

Using Biomass for Process Drying

Technical Report under the RASLRES project



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What is Biomass?

Biomass is the biodegradable fraction of products, wastes and residues of biological origin from agriculture (including vegetable and animal substances), forestry and related industries, including fisheries and aquaculture, as well as the biodegradable fraction from industrial and municipal wastes.

Biomass includes a broad variety of raw materials such as wood, agricultural crops, by-products of wood processing, agricultural and forestry industry products, manure and the organic fraction of waste streams.

Forestry and wood-based industries provide a wider range of different fuels including logs, bark, chips, sawdust and pellets. Biodegradable waste covers the organic fraction of municipal solid waste, wood waste, refuse derived fuels, sewage sludge, etc. Agriculture can provide dedicated energy crops as well as by-products in the form of animal manure and straw. Land can be used for growing conventional crops such as rape, wheat, maize etc. for energy purposes, or for cultivating new types of crops such as willow, miscanthus and others.

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Introduction

There are many enterprises using fossil fuel (coal, oil or gas) to dry their primary products. Typical applications in the Western Region are drying of animal feed or bedding. With the emerging demand for bioenergy, the drying of biomass fuels themselves is starting to take place. Most applications are for low temperature (<80°C) drying in a rotary drum dryer. Cement kilns are large high temperature rotary driers, although none are currently located in the region.

Due to the high cost of fossil fuel, the introduction of carbon taxes and a general trend towards green manufacturing, there is an opportunity to use biomass fuel for drying.

The RASLES project has facilitated a manufacturing plant in switching to biomass from coal for process drying. The purpose of this short report is to share the lessons of the RASLES experience with this particular plant with others considering this option.

This is a short review for information purposes and anyone considering a biomass fired dryer should seek professional advice and gain a more thorough understanding of the technology and specific implications at their site.

Dryer Technology

The technology typically used is a direct-fired rotary drum drier.



Figure 1: Direct Coal Fired Rotary Drum Drier

There is a trend towards using indirect drying, where fuel combustion gases are decoupled from the drying air and heat is transferred via heat exchangers. Such systems give high fuel flexibility. They also help prevent contamination of the product, but they are expensive and it can be difficult to justify replacing existing dryers.

Lower cost approaches are to burn biomass fuel in an existing solid fuel furnace, modify the existing furnace or install a new furnace suited to biomass fuel. This presents substantial technical challenges.

Solid Fuel Substitution

The biggest challenge in switching between solid fuels is to maintain the drying capacity. Due to the lower energy density of biomass fuels compared to fossil fuels (Table 1), it is not possible to maintain the nominal evaporation capacity.

It is possible to substitute coal with wood pellets, but at a reduced dryer capacity and with some efficiency losses, as coal burners are not optimised to run on wood pellets. It is more expensive to use wood pellets than coal based on current prices. However direct fired coal drying has presented some dioxin contamination concerns for drying of animal feed. Anecdotal evidence so far seems to indicate that direct combustion of wood pellets is not causing breaches of dioxin levels required for animal feedstuffs.

Wood chip would be a more cost-effective option. Due to the large difference in bulk density, it is not physically possible to maintain the required combustion in a coal burner using wood chip. To attain the same drying capacity as coal, 2.9 times the volume of wood chip needs to pass through the furnace in the same time period. A new burner would generally be required. In an animal feed plant wood chip at high moisture levels may present a risk of *Asperigillus niger* growth (an airborne fungus) and cross contamination of animal feed.

Table 1: Typical Solid Fuel Properties

Fuel	Bulk density	Energy density		Moisture
	(kg/m ³ loose)	(kWh/kg)	(kWh/m ³ loose)	(% w.b.)
Coal	800	7.7	6160	15
Wood pellets	670	4.5	3015	12
Wood chips	275	4.1	1127	21

Effect of Moisture Content on Drying

Wood pellets have low moisture content, but wood chip can have anything up to 60% moisture. Increased moisture levels have a disruptive effect on combustion temperature. It is difficult to maintain drying temperatures and capacity using biomass at elevated moisture levels. At constant air-fuel ratio and ash content, a temperature drop of over 200 C can be seen when moisture content of biomass is increased from 10% to 40% wet basis (Figure 2).

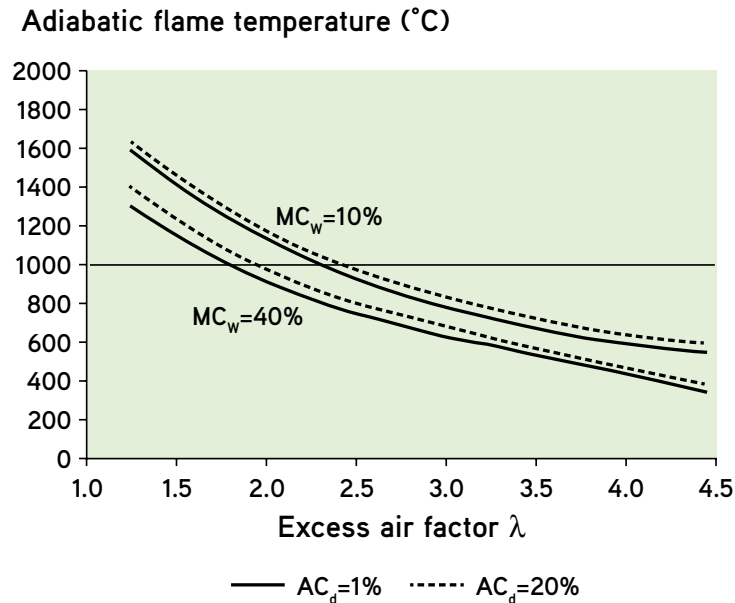


Figure 2: Effect of moisture on flame temperature¹ (AC= Ash content)

It should also be noted that drum dryers operate at high air-fuel ratio (typically >4). Biomass also requires a greater proportion of air supplied as secondary air, compared to coal. This decreases the attainable combustion temperatures in the furnace.

Dryer Efficiency

There are many things to consider in addition to the fuel source for drying.

Thermal drying is expensive. Any free moisture in the product should be mechanically removed, for example in a belt press, in advance of thermal drying. Any possibility to allow moisture reduction using natural ventilation should also be optimised. It is also recommended that the product and the dryer fuel are covered to prevent water ingress in advance of drying.

The heat loss calculations carried out by the RASLRES team indicate that insulating a drum drier could reduce fuel consumption by more than 5%. There are also several improvements that can be made to a dryer's efficiency through improved controls, particularly the control of combustion temperatures and air feed to the burner.

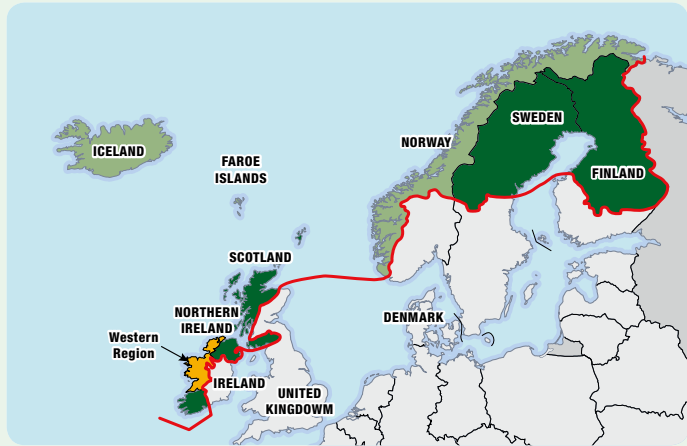


Figure 3: Testing of Wood Chip in Coal Fired Rotary Drum Drier

¹ 2009, Mande SP; Thermochemical Conversion of Biomass; Chapter 13 Renewable Energy Engineering and Technology (Ed Kishore VVN)

Key Learnings

- Wood pellets can replace coal in a solid-fuel fired drier, but at a reduced capacity and diminished efficiency. Some coal fired systems are completely unsuitable for conversion to biomass
- Wood chip energy density is too low to displace coal in a dryer without investment in a biomass-fired burner
- Anecdotally, biomass presents less potential for dioxin contamination than coal
- Biomass moisture content must be low (<20%) to attain high drying temperatures
- Energy efficiency is a key consideration and offers easier savings than fuel substitution



What is RASLRES?

RASLRES (*Regional Approaches to Stimulating Renewable Energy Solutions*) is an EU bioenergy project led by the WDC and funded under the Northern Periphery Programme of INTERREG IVB. The total project budget is €2.8 million over three years. Commencing in September 2009, RASLRES aims to increase the uptake of locally produced bioenergy solutions through the development and implementation of market development models. The project focus is on pilot actions in regard to wood energy, energy crops and marine biomass fuels.

RASLRES is an international partnership which includes:

- Western Development Commission – Ireland
- Action Renewables – Northern Ireland, UK
- Environmental Research Institute, North Highland College – Scotland
- Municipality of Norsjö – Sweden

In the Western Region RASLRES supports the growth of the wood energy sector by delivering practical services to market players and by informing policy development. During 2010 and 2011 RASLRES delivered a range of actions with a focus on selected pilot projects. The project aims to:

- build sustainable local loops of wood fuel supply and demand via new (or existing) wood fueled boilers
- offer best practice approaches to support industry development
- help build critical mass and scale in the wood energy sector of the region
- support investment plans and help secure project finance

RASLRES adopts a full supply chain approach - looking at the energy chain from supply (i.e. fuel producers / processors) to demand (i.e. energy users). The services to the wood energy sector include:

- provision of a range of impartial technical and business advisory support services to selected clients progressing wood energy projects in the region
- generation of market information and intelligence to support the sector e.g. resource forecasting from private sector forestry, assessment of energy crop potential, technical and business case studies
- accessing of international expertise and facilitation of networking with EU markets



RASLRES

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