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PERMEABILITY PROPERTIES OF URYLON 453-85RH AND POLYPROPYLENE

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The permeability properties of urylon 453-85RH and polypropylene were studied by α-particle detection techniques using methods previously described.

1. URYLON 453-85RH

A plane sheet of the material (thickness: 0.67 cm) was investigated by the twin-chamber method using a ^{226}Ra source of strength 2.2 kBq, and two scintillation cell/photomultiplier tube/nuclear scaler systems. The duration of the experiment was slightly over 6 weeks during which the growth of ^{222}Rn concentration in both chambers, i.e., the ^{226}Ra source chamber and the "permeability" chamber, were continuously and simultaneously monitored. The permeability, k, was calculated according to the simplified expression:

$$k = (R / 1-R)\ (\lambda \delta V / 2S) \qquad (1)$$

where, R is defined as the ratio of ^{222}Rn concentration, [^{222}Rn], in the "permeability" chamber relative to the "source" chamber ($R \leq 1$);

λ is the radioactivity decay constant of ^{222}Rn, i.e., $\lambda = 2.1 \times 10^{-6}\ s^{-1}$;

δ is the thickness of the sample ($\delta = 0.67$ cm);

V is the volume of either chamber ($V = 3551\ cm^3$) (both chambers have the same volume);

S is the surface area of the material (urylon), $S = 118.8\ cm^2$

The calculated value for R, based on the [^{222}Rn} in both chambers was: $R \sim 0.2 \times 10^{-6}$

The permeability was calculated as:

$$\mathbf{k}\ (\text{urylon}) \sim 4.4 \times 10^{-12}\ cm^2\ s^{-1}$$

2. POLYPROPYLENE

Four cylindrically shaped (capped at one end) samples (polypropylene tubing) of different wall thicknesses (0.1, 0.3, and 0.6 cm) were studied. The samples were coupled to specially designed detector/electronic circuitry systems, as described elsewhere. The detection systems consisted of a diffused function (DJ) detector housed in a "sensitive" volume terminated in a flange to which the above samples could be "coupled". Results from these samples were compared with the results from two samples to which small holes had been drilled and covered with glass fibre (GF) filter material.

Experiments were conducted in a sealed ^{222}Rn box, 3m^3 in volume in which a 2.2 kBq ^{226}Ra source was located. The ^{222}Rn produced by the decay of the ^{226}Ra source was thoroughly mixed and circulated inside the box by means of a mixing fan. The duration of the experiments was 7 weeks during which continuously monitoring of ^{222}Rn diffusing through the polypropylene and the GF systems was carried out.

The permeability, k, of the material was calculated according to:

$$k = (R\ /\ 1\text{-}R\ )\ (\lambda\delta V_2\ /\ S\ ) \tag{2}$$

where all the symbols in Eq. 2, except V_2, have already been defined (see Eq. 1). The symbol V_2 represents the total "sensitive" volume of the detector system, i.e., the "sensitive" volume of the detector per se plus the inner volume of the cylindrical (tubing) sample. The results obtained are summarized in the table below.

Detector type	Thickness (cm)	k (cm^2s^{-1})
DJ, AL	0.6	4.6×10^{-9}
DJ, AC	0.1	0.3×10^{-9} to 0.7×10^{-9}
DJ, AC	0.3	0.34×10^{-9} to 0.8×10^{-9}
DJ, AC	0.6	0.98×10^{-9} to 2.2×10^{-9}

Note: DJ stands for diffused-junction detector. AL and AC refer to the detector/electronic circuitry arrangement used.

It should be noted that in either case, namely, for Urylon and polypropylene, the more accurate method in which the time-lag, etc can be obtained graphically could not be used reliably because of the poor statistics of counting, i.e., low α-particle counting rates. The simplified method used here, based on the activity measured under radioactive steady-state conditions , is not rigorous because it does not meet an important theoretical requirement. Hence, the method is only approximate but justifiable here because of the difficulties indicated above. For the polypropylene case there is a further source of uncertainty because of the geometry of the sample. I have dealt with this geometry as it were a plane geometry, i.e., by "squashing" the internal surface of the cylinder to a plane "sheet" of the same surface area through which ^{222}Rn would diffuse, hence reducing this case to the plane geometry case discussed in previous reports.

The contribution to the count rate from ^{222}Rn emanating from the sample has not been measured and, hence is "buried" in the count. In addition, and in spite of all the precautions taken, the potential for leaks due to the finish of the polypropylene flanges is a real one.