

## ABSTRACT

Rubber Seals are one of the classified seals used in nuclear facilities. However rubber seals, when subjected to  $\gamma$ -radiation their mechanical properties, could be significantly degraded, depending on the dose level, and hence affects the sealing performance reducing their service life. NBR rubber and EPDM rubber are selected to develop their physical and mechanical properties against high gamma doses and to increase their service life.

Antiozonant materials are added to the rubber to protect the rubber against radiation and its increase its lifetime. N-Substituted P-phenylene diamines (PPD) antiozonants are selected to add to both types NBR and EPDM rubber and protect them against gamma irradiation up to 5MGy. The present work is focused on studying the effect of three types of PPDs antiozonants materials, N-isopropyl-N'-phenyl-p-phenylene diamine (IPPD), Phenyl B-naphthylamine (PBN), and N-(1, 3-dimethylbutyl)-N'-phenyl-p-phenylene diamine (6PPD), on increasing the rubber performance at high doses (1, 2, 3, 4, 5) MGy. The effect of addition of different PPDs antiozonants on the tensile strength, elongation at break, hardness, abrasion, and compression set of the both rubber under gamma irradiation is investigated. Testing was divided into comprehensive testing on linear materials (sheets) and O-ring seals.

The results show that there is an enhancement on the physical and mechanical properties for the two selected rubber with PPDs antiozonants

under high gamma doses. As a result, non-irradiated and low-irradiated rubber with PPDs antiozonants showed high abrasion resistance. The results also show that the compression set of NBR and EPDM O-ring seals decreased with increased gamma doses and these decreases in the compression set for the samples after exposure to radiation mean that the exposed samples were less deformed than the unexposed samples. The results also show that the 6PPD antiozonant is the most effective one for protecting the studied rubber against radiation. The results suggest that NBR rubber is a good seal material for low gamma doses and EPDM rubber a suitable seal material for high gamma doses. However, NBR rubber appears to be less satisfactory based on the testing results when compared to the testing results of EPDM rubber.