

OXYGEN AND WATER DIFFUSION INTO POLYAMIDE 11 (RILSAN) PIPE

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1. INTRODUCTION

The DELPHI detector requires minimum electromagnetic scattering due to internal materials: for this reason we are interested in the possibility of replacing copper or stainless steel gas pipes by lighter materials. Among the plastics, polyamide 11 (Rilsan or Flexilon) is a candidate material, as it contains neither sulphur nor halogens, and is not highly inflammable.

2. TEST SET-UP

Bottled argon was passed through a 100 m length of 8/10 mm plastic pipe, thence via a Teledyne oxygen meter and a Shaw hygrometer to a bubbler outlet. To establish the gas inlet properties the 100 m pipe was bypassed.

3. RESULTS ON UNTREATED PIPE

The base values of O_2 and H_2O in the bottle gas measured at 1 l/m at atmospheric pressure were:

- O_2 : 0.5 ppm.
- H_2O : 15 ppm.

At 18° average ambient temperature, 40% relative humidity, the stable outlet values were:

- O_2 : 12 ppm.
- H_2O : 520 ppm, at 1 sl/m flow.

The atmospheric partial pressure of O₂ (atm. = 73 cm Hg) was

$$0.21 \times 73 = 15.3 \text{ cm Hg,}$$

and of water vapour (relative humidity 40% at 18°C) was

$$0.4 \times 1.55 = 0.62 \text{ cm Hg.}$$

The specific diffusion rates were:

- For O₂: 4.0×10^{-10} cc/cm²/mm/sec/cm Hg.
- For H₂O: 4.3×10^{-7} cc/cm²/mm/sec/cm Hg.

These results are approximately a factor of 10 greater than those found by C. Gregory and V. Sergo in recent tests, using helium at 1 to 4 bar as the carrier gas.

We found that oxygen diffusion behaved as a classical leak, equivalent to a small hole, i.e. doubling the flow rate halved the O₂ proportion in the outlet gas.

Water diffusion appeared to have a different characteristic, producing little difference in outlet proportions at rates varying from 0.5 to 4 l/m. This saturated flow response led us to suspect that we were measuring desorption of water contained in bulk in the polyamide material. Water is in fact produced in the chemical formation of polyamide.

For this reason we attempted heat treatment to remove the bulk water. The tube was treated at 90°C over 60 h in a vacuum oven at 1 torr. It was then reconnected to the measuring system. The graph shows the results obtained. The initial negative slope corresponds to purging of the pipe and instruments with dry argon. The oxygen content fell to 4.5 ppm at 2 l/m (\equiv 9 ppm at 1 l/m), then rose to near its previous values. The H₂O content fell progressively to 12 ppm, which represents a factor of 40 improvement over the untreated value. Unfortunately the H₂O content then rose over a period of four days to near its original value. Evidently over this time the material reabsorbed water vapour from the atmosphere.

4. CONCLUSION

The transmission of oxygen through short lengths of Rylsan pipe may be tolerable in chamber systems. The transmission of water vapour will probably be unacceptably high.

Flow - 2 l/min

Bottle gas content $H_2O = 12pp$ $O_2 = 0.5ppm$

