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SOME INVESTIGATIONS INTO THE ELECTROCHEMICAL ENGINEERING OF FLUORINE CELLS

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Fluorine is manufactured by BNFL for use in the conversion of uranium tetrafluoride to uranium hexafluoride. The cost of manufacturing fluorine represents a substantial proportion of the total conversion cost. At 15,000 kWh/te, the power consumption of a fluorine cell is pro rata five times that of modern chlor-alkali cells. The principal features of cells used by BNFL are:

a. mild steel cell body and cathode;
b. porous carbon anodes;
c. KF.2HF electrolyte at an operating temperature of 85-90^{o}C;
d. water cooling within individual cells.

Many factors affect the operation of such cells, of which anode performance has been studied here extensively. The specific requirements of a porous carbon anode for use in a fluorine cell are that it shall be compatible with the electrolyte, a good electrical and thermal conductor and be capable of generating fluorine at acceptable current densities and transporting it into a product gas stream. The porous structure of the anode leads to electrolyte penetration in service; this is neither uniform nor confined to the immersed region. Laboratory studies indicate that the gas permeability is the physical property most directly related to the ability of an anode to sustain fluorine generation. During cell operation various types of anode failure are observed. These include physical loss of contact with the supporting hanger, surface degradation, disintegration, burning or the development of a high resistance across the anode surface. A number of developments have been made by BNFL to overcome these problems, including recently the development of a composite carbon anode. This anode comprises a dense carbon core round which is a layer of carbon having a higher degree of porosity and permeability than the core carbon. A reliable method of attaching the carbons to a metallic conductor inside the cell has also been established. In addition to anode studies other work aimed at reducing cell working voltage and understanding the factors which influence cell performance have been carried out. These include studies of cell voltage components, anode current density and current distribution, power efficiency and the dependence of current efficiency and off-gas purity on anode material and electrolyte impurities.