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Note

An Apparatus for Continuous Measurement of Radioactivity of Liquids in Systems »Solid - Liquid«

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The construction of a simple apparatus for continuous measurement of the radioactivity change of liquid or solid phase in closed »solid - liquid« system is described.

INTRODUCTION

The change of radioactivity in the liquid phase of two-phase systems »solid-liquid« can be quantitatively determined by measuring at intervals the radioactivity of an aliquot of the liquid or solid phase. By determining the radioactivity of the same phase at various time intervals the process of heterogeneous exchange could be quantitatively determined.

If the velocity of the excahnge process is greater than the velocity of the solid - liquid separation, the radioactivity of the same phase cannot be determined exactly.

In order to follow fast heterogeneous exchange processes a simple counting equipment has been developed. With this equipment continuous radioactivity changes of both phases in a system »solid - liquid« can be followed.

DESCRIPTION OF APPARATUS

A schematic diagram of the apparatus is shown in Fig. 1. The tube (1) is filled with quartz or glass wool and then connected with the centrifugal glass pump (2). Then the centrifugal pump is placed on the magnetic stirrer (3). The solid phase is introduced through the central stopcock (4). The Geiger-Müller tube (6) is introduced through the stopcock (5). The Geiger-Müller tube is then protected by the lead protector (7). The Geiger-Müller tube is connected with the scaler (S) and the recorder (R). The liquid phase is admitted dropwise through the stopcock (8). The liquid flows to the right over the Geiger-Müller tube and through the centrifugal pump, gradually fills tube (1) and then flows through tube (10) to the stopper (8). In this way the formation of air-bubbles in tube (1) is prevented. When the magnetic stirrer is put into action the liquid phase should move in the same direction as when the apparatus was filled. The solid phase carried by the liquid will fill the area in tube (1). Then scaler (S) and recorder (R) are set in motion. When the oscillations of the recording pen are stabilized, the apparatus is adjusted. By a micropipette the radioactivity amount necessary for this experiment is introduced through the stopcock (8). The process is recorded until the radioactivity change is observed on the recorder (Fig. 2). Decontamination of the apparatus is attained by washing with a decontamination solution (by opening 8 and 9). Decontamination control is performed by the recorder to the initial background value.

The known system of the magnetic pump for circulation of liquid phase in the closed system is applied in our case[1–3].

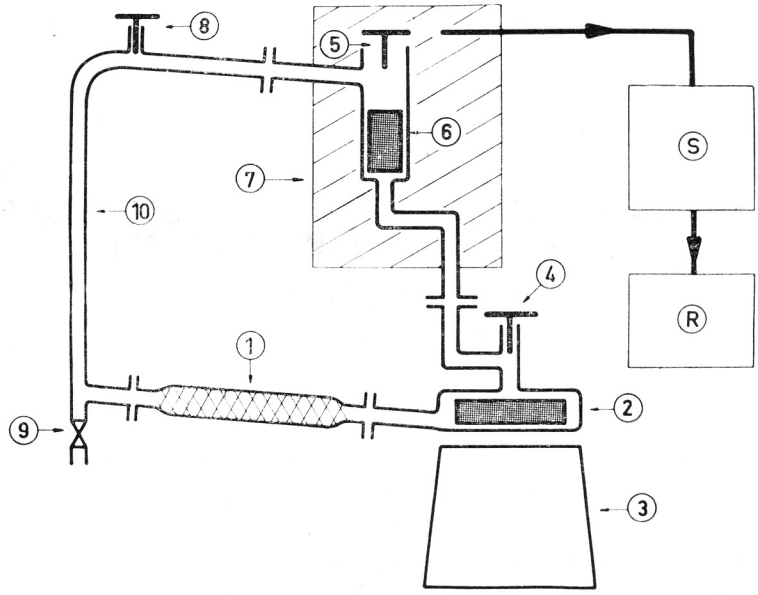

Fig. 1. Apparatus sheme for continuous recording of radioactivity change of liquid or solid phase in the »solid - liquid« system: (1) the area for catching solid phase, (2) the centrifugal pump with the stopcock (4) for bringing in the solid phase, (3) the magnetic stirrer for starting centrifugal pump, (5) the stopcock for Geiger-Müller tube, (6) Geiger-Müller tube, (7) lead protector, (8) the stopcock for labeling, (9) the stopcock for apparatus empting, (10) connecting tube, (S) scaler and (R) recorder.

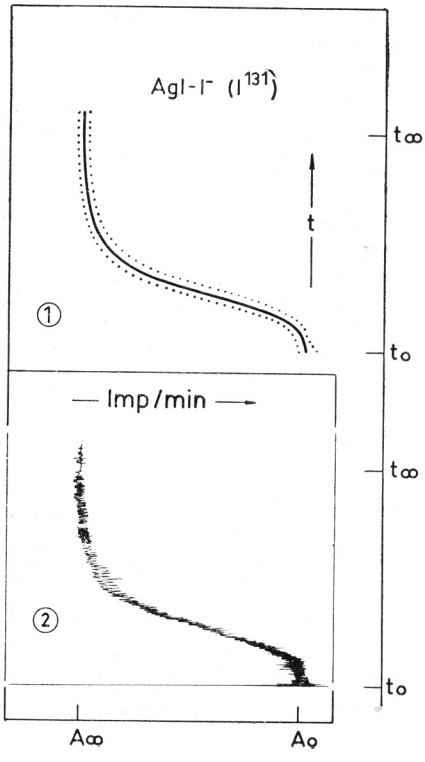

Fig. 2. Radioactivity exchange of liquid phase from the moment of labeling (t_0, A_0) to the equilibrium state (t_∞, A_∞) in the process of heterogeneous exchange on the model system AgI — I-(I^{131}) (2.1) the curve is obtained from the diagram (2.2) »radioactivity-time« recorded on the recorder.

For the adjustment of the apparatus the system $AgI - I^-(I^{131})$ is used, the exchange kinetics of which is more suitable than the one of the system $AgI - Ag^+(Ag^{110})$.[4,5] The result of the exchange process recorded from the moment, of labeling (t_0, A) to the equilibrium state (t_∞, A) is shown in Fig. 2.1, obtained from Fig. 2.2 The observed distribution data at $t_0(A_0)$ are the consequence of labeling since a minimum time is required for the added radionuclide amounts to be distributed homogeneously in the liquid phase. The velocity of the homogenization depends upon the velocity of the centrifugal pump. In order to use this equipment adequately, it is necessary, when studying very fast exchange processes to get uniform velocity of circulation of liquid phase depending on tube dimensions, time constants of counter, scaler and recorder. At these conditions the application of this equipment allows the radioactivity change of liquid phase in the »solid - liquid« system to be continuously followed.

The characteristics of the apparatus described in this work are as follows: the total volume of the system is 200 ml; the volume of the centrifugal glass pump is about 60 ml, and the balance is made up by tube (1) (cca 30 cm long and 1.5 cm in diameter), tube (10) (diameter 1 cm) and the volume around the Geiger-Müller tube (6). The dead time of the G—M tube was $\tau = 981\ \mu$ sec. In this work a GOERZ »Stromscreiber« Type SB-146311 (as recorder R) in connection with Labormonitor FH 55 with variable time constants from 2.5 to 60 sec was applied. The centrifugal glass pump has a capacity of approximately 20 ml per second.

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IZVOD

Aparat za kontinuirano mjerenje promjene radioaktivnosti tekućina u sistemima »kruto-tekuće«

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Opisana je konstrukcija jednostavne aparature za kontinuirano mjerenje promjene radioaktivnosti tekuće (ili krute) faze u zatvorenom sistemu »kruto-tekuće«.

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