Energetic study of the forced drying of residual lignocellulosic biomass: corn residues

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Lignocellulosic biomass using for energy production must fulfil a condition: low costs in the production, in the compilation, in the storage and in the previous processing to the transformation in easily usable fuel. If we take into account this condition can be intuited that a high moisture content in the corn residues create a lot of problems like the increasing on the transport expenses, the difficulty of the transformation into quality fuel and the reduction of the yields in processes of thermochemistry conversion since the maximum calorific value which biomass can provide is when it has a void moisture content.

Lignocellulosic biomass usually presents a moisture content around of 50%, the intervals accepted for its utilization at thermochemistry conversion are between 20% and 5%. To the forced drying of the lignocellulosic biomass, the most used drying rooms are: the rotary drum drying, the pneumatic drying or fluid bed drying. The drying temperatures experienced in this type of drying rooms are from 90º C until 165º C and the speeds of the drying air vary between 1,50 to 2,50 $m \cdot s^{-1}$ [1].

It is used a prototype laboratory of the drying room for the trials, of own manufacture, this drying room is called the trays drying room. The air of drying is put from the back of the drying room driven on by a motor trough a tube of 0,11x0,11 m^2 of section and 2,50 m of length. To the automation and to the acquisition data of the trials the following equipments have been installed: a variable speed controller, an electric power analyzer, a data acquisition system and a load cells.

At the entrance and the exit of the drying room the following parameters have been measured:
1. Air parameters measured at the entrance.
Speed of the air at the entrance: V ($m \cdot s^{-1}$).
Specific moisture at dry base of the air at the entrance: Hge (g water $\cdot g^{-1}$ dry air).
Temperature of the air at the entrance: Tge (ºC).
2. Air parameters measured at the exit[1].
Specific moisture at dry base of the air at the exit: Hgs (g water $\cdot g^{-1}$ dry air).
Temperature of the air at the exit: Tgs (ºC).
3. Solid parameters measured at the entrance.
Wet weight at the entrance: She (wet solid g).
Moisture at wet base of the solid at the entrance: H'se (g water $\cdot g^{-1}$ wet solid).
Temperature of the solid at the entrance: Tse (ºC).
4. Solid parameters measured at the exit.
Wet weight at the exit: Shs (g wet solid).
Moisture at wet base of the solid at the exit: H'ss (g water $\cdot g^{-1}$ wet solid).
Temperature of the solid at the exit: Tss (ºC).

All this is made for a determinate "time of dried" (residence time for the material to dry inside of the drying room): t (h). Matter and energy balances were elaborated for each of the trials:

If we compare furnished energy during the dried with the increment of the calorific value of the residues because of the reduction of the moisture content, that is to say: it is established the relationship increment/ energy furnished, in the trials called "satisfactory" the increment of the calorific value, because of the

[1] The air mass at the exit is the same as the air mass at the entrance of the drying room.

reduction of the moisture content is greater than the energy furnished to reduce that moisture, that is to say the relationship increment/ energy furnished (cal · g^{-1} incremented/ cal · g^{-1} furnished) is greater than 1. It can be observed in Table 1 that the averages of the relationship Increment/ energy furnished for each one of the variation factors of the drying room. They are greater than 1 for V3, T3 and t3.

Table 1. Relationship between the increment of gross calorific value and energy furnished for each one of the variation factors of the drying room.

Conditions of dried			Relationship increment/ energy furnished (cal · g^{-1} incremented/ cal · g^{-1} furnished)
Speed of the air (V) (m · s^{-1})	V1	0,85	0,58
	V2	0,60	0,87
	V3	0,35	1,32
Temperature of the air (T) (ºC)	T1	50	0,84
	T2	45	0,93
	T3	40	1,00
residence time (t) (h)	t1	0,75	0,59
	t2	0,50	0,86
	t3	0,25	1,32

On the other hand the expression that provides the gross calorific value for the corn residues is [2] (Ec. 1):

$$PCS(H') \ (cal \cdot g^{-1}) = 4293{,}98 - 42{,}94 \cdot H'(\%) \qquad \text{(Ec 1)}$$

According to this expression, for each reduced point of moisture, the calorific value is incremented in 42,94 cal · g^{-1}, therefore the energy furnished in the dried will not have to be greater than this value, that is to say, by each reduced point of moisture needn't be consumed more than 49,79 Wh · kg^{-1}. Thus within the trials called "satisfactory" the maximum energy furnished by each point of moisture reduced and kg of dry weight introduced in the drying room is always smaller to 49,79 Wh · kg^{-1} .

Conclusions

1. We have to get the energy furnished by each reduced point of moisture will be less than 49,76 Wh by each kg of dry weight introduced in the drying room for the corn remains drying can be energetic profitable.
2. It is possible to obtain satisfactory energy results using a trays drying room.
3. Conditions of drying which produced better relationship increment/ energy furnished were: the low speeds of the air of dried (0,35 m · s^{-1}), the low temperatures (40 ºC) and the short periods of time (15 minutes).

References

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