

complexes by about 300  $\text{cm}^{-1}$ , but a change of solvent to cyclohexane or to chloroform<sup>4</sup> has little general effect in the case of the *s*-trinitrobenzene complexes.

The correlations in the case of the iodine mono-chloride and iodine complexes are not so close. In particular it would appear that the value of  $\nu_{CT}$  for the naphthalene-iodine monochloride measured by Keefer and Andrews<sup>2</sup> is very high. Some of these variations may be due to differences arising from the perpendicular orientation of the acceptor in the complexes involving halogen molecules and the parallel orientation when the acceptor molecule is an aromatic or a quinone.

It may be noted that the variation of  $\nu_{CT}$  with changing donor molecule is less in the complexes with iodine monochloride than in the complexes with iodine. This might be expected, as iodine monochloride is the weaker Lewis acid of the two. The reverse appears to hold, however, in the case of the *s*-trinitrotoluene and *s*-trinitrobenzene complexes, where *s*-trinitrotoluene is the weaker Lewis acid.

This work was carried out during the tenure of an Edward A. Deeds Fellowship of the University of St. Andrews.

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### Adsorption Chromatography on Silica-treated Paper

PAPER partition chromatography is not successful with many organic compounds for two reasons: (1) the compounds have low solubility in water, and hence move on the solvent front in normal partition systems; (2) low reactivity of the compounds makes detection of the position of spots difficult.

To overcome the first of the difficulties, methods have been described which employ an organic solvent as the stationary phase on the chromatogram<sup>1-3</sup>. Alternatively, adsorption chromatography may be used instead of partition chromatography<sup>4</sup>. Also, Kirchner and Keller<sup>5</sup> have described the use of silica-treated paper for chromatography of dinitrophenylhydrazones.

The method here described has the convenience of paper chromatography, and may be used for a wide range of compounds difficult to chromatograph by partition methods. The chromatograms are run, with the solvents normally used in adsorption chromatography, on filter paper which contains approximately 20 per cent (w/w) of silica. Unreactive compounds are detected by the blue colour of the starch-iodine reaction, while other more reactive compounds may be detected by their own specific reactions.

The silica-treated paper is prepared as follows. Sheets of Whatman No. 1 filter paper (24 in.  $\times$  8 in. has been found a convenient size to handle) are passed slowly through a 25 per cent (w/v) solution of commercial sodium silicate in water and hung up to

drain for approximately 30 min. It is essential that the paper is not allowed to dry at this stage. The papers are then passed slowly through a 3 *N* hydrochloric acid bath, and once again allowed to drain for 30 min. After draining, the papers are washed in running tap water for 2 hr. and finally hung up to dry overnight. Heating the dry paper in the oven at 100° C. for 15-30 min. before use activates the silica considerably, and produces better resolution on the chromatograms.

The mixture to be chromatographed is spotted on the paper in the usual way. It is preferable to use a volatile solvent for applying the mixture, as the applied spot must be free from moisture before the paper is placed in the chromatography tank. Chromatograms are developed by the ascending-flow method, in tightly sealed jars lined with filter paper saturated with the solvent. (Battery jars with ground-glass edges have been found suitable.) Light petroleum (b.p., 40-60° C.), benzene and chloroform have been found to be the most useful solvents for development of the chromatograms. The solvent front is allowed to ascend about 10-15 cm. before the chromatograms are removed.

Unreactive compounds are detected by dipping the dry chromatograms in a solution of iodine (1.5 per cent) in carbon tetrachloride, and allowing excess iodine to evaporate off the paper. A stream of air is useful in hastening this process. Compounds then show up as brown spots on a white background<sup>6</sup>. The spots may be intensified by dipping the iodine-treated chromatogram in 1 per cent starch solution, when blue spots of greater intensity are obtained. Any background of blue due to residual iodine may be removed by a brief exposure to sulphur dioxide gas.

The method has been successfully applied to the separation of many types of organic compounds, including terpenes, leaf pigments, phenolic ethers and esters, and steroids.

I am indebted to Dr. W. G. C. Forsyth, director of the Colonial Microbiological Research Institute, for helpful advice, and to the Colonial Products Council for permission to publish this communication.

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Nov. 8.

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### Thermocell with Ion-exchange Polymer Electrolyte

RECENT communications<sup>1,2</sup> have described some thermocells in which two electrolyte solutions in contact with reversible electrodes are separated by an ion-exchange resin barrier. The ion-exchange resin in our apparatus is the sole electrolyte in physical contact with two identical copper electrodes and behaves as a solid electrolyte. The theoretical development of thermocells<sup>3</sup> is then applicable in an especially simple form.