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- *Wood ash should not be applied where products are grown for the human food chain.*
- *Wood ash can be used as forest fertiliser.*
- *If the wood ash is not used as a forest fertiliser, it should be deposited in a controlled land fill.*
- *Wood ash is highly alkaline and as such should be handled with care.*
- *Fly ash should be kept separated from bottom ash, because most of the heavy metals can be found in the fly ash.*

Wood ash

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Introduction

Wood ash results from burning or gasifying wood and consists mainly of minerals that the trees have absorbed over their lifetime. Pure wood without bark contains very little ash, wood with bark contains more ash, and if the fuel is made of whole trees with needles or leaves, than the ash level will be at its highest. Sometimes general woody waste, stumps and roots are used as fuel. These generally have a high level of soil contamination and ash levels can be very high (6-10%). Table 1 provides typical ash contents for a range of wood fuels. Ash levels are always given in weight percent of dry matter (unlike moisture content which is always given as percent of total or wet weight).

Table 1: Typical ash content of wood fuels.

Fuel type	Ash content hardwood	Ash content softwood
	% dry weight	
Wood pellets (pure wood only)	0.7	0.5
Firewood (wood with bark)	1.2	1.0
Wood chips (roundwood with bark)	1.2	1.0
Wood chips (whole tree)	1.5	1.2
Hogfuel[1] from stumps	6-8	6-8
Hogfuel from garden waste	6-10	6-10

In the Owens and Cooley (2013) COFORD Connects Note Ash content of Irish wood fuel, the data have been determined on several different types of wood fuel as well as different tree species from the forest.

A good wood ash is light grey; if the ash is black, it means that the fuel has not completely combusted and that in fact together with the ash valuable fuel is being thrown out.

Wood ash is highly basic with a pH around 12; it is corrosive and needs to be handled with care. As indicated ash can also contain soil and other contaminants. Some of the soil cannot be avoided: there is almost always a residue on the stem, with soil particles engrained in the bark. This soil cannot be removed before chipping unless the bark is removed. Soil can also come in contact with the stem during harvesting; this should be avoided as it will decrease heating value and increase the cost of ash disposal after the fuel has been burned. Likewise other contaminants such as stones will also increase ash content and lower the heating value and need to be avoided.

The chemical composition of wood ash

Wood ash contains most of the minerals that a tree will take up during its lifetime. These comprise three main categories:

- macronutrients
- micronutrients
- heavy metals

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[1] *Hogfuel is wood that has been crushed with a blunt instrument, unlike wood chip, that has been cut with sharp tools.*

Macro nutrients include elements such as phosphorus, potassium, calcium and magnesium. Micronutrients include iron, sodium, manganese and copper. Sulphur and nitrogen are also nutrients, but these are mostly vented in the flue gasses. Heavy metals are also absorbed in tiny amounts during growth and end up in the ash. These include zinc, lead, cobalt and cadmium amongst others.

In a Danish research project (Kofman, 1987) ash samples from sixteen locations were analyzed for all of these elements. (Similar work has taken place in Ireland but the results have not yet become available.)

The results in Table 2 are expressed in percentage of dry weight of the total carbon-free ash and are the average for that group of fuels, based on nine locations using softwood whole tree chips(SWTC), three using hardwood whole tree chips (HWTC), two using bark (B) and one which used hardwood firewood (F). Trace elements are expressed as parts per million (ppm).

Silicon[2] is probably the largest single large component of wood ash. In the material analysed it amounted to 43% of the ash from softwood chips, 39% from hardwood chips, 70% of ash from bark and 27% from firewood. Silicon is the main element in common sand.

The high content of calcium and magnesium in the ash accounts for the high pH of the ash.

The contents of macro and micro nutrients also indicate that the ash is a valuable fertiliser, but the content of heavy metals precludes use in circumstances where these substances might enter the human food chain. In short: wood ash is a valuable forest and tree/shrub fertiliser, but should not be used in agriculture and especially not in kitchen gardens.

Bottom ash and fly ash

In small boilers all of the ash ends at the bottom of the boiler (even though some may settle in the heat exchange tubes), but in larger boilers, the flue gasses are filtered to remove the very fine ash particles that are vented upwards. Thus two ash fractions can arise: so-called bottom ash that drops from the grate and fly ash from the filtration system.

During the burning of wood fuel, temperatures in the fuel result in the evaporation of heavy metals, but when the flue gasses cool off in the heat exchange tubes, the metals condensate on the fine fly ash particles.

Needles and leaves in the fuel have far higher concentrations of nutrients than woody material, and since the needles and leaves are light, they can be vented up in the flue gasses and often end in the filtering system. For this reason and the high levels of nutrients they contain needles and leaves should never be included with wood fuel. They can also contain higher levels of chlorine which when combusted can be extremely corrosive of boilers.

In the Danish research, fly ash and bottom ash of five separate plants was investigated. For the macro nutrients hardly any differences could be found, but for the heavy metals considerable differences were found. The bottom ash contained in all cases considerably less heavy metals than the fly ash, especially for the more problematic ones such as zinc and cadmium. The contents of zinc and cadmium in the bottom ash were only 20% of those in the fly ash.

The conclusion must be that by separating the fly ash from the bottom ash, one can improve the value of the ash as a fertiliser. The fly ash should be disposed of in a controlled landfill.

Using wood ash

There are two possible ways for the ash to come out of the boiler system: dry or wet. In the wet form, the ash is dropped into a water bath and then dredged out and dropped into a container. The dry ash also is dropped into a container, but may still contain some glowing particles, so care should be taken.

If one wants to spread ash, spreading is easier with wet material. Dry ash contains many fine particles, which will form a dust cloud. Dry wood ash should be stored under roof in dry conditions, as it is similar to cement, in that once it gets wet it will harden into large blocks.

Wet ash can be spread with a normal lime applicator, which is a normally strengthened to operate inside the forest.

Wood ash should be applied during the growing season and the best opportunity is normally just after the first thinning.

Wood ash is best applied to forests on poor soils (such as cutaway peat) or on very acid soils. The alkaline content of the ash might than alleviate the acidity of the soil somewhat. Applying ash on rich soils might result is washing out of the nutrients, because the trees already have plenty of nutrients available.

Wood ash contains very little or no nitrogen, and generally low levels of phosphorus; the main nutrient is potassium. So crops that are deficient in either of the two nutrients will need other sources of nutrition.

If the ash is not used as a forest/tree/shrub fertiliser, it should be deposited in a controlled landfill.

References

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Table 2: Macro- and micronutrients and heavy metals in Danish wood ash from a range of fuels.

Fuel type	P	K	Ca	Mg	Fe	Na	Mn	Cu	Zn	Pb	Co	Cd
	%						ppm					
SWTC	1.40	4.63	12.9	1.70	1.27	0.76	1.32	135	817	107	15	8
HWTC	1.78	5.18	23.2	1.83	1.12	0.92	0.25	142	242	158	17	4
B	0.70	1.84	9.10	0.96	1.12	0.44	0.44	134	325	50	12	3
F	0.79	6.78	18.9	1.16	2.07	0.63	1.28	200	900	130	27	8

[2] *Although not regarded as a nutrient as such, silicon has an important role to play in the development of plants.*