Problems of molecular motion in HV systems with adsorbing walls

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It is well known that terms such as pressure of a gas and all the derived quantities are not applicable to the situation existing in a high vacuum vessel with adsorbing walls. The molecular motion is highly anisotropic and depends on the geometry of the vessel, on the sorption properties of the walls, on the distribution of the gas sources. In many fields of vacuum science and technology it is important to know the relation existing between these parameters. Examples are the interpretation of sorption-desorption experiments, the evaluation of pumping devices, the computation of the conductance of connections of non-simple shape or with adsorbing walls. To solve such problems it is usual to resort to Monte Carlo methods, ie to simulate a large number of possible trajectories which statistically describe the average motion of molecules. In the present work a new method is proposed. It permits to express with simple mathematical formulae the relationships between the aforementioned parameters characterizing the system and the average motion of molecules. The theory applies to HV systems in the sense that molecular interactions in the gaseous phase are disregarded. Essentially, the theory rests on the construction of matrices and vectors which describe the geometrical coordination between surface elements, their sticking probability and the distribution of gas sources. The molecular trajectories are expressed in terms of operations on such matrices and vectors. The fundamental aspects of the theory are exposed and explicit computations which have been carried out to test the practical applicability of the method are presented.

The transport of oil molecules in tubulation

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It is a well known fact that in tubulation condensible vapours (like diffusion pump oil etc) show a quite different behaviour compared with permanent gases. This effect has been calculated by several authors. We tried to give an experimental verification by direct measurements.

We used a radioactive tracer method to get quantitative information on these transport processes of oil molecules in tubulation. As described elsewhere[1] diffusion pump fluid of the type Dow Corning DC 704 (tetramethyltetraphenyltrisiloxane) was labelled with tritium. The specific activity of the oil was about 70 mCi/gr. By means of this tritium labelled diffusion pumps fluid it was possible to measure quantitatively the distribution of the coverage inside tubes of different size. Because it is possible to detect about 10^{-4} of a monolayer the processes in the starting phase, that means at coverages well below one monolayer, could be easily measured. In our measurements the following parameters were changed:

(1) diameter of the glass tubulation
(2) temperature and
(3) running time of the experiment.

At the time $t=0$ about 0.5 cm^3 of labelled oil were admitted to the vacuum system. The vacuum system was as follows: three glass tubes of different size have been connected to the vacuum system and then baked at 400°C. A freon-cooled baffle prevented back-streaming from the diffusion pumps. The vacuum system including the tubes has been thermostated at a temperature between room temperature and 50°C. Then the run was started by admitting the labelled oil. After a given time the experiment was interrupted. The glass tubes were cut in pieces of equal length. The activity of the pieces has been measured in a Tricarb liquid scintillation spectrometer. The results depending on diameter, time elapsed and temperature are given.

Reference

[1] R Dobrozemsky, W K Huber and F Viehbock, *Z Naturforschg* 22*a*, 549 (1967).

SESSION II.E

Vacuum Metallurgy

Progress in vacuum metallurgy (Invited paper)

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In the course of the last ten years procedures in vacuum metallurgy have not only attained a great industrial significance because of the increase in the number and size of vacuum metallurgical plants but also because of the development of versatile and various new processes and methods of working. In this review the attempt will be to present the most important advances which have taken place in this period of time.

The most impressive is the development in the fields of steel degassing and vacuum melting of highly refractory metals and alloys. The applicability of the various processes, the plants which have been constructed and the process technology will be discussed briefly.

Vacuum processes have also gained increasing significance in extraction metallurgy. The most important applications here are indicated. The same is true also for the remaining applications: in sintering technology, in heat treatment and in the metal operations of welding, soldering and vaporisation, to give only a few examples. Likewise there are important improvements and, in part, new methods have been developed, which merit attention.

The effect of surface treatment on the outgassing rates of 304 stainless steel

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A system has been constructed for the purpose of measuring outgassing rates of each component of the gas released from the surface of materials used in vacuum system construction. The samples which have been studied are in the form of tanks, made by closing off the end of standard 18 inch diameter by 30 inch long 304 stainless steel bell jars. Two tanks are connected, through bakeable valves, to a pressure measuring manifold which contains a calibrated nude Bayard-Alpert gauge and a quadrupole residual gas analyzer which has been carefully calibrated on the actual system on most of the gases that have been observed in the system. The pressure measuring manifold is mounted on a sputter-ion pump which has been conductance limited to about 2 per cent of its rated pumping speed.

Outgassing rates are measured during pumpdowns in which first one tank and then the other is opened to the pressure measuring manifold. With one of the tanks opened equilibrium