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ASSESSMENT OF EXERGY EFFICIENCIES OF THE SRI LANKAN RAILWAY

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Depletion of fossil fuel and the increasing price of crude oil have led to the awareness that energy utilization techniques in the transportation sector must be made more efficient. Sri Lankan Railway (SLR) plays a major role in both passenger and goods transportation. The main energy source of SLR is diesel, with three locomotive subsectors namely, diesel-electrical, diesel-hydraulic and power set. The objective of this study is to estimate the exergy efficiencies of the individual locomotives, of the sub-sectors and of the overall SLR transport. Exergy depends on both matter or energy flow and the surrounding environment. Exergy is a linkage between the physical and engineering world and the surrounding environment, which expresses the true efficiency of systems, which makes it a useful concept to find improvements.

Actual work done by a locomotive and the actual energy consumption of the locomotive are estimated using $W_{act} = \lambda \times \eta_{gear} \times \eta_{motor} \times m_{sys} \times d$ and $Q_{act} = V \times \rho \times LHV$, respectively, where λ is the specific energy consumption, η_{gear} and η_{motor} are the efficiencies of gears and motors, respectively, m_{sys} is the mass of the locomotive (including the mass of coaches estimated at an average value of 100 tonne per locomotive), d is the distance of run per year, V is the volume of fuel consumed per year, ρ is the density of fuel and LHV is the lower calorific value of fuel. Energy efficiency of the locomotive is given by W_{act} / Q_{act}. Exergy efficiency is obtained when energy efficiency is divided by the exergy grade function of the fuel, diesel in this case. In calculating the weighted mean overall exergy efficiencies, the weighting factor used is the fractional energy consumption in the given year. Data for the years 2007 to 2010 obtained from the Sri Lankan Railway were used in this study. Data collected includes the distance run by a locomotive engine per year, the volume of fuel consumed by the engine per year and the mass of the engine.

Overall exergy efficiency varies in the range of 6.8% to 28.2% for the typical specific energy consumption range of 18 to 75 W.h/ (tonne.km). Since we have assumed the gear and motor efficiencies to be high at 76% and 80%, respectively, we could safely conclude that the overall exergy efficiency of SLR is limited to 28.2% with diesel-hydraulic subsector limited at 23%, diesel-electrical subsector at 28% and power set subsector at 33.5%. Results shows that power set subsector gives the highest efficiency and diesel-hydraulic subsector gives the lowest.