INFLUENCE OF IONIZING RADIATION ON RHEOLOGICAL, MECHANICAL AND ELECTRICAL PROPERTIES OF VARIOUS SORTS OF NATURAL AND SYNTHETIC RUBBER

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The influence of γ-radiation, upon elongation, resistance to tearing, module of elasticity, as well as upon the following electrical properties has been studied: $\varepsilon$, $\tan\delta$, and breakdown resistance, for various sorts of rubber.

Introduction

The construction of large nuclear power stations in Roumania raises a series of problems on the analysis of security and reliability of the component parts used. These achievements should be obtained at a cost as reasonable as possible. Therefore, in the areas undergoing low radiation exposure, numerous plastic material components are used, especially natural and synthetic rubbers, a fact which calls for checking the way they behave during this period of use.

The data presented may be available also for other types of devices which may raise similar problems (retreatment and stocking plants for wastes, research units).

To this end, three kinds of synthetic rubbers made up of binary and ternary copolymers were tested: ethylene-propylene (KSM); acrylonitrile and butadiene (LDS); butadiene-acrylonitrile and vinyl chloride (GP$_4$), and a composite of natural rubber and butadiene-styrene (FBE).

Similarly to the polymeric materials, rubbers of all kinds show a limited resistance to the action of radiations. The maximum radiation dose which allows these rubbers to be utilized depends markedly on their chemical structure and on the minimum remanent characteristics required.

Nevertheless, one may state that a resistance at $10^8$ rad represents rather good performance.
These materials may be used under two different circumstances. If the working period is extensive (10 to 30 years) and the radiation doses are small (of the order of magnitude $10^2-10^3$ rad/h), it is said that the materials undergo radiation aging, when high doses rates ($10^5-10^6$ rad/h) and severe irradiation conditions are to be considered, the materials should be exploited no more than a few thousand hours.

Table 1
Irradiation conditions

<table>
<thead>
<tr>
<th>Working regime</th>
<th>Dose rate (rad/h)</th>
<th>Integral dose (rad)</th>
<th>Temperature ($^\circ$C)</th>
<th>Pressure (bar)</th>
<th>Moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal regime</td>
<td>10–100</td>
<td>2.4 · 10^6 – 2.4 · 10^7 in 240,000 h</td>
<td>5–50 or 60</td>
<td>1 (max. 5.6)</td>
<td>15–40% (max 95%)</td>
</tr>
<tr>
<td>DBA</td>
<td>0–75 s 75–200 s 200 s 30 min 30 min–6 h 6 h 4 days</td>
<td>about 4 · 10^6 10^6 after 6 h 0.5 · 10^6 after 4 days</td>
<td>During the first hour: 4 · 10^6 1.5 · 10^8 for 10,000 h</td>
<td>5 100% steam jet following wetting by boric acid solution</td>
<td>5 3 2</td>
</tr>
</tbody>
</table>

The nuclear plants exemplify a combination between the two working types quoted above.

Table 1 summarizes the environmental conditions to which the materials are submitted under normal exploitation circumstances, as well as in the case of possible accidents.

It is thus found that, under normal circumstances, the radiation aging results from rather moderate conditions applied over a long period of time.

On the contrary, in the case of a possible accident, a massive irradiation at large outputs ($4 \times 10^6$ rad in the first hour) occurs, and a large radiation dose accumulates in a short time interval up to a total of $1.5 \times 10^8$ rad in 10,000 hours.