The New ICI Nitric Acid Plant at Ardeer

INTERMEDIATE PRESSURE AMMONIA OXIDATION

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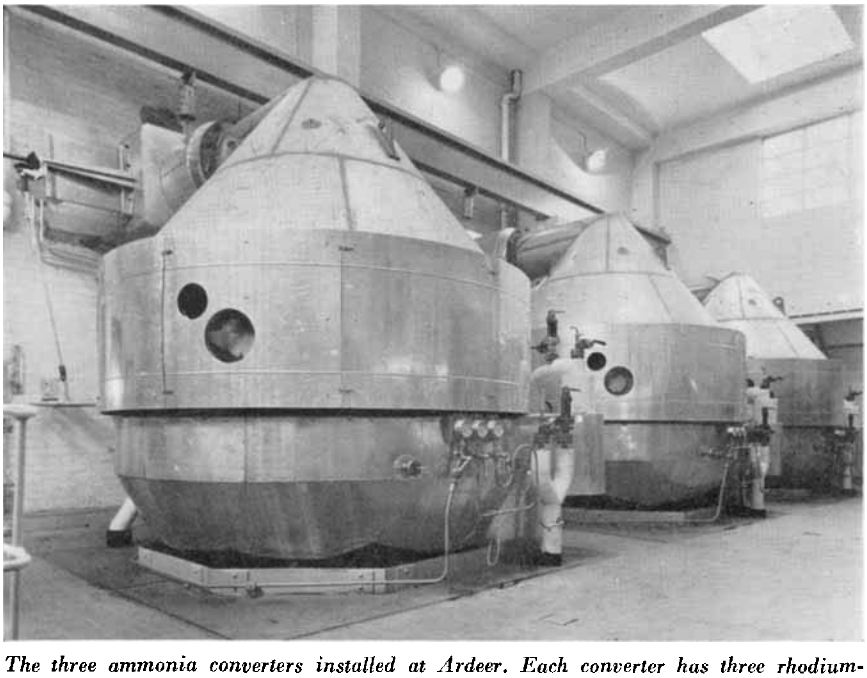
Nobel Division, Imperial Chemical Industries Limited

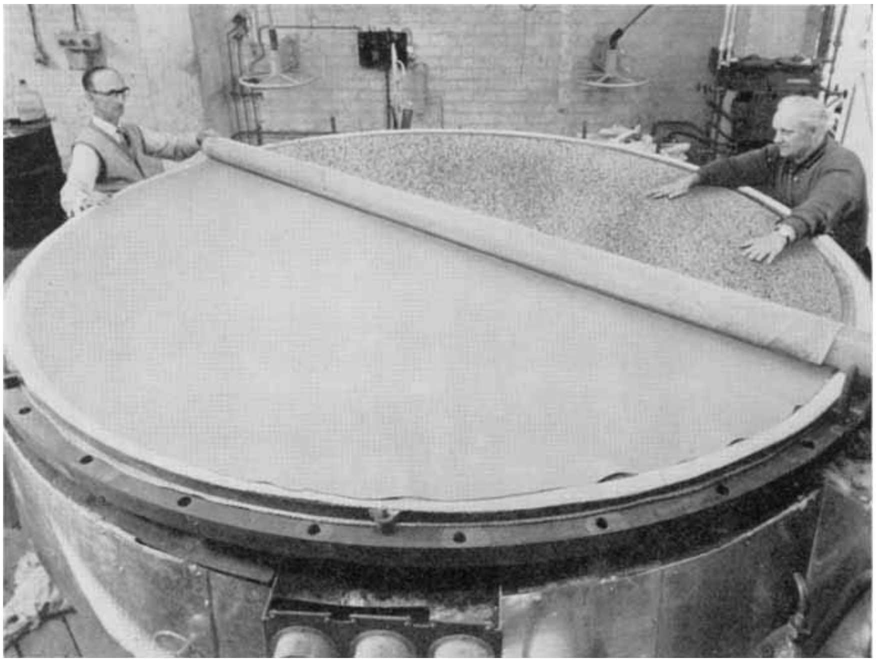
ICI Nobel Division have recently brought on stream a new nitric acid plant at their works at Ardeer, Ayrshire. This plant, with an annual rated capacity of 55,000 tons (100 per cent HNO_3), is designed to replace three older units—a 1928 atmospheric pressure oxidation plant and two more modern du Pont pressure oxidation plants with a total rated capacity of approximately 40,000 tons per annum. The new plant, designed by Stamicarbon N.V., produces 60 per cent HNO_3 which is primarily employed in a number of nitration processes used in the manufacture of nitrocellulose and explosives.

Liquefied ammonia is brought to Ardeer from ICI Billingham Division at Mossend, Glasgow, by 12-ton rail tankers. It is stored in 150-ton capacity spherical holders at 0°C, 45 psig, and kept at this temperature by a refrigeration system using recompression of flashed-off gas. Before mixing with the air stream, it is filtered in the gas phase by glass wool filters.

Air for the process is water-washed in a Peabody scrubber and mixed with the ammonia to form a mixture containing up to



The three ammonia converters installed at Ardeer. Each converter has three rhodium-platinum catalyst gauzes, 114 in. in diameter, woven by Johnson, Matthey & Co., Limited



The bottom gauze of a pad of three being placed in position in a converter. The gauzes rest on a Nimonic screen and are clamped between asbestos gaskets

11.5 per cent NH_3 by volume. The air and ammonia streams are individually preheated to 50–200°C before mixing. The gas mixture is further cleaned before entry to the converters by a series of three units containing a total of 3,000 ceramic candle filters. Homogeneity is ensured by a number of multi-nozzle mixers and the composition of the gas is continuously checked by a Cambridge recording catherometer.

The ammonia : air ratio controlling system is fully automated and forms part of the elaborate control exercised over the whole plant operation. It is closely related to the catalyst gauze temperature, which is also continuously measured by means of a radiation pyrometer and recorded.

Oxidation of the ammonia according to the well-known principal reaction

$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$$

is carried out in three parallel converters, each employing three rhodium-platinum alloy gauzes 114 inches in diameter. The reaction takes place at one to two inches water gauge below atomspheric pressure. Careful control of the flow rates, pre-heat temperature and ammonia : air ratio keeps the gauze temperature constant at about 850°C.

The catalyst gauzes, woven of 0.06 mm diameter rhodium-platinum alloy wire by Johnson, Matthey & Co., Limited, are placed in a pad of three in each converter and are clamped in position using asbestos gaskets. A catalyst loading of 140 lb NH_3 burnt per day per ounce troy of platinum alloy exposed is employed. The gauze pads are supported by a Nimonic grid above the waste heat boiler. A hydrogen torch is used to effect light-up of gauzes.

Conversion efficiency exceeds 96 per cent and an overall plant efficiency of over 94 per cent is usually attained. Platinum alloy losses are expected to be very low—about 50 mg per ton nitric acid. The greatly reduced loss rate is one of the major advantages of using low pressure ammonia oxidation units.

A Lamont forced-circulation boiler with superheater and economiser is placed immediately below each converter, making available a total of 15,000 to 20,000 lb/hr steam at 300°C, 270 psig. This steam provides two-thirds of the power requirements of the Escher Wyss rotary turbo compressor which compresses the nitric oxide containing gases prior to absorption.

Oxidation of the nitric oxide and its subsequent absorption takes place in a series of six stainless steel towers, each 60 feet high. These are ring-packed, and owing to the elevated absorption pressure, this operation is carried out at high efficiency, with a final stack loss of less than two grains of acidity per cubic foot.

An outstanding feature of this new plant is its very low requirement for operating labour. All flow rates, pressures and temperatures are automatically measured, recorded and controlled. Elaborate safety devices ensure rapid and automatic shut down of the plant in the event of impending disaster. The gas cleaning systems, together with a very low loss rate of catalyst alloy, enable long continuous operating runs exceeding three months to be achieved for maximum economy.

Rare Earth-Palladium Cermets

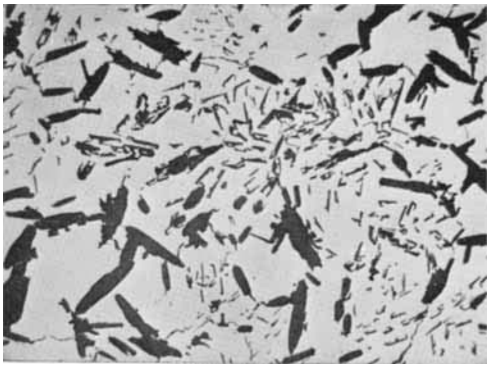
FABRICATION OF CONTROL AND SHIELDING MATERIAL

The exceptionally high thermal neutron absorption cross sections of samarium, europium and gadolinium make these rare earth elements particularly suitable for use in control rods and for shielding purposes in nuclear engineering. Unfortunately no technique has yet been evolved for their economic fabrication into the necessary shapes, although much effort has been put into research on this problem, more particularly into the use of rare earth compounds dispersed in metal matrices.

An interesting attack on this problem has now been reported by E. S. Funston and J. A. McGurty of the Aircraft Nuclear Propulsion Department of the General Electric Company, Cincinnati.

In the course of research aimed at the development of nuclear control or shielding alloys which could be used in air at high temperatures, studies were made on palladium base alloys containing neutron poisons such as samarium and gadolinium metal. In subjecting 5, 10, 15 and 20 weight per cent samarium in palladium to elevated temperature tests, it was found that these alloys possessed exceptional high temperature stability. It was also found, however, that the stability of these alloys did not arise as a result of the oxidation resistance of the binary alloy system, but rather due to the fact that, when heated in air, oxygen very rapidly penetrated the alloy causing oxidation *in situ* of the samarium and forming a cermet.

One of the features of cermets produced by such a procedure is the uniformity of oxide dispersions within the metallic matrices. Also, cermets containing large amounts of oxide dispersion are severely limited as to their workability. Cermets made by internally oxidising the rare earth metal allow for metal working or machining before the ceramic phase is formed. After the component is in final shape the oxidation process can be brought about in such a way as to produce a uniform dispersion of the ceramic phase throughout the metal matrix.



Microstructure of 20 per cent samarium-palladium alloy after treatment in air at 1200°C for 100 hours

In the photomicrograph the dark phase is the samarium oxide, the light phase is the palladium metal.

Obviously other rare earth metals may be substituted for the samarium constituent.