

NUTRIENT RECYCLING BY USING RESIDUES FROM FOREST INDUSTRY

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ABSTRACT

A major part of residues from pulp industry are deposited as waste at high disposal costs. This paper summarizes a five-year research project concerning implementation of an industrial, automatic roll-pelletizing method at a heating plant in the city of Kalmar, Sweden and presents the visions of the newly initiated research project where pulp industry residues are recycled together with wood ash. Also combustion issues are included.

KEYWORDS

Biomass fuel; Ash; Pulp industry residues; Recycling; Combustion

1. INTRODUCTION

Management problems concerning ash from biomass fuel incineration as well as residues from pulp processing are common for many industrial companies. The production of biofuel ash and pulp processing residues are estimated to be approximately 270 000 and 220 000 tons yr⁻¹, respectively, in Sweden [1]. A major part of these residues are deposited as waste at high disposal costs. On the acidified soils of southern Sweden, clean biomass fuel ash recycling is recommended by the forestry authorities in connection with whole-tree harvesting where also the nutrient-rich parts of trees such as bark, branches, tops and needles are removed from the forest. Transformation of ash into less reactive material is required in order to facilitate ash spreading on forest soils and to slower their decomposition rate.

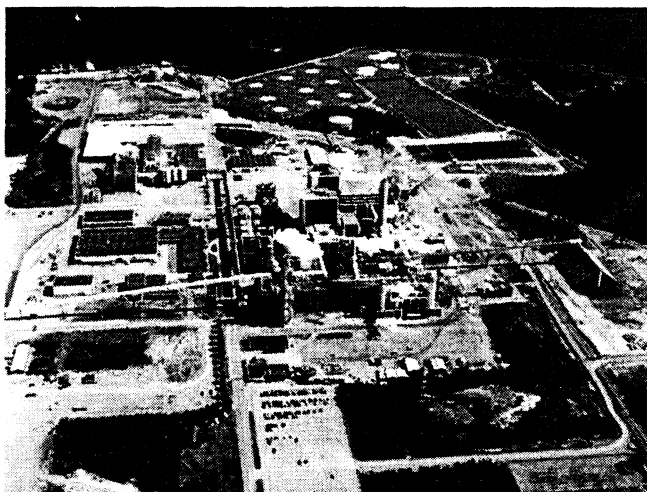
The mineralogical composition of biomass fuel ash varies depending on the fuel origin and properties, what kind of boiler is utilised and also on the combustion conditions, e.g. the combustion temperature. Biomass fuel ash may contain CaO up to 30 % (dry weight basis), that is very reactive. In order to make wood ash less reactive, they are hydrated by water addition. Ca(OH)₂ (slaked lime) is instantly formed and carbonation (forming of CaCO₃) will follow more slowly. Sometimes also additives (organic or inorganic binders) and heating are used in order to increase the hardening rate and the mechanical strength of the final material.

2. RESIDUES FROM THE FOREST INDUSTRY

The Swedish forest industry produces huge amounts of waste every year. For example, in year 2000, the amount of ash produced by the Swedish forest industry was approximately 270,000 tonnes and the amount of green liquor sludge 220,000 tonnes [1]. Approximately 70 % of the ash and almost all the green liquor sludge were deposited. Both wood ash and green liquor sludge contain a lot of nutrients. Green-liquor sludge contains generally 30 % Ca, 4 % Mg, 3 % Na and 1 % P. Wood ash may contain about 15 % Ca, 7 % K, 4 % Mg and 1 % P. Both materials also consist of a multitude of trace elements.

3. THE CENTRAL HEATING PLANT OF KALMAR, SWEDEN

The five-year research project resulted in implementation of an industrial, automatic roll-pelletizing method at a heating plant (located centrally in the city of Kalmar, Sweden), that supplies the main part of the town with central heating. Combustion of sawdust from flooring industry produces >200 GWh energy, resulting in more than 400 tons of ash yr⁻¹. The 40 MW Wanderrost-boiler has been converted to run on both sawdust and oil. The combustion temperature is about 800 °C. During autumn, winter and spring, the boiler is continuously operated unless combustion disturbances occur. The main part of the ash is transported by the flue gas and collected by electric filters.



Source: www.sodra.se

Figure 1. The pulp mill Södra Cell Mönsterås, Sweden.

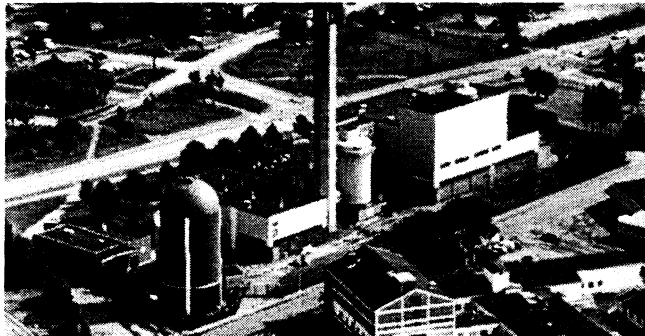


Photo: www.kalmarenergi.se

Figure 2. The central heating plant of Kalmar, Sweden.

4. PRODUCING FERTILIZING GRANULES FROM WOOD ASH, 1998-2003

The pelletizing equipment obtained its current design in late 2002. According to Svantesson [2], a today applied method for agglomerate dehydration is based on the so called self-hardening principle: firstly, the ash is ejected into a platform lorry. When this lorry is fully loaded, the ash is transported and dumped in large heaps at an intermediate storing facility; this is where the actual self-hardening occurs. The time required for the self-hardening process to be successful is approximately one month at a temperature of 0 degrees Celsius. These drawbacks imply that a new method must be developed: a drying method suitable for automated manufacture. Hence, fast and effective dehydration of the ash agglomerates gives the possibility of immediate packing and distribution. The initially adopted method based on self-hardening was outlined together with its apparent disadvantages and the roll-pelletizing technique was selected as the agglomeration method suitable for automated manufacture. It is now possible to automatically transform fly ash into agglomerates.

The knowledge of the properties of the ash at the heating plant has been widened. The most problematic property of the ash is its highly variable content of unburned matter, creating uncertainty about its quality for nutrient recycling. The conductivity is high due to the high content of K in easily soluble species. Decomposition of agglomerated ash with binder such as limestone or dolomite is slower compared to agglomerated ash without binder due to the formation of less soluble species during the production or during weathering of the agglomerates in the field. The agglomerates studied were produced during the development and application of the automated equipment at the central heating plant. However, there is no doubt that the ash from Kalmar is a valuable nutrient resource to make use of. Because the rapid initial release of salts and the high conductivity, up to 65 mScm^{-1} , the agglomerates are not suitable for spreading in newly harvested forests or during regeneration felling areas in order to avoid negative effects.

Within the development of the automatic agglomeration process, drying of the agglomerates by flue gases and utilization of “free” energy present at the heating plant became an interesting alternative. The effects of flue gas drying on agglomerate composition and properties were evaluated. Practical experiments were also carried out at the heating plant, with actual flue gases from combustion of sawdust. More carbonate was formed in ash agglomerates during drying in flue gas. The increase of carbonate concentration due to drying in flue gas was so small that it was unlikely to affect the mechanical properties (i. e. hardness) of the agglomerates. Visual inspection indicated that drying by flue gas gives a very hard and compact (not brittle, light colored) ash agglomerate product.

A belt dryer from Amandus Kahl GmbH & Co, heated up by electricity, was selected as drying method since fuel gas utilization should have required high investment costs. However, the economical benefits of using the free energy provided by the flue gas are considerable, and the initial investment cost must be balanced with the decreased operation cost. Therefore, this option is still under consideration.

5. ASH AND GREEN LIQUOR SLUDGE AS MINERAL NUTRIENT SOURCE IN FORESTRY 2005-2007

The current, on-going research project focuses on both the combustion system and recycling of pulp industry residues, such as green liquor sludge, together with wood ash. The focus of the combustion system analysis involves considerations of both mechanics and chemistry.

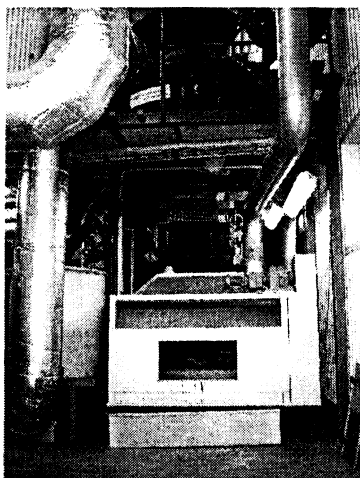


Photo: Tommy Claesson

Figure 3. The roll-pelletizing equipment at the heating plant of Kalmar.



Photo: Peter Mellbo

Figure 4. Pellets of ash and green liquor sludge.

In the project “Wood Ash and Green Liquor Sludge as Mineral Nutrient Source in Forestry” practical experiments will be performed in order to transform wood ash and green liquor sludge into pellets. One of the aims with the project is that the produced pellets could be spread on clear-cut forest areas. According to Swedish authorities the nutrient release of the pellet should last for many years. This means that the dissolution rate of the pellet is preferably very slow.

During the project pellets containing varying proportions of ash and green liquor sludge are surveyed. Leaching tests are carried out. Drying media such as flue gas and hot air are evaluated. Pellets are subjected to the drying media and leaching tests will then elucidate whether the different drying media influenced the leaching rate of elements from the pellets.

Physical hardening tests are also performed since the physical hardness is a very important factor when pellets are transported and spread.

Also complementary binders such as lignin and lignosulphonate are experimentally tested and the agglomerate stability re-estimated.

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