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BIOMASS CONVEYOR BELTS IN MICROWAVE FIELD

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Abstract: *An important component in the use of biomass is the transport system, as part of the machinery or equipment specific to a certain type of processing. Thus, a transport system is a mechanical system used to move materials from one place to another and is found in most processing and production industries, such as the chemical, mechanical, auto, mineral, pharmaceutical, electronic, etc. The paper presents a solution developed by INOE 2000 - IHP in partnership with a production company S.C LAMBDA MAT Bucharest.*

Keywords*: Biomass, transportation system, microwave*

1. Introduction

Biomass, the main fuel in rural area, can be used for heating livable spaces, water and for cooking. The maximum exploitation potential of the biomass implies the total use of the residues from the logging, the sawdust and other wood residues, the agricultural waste resulting from cereals or maize stalks, the vegetal residues of the vine as well as the urban waste and household residues.

From the point of view of the resources at least, bioenergy can make a decisive contribution due to the significant unexplored potential, coming from the available surface of agricultural area that Romania have. During the consultations that took place within the G2G European project, the Romanian experts in biomass energy agreed that biomass will make a major contribution to achieving the objectives set by the European Directive. A compromise must be made between the market potential and political objectives, which is in fact the role of strategic documents, such as the Biomass Action Plan. There are been made estimates regarding the other renewable sources of energy outside the biomass, the values ` being close to those presented in the PNAER.

The use of biomass has a great benefit for the atmosphere, which leads to a favorable balance of CO2, because the organic matter is able to retain more CO2 than that released by its combustion. Biomass can be obtained in a sustainable and renewable way, where the consumption speeds of these residues are not faster than their production speeds, giving a favorable balance for CO2 [3].

An important component in the use of biomass production is the transportation system, as part of the specific machinery or equipment to a certain type of processing. Thus, a transport system is a mechanical system used to move the materials from one place to another, and is found in most processing and production industries, such as the chemical, mechanical, auto, mineral, pharmaceutical, electronic, etc.

2. 2. Types of transporters used in the biomass transport system

The transport of biomass, as in any field, is a very an important activity, being sometimes determinant for establishing the speed of a technological process. This ensures the mechanization for lifting and transportation operations in the individual production, from small series to mass production, between the different machines and installations that make up the technological lines, automated lines or flexible processing systems [4].

Continuous transport equipment according to their construction characteristics include conveyors, which ensure a continuous flow of individual or bulk loads.

The conveyors, depending on the construction, are divided into two large groups:

● conveyors with flexible traction member: - conveyors with belt;

● conveyors without flexible traction member: - oscillating conveyors;

Conveyor belts

The lifting and transporting machines are made up of components of general use such as components of assembly, transmission of movement, bearings, couplings, etc.

The construction of conveyor belts is basically the same, even if the flexible traction component is a rubber band with textile, steel or wire mesh inserts. The main parts of a belt conveyor are shown in Fig. 1

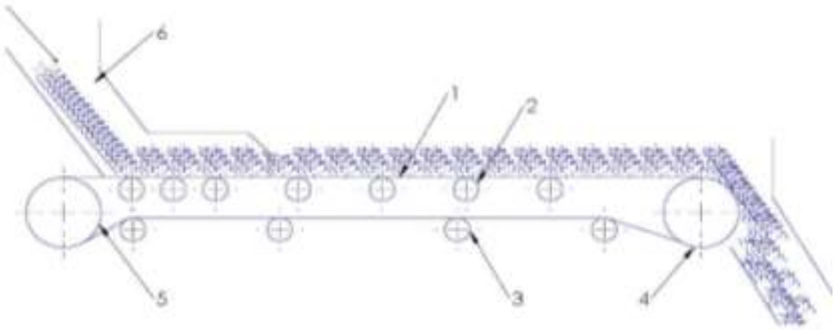

Fig. 1. Belt conveyor: 1- conveyor belt; 2- upper support rollers; 3- lower support rollers; 4- reel drive; 5- tensioning drum; 6- charging device; 7 device unloading.

Depending on the working conditions, the conveyor belts can also be provided with different devices for cleaning the belt surface, weighing, braking or blocking, etc.

The conveyor may be horizontal, or it may also be inclined over the entire length or portion of it.

From the point of view of the use of the belt, the conveyors can be:

► with flat surface, when used for the transport of individual loads (Fig. 2.a);

► with gutter-shaped tape, the surface being bent only on the loaded branch, in which case more material is transported than to the flat tape and usually loose material (Fig. 2.b).

The support components ensure the support of the conveyer belts on both sides, load branch and the return branch. The conveyer surface may be supported on boards, rollers or combinations of roller boards, but due to the frictional heating with the panels, the rollers are most commonly used in the construction of conveyors.

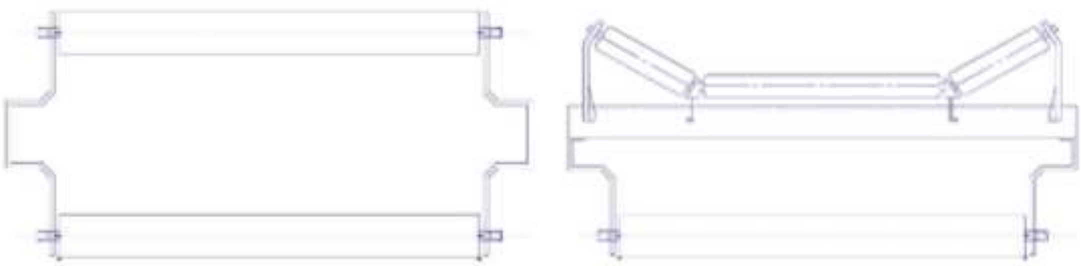

Fig. 2. Conveyor: a- with flat surface; b- with gutter-shape surface

Conveyor belts must meet specific requirements such as:

- high tensile strength in order to assure the traction force;
- sufficient elasticity to be able to withstand a large number of bends, when passing over rollers;
- not to lengthen much during operation;
- be resistant to abrasion from the material and to moisture, possibly weathering;
- to resist the chemical action of foodstuffs;
- be easy to repair and repair in case of breakage.

3. Conveyor belt in microwave field

When using the microwave as a biomass drying system, the selection of the material for fabrication the conveyor belt must also take into account the properties of the material in contact with the microwave. In this case, the selection of a plastic material that not influence the microwave field favors the life exploitation, the thermal influence being caused only by the contribution of the material (biomass) that will be heated under the action of the microwave.

Microwave heating is related to the polarization effect in the material with dielectric load, exposed to high frequency electromagnetic energy through waveguides. As a result of polarization, the electromagnetic waves are refracted and attenuated in dielectric material.

During microwave penetration into the resonant cavity, the electromagnetic waves undergo attenuation inside the microwave exposed material. If an electromagnetic wave of a certain density power reaches the surface of the dielectric (P_{in}), part of its density is reflected (P_{out}), while another part is absorbed by the dielectric material (P_{abs}).

The depth of penetration (Dp) in the material is an important parameter in the design of the heating systems in the radio frequency field because it gives information about the heat distribution in the material subjected to the heating. This parameter is defined as the depth material at which the power flow decreases to 1 / e (= 0.368) relative to the surface value and is described by the expression:

$$D_p = \frac{\lambda_0}{2\pi\sqrt{2\varepsilon'}} * \frac{1}{\sqrt{\{1+\left(\frac{\varepsilon''}{\varepsilon'}\right)^2\}^{0.5}-1}}$$

In the case of ε '' ≤ ε ', the above equation is simplified in the form equation leading to values with an error of up to 10%:

$$D_p \approx \frac{\lambda_0\sqrt{\varepsilon'}}{2\pi\varepsilon''}$$

In the case of a semi-infinite layer of ideal material (e.g. having constant temperature values of the parameters ε 'and ε' ') on which a plane wave acts at the normal incidence, the temperature increase in the material with the depth follows an exponential function. In Fig. 3 the temperature variation with the depth of penetration into the material is represented graphically.

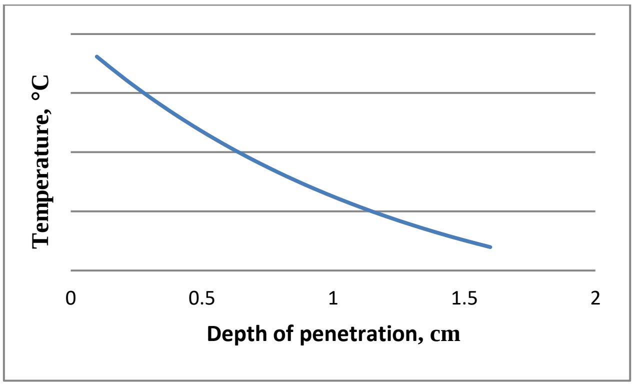

Fig. 3. Temperature variation with the depth of penetration into the material

An approximation of the heat distribution in a thin plate, heated consecutively on each face, can be made by overlapping two such exponential distributions having the origins in the two surfaces. It should be mentioned that the existence of this parameter does not limit the mass heating of the material beyond the penetration depth. The effect of the penetration depth is based on the dielectric loss factor ε '', which causes the power dissipation. As a result of this power dissipation, the density of the power flow decreases as the wave propagates into the material. It is interesting to note that, at a constant value of the loss factor ε '', the penetration depth increases with the relative permittivity ε '. This behavior is due to the fact that, as ε 'increases, the characteristic impedance Z0 of the medium decreases (as 1 / √ε'), therefore the stress of the electric field. They also decrease where the density of the power flow remains constant. Since the power dissipated on the volume unit is proportional to Ei^2, and it will decrease, therefore less energy will be taken from the wave as it advances in the material, the depth of penetration being thus greater [8].

It should be noted that the relative dielectric permittivity of a material is not constant, as it varies depending on the electrical parameters and the frequency of the electromagnetic wave. In addition, it is affected by the temperature, the degree of packaging, the humidity and the conductivity of the materials [1].

In the case of Teflon, for the relative electrical permittivity of 2.10 at 22ºC, the depth of field penetration at a frequency of 3 GHz is 146.44 m. For the frequency of 2.45 GHz, the depth of penetration at 20ºC is 32.56 m.

In addition, the maximum operating temperature of the Teflon being 260ºC, it recommends it as a material that can be used under the conditions of the drying process of the biomass for which the maximum working temperature can reach 150ºC.

4. The main technical parameters for the transportable installations

They are:
1. Productivity, expresses the quantity of material transported in the unit of time and is given by the relation:

$$Q = 3.6 \cdot q \cdot v, \text{ in t / h}$$

wherein q is the linear load, in kg / m; speed of material advancement, in m / s.
In the calculations a productivity will be taken that depends on the degree of unevenness:
Q calculation = average Q ·k
where k is the coefficient of nonuniformity, (k = 1,1….1,25).
2. The granulation of the spilled material is determined by means of the diagrams and depends on its nature.

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3. The volumetric weight, represents the weight of the material spilled from a unit volume and is expressed in kN / m3.
4. The angle of the natural slope, at rest or in motion of the material, represents the angle between the generator of the cone of spilled material, which is deposited freely on a horizontal flat surface and that surface. This angle is equal to the interior friction angle of the material and depends on the nature of the bulk material [5].

Conveyor belt testing

The main conditions that the conveyor belts must meet are the following:
• high longitudinal resistance to breaking;
• both longitudinal (when winding on the drums) and transversal (to take the shape of the gutter) flexibility;
• limited cross stiffness so as not to open too much between two roller supports;
• puncture resistance (for sharpened wood type);
• high wear resistance given by the material being transported;
• reduced hygroscopicity;
• maximum stability at temperature increases;
• anti-flammability;
• not to charge electrostatically.

The characteristics of the conveyor belts regarding the fireproof are also very important. The material handling systems are often the most important component of a modern complex machine, knowing that without efficient transportation, production can be severely affected. The conveyor efficiency depends largely on the working conditions, the life of the belt itself, but the conditions under which it must operate can be extremely difficult, given the resistance, impact, abrasion, bacteria, water, fire and general mechanics damages. When constructing a conveyor belt, we must assume that the conveyor belt used is not a fire generator and should not help on propagate the fire.
The sawdust deposited on different installations can ignite from sparks generated from friction, welding or cutting with flame and incandescent burn. One solution to reduce the impact of fire is to use PVC coating on the conveyor belt.
Figure 4 shows the conveyor belt that was designed within the POC project "Eco-innovative technologies for the recovery of biomass waste - ECOVALDES" together with the beneficiary company S.C. LAMBDA MAT Bucharest.

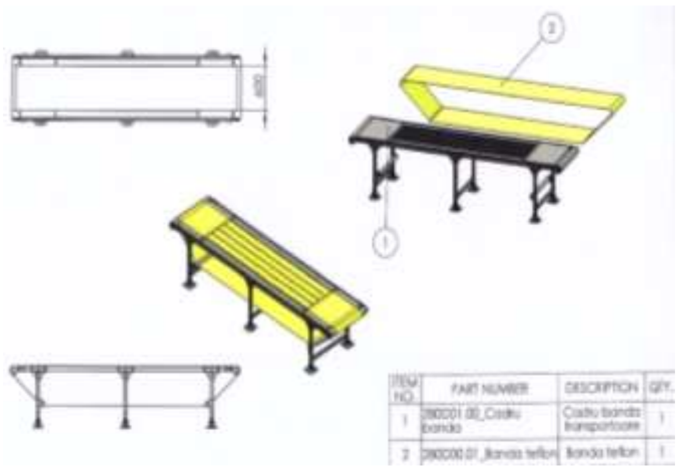

Fig. 4. The conveyor belt

Equipment components:

• Rubber band
• Conveyor belt drive motor (direct drive or drive belts)
• Turning drum - rubber
• Rollers with inclination of approximately 20 degrees
• Metal frame for rubber band - with wheels for transport
• Reception bunker
• Rubber band alignment rollers
• Transport bar
• Electrical installation

Once completed the design of the conveyor belt the partner company in the project will proceed to the physical realization of the equipment, in the next stage of the project.

5. Conclusions

Information regarding the operational conveyors that can be used within the biomass drying equipment under the action of microwaves was reviewed.
In this regard, the main technical parameters as well as the characteristics of the transported materials were scored.
Between those conveyors, the conveyor belt is an equipment that can be used in the microwave field, in the conditions of the selected material is for the belt that corresponds to the requirements of the process.
In order to select the material for the conveyor belt, in addition to the general conditions, it must meet the condition of transparency in the microwave field at the frequency of 2.45GHz. A suitable candidate is the Teflon material which, at the frequency of 2.45 GHz, the penetration depth at 20ºC is 32.56 m.

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