# From sawdust to pellets

*Still a challenge…*

According to the European Parliament Resolution of 14th December 2006, 25% of our total energy use by 2020 should come from renewable sources. It's a tough goal that will drive development in several ways. For example, the production of wood pellets has increased in Sweden and in several other European countries and there is high demand for knowledge about the process.

The pellet industry is a relatively young but well-established industry. In 2010 there was 2.28 million tonnes of wood fuel pellet used in Sweden, representing an energy value of 10.7TWh. Pellets are used in both large and small-scale applications. Between 2005 and 2009 the use of pellets for the purpose of domestic heating increased by about 50%. Many of the households that early converted from oil to pellets were 'pioneers' who wanted to use environmentally friendly fuels. For them design, maintenance and operation were not so important. They were enthusiasts and very tolerant of disturbances. After 2009 fewer households changes the heat source to pellets. To get more households to convert to pellets, the industry has to turn to a new category – those who want to reduce their heating costs while maintaining a high level of reliability and ease of operation. Crumbled pellets are one of the most common reasons for operational problems. To meet the needs of these new clients, there are many research challenges to overcome.

Pellets are produced all year round but are mainly consumed in winter. Seasonal storage is necessary. Pellets are just like other biological materials not stable in storage. Storage losses and crumbling are costly problems as the loss affects the finished product. Pellets also experience oxidation (rancidity) that can form foul-smelling substances and can be a cause of self-ignition when the pellets are stored in silos.

At the Department of Energy, Environmental and Building Technology at Karlstad University, we have since 1989 conducted research on the drying of sawdust and wood pellet production. Our experience and results of a recent survey of 20 of the Swedish pellet producers point to a number of challenges that we still face. The challenges focus on energy, environment, and quality.

## Research at Karlstad University

Today we have unique laboratory equipment that covers the whole production chain, from wet sawdust to finished fuel pellets. The dryer at Karlstad University can be run as a solid bed, a spouted bed or as a pneumatic dryer. This gives us the possibility to test and evaluate the full range of which the drying gas enters the biomass. Using this dryer we have published work on control strategies, heat and mass transfer, retention time and retention time distributions. The Karlstad University dryer can use either air or steam as a drying medium. The dryer is ready for new challenges.

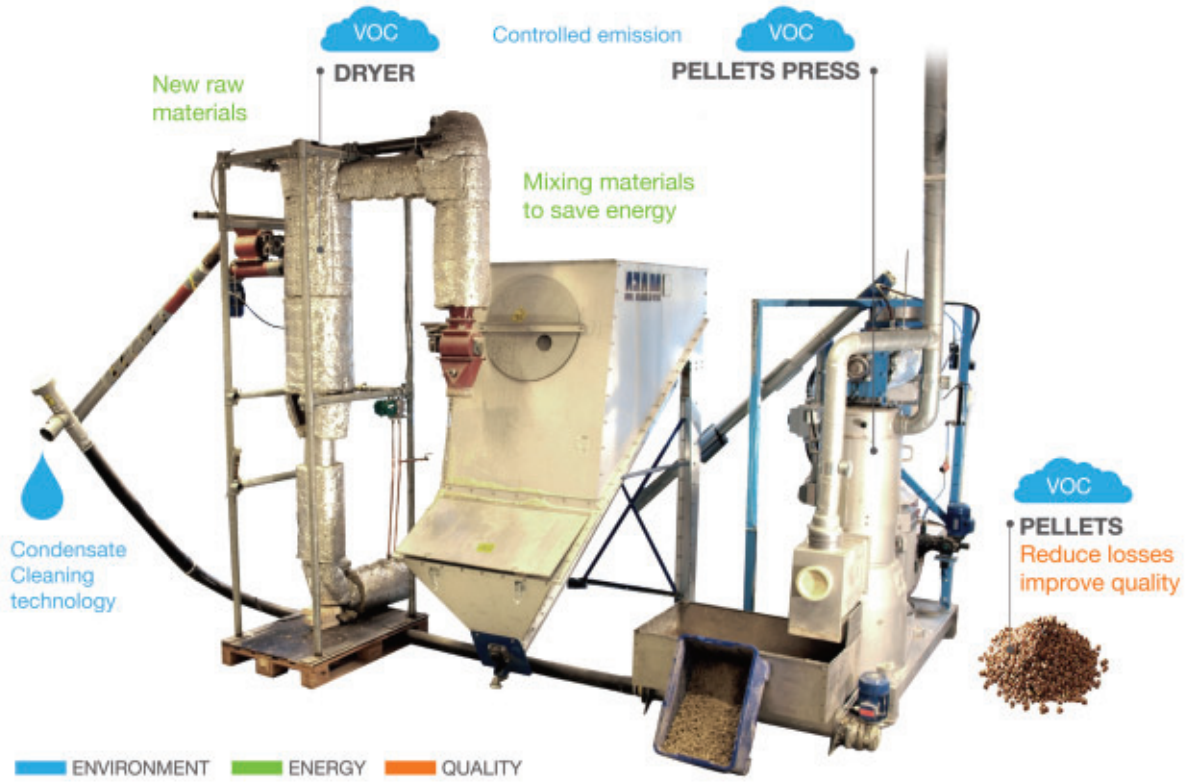
The drying of biomass is a necessary step in the production of wood fuel pellets. Drying is a very energy intensive process and also causes volatile compounds (VOC) from the wood to be emitted. A way to reduce energy use for drying and emissions to air, is to recirculate all or part of the drying medium, this in turn creates a condensate that is toxic to microorganisms but have a temperature useful for board drying or district heating. In the laboratory is there also an industrial sized pellet machine where we can test mixes of sawdust or different additives. We can measure power input, temperature and pressure during each test. Pellets can be made from new materials and by adding additives the pellets can be given other characteristics.

## Energy aspects

Experimental research on drying of sawdust in superheated steam and air started at Karlstad University more than 15 years ago. In order to both increase drying capacity and improved drying efficiency we now work on two step dryers of sawdust for pellet mills. The energy use is high when we run the pellet machine on no load operation. The increase in energy use when sawdust is added is surprisingly low. This means that the construction of the press is important. Studies show that the energy use of the pellet press decreases when starch is used as an additive. Since the availability of sawdust is limited, the pellet industry needs to find new raw material. The challenge is also to find mixes of materials in order to minimise the energy use in the entire chain from raw sawdust to pellets delivered to the end user.

## Environmental issues

During drying, hydrocarbons in resin are emitted. If they leave with the flue gas, to air, they exacerbate problems of ground level ozone. If they leave with the condensate, to water, they poison microorganisms. We have found that overdrying (a wood moisture content <10%) increases emissions




notably and should be avoided. Volatile emissions are also formed around pellets presses. The volatiles that were not emitted in the dryer can be expected to be released in the pellet press. Emissions during storage of solid wood fuels consist mostly of terpenes produced by the tree and of hexanal formed by oxidation processes. Terpenes are rapidly emitted from sawdust, whereas emission of hexanal has been found to peak within one to two months and has ceased after three months.

Some remaining challenging questions are: how to remove the terpenes from the wood in a controlled fashion to avoid emissions to the environment? A challenge is to develop cleaning technologies for the condensates. If biological treatment methods are needed, can microorganisms from pulp and paper mill effluents handle the toxic wood dryer condensate?

## Quality concerns

It is of great importance that the dried sawdust has the correct moisture content before it is pelleted. We have developed control strategies that achieve this. Overdrying leads to energy losses and underdrying leads to a reduction of the pellet quality or reduced production yield. Mixing sawdust with starch and lignin increases the durability of the pellets – we have found that oxidised starch improves durability more than native starch does. During storage in room temperature, we have found that the durability of wood pellets do not decrease for at least seven months. The oxidation processes thus did not affect durability. The pellet quality is questioned by the end-users although the pellets are within the limits set by the European standard.

A challenge still to be overcome is that a differentiated pellets standard is needed so that pellets of appropriate quality is used – a too low quality creates problems, a too high quality means that the pellets should have been used in a more quality demanding operation. Another important question is: how can we reduce the amount of pellets that is lost during handling and storage? An increased use of bio mass means that new more challenging raw materials are needed. So a lot of research is needed to reach the stated goal of 25% renewable energy.

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