SUGARCANE BAGASSE PARTICLES SIZE USED IN ENZYMATIC HYDROLYSIS IN THE LITERATURE AND OBTAINED BY A PNEUMATIC CLASSIFYING EQUIPMENT

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Introduction

The main objective of the physical pretreatment of the biomass is to reduce the particle size so as to increase the surface contact area and obtain a homogeneous material ideal to use in several energy conversion processes. Some operations often used for this purpose are milling, grinding and chipping or a combination of these.

The increase of contact surface area and homogenization of the material allow obtaining, for example, higher yield of hydrolysis, varying with the biomass type, hydrolysis type and duration of operation.

However, the main barrier to using these types of pretreatment on a large scale is related to continuing operation and the high energy expended, as the price of energy increases continuously, this process still ends up being economically unfeasible.

In this context it was developed new equipment that permits a continuous separation of sugarcane bagasse fractions with different particles size, which can decrease the energy consumption. Basically the operate principle of the pneumatic classifier is based on solid particles fluidization, elutriation and pneumatic transport within an air column. The fine particles are dragged and collected in a cyclone at the top of the equipment, the medium particles circulating in the column are collected through an opening next to the middle of this and the coarse particles, heavy enough to not be either dragged or put into lifting, fall by gravity action into an opening at the bottom of the air column.

Thus, the scope of this paper is to compare the particle size reduction pretreatment used in enzymatic hydrolysis experiments available in the literature with particles size obtained by pneumatic classifier.

Results and conclusions

Aiming assessment how the researchers are conducting physical pretreatments to study enzymatic hydrolysis was carried out a search on SCOPUS basis with the listed sequence of key words: ((TITLE-ABS-KEY(hydrolysis) AND TITLE-ABS-KEY(sugarcane) AND TITLE-ABS-KEY(bagasse))) AND ((ethanol)) AND (enzyme).

This search was performed on 16/08/2010 and resulted in 98 articles writen since 1985 to 2010, they were organized considering particle size of sugarcane bagasse to enzymatic hydrolysis.

Organizing the articles by particle size of sugarcane bagasse the first finding was that only forty five from ninety eight articles had the caution to describe the particle size of sugarcane samples used in experiments. This is an important observation since it

shows some researchers don't are worried with basic characteristics of biomass which could influence on hydrolysis yields.
Focusing only on articles that informed the particle size of sugarcane bagasse it was observed:

- Ten used particle size smaller or equal than 0.50 mm;
- Fourteen used particle size bigger than 0.50mm and smaller or equal than 1.00mm;
- Eleven used particle size bigger than 1.00mm and smaller or equal than 2.00mm;
- Ten used particle size bigger than 2.00mm;

The data evaluation allows concluding a remarkable standard absent and it represents a difficulty to assess different pretreatment methods. Refining the search was observed from forty five articles, which described particle size of sugarcane bagasse, twenty seven of them studied enzymatic hydrolysis, the others investigated either pretreatment methods or other subjects like acid hydrolysis, xylanase production etc.
From these twenty seven articles, nineteen carried out particles size reduction and the other eight performed sieving of sugarcane bagasse samples before experiments. These nineteen articles performed particle size reduction by milling but only seven described in details the used equipments.
This lack of information difficults not only the reproducibility of the experiments by other researchers but also the results comparison.
From eight articles that performed sieving the particle size distribution were:

- Three used particle size whose values range between 0.14 to 0.25mm;
- Three used particle size whose values range between 0.45 to 0.90mm;
- Two used particle size whose values range between 2.20 to 10.00mm;

One final observation is that fourteen articles from twenty seven informed the equilibrium moisture content of sugarcane bagasse used in experiments, varying from 5 to 10% (w.b.) according to the environmental conditions.
Experiments conducted in the pneumatic classifier with sugarcane bagasse dried at equilibrium moisture content, range from 7% to 10% (w.b.), with feed of 18.76kg sugarcane bagasse / h and column air flow of 88m^3/h showed the following results:

- Fine Fraction: particle mean diameter range from 0.52 to 0.54mm, consisting at about 25% to 26% of total bagasse classified;
- Medium Fraction: particle mean diameter range from 0.77 to 0.81mm, consisting at about 6% to 7% of total bagasse classified;
- Coarse Fraction: particle mean diameter range from 3.80 to 4.25mm, consisting at about 68% to 69% of total bagasse classified;

From the articles in which particle size reduction was performed and the particle size range was described, 77% used the particles size in the range correspondent to the fine and medium fractions, that is, around 30% of the classified sugarcane bagasse. Nevertheless, this result was reached without the need of milling, grinding or chipping, which are energo-intensive operations.
It is important to remark that varying the solids feed and air flow in the column bigger or smaller proportions of the classified fractions can be obtained, also occurring more or less variation in the average particles diameter. It is possible to adjust the operation conditions in order to achieve sugarcane bagasse with the desired characteristics.
We conclude that is almost impossible to compare yields obtained from enzymatic hydrolysis experiments with respect to particle size because there isn't a standard.

The literature review pointed out the importance to use small particles size in experiments but none of the reviewed articles determined the particle size range to reach the better hydrolysis yields.
This way it would be interesting further research in order to find the best particle size range for enzymatic hydrolysis of sugarcane bagasse, such range is dependent on the other pretreatments used prior the hydrolysis itself. The pneumatic classifier which works continuously and consumes low energy appears as a new alternative to achieve this goal.

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