*Indian Journal of Natural Rubber Research*, **7** (2) : 126-128, 1994

# AIR TRANSPORT IN EPOXIDISED NATURAL RUBBER

In an earlier communication the transport of oxygen through epoxidised natural rubber (ENR) membranes and the effect of epoxidation level on permeation and diffusion were reported (Ismail and Ng, 1988). This paper reports the results of a study on permeation and diffusion of dry air and the effect of the level of epoxidation in ENR on air transport.

The materials investigated were a series of vulcanizates of epoxidised natural rubber and natural rubber which were supplied in sheets of thickness in the range 0.70 mm to 0.76 mm by the Rubber Research Institute of Malaysia. All samples, prepared based on the semi-EV system (Rubber Research Institute of Malaysia, 1984), were crosslinked by hot pressing at 150°C. The notations ENR 10, 25 and ENR 50 denote epoxidised natural rubber samples with 10, 25 and 50 mol per cent epoxidation respectively. Dried air used in this investigation was prepared by passing air through a silica gel column. Diffusivity, D, and permeability, P, were calculated respectively from the time lag, L, and steady-state flux, J, measurements using the high vacuum apparatus as described earlier (Ismail and Ng, 1988). Measurements were carried out at several temperatures and pressures in the range 30°C to 50°C and 15 to 25 cm Hg respectively. Baker *et al.*, (1985) have reported the permeability of air in ENR using a different technique which utilizes higher in-going pressures than the atmospheric pressure and allows measurement of the steady-state flux only.

For the natural rubber and the epoxidised samples permeability, $\bar{P}$, was independent of pressure and obeyed the relation, $\bar{P} = P_0 \exp(-E_P/RT)$. The transient diffusion coefficients, D, were obtained from the relation $D = I^2/6L$ where L is the time lag and I is the membrane thickness (Barrer, 1939). The diffusion coefficients were in good agreement with the relation, $D = D_0 \exp(-E_D/RT)$. The absolute determination of $\bar{P}$ and D is accurate to 3.5 and 4.8 per cent respectively, while the reproducibility of measurements performed with one and the same membrane at different pressures is within 1 per cent. Table 1 summarises the transport parameters at 40°C. The Arrhenius plots from $\bar{P}$ and D for all samples are shown in Figures 1 and 2 respectively. The values of $E_P$ and $E_D$ were

Table 1. **Transport parameters at 40°C**

| Polymer | $\bar{P}$x$10^{10}$ (cm$^3$ (STP)/cm/cm Hg/s) | $E_P$ (kj/mol) | Dx$10^7$ (cm$^2$/s) | $E_D$ (kj/mol) |
|---|---|---|---|---|
| NR | 15.30 (11.48 x $10^{-17}$) | 35.46 | 28.67 (28.67 x $10^{-11}$) | 34.81 |
| ENR 10 | 10.10 (7.58 x $10^{-17}$) | 41.32 | 17.10 (17.10 x $10^{-11}$) | 41.01 |
| ENR 25 | 5.23 (3.92 x $10^{-17}$) | 45.68 | 9.47 (9.47 x $10^{-11}$) | 43.63 |
| ENR 50 | 1.85 (1.39 x $10^{-17}$) | 50.75 | 0.06 (0.06 x $10^{-11}$) | 47.52 |

Figures in parentheses are values expressed in SI unit : $\bar{P}$ ($m^4S^{-1}H^{-1}$), D($m^2S^{-1}$)