THE REMOVAL OF NITRATE IONS FROM POTABLE WATERS BY ION EXCHANGE USING THE
DUOLITE RESIN PES 196

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SYNOPSIS
The anion selectivity order for Duolite PES 196 has been confirmed to be nitrate > sulphate > chloride > bicarbonate, with the resin showing an added selectivity towards nitrite. The selectivity is greater than that shown by Amberlite IRA 904 which allows the treatment of an additional 100 bed-volumes of water before breakthrough. The lack of a peak in nitrate concentration in the breakthrough profile would allow this resin to be used at point-of-application with the assurance that the water quality could never be worse than that of the influent. Although some fouling by organic material and calcite was observed this was easily removed by the regeneration procedure with no significant loss of performance over the limited number of cycles tested.

1 INTRODUCTION
One of the major problems facing the water industry today is the rising level of nitrate ions in both ground and surface waters. Nitrate occurs naturally in water courses at relatively low concentrations but levels are increasing as a result of human activities. Two main sources of such pollution have been identified, sewage treatment plant effluent and agricultural fertilisers. The World Health Organisation recognising the potential hazard to health from consumption of high levels of nitrate
have issued guide-lines for water quality and these have been supported by EEC directives. The current recommendations stipulate a maximum of 11.3 mg dm$^{-3}$ of nitrate-nitrogen, which is equivalent to 50 mg dm$^{-3}$ of nitrate ions. To meet these guide-lines water authorities are undertaking research into methods of water treatment aimed at reducing the input of nitrate into the water sources and removal of nitrate from water supplies. A number of alternatives are available for nitrate removal from water, these include physicochemical techniques such as reverse osmosis, electrodialysis, ion exchange, and biological denitrification processes using bacteria to effect reduction of the nitrate to nitrogen. Of these and other alternatives probably the most convenient in terms of ease of operation, automation and control is ion exchange. However difficulties still occur with this technique especially with regeneration, where in conventional treatment disposal of brine used in this process can cause both a financial and environmental burden. Current practice in ion exchange treatment of potable waters to remove nitrate is to use a single-bed chloride-form resin. Both fixed and continuous bed designs have been used in pilot-scale and full plant operation. One of the disadvantages of this type of operation for a number of water supplies is the presence of a significant concentration of sulphate ions in the feed, because for most anion exchange resins the selectivity sequence favours sulphate, i.e. sulphate > nitrate > chloride > bicarbonate. The absorption of sulphate thus reduces the working capacity of the column for nitrate removal. In addition because nitrate is concentrated on the column and is subsequently displaced by sulphate, breakthrough of the nitrate must be carefully monitored as the concentration of nitrate in the effluent can exceed the influent concentration for a short period. Clifford$^1$ has proposed that anion exchange selectivity is much more dependent on the resin structure than cation selectivity, which can be related much more closely to the charge and size of the exchanging ions, thus resins containing large quaternary groups like $-N(C_2H_5)_3^+$ and $-N(C_3H_7)_3^+$ were shown to be selective for nitrate over sulphate$^2$. This paper provides some experimental data on the use of a commercial resin PES 196 (Duolite) which has been proposed for nitrate removal from potable waters compared with an alternative strong base resin IRA 904 (Rohm and Haas) which was previously shown to exhibit some selectivity for nitrate over sulphate$^3$. 