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Trends in biofuel technology

Fig. 1: The new screw chipper WoodCut by HTM, attached to a Big X

Below, the technical trends in the use of biofuels are presented which will characterize the Agritechnica 2007. This preview cannot replace a trade fair visit. It only provides pre-information and does not claim to be complete.

With growing prices of energy carriers, such as oil or gas, biofuels, such as wood, straw, grain, and miscanthus, are becoming more and more interesting. Whether a certain application can already be recommended today remains to be discussed in the individual case. The "bioenergy" centre at the Agritechnica 2007 provides a good overview of the available technology.

In small furnaces (up to 1 000 kW), only air-dry wood may be burnt in order to avoid unnecessary pollution and efficiency losses. Especially with regard to the current discussion about particle emissions, this aspect should be considered. Appropriate processing to firewood or wood pellets can accelerate the drying process.

Wood processing

For the processing of log wood, various splitters and cutter-splitters with different designs are offered today in addition to motor, circular, or ribbon saws. Most splitters are so-called wood cleavers, which work horizontally or vertically. These machines are suitable for logs up to 1.25 m in length and up to 45 cm in thickness. In individual cases, these values may be exceeded. They are driven by an electric motor or the tractor hydraulics. Cleavers which have their own oil circuit can also be driven by the tractor PTO. Only rarely do these machines have separate combustion engines. The cleaving pressure produced ranges between 5 and 30 t. If primarily short logs are intended to be cut, 6 to 7 t are sufficient. For longer logs, a pressure of more than 15 t is advantageous. Under appropriate conditions, approximately 3 to 5 stacked cubic metres (scm, 1 m^3 of stacked wood) can be split. If the splitting tool automatically returns to its initial position or if the machine is equipped with an adjustable return system which moves the wedge back only as far as necessary, a significant capacity increase can be achieved. Meanwhile, also machines providing two splitting speeds are available. The question of whether horizontal or vertical operation is advantageous cannot be answered generally, but only individually depending on the conditions of use.

Cutter-splitters cut and split wood in two subsequent work steps. The wood is cut by circular or chain saws. For splitting, a hydraulic splitting wedge (6 to 18 t) is used. In general, cutting lengths can be adjusted between 20 and 50 cm. Circular saws are more robust. Chain saws are susceptible to soiling, but they are often able to cut thicker trunks. Mounted conveyor belts can convey the split wood onto vehicles or into transport containers. In fully automatic machines, the wood is automatically fed into the saw, and the splitter is adapted to the individual thickness of the logs. If larger "professional machines" are used, hydraulic trunk lifters or cranes should be available so that heavy trunks can be lifted onto the work table. Even smaller machines can reach outputs of up to 5 scm/h.

The machines are used either as mobile units in the three-point hitch of a tractor, with a separate chassis, or as mounted implements on vehicles. Cutter-splitters can be driven by the tractor hydraulics (simple or double-acting connections), the PTO or a mounted oil pump, and/or an electric motor. Separate combustion engines are used rather seldom. A certain trend towards professional firewood processing can be clearly discerned. This means that individual entrepreneurs or so-called biomass farms process larger wood quantities and offer them to their customers in various forms. When buying the machines required for this purpose, one should look for test marks, such as "GS" (tested safety), PPA, or DLG approval. In firewood production, technical solutions for bundling, transport, and packing are slowly closing the gap between progressive, time and force-saving processing technology and high-quality furnaces.

Chippers

produce wood chips of different size and quality depending on the individual kind of use. These machines are offered with different capacities and as mounted or drawn models for tractors. Larger chippers have their own mounted motors or work as self-propelled machines. Fine wood chips, whose size ranges from 5 to 30 mm, are primarily produced by drum and disc choppers, which are used most frequently today.

Disc chippers work with two to four chipping blades arranged on a stable, heavy flywheel. Depending on the size and the capacity of the machine, the disc has a diameter of 600 to 1 400 mm. Due to the large flywheel mass, disc chippers require less drive power than drum chippers, which work with 30 chipping blades arranged on a rotating drum having a diameter of 450 to 1 120 mm. As compared with disc chippers, they have a relatively small flywheel mass so that more motor power is required. The size of the feed opening of the machine depends on the size of the chipping drum. In disc and drum chippers, forced hydraulic feeding is advantageous even if the machines are smaller. It should be possible to adjust the feed rate of the feeding elements for adaptation to different log sizes. In larger machines, the feed rate is often adjusted automatically depending on the engine speed. A reversing

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system is useful because it allows the machine to be unclogged quickly. Depending on the model, the size of the wood chips can be varied within different limits by changing the number of blades, the rotational speed, blade length, or the feed rate. Both designs are often equipped with regrinders (grid sieves). If the machines are not maintained properly, chip quality decreases significantly. The material to be chipped is fed into the machine either manually or by a mounted crane. Larger machines often feature a feeding table and additional feed belts or chains.

For coarse chips, which have a size of 60 to 80 mm, so-called screw chippers have proven themselves. They have a simpler design and do not require forced feeding because a screw with a growing cross section automatically feeds the material into the machine. In general, a certain trend towards large chippers, in particular drum chippers which are used cooperatively, can be observed. For use directly in the forest, smaller mounted chippers will be able to maintain their position. Chippers should be as robust as possible because they are exposed to great mechanical loads.

The drying of wood chips and log wood in biogas plants is currently an important topic. Many biogas plants have no reasonable heat concept because they were built outside of towns. In many cases, the drying of wood is an appropriate and also economical solution. Often, modified wagon dryers or containers are used. For the processing of large quantities, special dryers may also be a profitable solution.

Wood furnaces

Wood furnaces for one and two family houses with heating capacities up to ~ 100 kW are offered in various designs and with very different combustion qualities. Wood furnaces connected to central water heating systems which work alone or in combination with oil or gas furnaces reach the greatest efficiency. For any fuel form (wood logs, chips, or pellets), different furnace systems or combined plants are available. Wood log furnaces are primarily used in the range up to 60 kW. They are more cost-effective than wood chip furnaces and less demanding with regard to fuel storage. However, they require manual labour for fuel supply and furnace care. For reasons of labour management, automatic systems should be used to cover larger heat requirements. Today, most furnaces work according to the underfiring or gasification principle. In these furnaces, the production of wood gases and their combustion are spatially separated. “Dry combustion chambers” and specific ventilation provide temperatures of more than 1 000°C, which leads to clean combustion of low-temperature carbonization gases. The special furnaces used for this purpose are only suitable for log wood. Thanks to electronic control systems and combustion control by oxygen sensors, the combustion quality and efficiency of these furnaces is good.

Wood chips

Wood chips are burnt in furnaces with automatic fuel supply. Since the homogeneous form of the fuel allows for demand-oriented supply, combustion quality is good. The utilization of wood in the form of chips generally requires more technical sophistication than log wood combustion so that outputs of at least 30 to 40 kW are necessary for this technique to become economically interesting. However, the use of forest wood chips requires more extensive planning and investments than the use of log wood. An appropriate chip store should be built, for example, which provides the best possible protection against rain and allows the material to dry.

A discharge rotor with leaf springs or a push bottom withdraws the fuel from a storage container, and a screw or a lifting piston feeds it into the furnace depending on the demand. Compact wood chip furnaces where the storage container and the furnace are situated in one furnace block are only used in the smaller capacity range below 40 kW. In many cases, heat accumulators are also useful for wood chip furnaces. Sprinkler systems and falling or cell wheel locks in the feeding channels avoid back-burning from the fire zones into the storage area. Often, furnaces are also offered with automatic ignition.

As homogeneous bulk material, wood pellets can be metered and burnt without problems in rather small furnaces with automatic fuel supply. High-quality furnaces require high-quality fuel. The observation of quality standards guarantees reliable heating operation. Changeover to wood furnaces is often more expensive and sometimes even twice as expensive as the replacement of an existing oil or gas furnace. The greater the heat requirements are, the sooner wood furnaces work profitably because wood as fuel is inexpensive, in particular in the form of wood logs or wood chips. The costs of wood pellet furnaces are lower, but the fuel is considerably more expensive than the mentioned wood fuels.

Straw pellets

If straw is pressed into briquets or pellets, it is easier to store and to transport and can be burnt in small, more reasonably priced furnaces. Thanks to their homogeneous, fluid form, pellets are well suitable for mechanical fuel supply. The pressed pieces do not burn as impulsively as loose straw. Instead, they give off heat more slowly and more steadily. However, the technical and energetic requirements for the compression of the straw are high so that the higher fuel price must be compensated for by means of more reasonably priced furnaces. Since straw has other fuel characteristics than wood, straw pellets cannot be burnt in conventional wood pellet furnaces. In most cases, chip furnaces are used.

Due to the high compression and the resulting low water content, the pellets have a calorific value of 5 kWh per kilogram. For untreated, air-dry wood, this value ranges between 4.1 and 4.5 kWh/kg.

Fig. 2: Wood chips furnace: automatic furnaces for wood chips are almost technically mature.