

ABSTRACT

Defence aircraft plays a pivotal role in air defense, and every component requires extended degree of performance, especially in dynamic conditions. The performance of every system, equipment, component and part of an aircraft is vital. The flexible rubber diaphragm (FRD) is one of them. The present research is based on the failure investigation of existing FRD material, development of graphene nanoplatelet filled rubber nanocomposites, design validation, and life estimation. An in-depth analysis of existing rubber compound (RC) OEM14 was carried out, and the cause of service failures were established. During the course of analysis, it was found that the existing specification was mainly for quality control and batch acceptance for OEM14, supplied by the country of origin (OEM) of the aircraft without considering its final application. Further, failure investigation was progressed by designing five new formulations using graphene nanoplatelet in comparison with the existing OEM14 rubber compound. It was conclusively proven during this research work that the existing RC had inferior fatigue properties like heat build-up, cut initiation and cut growth etc.

The morphology study revealed that the existing RC included a huge amount of particulates which results in an enhancement in high hardness of the final product. A new technical specification was evolved considering an exhaustive literature survey wherein reduction in hardness and inclusion of fatigue properties, other product end-use tests, and curtailed performance enhancement properties were included. The graphene nanoplatelet loading in the newly designed formulations was optimized by measuring all conventional physical-mechanical properties as well as by finite element analysis (FEA). It was concluded that the 4 phr graphene nanoplatelet loaded newly designed indigenous rubber nanocomposite NPEG4 was best suitable for manufacturing the FRD. Life estimation was carried out using the Arrhenius method, and it was revealed that NPEG4 provides the highest calendar life as compared to remaining new formulations. However, existing OEM14 rubber compounds have been proven to have the least predicted life. The service life validation was performed by exhaustive endurance test on newly developed FRD using NPEG4 at room temperature, high and low temperatures. A satisfactory endurance test had proven the suitability of FRD on aircraft. Overall this thesis encompasses a systematic effort of designing indigenous rubber nano-composite based flexible rubber diaphragms for Air Defence.

Keywords: Graphene, flexible rubber diaphragm, failure analysis, endurance, life estimation.