TECHNICAL PAPER

FLUE GAS CLEANING DURING THE CARBONISATION PROCESS OF LOW VALUE BIOMASS CONTAINING RESIDUAL FLOWS

Considerations for the method chosen and description of the flue gas cleaning installation

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ABSTRACT

Whenusing low value biomass containing residual flows as feedstock for the carbonisation process the increased chlorine and sulphur content of these flows will be partly present in the process-syngas to that extent it will give rise to emission to open air problems (not meeting the emission standards).

Investigations showed, that cleaning of the process gas only can be done in an effective and controlled way after incinerating the process-syngas .

Literature research and consultation with potential suppliers of flue gas cleaning installations indicated, that a dry flue gas cleaning with addition of Ca(OH)2 or NaHCO3 is technically and economically the most favourable.

CONTEXT OF THE PAPER

This technical paper is part of a number of articles that describe the use of low-value biomass-containing residual flows as a raw material for the carbonisation process, whereby the carbonised product (biocoal) could replace fossil black and brown coal in various types of application.

PERPETUAL NEXT

INTRODUCTION

Exposing various biomass containing flows to a carbonisation process (heating up to 300 °C in an oxygen low environment), the properties of these flows will be changing in such a way these can be used as a fossil coal substitute for energy production and chemical industrial processes (like syngas production and steel production).

For business economic and sustainable reasons biomass containing flows are used, which cannot be used in their original form for other high-quality applications.

Unfortunately, these biomass containing flows mostly show an increased chlorine content (max. 2 w.-%) and / or sulphur content (max. 0,5 w.-%). During carbonisation the present chlorine and sulphur move partly to the process-syngas and partly these elements stay behind in the carbonised product.

The process-syngas is burned during the carbonisation process and flue gas will come into existence with HCl and SO2 content far above the allowed emission standard to open air.

By that it is necessary to remove sufficiently chlorine and sulphur from the process-syngas or the flue gas before emission to open air takes place (gas cleaning).

GAS CLEANING

About 50 % up to 90 % of the chlorine, present in the biomass feedstock moves during carbonisation to the process-syngas. Investigations have shown, that about 40 % of the chlorine, present in the process-syngas, is organically bound. The remaining 60 % is present as inorganic HCl.

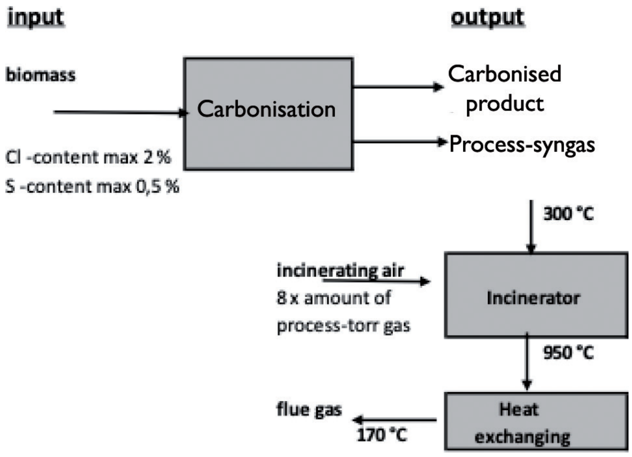
Only the present inorganic HCl can be removed with the common additives, like Ca(OH)2 or NaHCO3. By that it is not possible to remove chlorine in a sufficient way from the process-syngas. After burning of the process-syngas all chlorine will be present in the flue gas as inorganic HCl and can be removed almost 90 % by Ca(OH)2 or NaHCO3 at temperatures between 100 °C and 300 °C.

About 20 % up to 60 % of the sulphur, present in the biomass feedstock moves during carbonisation to the process-syngas Investigations done by ECN (commissioned by Perpetual Next C-Vertr technology) have shown, that about 58 % of the sulphur in the process-syngas will be present as SO2, 38 % as H2S and 4 % as COS (carbonyl sulphide). It is possible to remove at about 300 °C with certain common additives SO2 and H2S from the process-syngas .

After burning of the process-syngas all sulphur will be present in the flue gas as SO2 and SO3. These compounds can be removed for a large part by Ca(OH)2 or NaHCO3 at temperatures between 100 °C and 300 °C.

Besides the fact chlorine cannot be removed in a sufficient degree from the process-syngas there is another big disadvantage, if the removal of chlorine and sulphur will be done from the process-syngas. This gas contains, due to the carbonisation process, an amount of tars, which may have a disturbing effect during the removal of chlorine and sulphur from the process-syngas .

SUMMARIZED



One remark about the flue gas temperature. Looking to

- melting points of salts formed,
- reactivity of the additive with HCl, HF, SO2 and SO3,
- acid dewpoints (SO3 most critical: about 140 °C)
- temperature resistance of the filter bags,

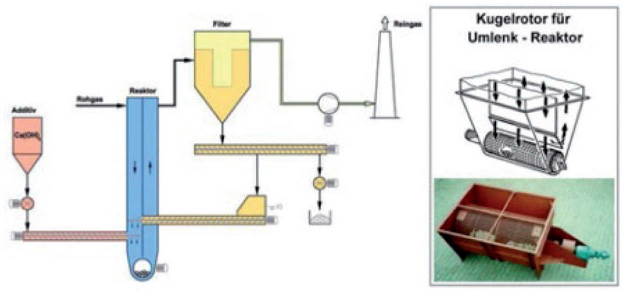


Figure 1: sketch flue gas cleaning installation

Distribution Cl and S: input to output

	carbonised product		process-syngas	
	min.	**max.**	**min.**	**max.**
Cl	10%	50%	50%	90%
S	40%	80%	20%	20%

Appearance of Cl and S in process-syngas (approx.)

Cl	
organical	40%
inorganical	60%

S	
SO2/SO3	58%
H2S	38%
COS	4%

Appearance of Cl and S in flue gas

Cl	
organical	0%
inorganical	100%

S	
SO2/SO3	100%
H2S	0%
COS	0%

The best way to prevent unacceptable emissions to open air is therefore to clean the flue gas (this means gas cleaning after incinerating the process-syngas) by adding to the flue gas dry Ca(OH)2 or NaHCO3 at a flue gas temperature of about 200 °C. This is a proven flue gas cleaning technology.

In other words, this flue gas cleaning installation is technically and process-based the most confident to realize the set emission to open air goals.

Flue gas cleaning installation consists of: a binder storage silo, transport system binder to reactor, a reactor (mixing binder / flue gas), flat-bag filter to separate used binder and cleaned flue gas, back and discharge of used binder, flue gas fan. Processing about 20.000 Nm³/hour flue gas total needed electrical power (installed) will be about 160 kW. Binder consumption depends on the amount of HCl, SO2 and SO3.

CONCLUSION

Low value biomass containing rest streams, like agricultural residues, wood from park and forest maintenance (branches), demolition wood and separated household waste (SRF), can be used as a raw material for the carbonisation process, whereby the carbonised product (biocoal) could replace fossil black and brown coal in various types of application.

Some of these raw materials will show an increased content chlorine (max. 2 w.-%) and / or sulphur content (max. 0,5 w.-%) and by that these elements will be partly present in the process-syngas (chlorine up to 90 % of original quantity in the raw material, sulphur up to 60 % of original quantity in the raw material) to that extent it will give rise to emission to open air problems (not meeting the emission standards).

It will be for sure an additional process is needed in that case to meet the prescribed emission to open air standards.

Investigations showed, that cleaning of the process-syngas only can be done in an effective and controlled way after incinerating the process-syngas .

Literature research and consultation with potential suppliers of flue gas cleaning installations and additives indicated, that a dry flue gas cleaning with addition of Ca(OH)2 or NaHCO3 is technically and economically the most favourable.

This gas cleaning system has been installed at the industrial carbonisation production installation in Dilsen (Belgium) end 2020. By that it will be possible to meet the prescribed emission standards, if biomass containing lowvalue residual flows with increased chlorine and sulphur content are used for carbonisation on industrial scale.

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