FFG collective research project „Development of innovative processes for wood ash recycling“

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FACT-SHEET: Utilization of wood ash in forest road construction

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1 What ash fractions are suitable for use as a binder?

The following ash fractions can be recommended for use as a binder in forest road construction:

- Bottom ashes from grate furnaces (dry)
- Bottom ashes from fluidized bed furnaces (dry)
- From a technical point of view the utilization of mixtures of bottom and coarse fly ashes (cyclone and boiler fly ashes) as generated in grate furnaces and coarse fly ashes from fluidised bed furnaces, which feature higher contents of volatile heavy metals such as, Cd, Pb and Zn, would be also possible. The possible application of these ash fractions is finally dependent on their heavy metal contents and on the limiting values set for biomass ashes in forest road construction.

Physical Properties:

- **For use as a binder, the ashes must remain dry during the entire process chain!**

Chemical properties:

- High calcium (at least> 15 % dry mass fraction) and CaO content (> 20 % dry mass fraction)
- If ashes with a low Ca content are used, the binding properties can be improved by adding burnt lime (weight ratio ash:burnt lime about 85:15) to the soil (a mixture of wood ash with burnt lime prior to application to the soil is not permitted due to the ban on mixing of wastes according to the Austrian Waste Management Act AWG 2002).
- Low percentage of organic carbon (<5% by weight maximum, recommended <2% by weight)
- The heavy metal content in the ashes must be in a range which excludes a threat to groundwater caused by ash utilization → therefore, filter fly ash from grate furnaces (high concentrations of volatile heavy metals such as As, Cd, Pb and Zn) cannot be used as a binder. Moreover, the concentrations of volatile heavy metals may also be critical in coarse fly ashes from grate and fluidized bed furnaces and filter fly ashes from fluidized bed furnaces. Thus, the possible application of these ashes can only be evaluated after analysing the heavy metal contents by wet chemical analysis.

Recommended analyses from a professional perspective:

- Wet chemical analysis to determine the contents in the ash: TOC (total organic carbon), Ca, As, B, Cd, Cr, Cu, Fe, Hg, Mn, Na, Ni, Pb, Se, Zn (recommendations for limiting values are currently drawn up, the frequency of analysis should be defined in the course of creating a respective guideline in Austria).
- Performance of laboratory pressure resistance tests in accordance with ÖNORM B 4710-1 to determine the optimal ash admixing ratios.

Ash admixing ratios:

- 10 to 15 % mass fraction, based on dry mass of soil; to determine the exact amount of ash needed laboratory pressure resistance tests are recommended in accordance with ÖNORM B 4710-1

Ash demand:

- Depending on admixing ratio and thickness of the soil layer to be stabilized:
- Applying an ash admixing ratio of 10% by weight, based on dry soil mass: 60 to 100 kg / m² soil surface to be stabilized
- Applying an ash admixing ratio of 15% by weight, based on dry soil mass: 90 to 140 kg / m² soil surface to be stabilized

2 Where can wood ashes be used as a binder from a technical perspective?

Wood ash can be used in all cases where conventional construction methods are not capable of reaching the bearing capacity desired or large amounts of gravel are needed otherwise. These are mainly silt and clay ("cohesive") soils. Similar to the application of burnt lime the application of wood ash enhances the compressibility of soils and thereby a higher strength of the stabilized soil can be achieved.

3 What are the advantages of the utilization of wood ashes for users?

Application of wood ash by tipping the ash on the road (left), mixing with the soil to be stabilized by a rotary hoe (right)

Compared to conventional forest road construction, the processing of wood ash as a binder requires increased personnel and equipment expenses and may incur costs for the addition of lime. Since the ash can be delivered free of charge to the construction site the costs incurred for the application of gravel can be saved. Thus, for long forest road projects (from about 500 m) the utilization of wood ashes generates a significant cost advantage compared to conventional forest road construction.

4 What are the benefits of the use of wood ash as a binder for the heating plant operator?

- No disposal costs (the ash can be delivered free at site)
- The plant operator has only to bear the following costs:
  - transport costs (depending on the distance 4 to 15 €/t, based on costs for forest vehicles)
  - storage costs if intermediate storage is necessary

- These costs are dependent on the respective local conditions. It is expected that normally the costs of utilization are below typical Austrian landfill costs.
- Due to the high ash demand per m² to be stabilized, large amounts of ash can be utilized in *one* forest road construction project with *one* partner which makes the organization of ash recycling considerably easier. This is a big advantage compared to other utilization paths such as the application on agricultural or forest soils, where due to the lower ash demand a significantly larger area is needed to utilize the same amount of ash and therefore usually several partners are required.

5 What are the economic benefits of the use of wood ash as a binder for soil stabilization?

The economic benefits are listed below:

- conservation of non-renewable resources
  - reduction of gravel mining, thus reducing dust emissions and reducing the loss of fertile surface
- conservation of landfill space
  - reduction of the amount of ashes landfilled in Austria

6 What is the current status in Austria regarding the legal basis and the implementation in practice?

Legal basis in Austria:

- Wood ashes are considered as waste within the meaning of the Austrian Waste Management Act (AWG 2002). Wood ash from the incineration of natural and chemically untreated biomass has to be categorized as a non-hazardous waste with the ID-number 31306 - wood ash, straw ash. In theory, by recycling the ashes (defined as an ecologically appropriate treatment of waste by using the properties of the waste material with the main purpose of using the waste directly for the substitution of raw materials or products obtained from primary raw materials) they are no longer considered as waste according to AWG 2002. However, since no specific Austrian ordinance or an EU ordinance legislated on the basis of the EU Waste Framework Directive regulates any end-of-waste-criteria, wood ashes are as long considered as a waste until the ashes, or the substances recovered from them, are used directly to substitute raw materials or products obtained from primary raw materials. Therefore, in the case of the use of wood ash for forest road construction wood ashes do not reach the end-of-waste status until they are applied to the soil as a substitution of burnt lime. For this reason, wood ashes have to be handled as wastes from the biomass plant over storage and transport to the application by the end user. The whole handling process is subject to waste legislation.
- Based on the definition of recycling according to AWG 2002 the utilization of waste can only be considered as recycling if the waste substitutes raw materials or products obtained from primary raw materials and if the utilization is environmentally safe. A utilization according to AWG 2002 is only permissible if the waste in question is used safely for the purpose intended, no protected goods (groundwater etc.) are affected by

this application and no legal provisions are violated. Since the criteria of the use of the material properties and the substitution of a raw material or products obtained from primary raw materials (burnt lime) are present without any doubt, the utilization of wood ash in forest road construction has to comply with the following requirements:

- the ashes are suitable to fulfill the purpose of soil stabilization,
- no protective goods (public interest in accordance with AWG 2002) are impaired and
- no legal provisions are violated

More precise binding targets, based on which the admissibility of the use of wood ash in forest road construction has to be assessed (e.g. in the form of limit values for pollutant concentrations) do not exist.

- According to AWG 2002, the owner of wood ash (= owner of the biomass combustion plant) may assign the wood ashes only to natural or legal persons who are entitled by the Governor to collect and treat waste categorized with ID 31306).
- The use of wood ash as a substitution for burnt lime for soil stabilization is a waste treatment within the meaning of AWG 2002. The use of wood ash for soil stabilization may therefore only be performed by a (natural or legal) person who is authorized under AWG 2002 to treat waste categorized as waste with the ID 31306. A permit for the collection and treatment of wood ash is to be granted if
  - the kind of collection and treatment applied corresponds to the requirements of the AWG 2002 and does not contradict public interests according to AWG 2002;
  - the kind of collection and treatment applied is suitable for wood ashes;
  - the waste collector has a suitable intermediate storage available which is approved for the storage of wood ash;
  - the reliability of the (natural or legal) person in respect to the collection and/or treatment of wood ash is given and
  - the technical knowledge and skills are demonstrated for the collection and treatment of wood ash.
- According to the Austrian Remediation Act (AlSAG), the depositing of waste above or below the earth but also the filling of uneven terrain (including the filling of pits or trenches), the construction of ground structures (including the construction of dams or substructures of roads, railway tracks or foundations) or the filling of mines with waste is generally subject to a remediation fee. Wood ashes are still characterized as waste according to the AWG 2002 at the time of application as a substitute for burnt lime and no exception according to § 3 para 1a AlSAG to the obligation to pay remediation fees exists. However, the use of wood ash as a substitute for burnt lime in forest road construction is not subject to remediation fees within the meaning of the AlSAG, since the use of wood ash in forest road construction meets the criteria for recycling according to AWG 2002. Since the results of the collaborative research project show that the criteria of substitution and environmentally sound utilization are met, the utilization of ashes in forest road construction has to be qualified as recycling and not as a deposition according to AlSAG. Moreover, the use of wood ashes as a substitute for lime cannot be qualified as backfilling or terrain adaptation, because wood ashes do not substitute

any backfilling material and are not used for landscaping (especially the construction of any structures), since the application of wood ashes by a spreader and a rotary hoe is only carried out for the substitution of burnt lime with the purpose of water retention and to improve the bearing capacity of an existing support layer.

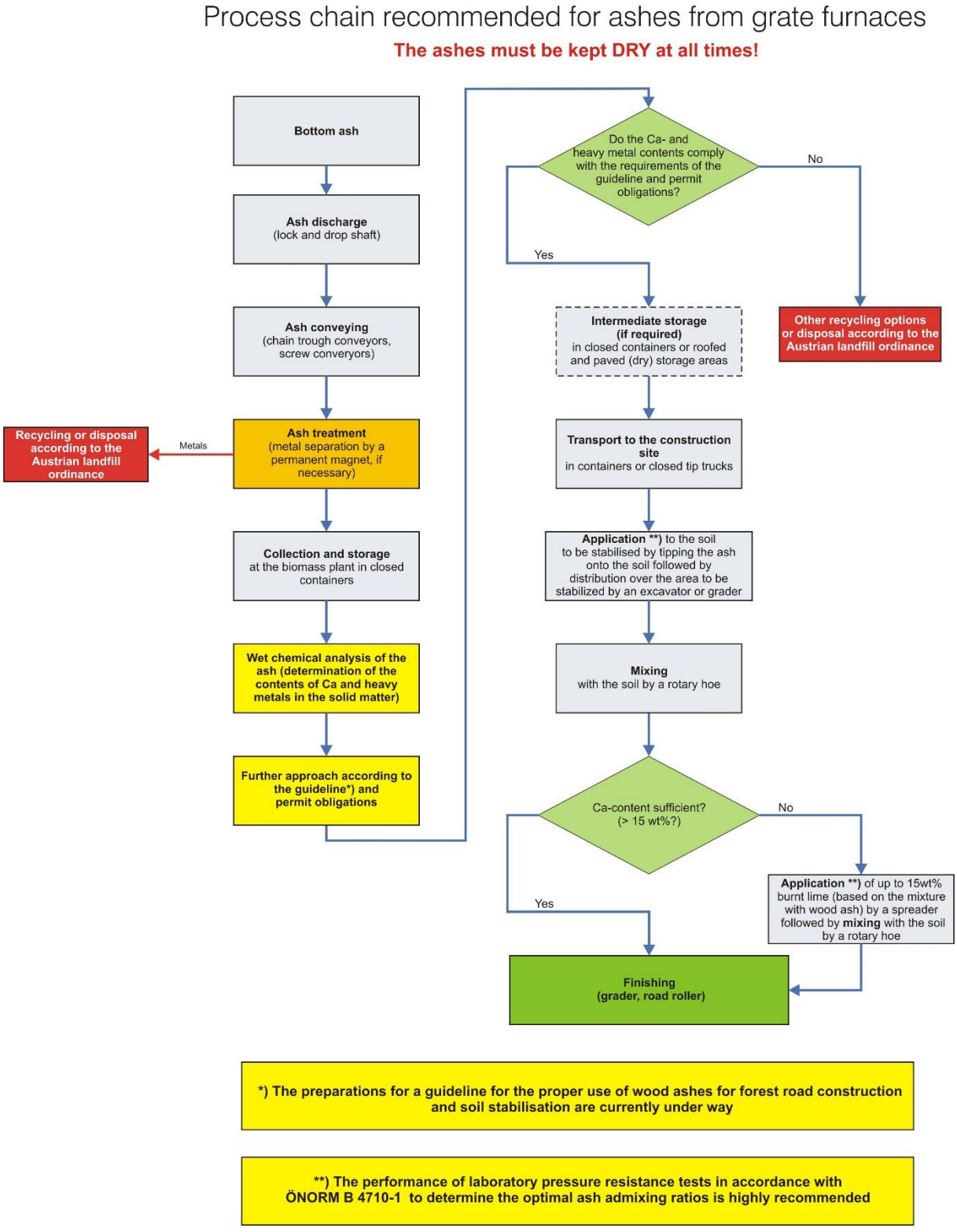
An obligation to pay a remediation fee according to AlSAG for the use of wood ash for the purpose in forest road construction is therefore not given, since these activities are not subject to remediation fees according to AlSAG. However, a legal certainty relating to an obligation to pay a remediation fee according to AlSAG is not given, since in this respect there is no positive opinion of the Federal Ministry of Agriculture, Forestry, Environment and Water Management available.

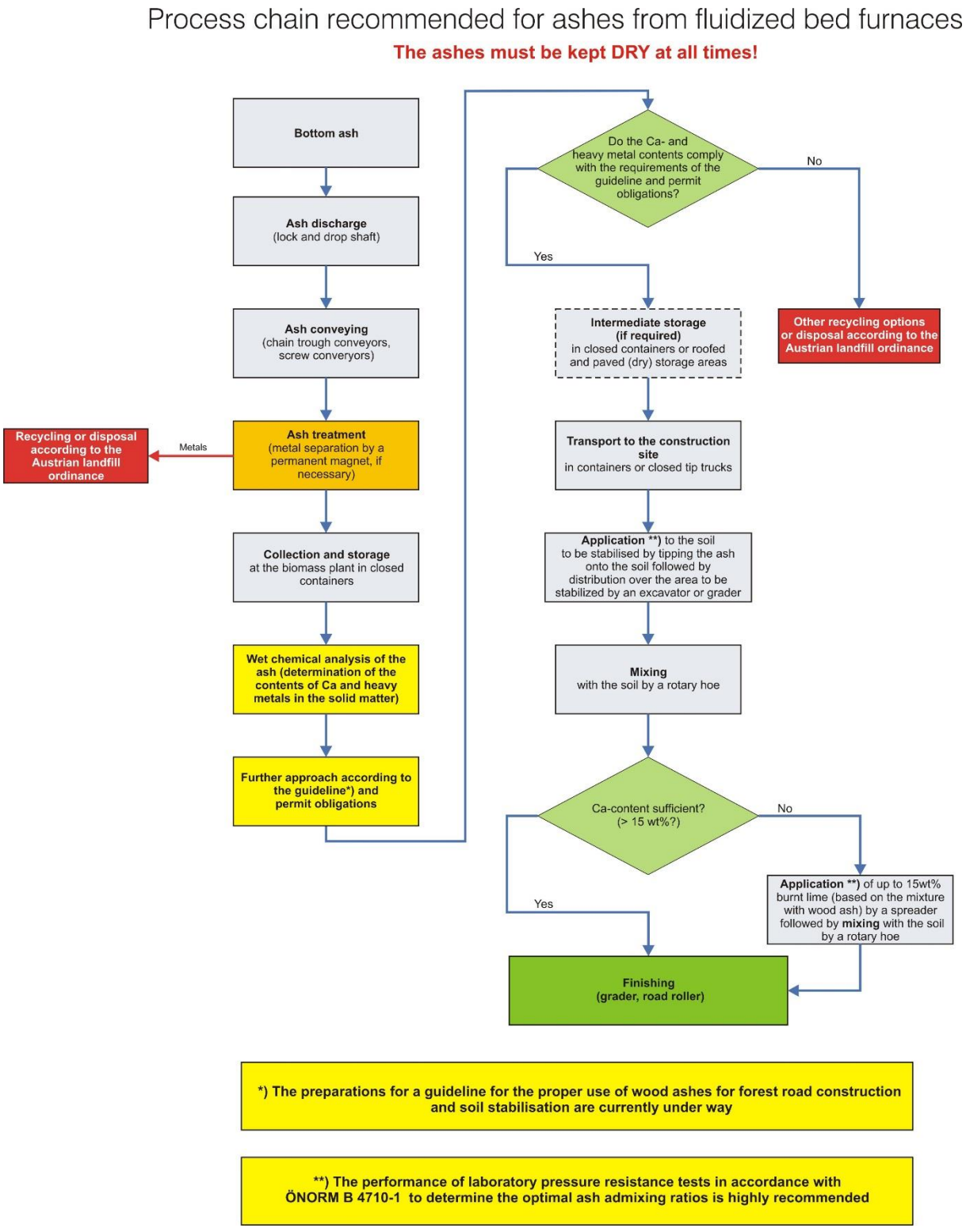
- Based on the results of the project a guideline for the proper utilization of wood ashes in forest and conventional road construction for soil stabilisation, which includes all relevant technical, economic and environmental framework conditions shall be prepared. The main goal is the definition of a standardized approach for operators of heating and combined heat and power plants as well as for users of the wood ash, which is accepted by the relevant authorities. Once such a guideline is prepared and come into force it shall be the basis for future approvals by the authorities.

Status in Austria:

- To date no use in industrial practice. The method was successfully tested as part of the four-year collaborative research project "Development of innovative processes for wood ash utilization" on experimental road sections (located in upper Austria).
- **Unfortunately, due to the lack of legal framework conditions a use in industrial practice is currently not yet possible.**

7 Process chain recommended





Ash treatment at the biomass plant

- Grate furnaces:
  - bottom ashes: metal separation by permanent magnet, followed by a mixing with coarse fly ashes. The metal separator has to be designed in a way that a high separation efficiency can be achieved at a high throughput and that the metal separated does not block the conveyor (e.g. positioning of the metal separator above a conveyor belt). Metal separation of the ashes can be omitted if metals were separated during biomass fuel processing.

- Coarse fly ashes (if the utilisation is allowed): no ash treatment necessary

- Fluidised bed furnaces:
  - bottom ashes: metal separation by permanent magnet, followed by a mixing with coarse fly ashes. The metal separator has to be designed in a way that a high separation efficiency can be achieved at a high throughput and that the metal separated does not block the conveyor (e.g. positioning of the metal separator above a conveyor belt). Metal separation of the ashes can be omitted if metals were separated during biomass fuel processing.
  - Coarse fly ashes (if the utilisation is allowed): no ash treatment necessary

Ash conveying and storage at the biomass combustion plant

- Grate furnaces:
  - Bottom ashes: conveying by conveyor belts, chain trough conveyors or screw conveyors, mixing with coarse fly ashes (if utilization of coarse fly ashes is allowed) and storage in closed containers
  - Coarse fly ashes (if the utilisation is allowed): conveying by chain trough conveyors, screw conveyors or pneumatic conveying, mixing with bottom ash and storage in closed containers
- Fluidised bed furnaces:
  - Bottom ashes: conveying by conveyor belts, chain trough conveyors or screw conveyors, mixing with coarse fly ashes and storage in closed containers
  - Fly ashes (if the utilisation is allowed): conveying by chain trough conveyors, screw conveyors or pneumatic conveying, storage in silos

Intermediate storage (if required)

Dry storage is very important!

- Grate furnaces:
  - Bottom ashes: storage in a container or at roofed and paved storage sites (dust emissions have to be minimised), if the ashes are untreated; crushed/milled ashes shall be stored in silos.
  - Mixture of bottom and coarse fly ashes as generated in the heating plant (if the utilization of coarse fly ashes is allowed): storage in a container or at roofed and paved storage sites (dust emissions have to be minimised), if the ashes are untreated; crushed/milled ashes shall be stored in silos.
- Fluidised bed furnaces:
  - Bottom ashes: storage in a container or at roofed and paved storage sites (dust emissions have to be minimised), if the ashes are untreated; crushed/milled ashes shall be stored in silos.
  - Fly ashes (if the utilization is allowed): storage in silos

External treatment

An external treatment (i.e. grinding of bottom ashes), as it is necessary for wood ashes used for soil stabilisation in road construction, is not required for the utilization in forest road construction, since the ashes can be tipped onto the soil and spread by graders or excavators.

Transport to the construction site

- Grate furnaces:
    - Bottom ashes or mixture of bottom and coarse fly ashes as generated in the heating plant (if the utilization of coarse fly ashes is allowed): transport in containers or tip trucks (the cargo area has to be covered to avoid dust emissions during transport)
- Fluidised bed furnaces:
    - Bottom ashes: transport in containers or tip trucks (the cargo area has to be covered to avoid dust emissions during transport)
    - Fly ashes (if the utilization is allowed): silo wagon

Application

- Bottom ashes or mixture of bottom and coarse fly ashes as generated in the heating plant (if the utilization of coarse fly ashes is allowed) from grate furnaces and bottom ashes from fluidized bed furnaces:
    - Tipping onto the soil from the container or tip truck
    - Even distribution over the area to be stabilized by a grader or an excavator
- Fly ashes from fluidized bed furnaces (if the utilization is allowed):
    - Immediate filling of the spreader out of the silo wagon.
    - Application to the soil by spreaders (maximum particle size 1mm).

    or

    - Tipping onto the soil from the silo wagon
    - Even distribution over the area to be stabilized by a grader or an excavator
- A mixture of ashes with burnt lime is necessary if the Ca and the CaO content in the ashes is too low. However, due to the mixing ban for waste, the mixture must take place on site by applying ash and burnt lime one after the other.

Processing

- Mixing with the soil by a rotary hoe.