

are positioned with their longer dimension in the horizontal plane. Bubble resistance seems to increase if the vertical dimension is longer than the horizontal; the electrode width to height ratio should be at least 2 to 1.

The semi-industrial cell containing 3.89 square feet of electrode surface was made up of five copper cathodes and six platinum mesh anodes each spaced one inch apart. Cell operation on acid strengths up to 23 per cent nitric removed 0.75 lb. chloride per square foot of anode. With acid strengths greater than 23 per cent the copper cathodes were attacked. This occurred at a temperature of 120°F and it was assumed the energy going into heat was too great to be removed by air diffusion. Water tubes were placed between each of the electrodes in vertical banks of five tubes. Cooling water passed through the tubes removed sufficient heat to allow copper cathodes to operate in 35 per cent acid without attack.

Design data obtained from the operation of three sizes of continuous flow cells were

sufficient to construct a large industrial model. This cell was composed of six anodes, each 24 inches wide by 6 inches deep, constructed in platinum Unimesh by Johnson Matthey & Mallory Ltd., Toronto, and five copper cathodes of similar size.

Water cooling tubes were necessary to operate the cell with nitric acid strengths up to 35 per cent. The current efficiency of a large cell was 30 per cent and the power cost was \$1.60 per pound of chlorine removed, compared with \$7.00 for the ozone process. The industrial cell has been operated three months without requiring maintenance.

In any plant concentrating a nitric acid contaminated with chlorides by a fractionation process, electrolysis is competitive with ozone oxidation for the removal of the chlorides. The capital expenditure is \$1,000 per pound of chlorine removed per day, or about 30 per cent of the cost of the ozone process, and the operating cost is about 25 per cent. The amortisation period is estimated to be 10 years.

## Synthesis of Penicillin Derivatives

### HYDROGENATION WITH PALLADIUM CATALYST

An important advance in medical treatment, made possible by the synthesis of penicillin derivatives of greater antibiotic activity than those produced naturally, has recently been announced by Beecham Research Laboratories Ltd.

The first major step in a long programme of research was the isolation of the common nucleus of the penicillin compounds, 6-amino penicillanic acid, which has the simple basic structure of the penicillins without any side-chain other than one hydrogen atom. From this compound it became possible to produce an immense number of penicillins that could not be obtained from the natural mould by the introduction of substituent groups into the side-chain of existing penicillins, or in other words, into the amino group of 6-amino penicillanic acid. Very broadly, the replacement of one hydrogen in the simple side-chain of the penicillin nucleus by one of a wide range of aminoacyl groups can yield a variety

of derivatives, some of which possess activities against a wider range of infections than did earlier preparations. Others of the range are either more readily absorbed orally than the older penicillins or are lethal to certain strains of staphylococci that have hitherto destroyed penicillins by producing a substance called penicillinase.

In the course of preparing these synthetic penicillins, the 6-amino penicillanic acid is coupled with the desired amino-substituted carboxylic acid having its amino group protected, and the protective group is then removed by catalytic hydrogenation. This last procedure must be carried out under conditions sufficiently mild to avoid attack on the penicillin nucleus with subsequent loss of antibiotic activity, and it has been found that, with a palladium catalyst on an inert support such as barium carbonate, this reaction can successfully be carried out at room temperature and atmospheric pressure.