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PRODUCTION OF FERTILISER FROM WOOD ASH

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Abstract

In 1995, at the central heating plant of Kalmar, *Draken*, a project aiming to manufacture a granular ash product for nutrient recycling to forest soils instead of depositing it in landfills was started. Prototype equipment for granule manufacturing was developed and built by Kalmar Energi & Miljö in co-operation with Kalmar University College. Production of fertiliser from wood ash comprises aspects of technology, ecology and economy. The composition of granules mostly complies with the requirements of The National Swedish Board of Forestry for nutrient content and heavy metal levels. When constructing an automatic and continuous manufacture process, the on-line measurement of percentage of unburned carbon present in the wood ash is most important for the overall granule properties. Granulation is a more expensive method of treating ash, but granulated ashes give very slow ecological effects and could make ash recycling more acceptable in ecologically sensitive areas.

Sustainable forestry requires recycling of wood ash

In 1997 bioenergy constituted ca. 91 TWh or 19 % of the total energy supply in Sweden[1]. The annual production of wood ash is estimated to be between 100 000 and 150 000 tons[2]. About 15% of the ash is produced from district heating and combined heat and power plants. The quantity of wood ash produced is expected to increase in future. Whole-tree harvesting, logging residues such as tops and branches taken from the forest and acid deposition in southern Sweden, may lead to a nutrient depletion that will affect the productivity of forest soils. By recycling wood ash nutrient losses can be compensated for and decrease of soil pH prevented.

Ash stabilisation

Reactive oxides and soluble salts in biofuel ash can produce undesirable effects such as pH shock, burning damage to plant tissues and salt effects if spread in an untreated state in forest biotopes[4]. Handling of untreated wood ash also creates severe dust problems and stabilisation is necessary to make spreading feasible. The ash is stabilised by adding water and by a slow

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reaction with carbon dioxide in the air[1]. One technique for making larger ash aggregates is granulating. Using this granulating technique has many advantages. Dust problems decrease significantly. It is easier to spread granulated material than untreated ash and transport and spreading costs decrease[2]. The granulating process also allows particle size and composition of the ash product to be controlled.

Ash treatment at the central heating plant of Kalmar

In 1995, at the central heating plant of Kalmar, *Draken*, a project aiming to manufacture a granular ash product for nutrient recycling to forest soils, instead of depositing it in landfills, was started. Fuel for heat production comes from saw-dust from wood flooring industries. About 30 000 tons saw dust incinerated at Draken result in approximately 200 tons wood ash (filter fly ash) every year. The boiler is a coal-fired Wanderrost boiler which has been converted to run on both saw-dust and oil. Prototype equipment for granule manufacturing was developed and built by Kalmar Energi & Miljö in co-operation with Kalmar University College. The manufacturing process includes mixing, size reduction, granulation and drying. It is difficult to produce a permanent granular ash product without using binding material. Therefore, ETEC-dolomite (Environmental, Technical dolomite) is used as a binder at *Draken*. ETEC-dolomite originates from Anelema quarry in Estonia. The crushed dolomite delivered at *Draken* includes particle sizes < 6mm, of which 80 % are from 0.5 to 4 mm. Argillaceous ETEC-dolomite agglomerates easily and this ability is utilised in granule manufacturing.
The ash, dolomite and water are mixed into a paste and the paste is put on a feeder that forces the material through a raster that reduces the size of the passing mixture. The small particles pass through a drum where granulation occurs. The granules are dried with hot air before they are packed. The prototype equipment has the capacity to produce 300 kg granules per hour, and the particle size is < 6mm.

Technical aspects

Up to now, the equipment prototype at *Draken* has been controlled manually, and the granule properties have depended on the operators knowledge and experience. The aim is for the whole manufacturing process to become automatic and continuous[3]. If an ash has a high content of combustible matter (>10%), solidification is hindered[4]. Therefore, an on-line measurement of the percentage unburned carbon present in the wood ash is crucial for the overall granule properties and several measurement techniques have been investigated[3]. A Fejmert S-750 ash mixer was recently installed and provide a clean, dust-free working environment. In order to try and replace the current method of granule drying by blowing hot air from a fan heated by oil, the use of fuel gases (exhaust gases) has been initiated.

Ecological aspects

To achieve the desired effects of ash recycling and at the same time be able to guarantee that the ash product is environmentally safe, the ash producers have to define the ash particle size and dissolution rates. The ash product aimed for nutrient recycling in Sweden must contain macro and micro nutrients between certain minimum and maximum levels, set by The National Swedish Board of Forestry. Additionally, the heavy metal levels must be below the limit values.

Results from chemical analyses of the Draken *wood ash* show that the levels of nutrients such as calcium, manganese and phosphorus are occasionally insufficient for recycling. Further, the arsenic and cadmium contents are higher than the limits. However, the composition of *granules* largely complies with the requirements of The National Swedish Board of Forestry for nutrient content and heavy metal levels. By mixing dolomite with the ash, high concentrations of heavy metals are avoided, and the required Ca and Mg concentrations are achieved. Field and laboratory studies suggest that a major part of the alkali metals Na and K, as well as Cl and S are leached from granules during 7 month in the field[5]. The release of Ca and Mg is low, between 1 and 5% during a 7 month period. The ash component in the granules is the first to dissolve and leach, and the dolomite component is a slow release soil conditioner and a creator of the basic skeleton of the granules[5].

Economic aspects

Depositing ashes is expensive and if the biomass ash can not be recirculated, the economic and ecological impacts will be significant. The disposal cost for ashes was reported to be 50-200 SEK/tonne, and a tax on land-filling of waste, 250 SEK/tonne is proposed[1]. In Sweden, the total cost for ash handling at the plant and during transport and spreading widely: 200-900 SEK per tonne ash product corresponding to a few percent of the cost of the biofuel or less than 5 SEK/MWh fuel[1]. From an economic point of view, the ash product should be manufactured locally at the producer and then distributed to the forests nearby. Granulation is a more expensive method of treating an ash, but granulated ashes give very slow ecological effects and could make ash recycling more acceptable in ecologically sensitive areas.

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