学位論文内容の要旨

The conversion of available bicylce/rickshaw, motorcycle, passenger car and truck tire wastes, which are found in aboundant 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 the present 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 rate of 10 and 60 ℃/min over a temperature range of 30-800 ℃. The percentage of total weight loss was higher for truck tire and was lower for bicycle/rickshaw tire wastes. An overall rate equation for the tire wastes has been modeled satifactorily by one simplified equation from which the kinetic parameters of unreacted materials based on Arrhenius form can be determined. The predicted rate equation compare fairly well with the measured TG and DTGdata. 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 have been 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 form 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 is unbable to initiate a rotational flow inside the reactor during ejection of char.

The four type of tire wastes were pyrolysed in a 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 46-55wt% of solid tire wastes, which was obtained at 475 ℃ for feed size of 4cm ^{3} and apparent vapor residence time of 5 sec. Liquid products obtained under those conditions were characterized by physical properties, elemental analysis, FT-IR, ^{1}H-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 has been carried out on a DI diesel engine with the pyrolysis oil-diesel blends and neat diesel. The results supports the statement "the pyrolytic liquid may be a potential alternative for diesel fuel" after treatment.

論文審査結果の要旨

本研究は、世界中でふんだんに有る自転車、人力車、バイク、乗用車およびトラックの廃タイヤを、固定床加熱管熱処理によって液体燃料や有用化学物質へ変換する試みである。

廃タイヤの熱処理は窒素を雰囲気ガスとして、３０度Cから８００度Cの範囲を１０度C／分および６０度C／分の熱上昇率で変化させた熱重量測定によって調べた。 重量の減少割合はトラック廃タイヤで大きく、自転車や人力車の廃タイヤで低いことが分かった。 未反応物質の挙動因子を決定できる簡便な式によって、タイヤ廃材の総体比率の式をモデル化し、熱重量解析および差分熱重量解析のデータと良く一致する結果を得た。 液体成分の最大生成率は供給廃タイヤ重量の４６～５５％であり、４７５度C、供給タイヤ廃材サイズ４ｃｍ^3、見かけの

気相残留時間５秒の条件において達成された。　これらの条件下で得られた液体生成物は、物性解析、要素解析、FT-IR、^{1}H－NMR　とGC-MS技術によってその特性と組成が明らかにされた。

また、エアーコンプレッサーと模擬固形炭化物を用いた固形炭化物の排出圧力を知るためと、レーザー流速計による反応炉内の流れを知るための二種類の流体工学的実験を低温模型において行った結果、固形炭化物の重量よりも９％以上大きな上昇力を固形炭化物に与える圧力の供給が必要であることが分かった。

本研究で得られた結果は、熱処理条件を適切に設定することによって廃タイヤから、化石燃料と遜色のない液体生成物や有用な化学供給原料を得ることが可能であることを示すものであり、申請者は北見工業大学博士（工学）の学位を授与される資格が有るものと認められる。