Up-draft gasification of poultry litter

N.C. Taupe[1], D. Lynch[1], R. Wnetrzak[1], F. O'Grady[1], W. Kwapinski[1], J.J. Leahy[1*]

[1] Department of Chemical and Environmental Science, University of Limerick, Limerick, Ireland

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Intensive livestock production results in a surplus of manure, which can accumulate and lead to environmental pollution. This has engendered support for changes to waste management practices. As the application of manure to land is restricted by legislation, treatment of the waste has gained increasing attention. Thermal treatment technologies, such as gasification and pyrolysis, yield a low to medium calorific value gas, and reduce the animal waste for disposal. Poultry litter is rich in inorganic nutrients, which remain in the char and increase its fertilising value. Furthermore, its low moisture content eliminates pre-treatment requirements, making it a uniquely suitable feedstock. Significant advances have been made in pyrolysis, gasification and combustion studies; however, field studies related to modelling are required to gain better comprehension of poultry litters behaviour during the process. Poultry litter can vary significantly depending on its origin and management practices of the farm. Biomass properties are important in thermal conversion processes, especially moisture content, calorific value, fixed carbon, volatile and ash content.

A pilot scale study was performed using an up-draft fixed-bed gasifier with an approximate 28-30 KWth capacity. The gasifier operated under atmospheric pressure using air as the oxidising agent. During the test period, samples of feedstock, gas, oil and char were collected for further analysis. Mass and energy balances were determined on site. The gas, oil and char yield was 44 wt %, 33 wt % and 23 wt % respectively. The product gas consisted of CO (13 %), CO_2 (21 %), H_2 (8.4 %), CH_4 (1.0 %) and C_2H_6 (17 %) with a higher heating value (HHV) of 12 MJ m^{-3} by calculation. This high value is attributed to the high amount of ethane found in the analysed gas samples. The moisture content of the oil samples was between 79.7 wt % and 94.0 wt %, which is relatively poor and will require post treatment and upgrading. The oil contained nitrogen at an amount of 3 wt %. The residual char had a HHV of 14.26 MJ kg^{-1} compared to the initial feedstock of 16.12 MJ kg^{-1}. The high ash content in the char has shown to enhance plant growth, increasing yields of lettuce (*lactuca sativa*) by a factor of 27 compared to the control (no amendment). The gasification char was compared with chars from various manures produced under slow pyrolysis on a laboratory scale. The HHV increased with decreasing ash content in the chars. In conclusion, the gasification unit is robust and suitable for on-farm use. The gasifier operated for several hours with consistent reaction temperatures and gas quality.

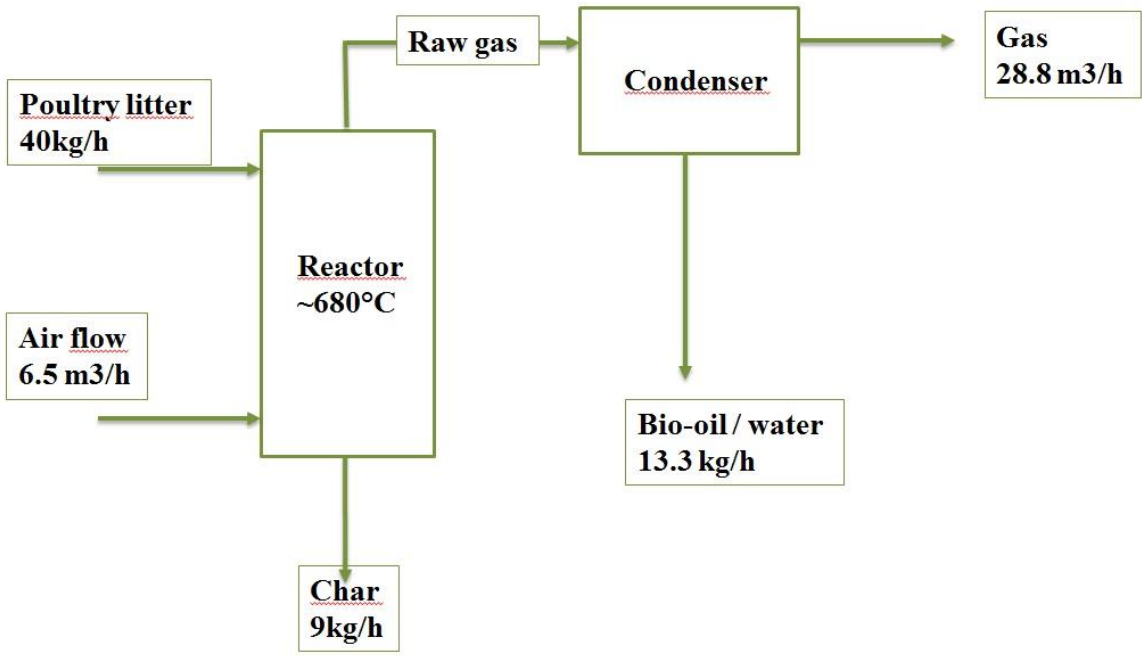

Figure 1: Schematic diagram of the on farm up-draft gasifier