## Abstract:

The need of sustainable energy source arises with the time due to the reduction of the other energy sources like diesel, petroleum etc. Tyre pyrolysis oil (TPO) is used in the industry in place of furnace and diesel oil. Application of tyre oil in place of diesel hinders due to the high level of impurities, emissions and bad odor. This study comprises of removal of these impurities and reduction in emissions by oxidative desulfurization of TPO at laboratory scale. Different treatments are conducted through the different concentrations (15%, 20% and 25%) of acid and $H_2O_2$ mixtures such as acetic acid/$H_2O_2$, formic acid/$H_2O_2$ with different mixing ratios (1:1, 1:2, and 2:1), 8%$H_2SO_4$ and 20%$HNO_3$ at varying temperature conditions (40°C, 45°C and 50°C). Emissions of crude TPO, desulfurized TPO and diesel measured by burning it into enclosed cylindrical iron container at small scale without mixing any other fuel. Gaseous emissions such as SOx, NOx, CO, $CO_2$ and $O_2$ are measured by Optima7 mru. Reduction in the emissions is observed for all treated samples that shows the effectiveness of all treatments. Values of $O_2$ not show much variation in all the treated TPO, crude TPO and diesel samples. In Acetic acid treatment maximum reduction of the SOx emission occur at 45°C. This treatment removes 99.42%, 98.71% and 91.9% of SOx, NOx and CO respectively for 1:2 with 20% conc. It is most effective treatment than all the applied treatments. In formic acid treatment maximum reduction in the emission observed at 45°C. The treatment removes the significant amount of SOx, NOx and CO (99.71%, 71.69% and 83.2% respectively) for 2:1 ratio with 25% conc. Nitric acid and sulfuric acid also reduced the SOx, NOx and CO emissions effectively. Physical parameters such as viscosity and calorific values also affected by the process of desulfurization. Viscosity of the treated samples varied significantly from 1.96cSt for nitric acid to 87.65cSt for formic acid/$H_2O_2$. Highest variation in the viscosity for formic acid treatment is due to the conversion of compounds. Calorific values of samples are insignificantly ($p>0.05$) even at the lowest emissions of SOx. The lowest value is for formic acid (2:1) that is 40.40MJ/kg and highest for nitric acid (43.40MJ/kg). Comparison between the crude TPO and diesel assess. Emissions of SOx, NOx, and CO vary significantly. Viscosity and calorific values of both fuels is not varying significantly. Reduction in the emissions prove that treatments removed the sulfur from the crude TPO effectively. So, the oxidative desulfurization of crude TPO is effective for the reduction of the sulfur content, hazardous gaseous emissions and improve fuel and air quality of the TPO to be used as diesel. Cost analysis of crude TPO shows that the use of TPO in power generation is 85% more economical than the diesel and

furnace oil. Among all the applied treatments for the desulfurization of crude TPO, sulfuric acid is more economical in case of treatment cost. Nitric acid cost 25,000-45,000Rs for the treatment of 6000-7000liter/day of crude TPO. Cost of treated TPO is economical for the treatment of sulfuric acid that cost 65.2Rs/liter. It shows that the desulfurization not only remove the impurities but also economical as well.