Presentation by: **Fergus Melligan**
Title: **Review of biomass pyrolysis oil properties and upgrading research**

Abstract

Over the past few years a great deal of interest has being placed on biomass as an alternative fuel source. A very promising area of converting biomass into energy is thermo-chemical conversion, more particularly pyrolysis. Under some conditions we can say that the major advantages of biomass as a fuel is that it is carbon neutral and contains very little sulphur and nitrogen and thus contribute very little to the greenhouse effect and global warming. Pyrolysis is carried out within a temperature range of 300-600^{o}C, in the absence of oxygen, typically in a nitrogen atmosphere. Biomass pyrolysis results in the production of three products: gas, bio-oil and bio-char. The relative proportion of these products depends very much on the pyrolysis method, the characteristics of the biomass and the reaction parameters. Conventional carbonization or slow pyrolysis has slow heating rates and long vapor residence time and is used to maximize char yields at around 35-40% together with around 30% liquid. Fast pyrolysis uses high heating rate and short, hot vapor residence time, this maximizes the liquid production to around 75%. For this research the emphasis is on producing liquid fuel and therefore fast pyrolysis is of more interest.

The liquid produced from pyrolysis is more commonly known as bio-oil. Bio-oil is not a product of thermodynamic equilibrium during pyrolysis but is produced with very short residence time and rapidly cooling and quenching the reaction. Bio-oils are very complex mixtures of organic compounds of different size molecules from depolymerisation fragmentation of cellulose, hemicelluloses and lignin, resulting in the formation of an excess of 50 different compounds, which can be identified using GC/MS. These compounds include carboxylic acids, ketones, phenols, aldehydes, alcohols and esters. Bio-oils differ greatly from petroleum based fuels and as a result present some difficulties if they are to be used as a replacement for petroleum fuels. The major issues to be tackled are the high water content, the high oxygen content and high viscosity. Depending on the pyrloysis conditions the crude bio-oil can contain up to 30% water, (diesel has a water content of 0.05% [3]) 35-40% oxygen and has a viscosity of about 13.2(@40^{o}C in CsT), (diesel viscosity is 4.5 @40^{o}C in CsT). Some methods used for upgrading the properties of bio-oil which have recently been developed, include techniques such as hydrodeoxygenation, catalytic cracking of pyrolysis vapour, emulsification and esterification.

The techniques which have been used to analyse the bio-oil are GC/MS, thermogravamitric analysis, FTIR, Karl Fischer titration, bomb calorimeter, elemental analysis, viscometer.

About The Presenter

Fergus holds an honours degree in Industrial Chemistry from the University of Limerick and is currently pursuing a PhD in the University. His supervisors are Prof Michael Hayes, Dr JJ Leahy and Dr Witold Kwapinski.

His PhD work involves studies of pyrolysis and second generation biorefining for the processing of carbohydrate waste materials and lignocellulose biomass to produce bio-oil. Another useful product which he investigates is the residual bio-char which has value in soil amendment.

He will also investigate the most efficient procedures (time, temperature and pressure) for the bio-refining process of wastes and biomass. An analysis of the products formed as the parameters are varied will lead to an awareness of the transformation mechanisms involved.

DATE: **27th Nov 09**
TIME: **10- 11am**
VENUE: **POD meeting room FG 028**