The conversion of bicycle/rickshaw, motorcycle, passenger car and truck tire wastes, which are found in abundance in Bangladesh as well as all over the world, into liquid fuels and chemicals by fixed-bed fire-tube heating pyrolysis technology has been taken into consideration in this study. The solid tire wastes were characterized through proximate and ultimate analysis, gross calorific values and thermogravimetric analysis to investigate their suitability as feedstock for this consideration. Pyrolysis kinetics of the selected tire wastes have been investigated thermogravimetrically under nitrogen atmosphere at heating rates of 10 and 60°C/min over a temperature range of 30-800°C. The percentage weight loss was higher for truck tire and was lower for bicycle/rickshaw tire for both heating rates. An overall rate equation for the tire wastes has been modeled satisfactorily by one simplified equation from which the kinetic parameters of unreacted materials based on Arrhenius form can be determined. The predicted rate equation was found to fit the measured TG and DTG data fairly well. DTA curves for all of the samples show that the degradation reactions are three main exotherms and one endotherm.

Two types of fluid dynamics experiments were carried out on a cold model of the fixed-bed fire-tube heating reactor: first to determine the char ejection pressure, which was conducted with the aid of an air compressor and artificial solid char while second to determine flow pattern in the reactor chamber during the ejection of solid char that was conducted by LDV measurement and flow visualization test. For complete removal of char product from the reactor, the ejection pressure should be sufficient enough to create 9% higher upward force than the weight of the char. The spiral shaped char exit port was unable to initiate a rotational flow inside the reactor during ejection of char.

Four types of tire wastes were pyrolysed in the fixed-bed fire-tube heating reactor under different pyrolysis conditions to determine the role of final
temperature, sweeping gas flow rate and feed size on the product yields and liquid product composition. The highest liquid product yield was 46-55 wt% of solid tire wastes, which was obtained at 475°C for feed size of 4 cm³ and apparent vapor residence time of 5 sec. Liquid products obtained under these conditions were characterized by physical properties, elemental analysis, FT-IR, ¹H-NMR and GC-MS techniques. The results show that it is possible to obtain liquid products that are comparable to petroleum fuels and valuable chemical feedstock from the selected tire wastes if the pyrolysis conditions are chosen accordingly.

A preliminary investigation was carried out on a DI diesel engine with the pyrolysis oil-diesel blends and neat diesel fuels. The results support the statement “the pyrolytic liquids may be a potential alternative for diesel fuel” after treatment.

A study was conducted to develop a comparative techno-economic assessment of three different-scale plants of capacity 18 kg/day, 2.4 ton/day and 24 ton/day of tire waste feed converted to crude pyrolysis oils. For the large-scale plants, the capital cost, the feedstock cost and the operating labor cost were found to be the major cost items influencing the Unit Production Costs. The greater the plant capacity the lower was the Unit Production Cost.