted on a large updraft sintering machine.

The sintering gases withdrawn from the machine contain from 6 to 7% SO₂ and are delivered to a conditioning tower and hot gas electrostatic precipitator (H.G.P.) for cooling and de-dusting, respectively. Some 97% of the total sulfur and 85 to 90% of the total cadmium are eliminated from the charge during sintering and are removed in the sintering gases. Fume present in these gases has the following typical analysis: 1.0% Zn, 65% Pb, 3.5% Cd, and 10% S.

The bulk of the fume (over 99%) is recovered in the H.G.P. unit and is extracted continuously by means of screw conveyors. It is then delivered into a rubber-lined, agitated storage tank for pulping with dilute sulfuric acid. The latter is obtained from the weak acid liquor removed from the conditioning tower, as well as from the circulating liquor bled from the wash tower system in which the dedusted sinter plant gases are scrubbed and further cooled before passing to a large contact sulfuric acid unit ("D" plant). The weak acid liquors used for slurring the H.G.P. fume are saturated with SO₂ gas, and this appears to be necessary for good cadmium extraction.

When the desired pulp density of approximately 40% solids (by weight) has been achieved, some 30 gal* of 80% sulfuric acid are added to each batch of slurry before pumping from "D" plant to the adjoining cadmium plant. This acid addition helps to control froth formation, which can be troublesome in the subsequent counter-current washing operation.

OUTLINE OF PROCESS

The main steps in the process are shown schematically in Fig. 1 and are as follows:

1. Addition of 80% sulfuric acid to give a constant pH of 2.0 to 2.5 during leaching.
2. Recovery of soluble cadmium in overflow liquor from three stages of counter-current thickening.
3. Clarification of the cadmium-bearing pregnant solution.
4. Ion exchange treatment of pregnant solution to separate arsenic and to concentrate the cadmium in a strip liquor.
5. Trommelng of strip liquor with zinc rods to precipitate cadmium sponge.
6. Pressing of sponge to remove excess liquor.
7. Melting of sponge under caustic soda flux to produce crude cadmium metal.
8. Distillation of crude cadmium to produce metal of marketable grade.

LEACHING AND COUNTER-CURRENT WASHING

The H.G.P. fume slurry is pumped alternately to two rubber-lined tanks of 4000-gal capacity each. Both tanks are fitted with rubber-covered agitators running at 60 rpm and are provided with pH indicators. Sufficient sulfuric acid (80% strength) is added to each batch of slurry to maintain a constant pH of 2 to 2.5 during retention in the tank. Leaching of cadmium is virtually complete after about one hour.

The leached slurry is pumped at a controlled rate by a 2-in. rubber-lined centrifugal pump to a counter-current washing system. Washing is carried out in three 15-ft diameter rubber-lined Dorr thickeners in series using a liquor consisting mainly of clarified smelter effluent. Liquor flow is controlled at 30 gpm and between each stage of washing, pulp and liquor are agitated in a 200-gal rubber-lined tank. Each thickener is fitted with froth baffles, and a floculant solution (Separan NP 10) is added to accelerate settling.

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* All gallons refer to Imperial gallons.
Thickener underflow slurry, which is controlled at approximately 40% solids, is pumped by Oliver No. 2 diaphragm slurry pumps while the overflow liquor is handled with 1-in. acid-resistant (A.R.) centrifugal pumps. In most instances, duplicate pumps are installed for each duty, with one pump operating and one on standby. All pipes conveying acidic liquors are either polythene or rubber-lined mild steel. Average throughput of dry fume is approximately 35 tpd.*

**PREGNANT LIQUOR CLARIFICATION**

Cadmium-bearing liquor from the washing section contains up to 200 ppm of suspended solids, which are removed in a 4-ft 6-in. diameter rubber-lined, sand pressure clarifier. Liquor is pumped through the clarifier by a 1½-in. A.R. centrifugal pump. A rubber-lined surge tank of 1500-gal capacity is provided for unclarified liquor, and two 10,000-gal rubber-lined storage tanks are provided for liquor after clarification.

Town water for forward and backwashing of the clarifier and ion exchange columns is pumped by a 2½-in. C.I. centrifugal pump from a 750-gal M.S. tank painted internally with neoprene to prevent rust formation. A flow indicator is provided for manual control during backwashing of the clarifier.

**ION EXCHANGE**

Two 4-ft 6-in. diameter rubber-lined columns (see Fig. 2), each containing 88 cu ft of wet settled Zeocarb 225 cation exchange resin, are loaded in series until cadmium breakthrough is obtained on the leading column. Arsenic, which is taken into solution during leaching, is in an anionic form and consequently is not loaded on to the resin.

Pregnant liquor is pumped through the columns by a 1½-in. A.R. centrifugal pump. The flow rate is measured by a rotameter and is controlled by a hand regulating valve. Operation of the columns is completely manual.

Brine eluting solution is prepared from salt containing a minimum of 98.5% sodium chloride in two concrete bunkers protected by a bitumastic paint. The solution strength is approximately 12.5% (w/w). Three 1500-gal rubber-lined tanks hold the solution for the three-split elution cycle, all solutions being handled by a common 1½-in. A.R. centrifugal pump. The first portion (620 gal) of eluate solution, i.e., the strip liquor or rich eluate fraction, is collected for cadmium recovery while the second (recycle) and the third (fresh brine) portions are collected for use in the next elution cycle. Resin loading is approximately 0.07 lb-equivalents of cadmium and zinc per cu ft of wet settled resin.

**CADMIUM SPONGE PRECIPITATION**

Strip liquor from each elution cycle is collected in a neoprene rubber-lined tank of 6000-gal capacity. Direct steam injection raises the liquor temperature to 70°C at which it is thermostatically controlled. A

* All tons refer to long tons (2240 lb).