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Testing of Machines for Processing of Waste Materials in Agriculture

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The paper presents the machines for processing of waste materials in agriculture. There are many waste materials from which it is possible by means of suitable machines to obtain the product which can be favourably used. The aim of crushing of waste materials is to reduce their volume and to use them favourably. For crushing small waste wood and branches into matchwood small tractor-driven machines and electric motor machines are used. Larger machines for the biomass preparation are more capable and more expansive; they have their own drive and a motor output of more than 200 kW.

The paper discusses testing of the new crushing machine TERMINATOR 5000S – 181024 of Komptech make for different materials to be crushed. The test includes crushing of different types of materials of different densities by means of new crushing rolls.

1. INTRODUCTION

Recently, the processing of waste materials in agriculture has become topical. The biomass production requires the machines crushing or defibrating the material into suitable pieces from which, by further processes, multi-purpose products are obtained.

The wooden biomass, usable for power production, is obtained when cleansing the pastures, meadows, hedge surrounding zones, gardens, parking areas, transport route surrounding zones and when renovating and maintaining the orchards and vineyards.

No doubt the use of wooden biomass as an easily accessible, renewable source of energy in Slovenia has a promising future before it. The reasons for this argument are the obligation to reduce the carbon dioxide emission, the EU requirements, the necessity for the self – supply of energy, the prevention of excessive penetration of shrubs into cultivated land, the increase of utilization of small wooden biomass and wooden wastes [1].

The fact that the biomass utilization technology, friendly to the environment, is integrated into the circulation of energy and carbon in the nature, is the most important reason for giving priority to biogen sources of energy over the fossile fuels, since this contributes to the improvements of local and global conditions in the environment [2].

The final purpose of generation of energy from the biomass in the ecological and economic respect should be protection of the environment [3].

2. MACHINES FOR PREPARATION OF BIOMASS

The wood chippers are intended to chip the wood into small pieces matchwood that can be fed by a warm conveyor into the boiler [4]. The crushing machine Willibald MZA 3500 is intended to crush waste wood (pallets, branches, furniture). The machine MZA 3500 is equipped with an incorporated MAN Diesel engine of 420 H.P. Crambo is a rotating crushing machine intended to crush wood, waste wood and branches. The Diesel engines of up to 320 kW output and the 200 kW electric motors, suitable for heavy operations are capable to crush any wooden pieces [5]. The Terminator is a slow running crusher with hydraulically continuously controlled gaps. It is driven by Diesel engines of up to 320 kW suitable even for the heaviest duties and capable to crush any materials. Induction motors of up to 200 kW can be used as an equivalent of the Diesel drive.

3. TESTING OF THE TERMINATOR 5000S - 181024 WITH DIFFERENT MATERIALS TO BE CRUSHED

The machine was tested for its capacity of crushing different types of waste [6]. The cutting edge can be adjusted for each individual type of material to be crushed. During the test the material was loaded into the Terminator by means of the loader Volvo L70C of 2,4 m^3 shovel volume. For crushing the Terminator used an automatic drive with a new crushing roll with 45 teeth and a new opposite cutting comb.

When test crushing large pieces of the waste material two measurements were executed, one for large pieces of waste and one for large pieces of domestic waste. In both cases the waste included spring mattresses, used furniture, a large portion of foils. The domestic waste included particularly the house windows, doors etc. in both cases the flow rate was about 35 t/h. Due to improvements of the crushing roll and due to new tooth shape the flow rate on the Terminator 5000S - 181024 was increased for 33 % during the waste crushing test. The results of the test with rubber tyres show that the input and the quality of crushing are very good and that the torque of the new crushing roll sufficies for crushing of rubber tyres. The flow rate of special types of rubber tyres is 5 - 12 t/h.

The analysis of sieves shows a slight improvement of crushing quality of the new crushing rolls in comparison with the previous comb. This new simplified type excludes the "Booster" therefore it does not need the hydraulic movable opposite handle retaining the material which must be crushed always in motion. The flow rate value always correlates with the cutting gap. On the basis of the calculations based on the FEM method further features on the Terminator 5000S - 181024 have been developed to assure a moderate stress level and connections safer during use than if only one bolt is used. The process has led to the optimum shape of the tooth and holder on the new Terminator. Also the tooth contour has been improved [7].

4. RESULTS

The Table 1 shows the values of the capacity and flow rate of crushed material – biomass on the test Terminator 5000S - 181024 for crushing different types of materials.

Table 1
List of capacities of the test Terminator 5000S - 181024 for different materials crushed

MATERIAL	Density of material before crushing [kg/m^3]	Cutting gap [mm]	Flow rate [m^3/h]	Capacity [t/h]	Density of crushed material [kg/m^3]
Waste material	150-200	10	250-400	50-80	250-400
Large pieces of material	70-100	20	120-200	25-35	180-200
Combined pieces	100-150	10	250-300	45-60	200-250
Railway sleepers	150-200	40-60	140-160	20-40	280-320
Trunks and stumps	200-250	40-60	90-130	20-30	150-200
Automobile rubber tyres	120-140	5	160-230	20-30	350-400
Truck rubber tyres	220-280	20	60-110	25-35	350-400
Special types of rubber tyres	180-220	5-20	20-40	5-12	350-450
Refrigerators	100-150	40	100-150	20-30	200-300
Pallets	80-100	10	100-150	25-30	150-200

The value of the machine capacity indicates the tons of the individual types of material crushed per hour by the machine. The capacity depends on the density of the material crushed and the cutting edge. The cutting edge can be adjusted to 5 - 100 mm depending on the individual type of material. The flow rate value tells how many cubic meters of material – biomass crushed are obtained from the machine.

The data for comparison of both machines are based on crushing waste wood. The test machine Crambo was driven by a 320 kW Diesel engine with 8 rolls. The flow rate of this type of the Terminator is increased for 20 % and the waste wood crushing is improved. Unlike previously the crushed pieces are now of square shape. The comparison data show that the capacity value 27 t/h is the same on the Terminator 5000S - 181002 as well as on the Crambo 5000 - 167005 with 80 mm sieve.

The Table 2 shows a comparison of the Terminator 5000S - 181002 with the Crambo 5000S - 167005 with respect to the capacity of waste wood crushing.

Table 2
Comparison of the Terminator 5000S - 181002 with the Crambo 5000S - 167005 concerning the waste wood crushing capacity

DESIGNATION	Cutting gap [mm]	Weight of waste material [kg]	Volume of waste material [m^3]	Crushing time [min]	Capacity [t/h]	Flow rate [m^3/h]
Terminator 5000S - 181002	5	5000	22	11	27	120
Crambo 5000S -167005	Sieve 80 mm	5000	22	11	27	90

Figure 1 shows comparison of the Terminator with the Crambo concerning capacity and flow rate of waste wood crushing.

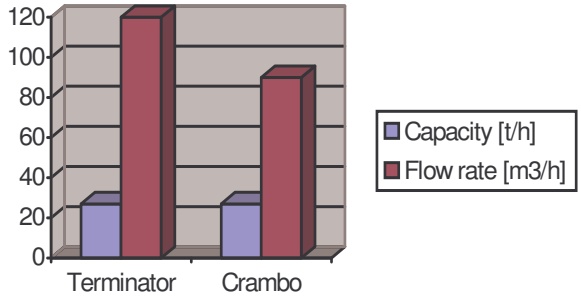

Figure 1. Comparison of the Terminator with the Crambo.

The test crushing time of both machines was 11 min. on the basis of the value of the waste weight it is possible to calculate the machine capacity which is identical for both machines.

On the Crambo the crushed material flow is slightly smaller in quantity because of smaller pieces crushed. During crushing the Crambo uses sieves through which the material is pressed. In this way the crushing quality is higher.

5. CONCLUSION

Most frequently, the machines for preparation of the biomass and/or the matchwood are used. These are small tractor driven cutting machines suitable for crushing different waste wood, branches and other remnants accumulated when cleansing the orchards, vineyards and pastures. The other machines, used for mechanical and biological processing of hard waste materials, have a higher capacity and are provided with their own drive and a motor of up to 320 kW. These are high-quality machines complying with all rules and regulations concerning operation and reach a high capacity. The Terminator is capable of reaching even a capacity of up to 80 t/h.

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