BIOMASS WOODCHIP TRACKING BY IMAGE ANALYSIS IN A MODEL OF A FIXED BED COMBUSTOR

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EXTENDED ABSTRACT

Recently, an increasing interest has been devoted to external combustion cycles (e.g. supercritical CO2 Brayton cycles) due to the opportunity to use low quality fuels. Among these, the use of biomass is of particular relevance for its low environmental impact. On the other hand, the combustion of biomass has several critical aspects that might hamper the efficiency of the process, especially in case of solid biomass (woodchip). A detailed experimental analysis of biomass woodchips behavior inside the combustion bed can provide useful information on fuel distribution, combustor loading pattern, fuel segregation and stacking. Unfortunately, a detailed experimental analysis is quite hard to perform due to the harsh environment, the difficulty in setting up a well scaled model of the device (both as geometrical and power sizes) and an efficient particle tracking method. Regarding this last issue, in this study, an optical tracking method to provide information on the main pattern of motion of the fuel inside of a model of biomass fixed bed combustion system is proposed.

Tests were performed without combustion, by inserting the woodchips in the bed through a charging screw. A portion of the fuel has been colored according to its size with negligible modification of the particles mass and dimensions. A digital camera, placed above the bed, was used to constantly capture pictures of the bed surface. The position of the screw during its revolution was correlated to the acquired images. A Matlab tool was developed to detect the movement of the particles on the top of the fuel bed over time (theoretically exposed directly to the flame) by distinguishing the path according to the particle sizes.

The motion of the particles was detected by using a specifically developed procedure which operates in four steps:

1) Image resizing to avoid perspective deformation or orientation variations (a set of reference pins was installed on the test bed and used to have all the images with the same orientation and size)
2) Identification of the particle size by detecting their color
3) Sseparation of the images in sub images according to particle size
4) Detection of particle position and definition of particle centers
5) Calculation of particle motion by comparing the particle center position in subsequent images

The procedure, allowed the detection of the particles preferential pattern as a function of their size and the bed parameters. The results were particularly useful to understand potential inefficiencies of the combustion system due to an uneven woodchips distribution. In addition, the results achieved with the proposed test rig and the adopted methodology can also be used to validate results from Discrete Element Modelling (DEM) simulations.

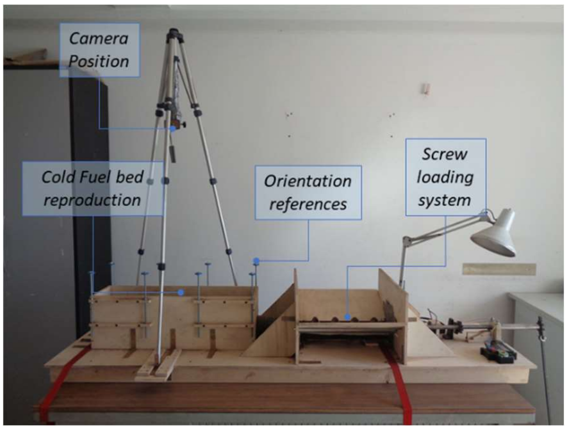

Figure 1. Fuel bed and fuel supply reproduction

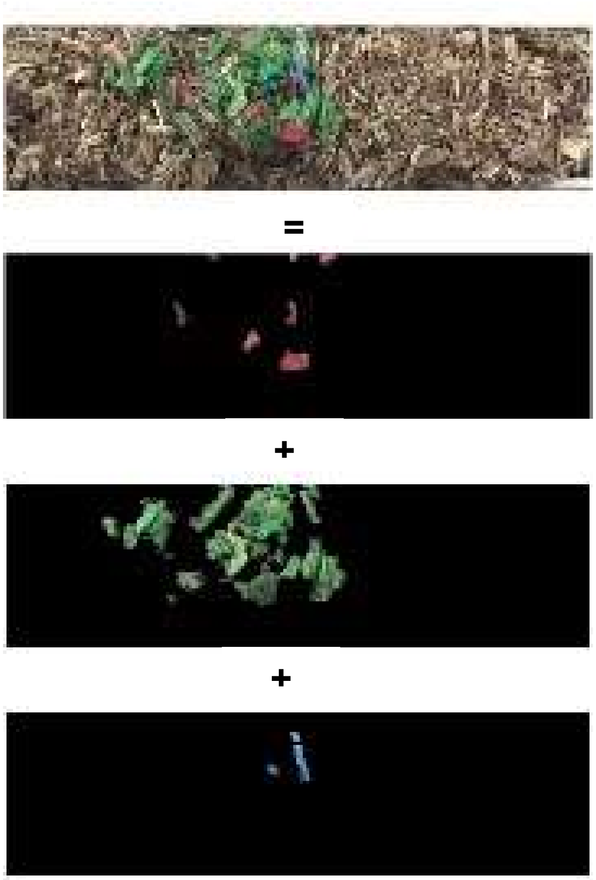

Figure 2. Detection of particle position **Figure 3. Detection of particle size and position**

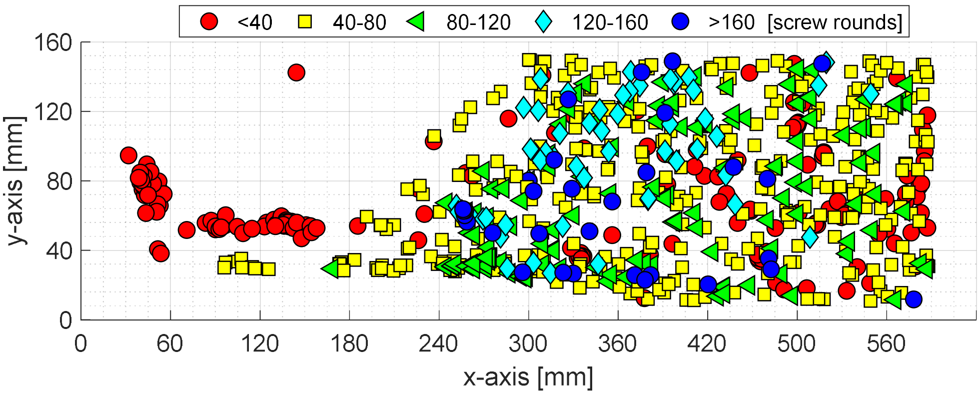

Figure 4. Distribution of particles as a function of the screw rounds (particles with the biggest size)