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4.3 MEASUREMENT OF HYDROGEN DISTRIBUTIONS BY NEUTRON RADIOGRAPHY,
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1. Introduction

A powerful application of neutron radiography is the detection of hydrogen. This is possible because of the high scattering cross section of hydrogen. Thus hydrogen in Zr /1/ and Ti /2/ can be measured. Also experiments on the diffusion of H in Zr /3/ were performed. Other applications are the detectability of H-containing inclusions in steel /4/ eventually using cold neutrons /5/, the inspection of metal adhesions, of explosives of O-ring seals within apparatus and so on.

In the following the recent experiments performed at the Triga Vienna reactor will be reviewed. In a tangential beam hole of the reactor we have placed a conical collimator with length of 2200 mm. The diameter of the focal spot is 17 mm, the diameter of the useable beam 125 mm. The neutron flux obtained is $6 \cdot 10^5 \text{ cm}^{-2} \text{ s}^{-1}$, the gamma dose rate is 3.3 Rh^{-1} because of a 80 mm thick Bi-filter placed at the inner end of the beam hole. This leads to a neutron-gamma-ratio of $6.6 \cdot 10^8 \text{ cm}^{-2} \text{ R}^{-1}$.

2. Diffusion of liquids

Experiments were performed on the $\text{H}_2\text{O}-\text{D}_2\text{O}$ and on the methanol diffusion process. The ratio of the total attenuation coefficients

3. Water motion in non-liquid systems

Test experiments were performed with polyacrylamide (PAA) gel which is used in electrophoretic experiments as a carrier. The PAA gel consists of 15% Cyanogum, 2% tetramethylethyldiamine, rest water. Using for the production of the gel D_2O and H_2O alternatively a contrast between these two phases can be seen by neutron radiography. This leads to further possible applications in chemical studies, especially for investigations of the motion of water and hydration spheres with various ions.

Recently an experiment on water diffusion in concrete was made. Here a 5 cm thick concrete plate was heated at one end and the transmission of a fine collimated neutron beam measured at different distances from the heated end. Alternatively radiographs were taken. The measurements were performed at different heating times and showed a very clear picture of water motion in concrete under a thermal gradient. The results will be published in due course.

4. Investigations of resolution of neutron radiography in the presence of hydrogen

As it is commonly well known the presence of greater amounts of H has negative influences on the quality of radiographs. This is an effect of the heavy scattering of neutrons by H. In detail it leads to a diminution of spatial resolution and to a reduction of the contrast of radiographs. A possibility to overcome these problems is the use of an antiscatter grid. This is a collimator being placed between sample and film thus reducing the amount of scattered neutrons reaching the converter. This antiscatter grid must be moved during the exposure for avoiding

Literature

- /1/ H.H.Klepfer, H.D.Kosanke, E.L.Esch: Conf. "Applications-Related Phenomena in Zr and its Alloys", Americ.Soc. for Testing and Materials, Philadelphia 1968, ASTM STP 458, p. 372.
- /2/ D.Hagemeier, J.Halchak, G.Basl: materials evaluation 27 (1969) 193.
- /3/ K.Chountas, H.Rauch: Atomkernenergie 13 (1968) 444.
- /4/ H.Rauch, G.Saringer: Materialprüf. 8 (1968) 134.
- /5/ J.P.Barton, Brit.Part.No. 1 124 584.
- /6/ M.Mannoussakis, H.Rauch, A.Zeilinger: BNES Conf. "Radiography with neutrons", Birmingham 1973. Atominstitut Vienna report no. AIAU 74403.

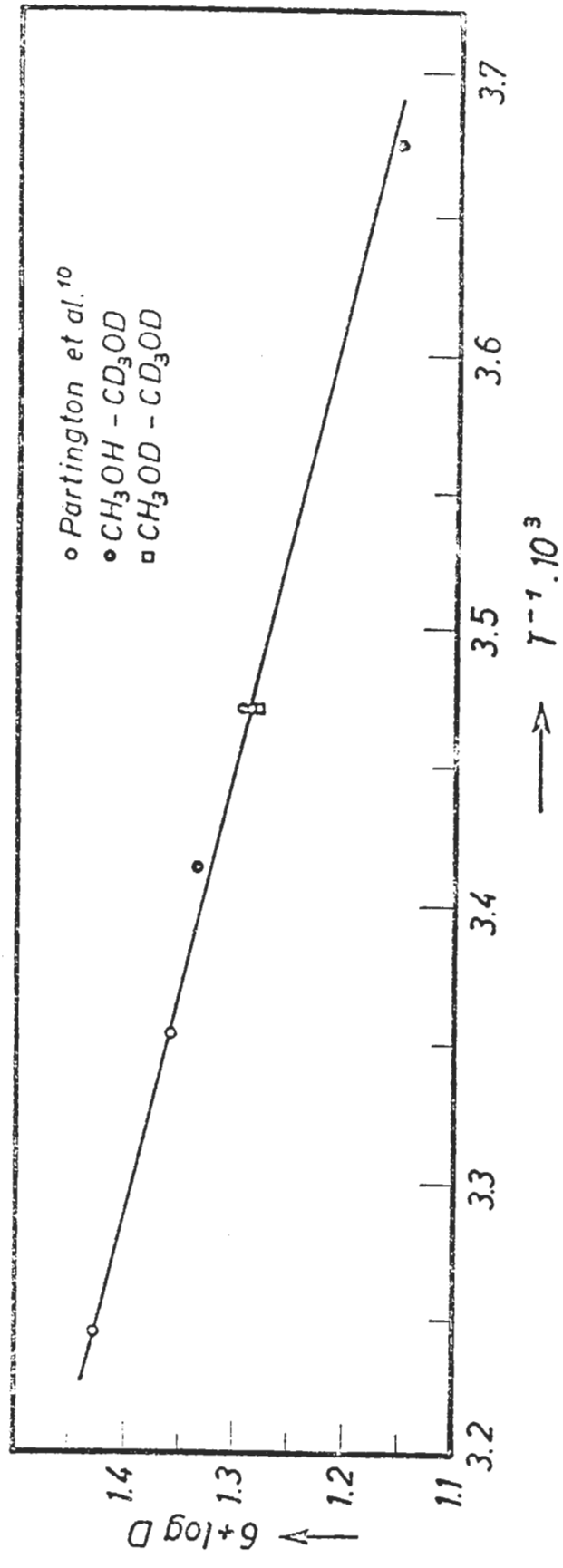


Fig.2: Diffusion coefficient of methanol as a function of temperature.

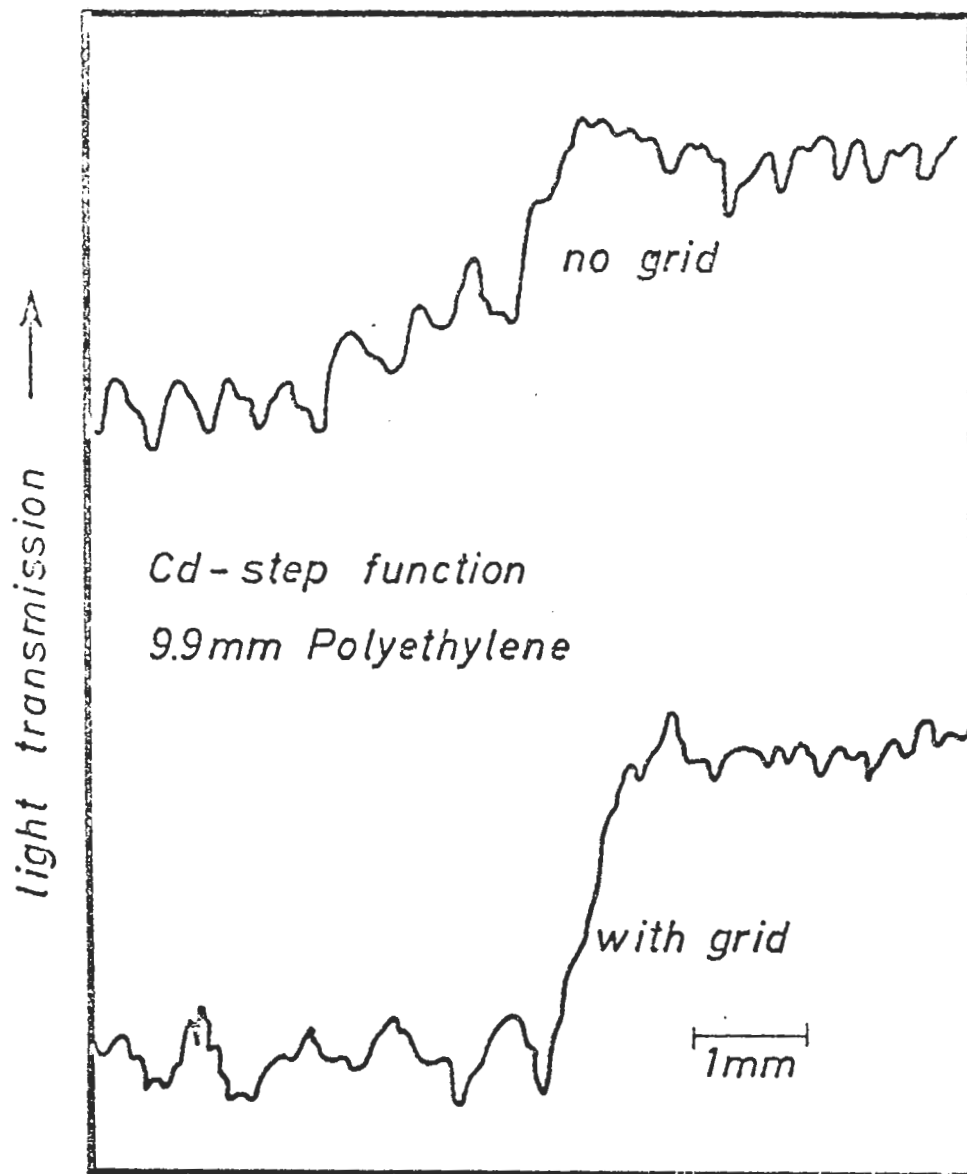


Fig.4: Edge-spread function of a Cd-step with 9.9 mm polyethylene between Cd and film. Light transmission through a track-etch foil as a function of position.