Proceedings of the 20th International Wood Machining Seminar

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Anders Grönlund    Luís Cristóvão    (Editors)
Welcome to the 20th International Wood Machining Seminar

Dear Colleagues and Friends

On behalf of the Organizing Committee, I am pleased to welcome you to Skellefteå for the 20th International Wood Machining Seminar (IWMS 20). Luleå University of Technology (LTU) Division of Wood Technology is proud to host the seminar that started some 48 years ago. It is a credit to the founders and past seminar hosts that the seminar continues to attract a wide range of participants from many parts of the globe.

The objective of IWMS-20 is to provide a forum for leading international researchers and practicing engineers to present and discuss recent advances in wood cutting tools, processes and machinery. Primary objectives are practical information exchange and technical interaction among wood machining professionals.

I will particularly thank Professor Gary Schajer that has helped us a lot in planning and organising the seminar. Without Gary’s help and experienced advices we would not all be together at this time.

I will also thank the entire staff at LTU/Skellefteå that has helped me with a lot of different practical issues. Your dedicated work has brought the seminar into reality.

To our attendees and participants, welcome to the 20th IWMS. Enjoy the light summer nights and the beautiful nature in Northern Sweden. Meet colleagues and friends, make sure to make new ones, and give plenty of encouragement to those just starting out in this challenging field.

Yours sincerely

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Energy Consumption Structure of the Hungarian Wood Industry

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ABSTRACT

The energy used in woodworking plants can be classified basically into heat energy and electrical energy. Based on our survey, in the 1980’s the ratio of the heat and electrical energy shifted from the ordinary 80%/20% to 50%/50% in several modern factories. Within the electrical energy consumption, the highest portion is used by machines (45%-60%), dust-chip suction systems (22%-28%), and in many cases the auxiliary equipment of kiln dryers (which may exceed 10%). Machines and infrastructure share the heat demand using 55%/45%. The energy consumption structure of companies with different profiles in the wood industry was investigated (companies from the timber industry and furniture industry, parquet and wooden house manufacturers, briquette and pellet manufacturers).

It is clear that the structure of the energy consumption can be analyzed precisely only for individual companies since each company is different. The best examples are the diversity of suction systems and the air feedback (filtration heat loss, controlled or non-controlled ventilator engine rev). Another good example is the kiln drying. If a furniture manufacturer uses dried raw material, the value of this energy-segment will be 0%, while using a kiln dryer may result in an electrical energy consumption of 10% and a heat demand of 45% compared to the overall energy consumption of the company.

INTRODUCTION

The development of wood processing technologies, their modernization, the increase of the level of mechanization, the presence expansion, the application of cutting edge technologies, the increase of automatization, the of quality environment protection and labor health obligations all contribute to the increase of energy use.

Naturally the technical modernization partly reduces the specific energy consumption. In the wood processing factories, the energy used is basically heat and electrical energy.
The electricity users in the technologies are as follows:

a) Woodworking machines and woodworking equipment, as well equipment required to maintain machines and equipment.

b) Materials handling, storage of machinery and equipment.

c) Extension of the technological process, auxiliary mechanical equipment, such as:
   - general building engineering
   - lighting
   - caloric devices
   - compressed air supply
   - hydraulic equipment
   - dust and chips extraction system
   - steam-gas extraction system
   - briquetting and pellet making machines
   - any other equipment (e.g. small machines)

Heat users:

a) Technology equipment
   - heat treatment equipment (dryers, steamers, wood modification etc.)
   - presses
   - surface treatment equipment

b) Heating, hot water supply equipment

**MEASUREMENT**

The presentation of the current structure of the wood industry energy consumption in Hungary

First, the structure of energy consumption in Hungary is briefly the following. 70% of primary energy (1100 PJ) is the final energy consumption (794 PJ). The efficiency is about 44% from this 31% of useful energy (350 PJ). The final consumption is 18% of the industrial sector's energy consumption (142 PJ).

On the basis of our measurements, we have defined the ratio of the total industrial energy use of half finished products in the sawmilling industry and their demand for energy. We started with the annual volume of the processed logs (Agricultural Office data: 1.6 million m³) The calculated value represents a very small proportion of the total industrial energy consumption (~1%, 1.33 PJ). Our research indicates that when the heat and electrical consumption is probably 50%-50%, the electricity consumption is approximately 105,000 tons of CO₂ emissions. (Standard emission factor in Hungary: 0.566 tCO₂/MWh; source: “Technical supplement to the guide related to the planning for sustainable energy”). (If the current quota prices are taken into account that is more than 450 million Forints in the carbon market.) The heat energy consumption is approximately 37,000 tons of CO₂ emissions if we use natural gas for heat production (standard emission factor in Hungary: 0.202 tCO₂/MWhnatural gas). This means that 1 ton of wood processing creates about 150 kg CO₂ emissions. Naturally if the heat production locally and that made from waste wood, then this value may be less due to the neutrality of the wood. (According to our estimates about seventy percent of the heat thus produced). The situation would be even more ideal if in the factories were using sun and geothermal energy. (We will develop implementation at the next phase of research).

In part of this research, the various wood industry companies were analyzed (saw industrial, furniture industry, parquet manufacturer, wooden houses manufacturer as well as briquettes and pellet production companies). We have analyzed the company’s energy consumption. The
surveys have appeared markedly in those areas where the levels of energy consumption are large and the CO₂ emission reduction can be done.

Our investigations informed us about the energy use of wood industry companies, which are summarized as follows.

Figures 1 and 2 show examples of the energy consumption in the saw and furniture industry. Naturally, on the figure the total installed electrical capacity isn’t seen, but the electrical capacity of those machines which are working at the same time. This value is about 45%-50% in small and middle sized wood industry companies in Hungary. In the wood industry, production equipment, uses 45%-60 % of electrical consumption; dust and chip extraction systems use 22%-28% and in some facilities the dryer’s fans use about 10%, (if the company doesn’t buy dry material). Dust and chip extraction and dryers use a significant share of the energy. Special attention must be given to these areas, and we propose a solution based on surveys, to reduce energy consumption.

**Figure 1** *The energy distribution of the sawmills*

**Figure 2** *The energy distribution of the furniture factories*

In our research, we emphasized the energy consumption of drying; therefore, we examine the ratio of electric and heat energy in the drying. Figure 3 shows the convection heat drying and electric power distribution.
Based on our calculations, drying of wood per unit volume (using the same parameters) 20% of the minimum required invested energy is electrical energy and 80% of energy is heat energy in convection drying. We built an industrial test environment for the subsequent research that we will be able to use for energetic measurement. This system shows an exact picture from the real drying heat and electrical energy consumption for different wood species and moisture content. We summarized in a table the measured values from the initial test period. The calculated values, which are from the published formulas and from the surveys, approximately correspond to the real measured values.

Table 1 Summary table of the drying energy demand

<table>
<thead>
<tr>
<th>Denomination</th>
<th>Total energy demand /Oak/</th>
<th>The electrical energy rate from the total energy necessity [%]</th>
<th>The heat quantity rate from the total energy necessity [%]</th>
<th>Theoretical calculated energy demand /Oak/ [MJ/m³]</th>
</tr>
</thead>
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<tr>
<td>Convection dryer (max. capacity 90 m³; drying time: 22 days)</td>
<td>2377</td>
<td>12</td>
<td>88</td>
<td>2200</td>
</tr>
<tr>
<td>Vacuum dryer (max. capacity: 8 m³; drying time: 6 days)</td>
<td>1248</td>
<td>40</td>
<td>60</td>
<td>Not found exact calculation method</td>
</tr>
</tbody>
</table>

The heat demand is shared between production and infrastructure equipment (55%-45%)

The surveys showed that we can precisely analyze the structure of energy consumption only at the particular companies, because every company is different. The best examples are different extraction systems and specific solutions of energy recovery. (We consider only the filtration heat loss but from a more complex examination, it matters if a fan motor speed is regulated or not). Another example is the drying. If a furniture industry buys dried wood then “the slice of energy cake” is 0%, but if the company dries wood, then 10% of total energy is electrical and 45% of
total energy is heat energy. The measurement of exact quantity of heat used can cause many problems because many companies generate heat from wood waste (locally generated) and this isn’t registered anywhere. (The energy consumption can be inferred from the wood waste used as fuel, performance of the boiler and from the working time).

**Electric energy required for a unit of base material**

Figure 5 shows how much electric energy is needed to produce a unit of base material/product and how it differs between companies. We have defined the given values mathematically in the function of the quantity of the base material and the finished product. To produce one cubic meter of product, more energy is needed than to process one cubic meter of base material. This means the change of production costs among the different company groups. The differences between the production bar, and the base material bar, come from the different amount of waste material and secondary products. Closer inspection shows that the ratio of the use value impacts the energy costs used in manufacturing a product. In furniture production the energy use of the sawmilling industry needs to be included since most furniture manufacturers work with sawn base material. This is generally bought in a dry condition. Small and medium enterprises buy sawn lumber as undried in order to increase their cost effectiveness. They dry the products later themselves.

Distribution of electrical energy (unit of base material and unit of product)

![Graph](image)

**Figure 5** Data from woodworking companies about their distribution of the energy demand which is needed to produce to unit of base material or unit of product (companies which included in our survey)

Main factors for the exceptionally high energy consumption in the furniture industry:
- Processing unit of base material and product development is much more time consuming and also needed more equipment.
- Generally better implemented all of the dust and chips extraction systems (usually each machine has its own extractor) and therefore, needs more electrical energy. The same is to be treated in the sawmill industry.
- Today, the SME furniture companies have better infrastructure, which had an impact on energy consumption.
Industrial test environment

We built an industrial test environment for the subsequent research. It has been integrated into heat, electrical energy meters and analysis system (Figure 6). We surveyed the energy structure of a typical Hungarian company. Then we can offer effective solutions to reduce energy consumption. The solutions to reduce energy consumption will be easy to adopt for the various companies during the project, whether large companies or SME.

Figure 6 Industrial test environment

The measurement system has been built for measuring quantities of electricity and heat. A measuring device has been installed on the energy consumer which we want to measure. These devices communicate through a bus system with a bus controller which transmitted the measured data to a computer. Software saves the data which are necessary. The data can be seen on the measuring device and on the computer. The saved data can be queried by several criteria.

Figure 7 A schematic diagram of measuring system
When we were done with installation, we started the testing (with 8 pieces electrical and 2 heat measuring devices). Our current financial situation did not allow us to buy more instruments. Therefore, only the dominant energy consumers were selected. When there were more of the same type energy consumers, we chose one of them and we examined only that.

In the next part we will show the electric and heat energy use of certain consumers with the help of data from a measuring system. Since we have set the sampling intervals at 5 and 15 minutes we got a data line of 3000-9000 lines. These data lines show year, month, day, hour, minute and seconds. These can easily be adjusted to the technology. To simplify the evaluation, we show the amount of electricity and heat used by machines and equipment over monthly periods. Since we do not collect data from each machine, we did the missing measurements ourselves with a hand operated benchmarking device. During testing we created a map of one month’s energy use and this is shown as follows:

**Figure 8 The map of test environment**

**CONCLUSIONS**

We concluded that we can achieve significant decreases in energy consumption. These include:

- **Dryers:** Our preliminary surveys show that these devices have the largest energy consumption (electrical and heat energy), so substantial energy savings can be made. We can use alternative energy sources (reducing energy consumption about 30% in summer) and observe the drying schedules.

  Our research reviewed the dryer’s external structure too, because a dryer with smaller overall heat transfer coefficient needed less heat. (The transmission heat loses are high now). We will do thermo vision tests in future research.

- **Dust and chips extraction systems:** Heat and electrical energy can be more efficiently used in the wood industry’s dust and chips extraction systems. Here, the electrical energy is consumed by fans, separators and the operation of other ancillary equipment. The heat
energy is consumed by filtration losses. (Usually the filtration heat losses are more than the transmission heat losses). For these reasons, we started comparing energy consumption in the operation of the traditional system used by 90% of the factories and a flexible technology solution.

- **Space Heating:** Heat loss: heat flux from across the room’s wall. This amount is high in the current wood industry, because the structure of the walls, windows and doors are obsolete. The proper insulation would reduce heat transmission approximately by 15%-20%.

- **Compressors:** The recovery of generated heat for space heating during their operation.

- **Ways to reduce electricity consumption in production lines:** Production lines use more than half of the factories’ energy. This can be reduced by rationally coordinating the processing and reduce the machines and grouping of machines simultaneously. Another substantial energy reduction options is the examination of the processing machines’ motors. Generally motors are built into the machines that are more powerful than needed. They need more electricity, which deteriorates the efficiency of energy use increasing the energy cost. One solution is newer motors with a better power factor. The control of frequently used machines will reduce electricity consumption by 30%.

- **Use of the electronic energy management system and power operator system:** The system turns equipment turning on and off keeping consumption within fixed limits instead of instantaneous power consumption. Therefore, the electricity supplier does not need such a large fixed capacity. This avoids the substantial penalties for exceeding limits of consumption. For example the processing control systems of the dust and chip extraction system are easily amenable to the management operation of the system. The Institute of Machinery and Mechatronics has developed an innovative monitoring system, which increases factory safety and reduces power consumption. The energy monitoring falls within the working area, buildings, lighting regulation (to optimize the light in the breaks or turning off unused lighting in workshops; insulating technical equipment).

**REFERENCES**