

Two pumps of the design described were used in the investigation of phase equilibria in the urea-synthesis system at pressures up to 1000 atm. A urea melt (an aqueous ammonia solution of urea and ammonium carbamate), which is highly corrosive, was used as the working medium. Therefore all the components of the pumps in contact with the medium were made from chrome nickel and chrome-nickelmolybdenum steel. Since the working solutions crystallised near room temperature, the jackets of the cylinders were maintained at a temperature of 40–50°C. The solution was applied to the pumps from a reservoir under a pressure of 12–16 atm; under these conditions the appearance of gas bubbles due to the evaporation of ammonia cannot be excluded. At the instant when the pumps were started the working stream consisted of a gas-liquid mixture, which, however, did not interfere with the normal functioning of the pumps. However, in the case of considerable overheating of the cylinders (or the suction connections), and the resulting formation of gas locks, the operation becomes unstable. To remove the gas locks, the collectors of the pumps were fitted with blow valves (not shown in Fig. 1).

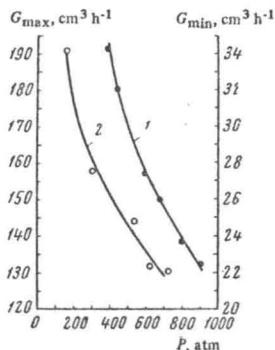


Figure 2. Calibration curves for the pump in operation with water: 1) calibration curve for the maximum operating rate of the plungers; 2) calibration curve for the minimum operating rate of the plungers;  $P$ —pressure in the compression line of the pump (atm);  $G_{\max}$ —flow rate at the maximum operating rate of the plungers ( $\text{cm}^3 \text{h}^{-1}$ );  $G_{\min}$ —flow rate at the minimum operating rate of the plungers.

Fig. 2 presents the calibration curves for one of the pumps. In the calibration water supplied by the pump was collected in a measuring cylinder for 10 min at the maximum possible operating rate of the plungers and over a period of 15 min at the minimum rate. As was to be expected, with increase of pressure the flow rate produced by the pumps decreased steadily. Fig. 2 shows that the maximum scatter of the points about the curves does not exceed  $\pm 3\%$ .

#### REFERENCES

1. B. A. Korndorf, "Tekhnika Vysokikh Davlenii v Khimii" (High-pressure Techniques in Chemistry), Goskhimizdat, Moscow-Leningrad, 1952.

2. D. S. Tsiklis, "Tekhnika Fiziko-khimicheskikh Issledovani pri Vysokikh i Sverkhvysokikh Davleniyakh" (Physicochemical Techniques at High and Ultrahigh Pressures), Izd. Khimiya, Moscow, 1965.

State Research and Design Institute  
for the Nitrogen Industry and  
Products of Organic Synthesis,  
Dzerzhinsk Branch

Received 17th March 1967

U. D. C. 541/543

## A Magnetic Detector for Gas Chromatography

N. G. Farzane and L. V. Ilyasov

A method for the detection of gases emerging from the chromatographic column based on the measurement of the paramagnetic properties of air or oxygen used as carrier gas has been examined. A magnetic detector cell operating on this principle has been described. The magnetic cell has the same sensitivity with respect to almost all gases and therefore does not require calibration.

In all the existing differential detector devices in gas chromatography (the only exceptions are the argon ionisation detectors for  $\text{C}_3$  and higher hydrocarbons<sup>1,2</sup>) the signal from the cell depends on the nature of the substance. Therefore, in deriving concentrations from the chromatogram, it is necessary to introduce correction coefficients for each mixture component. These coefficients are determined experimentally. In the case of detectors for which the relation between the signal (peak area) and any physical chemical property of the substance is known it is necessary to determine the sensitivity with respect to only one component, the sensitivities with respect to the others being then calculated. In the calculation of the concentrations of the components from the chromatograms obtained with the aid of such detectors each peak on the chromatogram must be identified. After the identification, correction coefficients for each gas are found.

It is important to devise detectors which give a signal depending on the number of molecules of the component and not on its nature. One such detector is described below. The magnetic detector does not require calibration with respect to the mixture of diamagnetic gases analysed. The detector signal (peak area) is independent of the nature of the diamagnetic gas, and since the vast majority of gases are diamagnetic<sup>3</sup> (exceptions are  $\text{O}_2$ ,  $\text{NO}$ , and  $\text{N}_2\text{O}$ ), the detector is equally sensitive with respect to all gases. The peak area for a given component is directly related to its partial pressure and therefore the determination of its concentration does not require the introduction of any experimental coefficients.

The Figure presents the circuit of the proposed magnetic detector. It consists of a measuring cell 1 made of a diamagnetic material and separated by washers 2 from the end-pieces 3–6. The operating pair of pole pieces 3 and 4 is made from mild steel. The compensation end-pieces 5 and 6 are made of brass, and are introduced to eliminate the aerodynamic effects arising when the density and viscosity of the gas mixture change.

The end-piece 6 may be moved along the thread relative to the bush 7 attached to the shell of the detector,