ABSTRACT

This study aimed to analyze the environmental sustainability of manufacturing glass fiber reinforced polymer composites (GFRP) in Pakistan by the life cycle assessment (LCA) method, while the economic viability of these pultruded and filament wound GFRP composites was also assessed. For the analysis of environmental sustainability of these products a functional unit of kg and 8 impact categories as; i) Global Warming potential (GWP), ii) terrestrial ecotoxicity potential (TETP) iii) ozone depletion potential (ODP) iv) abiotic depletion potential (ADP), v) acidification potential (AP), vi) eutrophication potential (EP), vii) particulate matter potential (PMP), and viii) water consumption potential (WCP) were selected. The highest score results depicted in these respective categories were 5.01E+00 kg CO_2 eq. and 10.8E+00 kg CO_2 eq. for GWP, 2.59E+00 kg Oil eq. and 3.96E+00 kg Oil eq. for AFD, 2.43E+00 m^3 water and 1.32E+00 m^3 water for WCP, 2.2E+00 kg P eq. and 6.97E0-3 kg P eq. for EP, 1.28E+00 kg $PM_{2.5}$ eq and 8.01E-03 kg $PM_{2.5}$ eq for PMP, for pultruded and filament wound GFRP composites respectively. Whereas refuse-derived fuel (RDF) values for the process waste of these products under study were also determined using bomb calorimeter, the relevant results depicted higher gross calorific value for filament wound GFRP composite 6216.48(Btu/lb) as compared to pultruded GFRP composite 3523.12 (Btu/lb). The economic analysis was conducted using four economic indicators, net present value (NPV), internal return rate (IRR), benefit to cost (B/C) ratio, and payback time. The initial investment cost was high for filament wound composites as the epoxy resin is costly, therefore the values of these indicators obtained were. NPV was higher for filament wound FRP composites $2040 and IRR was 8% higher than pultruded GFRP composites. The benefit to cost ratio was 2.63 and 2.60, and payback time was five months more for pultruded and filament GFRP composites. In a nutshell, the results indicate the significant environmental performance of filament wound GFRP composites manufacturing. The utilization of composites waste in energy production can recover the cost invested. In developing countries pultruded GFRP composites can be commercialized because these are more cost-effective as indicated by economic analysis, but under controlled circumstances and emissions monitoring. Moreover, research and development (R&D) regarding composites manufacturing should be better integrated into policymaking to ensure environmental sustainability.