NEW CATALYSTS FOR THE FLUID BED CATALYTIC GASIFICATION OF BIOMASS

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ABSTRACT

Various kinds of catalysts are being developed and tested for the pyrolytic gasification of biomass using the Waterloo Fast Pyrolysis Process (WFPP) technology.

The present report describes gasification tests with wood but with no added air or oxygen in the region of 600°C to 650°C and at short gas contact times, using catalysts of variable compositions. The objective was to determine the most appropriate operating conditions for the production of a synthesis gas in high yields.

Experiments were carried out with different catalysts in an inert gasification media. The results show the influence of the catalyst composition on the nature of the gasification products and on catalyst regeneration, as well as on the mechanical strength and the physical structure of the catalyst.

Gas compositions are given for typical WFPP operating conditions. Evidence is presented which indicates that the gasification mechanism is a fast thermal pyrolysis followed by catalytic reforming of the vapours with a high yield of synthesis gas.

INTRODUCTION

Gasification of biomass has been extensively studied and a voluminous journal and patent literature exist. Among the many excellent reviews available, two recent publications may be mentioned as useful references, by Bridgewater and Double [1] and by Beenackers and Bridgewater [2]. In the great majority
of gasification studies air, oxygen, steam or mixtures of these three have been used as gasifying media. In most developments, no catalysts have been employed. Only in more recent years have reports appeared concerning the effects of catalysts in various biomass gasification schemes. Extensive studies by workers at Battelle have been described by Mudge et al. [3] and the catalytic methanation of wood with carbon conversions to methane of over 80% has been described by Garg et al. [4], to give only two recent examples.

There are two advantages apparent in the use of catalysts for the gasification of biomass. First, the gasification reactions can be made to occur at much lower temperatures resulting in energy economies as well as the possibility of altering product compositions because of equilibrium relationships. Second, the catalyst, because of the greater reaction rates possible, may give a gas product more nearly at equilibrium yields, and thus allow more accurate predictions of product composition to be made.

In some early tests with nickel-alumina catalysts, we had observed that even in an inert gas atmosphere (nitrogen), high gas yields could be obtained in the surprisingly low temperature range of 500° to 650°C. It is also an interesting fact that the hydrogen which could be produced from a biomass gasification plant of feasible size, say 1000 tonnes/day, would be adequate for the hydrocracking or hydrotreating of about 15000 to 30000 bbls/day of heavy petroleum refinery residue, tar sand stripped bitumen, or other heavy crudes or residues. This would appear to be one of the few instances in the energy field in which the feasible scale of operation of a biomass conversion plant can be matched to an economical operating level for a petroleum process.

For these reasons, it was decided to undertake more extensive investigations of catalytic gasification of biomass with the objective of producing maximum yields of synthesis gas components, that is, carbon monoxide and hydrogen, while at the same time not employing any auxiliary oxygen or steam production facilities, and not diluting the gas product with inerts. The present report describes a part of this study in which new catalysts were evaluated.