Energy demand of briquetting and pelleting of wood based by-product

Gábor Németh[a] – Mihály Varga[a] – Zoltán Kocsis[a]

[a] University of West Hungary, Faculty of Wood Sciences, Institute of Machinery and Mechatronics, Sopron, HUNGARY

Postal address: Bajcsy-Zs. Str. 4, H-9400 Sopron, Hungary; email: ngabor@fmk.nyme.hu

INTRODUCTION – In Hungary, several major "industry" of the production of briquettes and pellets has evolved, so we split the basic manufacturing facilities in three groups:

1. First wood processing plants, the by-product in situ,
2. Second after the acquisition of by-products of wood-product plants and the collection of agricultural by-products (eg straw, corn stover) (dedicated specialist companies)
3. Third energy plantations can be obtained "raw materials" breeding power.

Through the production of briquettes and pellets referred to in the list with completely different energy investment we can obtain a fuel which has higher energy density, smaller footprint and comfort like natural gas compared to the starting materials. In all three cases we can talk about non-drying and after drying energy breeding. Of course, we can find a number of individual enterprises, where raw material drying is not possible, therefore these enterprises need dry raw material, which restricts the possibilities (for example they cannot receive wet raw material from sawmills, thus have to purchase raw material from distant places, which will increase their raw material input costs). We can see that through the briquetting and pelleting process we have to count with heat and also with electricity use, the ratio of which is determined by the applied technology and the properties of raw material.

Our aim was – within the cases in the first and second point – to investigate the energy use of briquette formulation and pelleting of wood-based by-products generated through wood machining.

BRIQUETTING AND PELLETING TECHNOLOGIES

First step we have to investigate the briquetting and pelleting processes, which seem to be similar, but consist of completely different machines.

Considering a complete pelleting machine line the following units have to be present (in case of each raw material some units do not need apply)

1. Cleaner of the raw material (removing stones, metal, etc)
2. Primary chipper (with pre-store)
3. Dryer. The aim is to reach and maintain 8-10% moisture content (conditioner)
4. Secondary chipper, refiner (usually with cyclone separation and dry chip silo). Aim is a particle size of 0,5-1,5 mm
5. Sieve and vibrating table because of the possibly bigger particles
6. Pelleting equipment(s)
7. Cooler (Counter-flow cooling is recommended. Through cooling the strength of the pellet is increasing, and the formation of dust is decreasing)
8. Sieve (Removing of fine dust which is necessary both for medical reasons and for the sake of heating technology)
9. Bagging (sacking)
10. Auxiliary equipment. Transport equipment for the whole line and an exhausting, which feed back to the cyclone separation.

Typically enterprises specialized in this field invest into machine lines consisting of the machines described above (in Hungary machine lines with a capacity of 1-2 tons/hour are the most frequent). In enterprises in the secondary wood industry, where the main by-product is the dry dust or sawdust, the dryer and connected containers are omitted and the pelleting machine is connected directly to the silo of the suction system with a transporting system, possibly complemented with a secondary chipper, refiner. Of course this way we get a cheaper energy source, but the lower quality product can cause problem at the sales.

Considering briquetting from the same point of view we can state, that it has a considerably less demand on equipment thus also on in investment.

MEASURING THE ENERGY CONSUMPTION OF THE BRIQUETTING AND PELLETING

For measuring the electric power we used the power meter C.A 8230 which is also capable of measuring the power of alternate power.

The handheld meter is not suitable for measuring the machine line units separately at the same time. An electric power consumption measuring and evaluation system would be suitable for this purpose, but this would mean a fixed installment in the plant. We could separate the chipping part with our measurements in the pelleting systems. The simultaneous measurement on several spots would have the advantage that we would be able to monitor the chipper and the pellet press, the two spots with the highest consumption at the same time. These are the places where the actual power consumption changes continuously as a function of the load.

The particle composition (fraction size) and the kind of raw material (pine, hardwood, softwood) have a considerable effect on the effective power consumption of the main motor of the pelleting machine (rotational motion between the ring die of the pelleting and the roller shells)

During our industrial research we did not have the possibility to analyze the particle composition of the material, we intend to do this in a more complex subsequent research.

CASE-STUDY: The effective total power of the production line is about 180 kW, while the built-in power is 250 kW. The technology and the built-in powers are demonstrated on the following graph.

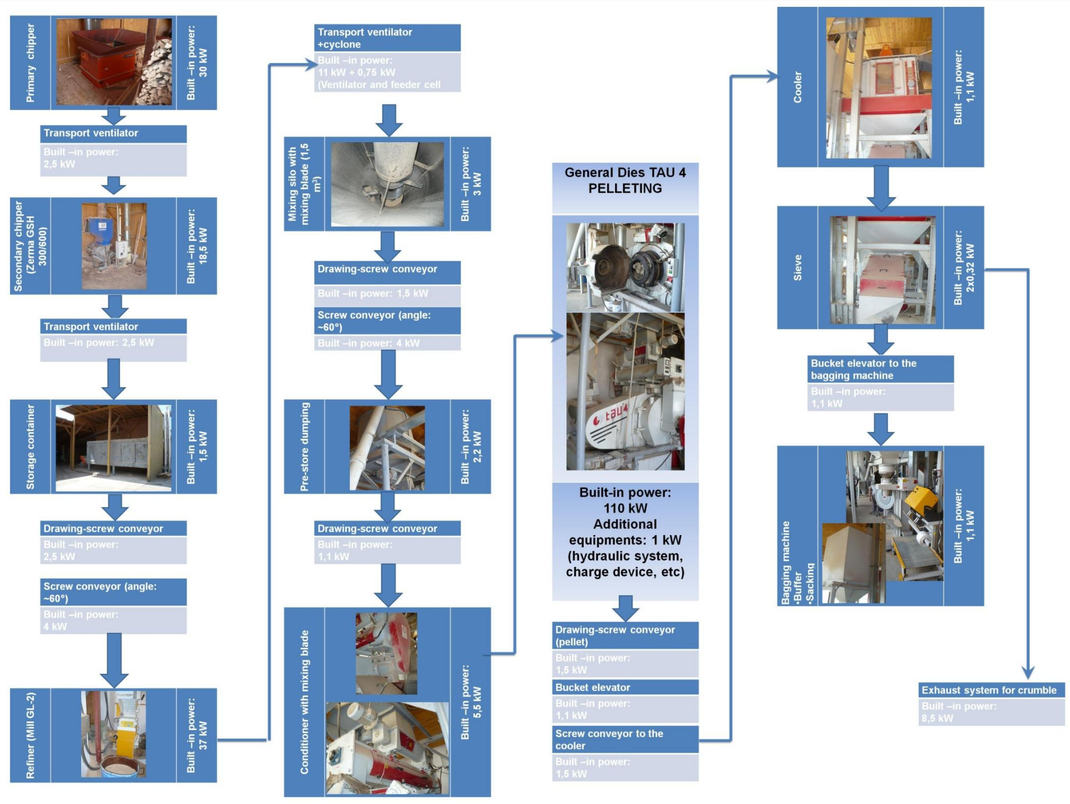

Figure 1. Process model and built-in powers of the pelleting process

TOTAL ENERGY DEMAND OF THE PELLETING PROCESS

By the production of any energy raw material one should not forget about the additional energy demands. Here we have to consider the energy use related to the preparation of the raw material and to the transport of the raw material and of the product.

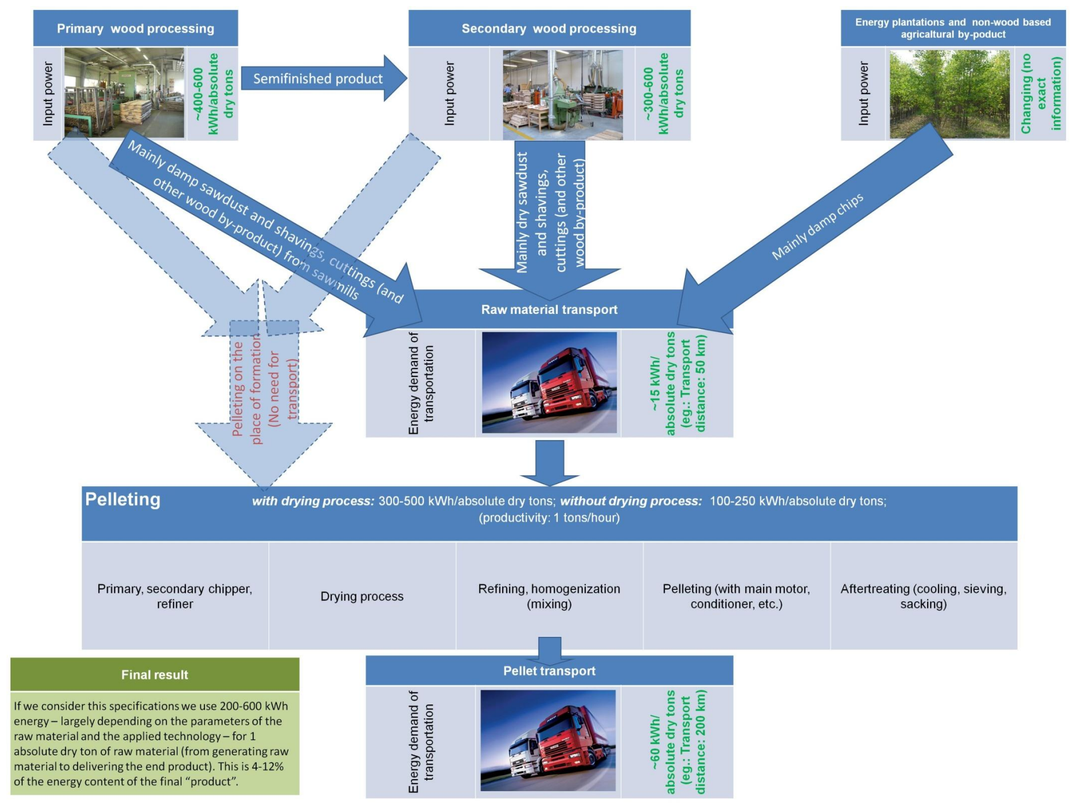

Figure 2. Total energy consumption of pelleting

SUMMARY, RESULTS - According to our measurements the energy use and the costs of pelleting are as follows:

1. At present 1 ton of good quality chips (12-14 MJ/kg, 20-30% content of moisture) can be purchased for about 20-22 thousand HUF/absolute dry tons (ADT) (1,1-1,2 HUF/MJ). Of course in the case of different chips or if there are wood processing plants nearby then in an optima case this price can be as low as 6 thousand HUF/tons.
2. Considering heating value 2 kg briquette or pellet is equivalent to 1 m^3 natural gas (the present price of natural gas is 3,8 HUF/MJ, while the price of pellet or briquette is 2,7-3,4 HUF/MJ)
3. The average electric power need of pelleting – without drying – is 100-250 kWh/ADT (360-900 MJ/ADT) which means a cost of 3000-7500 HUF/ADT. In the case of drying this cost is increased by the heat demand of the drying. If we have to dry raw material with a moisture content of 30% to 10-12% we need 200-250 kWh heat energy (depending on efficiency) which can be produced by using 20-25 m^3 natural gas (2600-3300 HUF). Of course we can produce this heat from our raw material, but in this case we use approximately 60 kg chips of 30% moisture content to dry every ton of pellet.
4. If we consider this specifications we use 200-600 kWh energy – largely depending on the parameters of the raw material and the applied technology – for 1 ADT of raw material (from generating raw material to delivering the end product). This is 4-12% of the energy content of the final "product".
   If we express the specific energy values in terms of money (HUF) then we get different proportions (obviously primarily depending on the price of the purchased electric energy). The purchase price of a good quality raw material is about 1,1 HUF/MJ, while the selling price of pellets is about 2,7 HUF/MJ. If we consider an average electric energy consumption in technologies without drying – like in our example – then the specific consumption calculated on the basis of the energy content of the end product will be 0,01 kWh/MJ, which is equivalent to 0,3 HUF/MJ. This is about 27% of the specific of the raw material price based on the energy content, while 11% of the specific sale price of the pellet. These proportions can even be doubled in case of raw materials which need drying.
5. In case of briquetting – according to our measurements and calculations – 50-100 KWh energy is needed to produce this energy raw material.

Of course to these costs we have to add overhead, maintenance, loan and other costs. In the case of pelleting the production cost can reach 20-28 thousand forints (in case of the economic production: 1-1,5 tons/hour)

These figures are of course completely different if we have raw material from our own wood processing, because in this case we don't have to buy the raw material.

We will have possibility for experiments with raw material and technology parameters with the NOVA Pellet N-Micro B laboratory pelleting machine installed at the beginning of 2012. These experiments are still in preparation.

TÁMOP 4.2.1/B-09/1/KONV-2010-0006

National Development Agency
www.ujszechenyiterv.gov.hu
06 40 638 638

HUNGARY'S RENEWAL

The projects are supported by the European Union and co-financed by the European Social Fund.