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Dealing with pest infested wood in the pelleting process

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Abstract. The performance of a pellet plant depends highly on the feedstock quality and the pretreatment. The usual difficulties in operation increase when the wooden raw material is infested with pests and varmints. For the past years, we have been experiencing an increase in infections on a larger and broader scale. This means, more and more forests are experiencing dramatic losses. Infested wood is useless to the timber industry and needs to be removed from the woods to prevent further damage.

1. Introduction to Wood

1.1. Wood Structure

Approximately 20 to 30 percent of dry mass of woody plants consists of lignin and the total production ads up to some 20 billion tons per year. Together with cellulose and chitin, lignin is the most common organic compound in the world. Biological and chemical-technical processes can break down lignin. Especially bacteria and fungi decompose lignin. However, higher evolved organisms cannot break down lignin. Thus, any pest infestation with insects such as longhorn beetles do not decrease the lignin amount of the wood. However, pelleting high ratios of infested wood in the feedstock mix will cause major issues with stability and abrasion resistance.

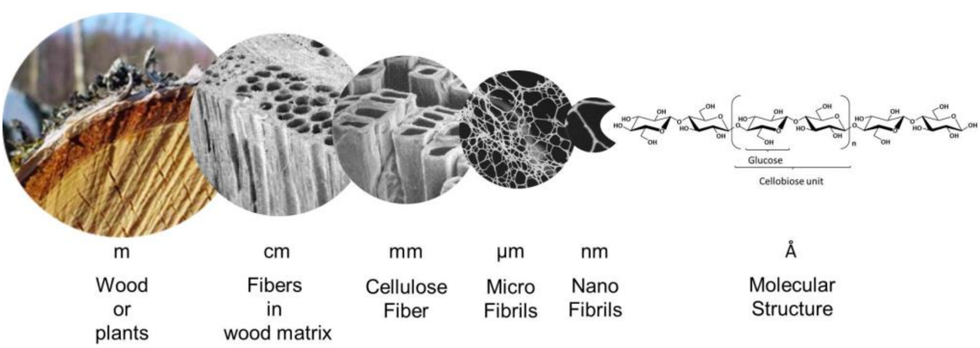

Fig. 1 Wood structure [1]

Plant cell walls are made of cellulose fibrils that are set in a matrix of pectin, hemi cellulose, proteins and lignin. Cellulose is the backbone of the plant cell wall and is characterized by its tensile strength, whereas lignin gives pressure strength. It is comparable to steel beams in a concrete ceiling.

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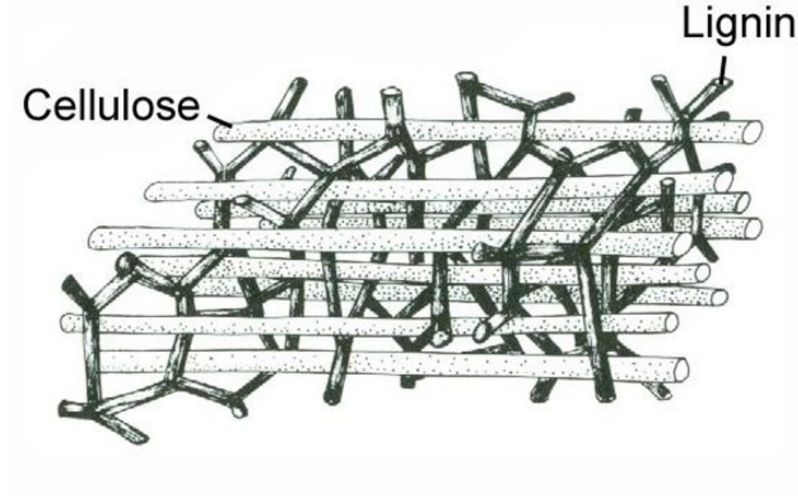

Fig. 2 Cell walls [2]

1.2. Defense Mechanisms

A healthy tree has multiple defense mechanism against varmints. Poisons, such as tannin and robinin, volatile aromatic substances, e.g. essential oils and terpenes that keep away insects and other natural enemies. However, as soon as the bark is bruised, weakened by drought or the tree is cut, all kinds of varmints come along to lay eggs below the bark and into the wood. The emerging larvae eat their way through the wood. The most common green wood varmints are bark beetles, wood wasps, carpenter millers or longhorn beetles. In addition, there are varieties of wet wood insects that need a high moisture content to thrive. It often happens that the infected wood is not debarked and / or already seized by fungi.

2. Varmints

Longhorn beetles (cerambycidae) are the most common pest to green wood. About 26,000 species are known worldwide, of which about 200 are in Central Europe. Their larvae are laid in the wood, where they develop and pupate. The active life of the adult animal is usually a maximum of 90 days, in many species, but only 30 days or less. Adult beetles pose no threat to the wood and some beetle species are so rare that they under species protection. Europe is mostly suffering from the red long horn beetle (stictoleptura rubra) and the violet tanbark beetle (e.g. ropalopus femoratus, callidium violaceum, callidium aeneum, etc.). The up to 2 ¾ inches long (7 cm) larvae of the long-horned beetle (ergates faber) are often a frightful discovery when unfamiliar. The tanbark borer (phymatodes testaceus) lives up to its name and can be found in many different color combinations.

Fig. 3 Stictoleptura ruba, Red Longhorn Beetle [3]

The biggest issue of varmints in green wood is larvae eating their way through the wood in a hook-shaped path. Before pupating, larvae eat up to 1.5 inch horizontally into the heartwood and gnaw a 1 to 1.5 inches long vertical chrysalis chamber. These eating paths lead to a larger waste. Many wood-eating larvae of longhorn beetles harbor yeast fungi symbionts in their mid-gut that help them with the digestion of cellulose and hemi cellulose into sugar. The infestation of a tree by fungal pests is notifiable in some German federal states. An expert, who then determines remedial measures, must determine the infestation. A fungal infection is characterized by different destructive phenomena. White rot manifests itself in attacking the white matter, lignin. The local lignin degradation creates honeycomb holes in the wood and turns it white. Brown rot mainly occurs on coniferous wood. It destroys the cellulose of the wood, leaving the lignin, which then turns the wood dark. The wood is cracked, crumbly and eventually decays cube-shaped.

3. Dealing with Infested Wood

Enough of the creepy-crawlies and fungi. The question at hand is how to deal with infected wood. Is it still pelletizable? Does it affect the pelleting process and the quality? The unsightly truth is: Yes, varmints have a great negative effect on the quality of pellets, especially the structural strength. Pellets with a high content of infected wood tend to break much faster and have higher abrasion. The infestation often comes multilateral, affecting both structural components of the wood. A fungal infestation destroys lignin; insects digest the cellulose. Even with only one infestation, the woody material is weakened and the ratio between cellulose and lignin is misbalanced.

Many pellet producers in Europe add starch as a binder. However, there are certain limits to adding starch (1%) and it does not substitute for the natural balance of cellulose and lignin. Eventually, it rather works as a lubricant than an adhesive. A longer effective press channel only pretends to have an effect. The pellets look good and shiny; however, this is only on the surface. The pellet will still suffer from the weak structure of the wood. In addition, the effective press channel is longer in North America than in Europe, so any prolongation possibilities are already exhausted. It is common to add water in the pelleting process. Water helps releasing the lignin and lowering the stress on the equipment. However, increasing the moisture content has no effect on the binding characteristics, if the wood is already damaged. The only solution is to mix with healthy green wood, fresh wood chips and clean sawdust to lower the structure weakening effects of infested wood.

In portfolio theory, risk mitigation is achieved by diversification. The same principle can be applied to feedstock management: By sourcing from many suppliers and different woody biomass types, a plant can process a more homogenous feedstock, than relying on few sources. This applies not only to already infested or overaged wood, because the risk of a quality change is given at any time. In the case of infested wood, we found that the share should not exceed 15% and must be mixed thoroughly with the healthy wood to avoid imbalances of the feedstock.

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