A MODIFIED VAPOUR PHASE CHROMATOGRAPHIC ANALYSIS FOR RESIDENCE TIME DISTRIBUTION STUDIES

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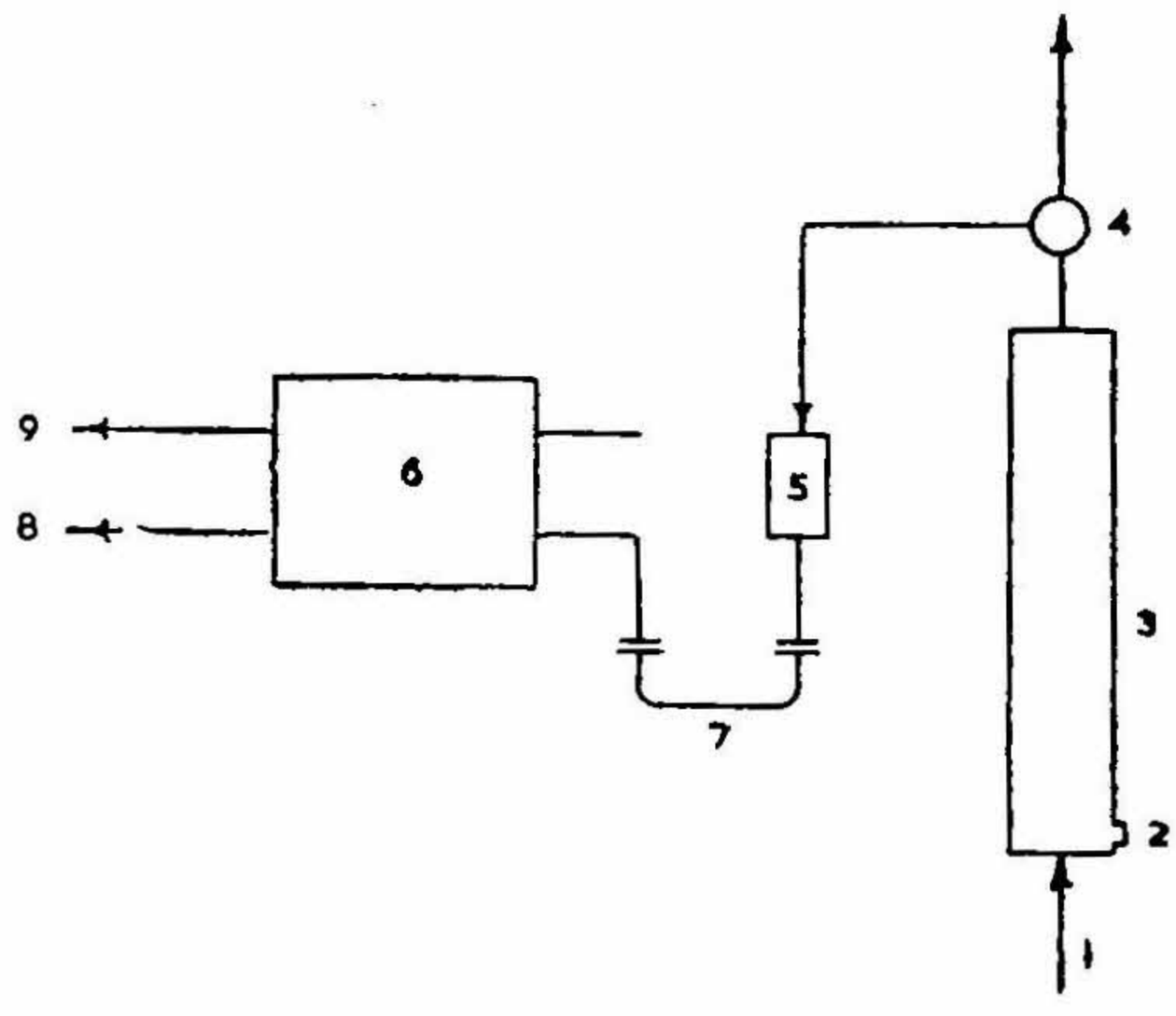
Experimental studies on residence time distribution (RTD) consist of the following two steps in general.

1. Collection of samples at various time intervals (the time interval is usually very small, because of higher flow rates), and

2. The analysis of the samples for tracer concentrations.



1. INLET TO THE REACTOR
2. TRACER INJECTION POINT
3. REACTOR
4. FLOW DIVIDER (IF NECESSARY)
5. INJECTION PORT OF THE VPC
6. DETECTOR
7. SHORT CIRCUITED COLUMN
8. OUTLET
9. REFERENCE STREAM

FIG. 1

The sampling device for the collection unit is generally a complicated one in its construction and some times not reliable. Unless the analytical procedure is very accurate, the second portion of the study is also subjected to errors owing to the small amount of sample. The application of radio active materials as tracers is being employed to minimize these errors. Even though this technique appears to be attractive, it is not always possible to get suitable isotopes particularly in India. Any improvement, made for RTD studies in the existing apparatus would be helpful and useful.

In order to collect samples and analyse accurately, a method involving the modification of the vapour phase chromatograph (VPC) apparatus has been found to be more suitable and reliable. The modifications of the VPC suggested and tested, minimize to a large extent the errors involved in sampling and analysing, since these two were done simultaneously.

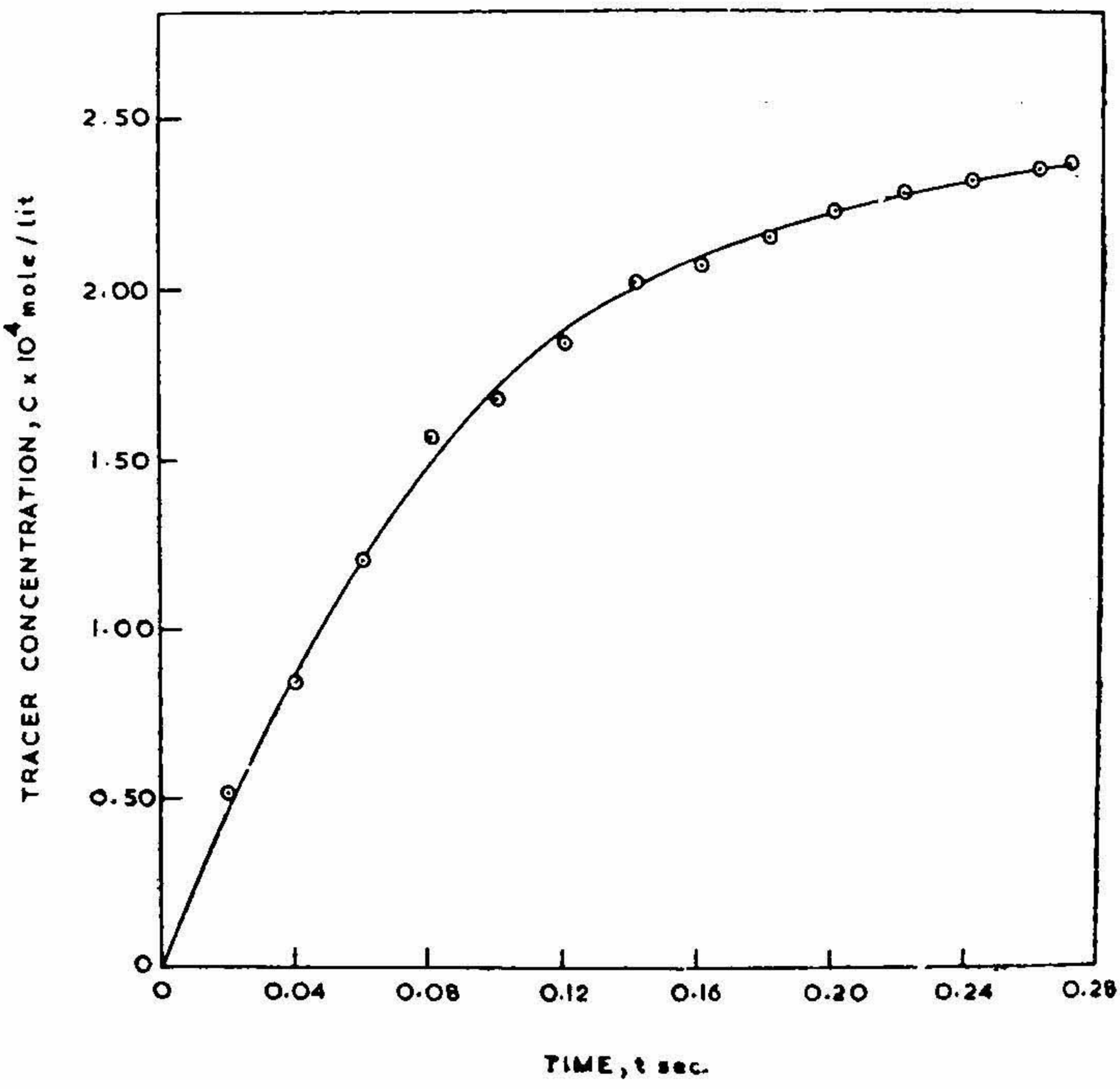


FIG. 2

. Figure 1 represents the schematic diagram of the modified VPC. In the modified VPC, the column was removed and the flow was maintained through the rubber tube, short circuiting the two ends. A suitable carrier gas at a desired flow rate was admitted to flow through the reactor for which the RTD studies have to be made. The flow may be divided near the exit

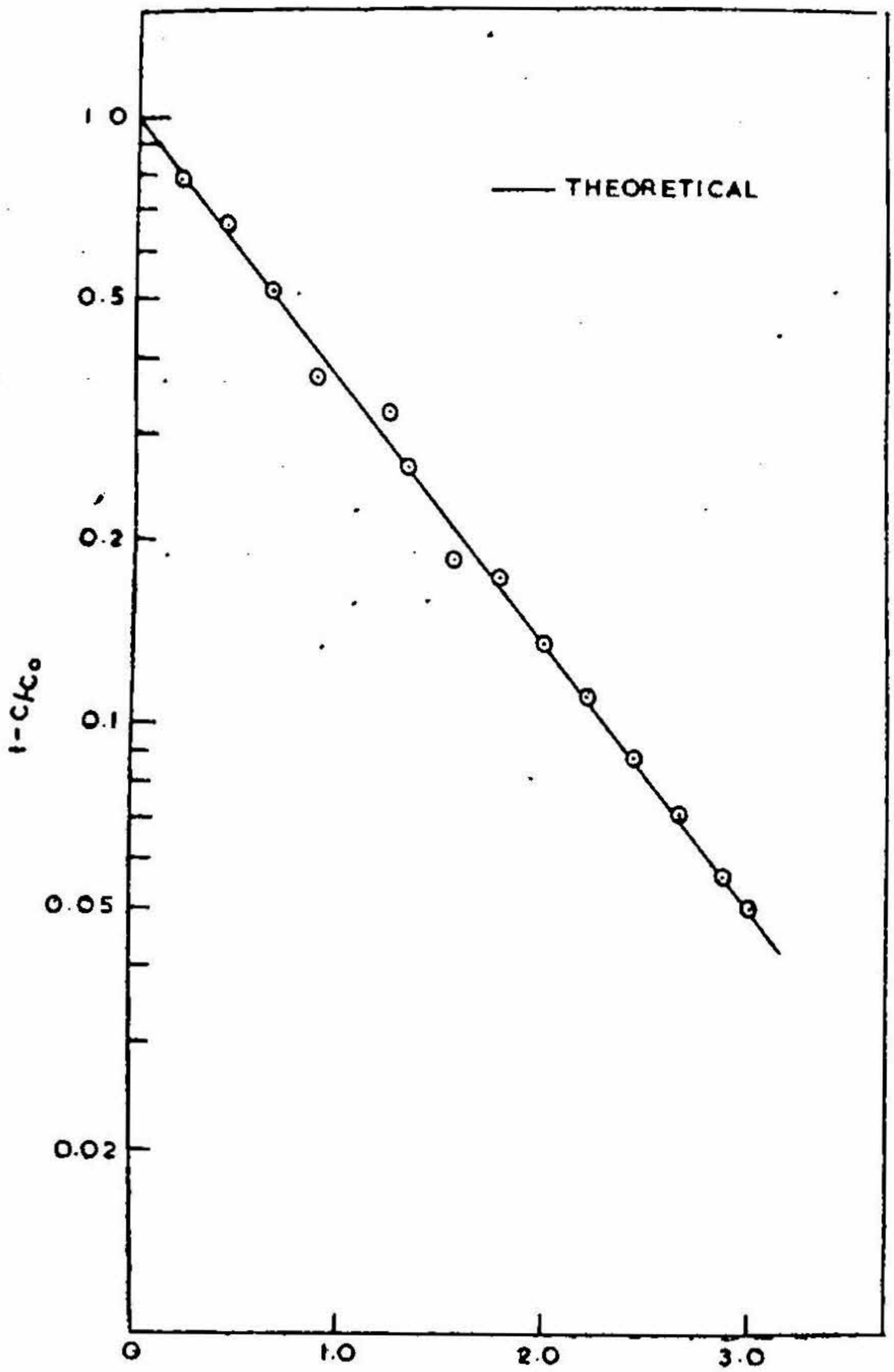


FIG. 3

of the reactor in a suitable ratio depending on the sensitivity of the detectors. The outlet gases are admitted through the detecting element in the VPC. The reference portion of the detecting element is also maintained in the same atmosphere of the carrier gas by admitting the carrier gas through it at very low rates separately. A step input of the tracer is admitted at the entrance to the reactor. The response of the detecting element is recorded by a recorder. From the recorder speed and from the division ratio of the flow rates (when employed), the concentration of the tracer in the outlet stream at any time can be obtained. The entire operation is carried out at room temperature.

The residence time distribution studies were carried out with this set-up for the gas-solid mixing device. Nitrogen gas was used as the tracer and hydrogen, as the carrier gas. A step input of the tracer was admitted near the entrance of the mixing device. The concentration of the tracer (C_0) was kept at $2{\cdot}50 \times 10^{-4}$ moles/lit. The response of the thermal conductivity cell (detector) was recorded by the recorder moving at 3,600 mm/hr. The concentration of the tracer was recorded for three times of the average residence time (τ). The concentration of the tracer 'C' at any time 't', is given in Fig. 2. Figure 3 represents the data, when they were fitted to a theoretical expression [1]. It is evident that the agreement is very satisfactory and this modified VPC can be employed for the RTD studies.

REFERENCE

1. Levenspiel, O. .. *Chemical Reaction Engineering*, Wiley Eastern Private Ltd., 1969, New Delhi, p. 250.