ISSN 1454 - 8003
Proceedings of 2018 International Conference on Hydraulics and Pneumatics - HERVEX
November 7-9, Băile Govora, Romania

ANALYSIS OF THE FUNCTIONAL SOLUTION OF THE PELLET PRESS

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Abstract: *The present paper presents the analysis of the constructive - functional solution of a pellet press made with ROLIX IMPEX SERIES SRL on the basis of an idea developed by INOE 2000 - IHP, on the subsidiary contract of a single project on Axis POC - G. At the level of the experimental model a pellet press with a motorized sieve and it was tested in real conditions to see if it achieves the designed parameters. During the work the functional samples and the results obtained during the experiments are presented.*

Keywords*: Biomass, pellets, eco-innovative technologies, pellet press*

1. Introduction

Wood pellets (fig.1) are a new fuel that meets the new "clean" and regenerative energy requirements. They represent the best alternative to domestic heating, and in the conditions of aligning the prices of classic fuels with European prices, soon will be the most economical and at the same time comfortable alternative in Romania. They are produced from biomass materials, especially wood. Typically, these are produced by pressing the sawdust resulting from the saw blade, from the wood chips of the trees blow by the wind and generally from the waste resulting from the wood processing. Their production usually does not require additives or binders due to the naturally occurring resins in the basic raw material. [2,3]
Pellets are solid, low-moisture fuels made from sawdust, wood chips or even bark.
Short history**:**

- In the 1970s, the first production facility in the US Brownsville was built.
- In 1983 the first pellet plant in the US is sold.
- In the 1990s, in Sweden, industrial production of wood pellets was started as a fuel.
- In 1996 there are already more than 20 producers of thermal power plants and more than 80 pellet producers. Already about 1,000,000 tons of pellets heat homes in North America.
  In 1997 there were already over 500,000 pellet plants in North America alone.

Romania's rich forests can provide the raw material for the production of pellets. Poor quality wood resulting from their cleaning, wood resulting from scheduled cuttings as waste (sawdust, slurry) resulting from its processing in the industry, are in more quantities than necessary to cover the country's needs and currently almost no used. Let's think about 1,000,000 cubic meters can replace about 180,000,000 L of conventional fossil fuel. Ensuring energy needs is one of the greatest challenges of this early millennium. The huge volume of demand worldwide can only be covered by the ingenuity of new technologies. Pellets represent such an alternative technology with spectacular success in the West.
Pellets are a nonconventional fuel being:

- Ecological (the cleanest form of heating a home - burning almost no smoke).
- Regenerative (uses wood waste or plants as raw material).
- Economically advantageous.
- Adaptable - can be used both in heating plants for residential or industrial premises, as well as in apartment houses.

The raw material for pellets is more than abundant in Romania, which will be an asset in order to begin exporting them and comes from two variants:
• The first option is the use of wood waste: sawdust, chips, bark, trees cut down from forests as well as agricultural waste and vegetal remains.
• The second is the cultivation and processing of special plants for this purpose.

The primary resource for pellet factories remains the waste of timber and furniture factories, and therefore the location of mobile production units must be in the vicinity of the sawmills, or the construction of a factory should be in an area of tradition in this field. Pellet heating costs 60% less than heating oil and 40% less than electricity. Pellets are cheaper than fossil fuels, and are renewable.

Fig. 1. Pellets, [6]

2. Methodologies and production lines for the production of pellets

The usual pellet making system is the extrusion of the chopped material through a mold provided with a series of holes.
In general, pellet presses are the main equipment in a pellet production line. The technical characteristics of a pellet press greatly influence quantity and productivity. These characteristics are in general the dimensions of the mold, the mold speed and the distance between the workpieces.
Also, elements that influence equipment parameters are also the quality of friction materials that will affect friction and implicitly increase temperature during pelleting, the shape of the holes and their number with effects on productivity. Also, the die thickness (L) relative to the die diameter (D), known as the L: D ratio or the compression ratio, which is decisive in the density of the pellets. [1]

The block diagram of a pelletized compacting plant is according to Figure2

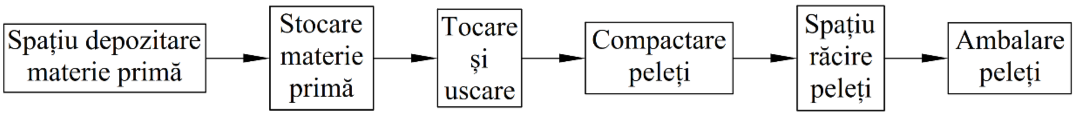

Fig. 2.

The pellet production process involves two stages [7]:
1. Obtaining the chopped material at the pellet size and the maximum admissible humidity ≤10: 15%;
The straw bales, with the help of the conveyor, reach the chopper where they are chopped into pieces of 10-90 mm in length. Supplied by a worm conveyor, through the stone separator, the chopped material reaches the hammer mill. The material is milled in 1-3 mm fractions and blown into the primary separation cyclone. The dust leaves the cyclone and is further filtered into the filtering equipment. From the cyclone, the milled material enters the worm conveyor, then into the silo, from which through the dozer and the mixer reaches a pellet press.
2. Pellet compacting.
The material, with the help of the rollers, is pressed through the mold, thus forming pellets. On the outside of the mold a knife cuts the pellets at the desired length. After extrusion, the pellets reach the temperature of 90-1000C and are transported to the cooler where their temperature drops to 250C. It fixes lignin and strengthens the product by contributing to its storage and transport quality.

Finally, they are sifted so that the residual fragments are separated and reused in the process. Dust-free pellets are ready for storage, shipped to packing equipment and stored.
A pellet making equipment is composed of * (see Figure 3) [5,6]:

-a helical feed system for dosing the compaction material;
-a funnel for directing the compacted material;
- pellet press;
- drive motor drive;
- Control box.

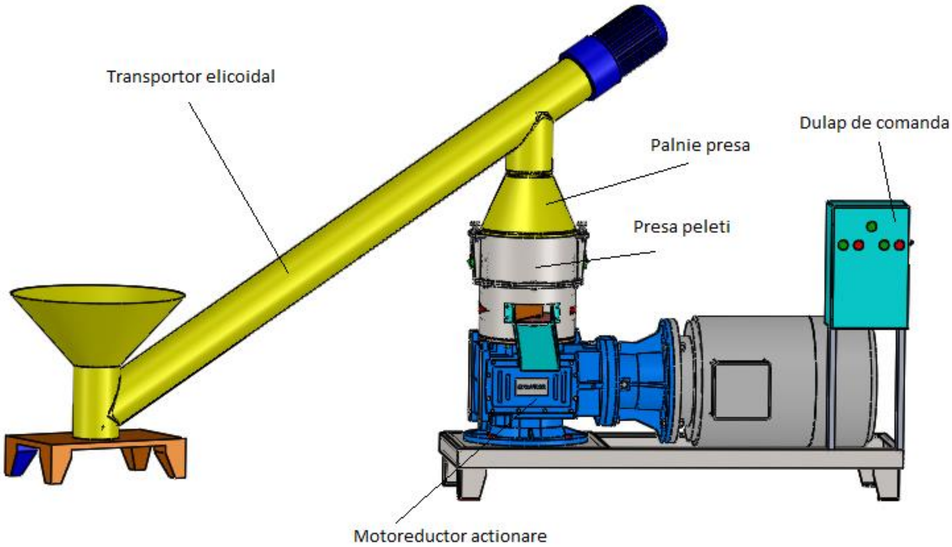

Fig. 3. Pellet feed and dosing with screw conveyor

3. The technical solution made by the company

For the introduction into production of a pelleting press S.C. ROLIX IMPEX SERIES S.R.L. together with INOE 2000-IHP made a technical-economic analysis of a small-medium series production of pellet presses [1]
The main criteria are:

- o Productivity of the press;
- o Manufacturing costs
- o Costs of media maintenance
- o Consumption of energy;
- o Quality and composition of raw materials;
- o The complexity of the technological line in which the pellet press will be included. The main constructive elements are presented in figure 4 a and b in which is presented the functional constructive solution (variant), the one with the motor sieve.

The pellet press was made by S.C. ROLIX IMPEX SERIES S.R.L. under a subsidiary contract of ctr. 129/2016 POC - G and tested under real conditions to see if it is reliable.

4. Pellet press testing and results

The pellet press was subjected to two types of samples [1]:

a. Functional tests:

- Running the equipment without material to check its functionality. The equipment corresponded with the fact that the engine started and moved the engine sieve for making the pellets.
- **Checking the electrical installation.** The press was electrically controlled and the start-stop operation checked. During this check, it was found that the machine is functional and makes all the

necessary moves. Verification with the door opened of the system command and control has shown that the press does not start, which is in line with the project prescriptions.

Fig. 4 a.

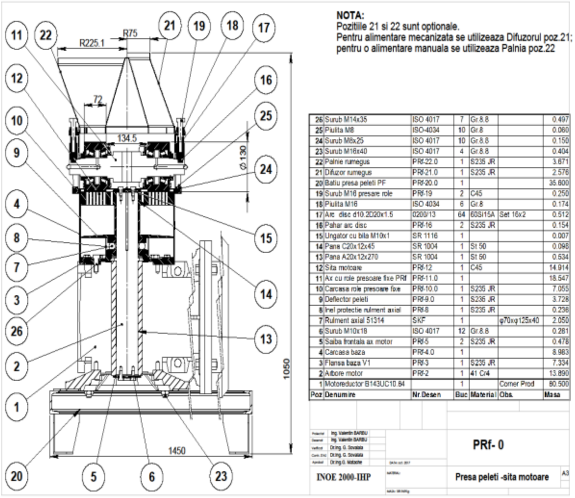

Fig. 4 b.

Pellet press with motor sieve

- **Check for stopping when metal elements enter the press area.** To perform this test, some metal elements (nails) were inserted into the pellet press and it was observed that it stopped. It is necessary to strip it down and extract the metal parts between the pressure rollers and the motor sieve. The product also corresponds to this point of view.
- **Checking the speed range.** It was checked and observed that it corresponds to a range between 300-1450 rpm

b. Samples with unsorted compaction material to check for load performance.

The material used in the verification process was wood sawdust. Prior to performing the tests the possibility of priming the press and the technological process of pellet production was checked. Within these two activities, the production of compacted parts was also carried out by grinding the holes of the site with grated biomass, but also with specific material (fine sand, engine oil etc.

Several steps were required to prepare the equipment for operation in real conditions these consist of polishing the motor web extrusion holes. We proceeded to:

a) 6 times the abrasive material (consisting of a mixture of 5 kg of raw material (sawdust, straw pastry), 1 kg of fine sand and 1 kg of used motor oil)

b) Compaction samples resulted in low density pellets (Fig. 5), which led to the conclusion that an additional crossing of the abrasive mixture for grinding the holes of the motorized

The samples from a) and b) were repeated three times so it was concluded that only after a pass of at least 18 times off the specific material, the pellets were within the limits required by the design theme from in terms of density (Fig. 6).

After these passes, the equipment technically corresponded to the execution validation samples.

The pellet press was verified at:

- Verification of movements in accordance with manufacturing technology.

It has been observed that depending on the type of press there is either a sieve (mould) or a roller (s). On this occasion the component of the machine was checked according to the execution documentation. The functional test was carried out both without starting material and with raw material according to the documentation and instructions for use, the raw material that was wood sawdust.


Fig. 5. **Fig. 6.**

- Check the power consumption
This verification was carried out by measuring the electrical consumption in different stages of work, established by the designer and executor for each type of press. This measurement was made mandatory and, in the task, and it was found that for the accepted productivity the 15-kW motor is too high.

- Checking the possibility of adjusting the press rollers on the sieve. The check was carried out with the machine in a non-functioning state and it was found that the equipment fell into the areas indicated on each functional drawing. It has been found that it is very important to regulate this pressure, even if the actual value is relevant, since it depends on the level of grinding and the type of raw material. For wood sawdust, a pressure ranging from 20 to 600 N was used, useful in the range of 100-500 N.

- Measuring press productivity
A functional test of the machine was carried out with the type of biomass specified in the documentation as a raw material and its processing in the field accepted by the indicative prescriptions from the research-design program. Measurement was done by weighing the number of pellets produced in one hour under normal working conditions. The 50 kg / hour result is not final, and further evidence will be made.

- Dimensional inspection of pellets
It is a simple process of checking the machine settings by dimensionally measuring the pellets and checking the fitting in the press fabrication prescriptions. The range of presses designed within this project produced pellets with a diameter of 8 mm and a length of 12 mm, even if there were many deviations (15% of the pellets).

- Checking the density and compaction of the pellets
The test carried out a verification of the entire manufacturing technology and covered two stages. In the first stage you will be checked for the structural preservation and the shape of the pellets in time and the appearance of some small value shocks. In stage two, weighing the pellets and checking the compaction density. In principle, the density depends on the material and its previous processing and ranged from 0.9-1.3g /cubic cm.

5. Conclusions

After performing the functional samples at the pellet press it was found that important in the pelletizing process are:

- *the dimensions and granule-metric form of the mixture used for the compaction process;*
- *the moisture content of the mixture used;*
- *density;*
- *compactness;*
- *porosity and void volume;*

Granulometry of the mixture is a fundamental feature of a powdered product or suspension. It directly influences the deployment of a large number of unitary operations (shredding, separation, mixing, transfer of substance, etc.).

The need to determine particle size and shape as well as to determine the percentage distribution of particle size is implied by the fact that it influences how specific impulse and / or mass transfer operations are carried out. In mechanical or hydrodynamic operations, flow behavior, a characteristic that defines the relative displacement of dispersed system particles, depends on a series of properties that are related to particle geometry and mechanical characteristics of the surface.
Moisture content is an important physical feature that influences biomass retention, combustion process and calorific value. The transformation of biomass into combustion thermal energy requires certain values of fuel humidity as follows [16]:

- maximum biomass humidity for combustion in classical combustion plants = 25%;
- maximum humidity biomass for combustion in special combustion plants = 60%;
- optimal humidity biomass for combustion = 7 - 10%;
- maximum biomass humidity for gasification = 35%;
- maximum biomass moisture for transformation into pellets or briquettes = 10%.

Density is determined by appropriate methods for each type of material. It can be discussed: absolute density, apparent density, bulk density (bulk density) and stack density (especially for wood material).
Compaction characterizes the degree of solid material filling of the porous bulk unit.
Porosity represents, in percent, the total volume of pores and voids in the volume unit of porous material (apparent volume).

Acknowledgements

This paper has been developed in INOE 2000-IHP, as part of a project co-financed by the European Union through the European Regional Development Fund, under Competitiveness Operational Programme 2014-2020, Priority Axis 1: Research, technological development and innovation (RD&I) to support economic competitiveness and business development, Action 1.2.3 –Partnerships for knowledge transfer, project title: Eco-innovative technologies for recovery of biomass wastes, project acronym: ECOVALDES, SMIS code: 105693, Financial agreement no. 129/23.09.2016.

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