Remarks on Ramboll‘s basic concept for the new Antwerp WtE-plant on behalf of ISVAG

short report for

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September 2016

1 Summary

ISVAG is currently advancing the development of a new WtE-plant as replacement for the existing facility. Requested key parameters are a low environmental impact, high energy output and well-proven technical solutions.

On this basis Ramboll designed a layout for the new plant, which was presented and discussed on August 30th 2016 in Berlin. In general, the layout suggested by Ramboll is judged to be well deliberated, reasonable arranged and elaborated with a high quality.

Regarding furnace and boiler, bottom ash treatment, energy concept as well as general layout and operation the suggestions of Ramboll can be followed. Also the design concept with only one line is supported, if organizational arrangements guarantee a save waste disposal in case of plant shutdown.

Regarding the flue gas treatment, a different solution is recommended. In contrast to Ramboll's advice [combined semi-dry/wet treatment], a two-stage dry flue gas treatment [bicarbonate + dry lime; cf. figure 1] is suggested. Both systems offer very similar and very low emission values, with an advantage in energetic efficiency for the dry system. Nevertheless, both solutions are reasonable, applicable and ecologically beneficial.

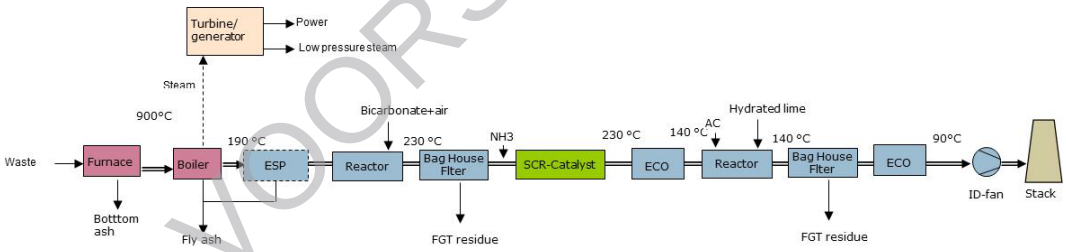

Figure 1: Bicarbonate, SCR, lime based dry adsorption [Alternative 3, Ramboll's MEMO 4]

2 Scope

Intercommunal Slib en Vuilverwijdering Antwerpse Gemeenten [ISVAG] is currently advancing the replacement of the existing WtE-plant by a modern installation. Requested key parameters – regarding the technology – are

- a low environmental impact [special focus on NOx, fine dust and heavy metals]
- high electrical efficiency and flexible district heating
- at least 8.000 h/a operation and 20 years lifetime

Additionally, the application of "well-proven and commercial standard components and solutions", with the possibility of flexible reaction on changes, e.g. in waste, environmental requirement, heat delivery, is desired.

On this basis and other framework conditions Ramboll designed a layout for the new plant, regarding different alternatives and giving recommendation for a preferred configuration. The results of Ramboll's engineering work and the applied frame conditions and assumptions are described in the documents [MEMO 000-011] sent via e-mail on August 24th 2016 by Tom De Bruyckere to the members of the board. Additionally a revised version of the MEMO 4 about flue gas cleaning – ISVAG-31-010-MEMO 4 Flue gas treatment_NL[1] – was submitted by mail on September 13th. This document should replace the former elaboration about the flue gas cleaning installation.

The plant layout was presented by Ramboll [Ole Poulsen] and discussed during the meeting of ISVAGs External Scientific Advisory Board on August 30th 2016 in Berlin.

In the following the suggested plant layout is discussed and, where appropriate, suggestions for adaptions or modifications are made.

3 Discussion of plant layout

In general, the layout suggested by Ramboll seems to be well deliberated, reasonable arranged and elaborated with a high quality. Nevertheless, in some points improvements regarding the plant configuration seem to be adequate. This concerns predominantly the concept for flue gas cleaning, where two different solutions are in discussion.

3.1 Furnace and boiler

The furnace concept, consisting of a water cooled feeding chute, a ram feeder and an air cooled grate, with the possibility of air preheating up to 145 °C, is robust, flexible and state of the art.
Boiler steam parameters of 53 bar and 425 °C may for some areas of the superheaters already cause corrosion problems [extended corrosion area]. Suppliers should issue reasonable guarantee periods for the boiler durability.

3.2 Flue gas treatment

ISVAG has a very clear idea about the emission characteristics of the new plant. Ambitious emission levels have to be reached [cf. table1, right column], which are only achievable with a two-stage configuration of the acid gas and heavy metal adsorption unit and reasonably with an SCR-catalyst for nitrogen oxide reduction. Ramboll regarded five different concepts – a base and four alternative configurations – in their preliminary study.

During Ramboll's presentation in Berlin, a combination of a lime-based semi-dry adsorption unit with a wet scrubbing system and a tail-end SCR-catalyst [base scenario in MEMO 4] was suggested as the best solution for the requirements of ISVAG. The following discussion showed that some of the attending members of the External Scientific Advisory Board would prefer a combination of two dry adsorption steps with bicarbonate and lime as a more suitable solution. Main reasons for this opinion are the following issues regarding the wet system:

- The necessity to reheat the cooled flue gas to the temperature level of the SCR-catalyst after scrubbing. This is highly energy consuming, because – even with a sophisticated heat transfer system – the whole flue gas volume stream of ca. 140.000 $m^3_{i.N.}$/h has to be heated up by 20 °C. This means a thermal power of about 0,65 MW which has constantly to be raised.
- The discharge of the water from the scrubber system. There are two principle possibilities to treat the waste water:
  - waste water cleaning and discharge to a river,
  - evaporation of the water in a special facility or within the plant.

  In the suggested configuration, it is foreseen to evaporate the waste water in the lime reactor, to adjust the optimum temperature for the reaction from

about 170 to 140 °C. This means a loss of approximately 1 MW thermal power by quenching, which otherwise could be used for energy purposes.

Ramboll also suggested a two-stage bicarbonate-based FGT-system [Alternative 3 in MEMO 4; cf. figure 1] in the preliminary study as a possible alternative for the wet system. This configuration makes it possible to run the whole zone between boiler outlet and SCR catalyst at a constant temperature level [between 180 and 230 °C]. Both, catalyst [with periodical regeneration by gas burners] and adsorption unit with bicarbonate and bag filter, can be operated under these conditions and therefore no energy consuming reheating of the flue gas upstream the catalyst is necessary. The recirculation of hydrated lime should be applied to enhance the utilization of this adsorbent and to get reasonable stoichiometric factors.

On the base of the discussion in Berlin, Ramboll revised some details [especially the water-side integration of the economizer, located between the two adsorption steps] of the two-stage dry configuration and recalculated the characteristic figures [e.g. energy balances, costs]. After recalculation, Ramboll came to the same conclusion and suggested still that the original approach with lime-based semi-dry adsorption and wet scrubbing system is the most suitable configuration for ISVAG demands. Main argument for this assessment is the good suitability to reach the requested challenging low emission values [especially for HCl and SO_2].

In the following [figure 2, table 1], technical configuration and emission performance of a two-stage dry flue gas cleaning system – as suggested by the author for the new Antwerp plant – are shown by the example of the WtE-plant in Delfzijl, NL.

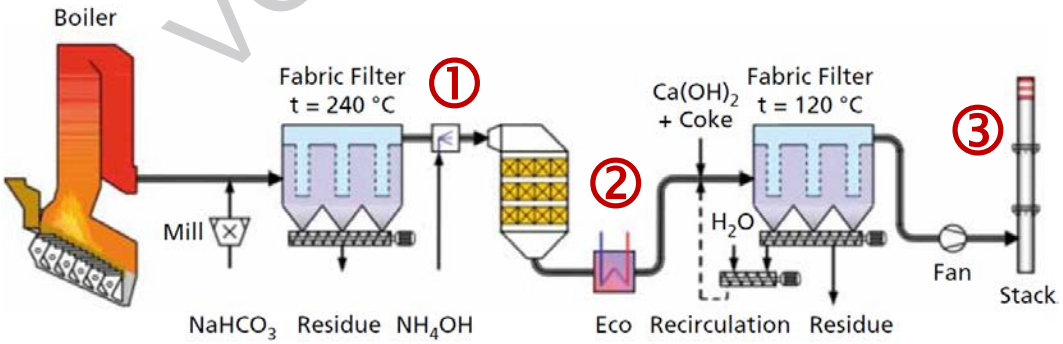

Figure 2: Configuration of flue gas cleaning in the WtE-plant Delfzijl, NL [Löschau].

The comparison of the plants emissions with the ISVAG specifications shows far-reaching compliance [table 1]. For the extremely toxic component mercury even lower values than requested can be reached with the suggested dry system.

Table 1: Flue gas composition WtE-plant Delfzijl, NL [Karpf] [① = downstream bicarbonate-step, ② = downstream catalyst, ③ = emission values, numbers refer to figure 1; plant has similar configuration as Alternative 3, suggested by Ramboll, cf. MEMO 4], in comparison with the EU limits according to IED [2010/75/EU] and with the ISVAG specifications.

Parameter	Unit	WtE-plant Delfzijl [NL]			EU Limit	ISVAG *specification daily average*	ISVAG *specification annual average*
		①	②	③			
Dust	[mg/m³i.N.]	< 1	< 1	< 1	10 [a)]	5	1
TOC	[mg/m³i.N.]			< 0.5	10 [a)]	5	0.5
HCl	[mg/m³i.N.]	< 115	< 115	< 1	10 [a)]	3	1
SO_2	[mg/m³i.N.]	< 30	< 30	< 5	50 [a)]	10	1
NO_x	[mg/m³i.N.]	350	< 70	< 70	200 [a)]	70	65
Hg	[mg/m³i.N.]			< 0.005	0.05	0.01	< 0.01
CO	[mg/m³i.N.]			< 10	50	25	10
NH_3	[mg/m³i.N.]			< 2	-	3	1
Temp.	[°C]	230	230	135			

[a)] daily average

3.3 Bottom ash

Incineration residues are: bottom ash, boiler ash and fly ash, together with the flue gas treatment residues. Whereas the bottom ash can be further treated [metal separation] and possibly utilized as a construction material, the other fractions are classified as hazardous wastes and should therefore strictly be kept separately from the bottom ash.

According to Ramboll's report an onsite processing of the bottom ash for metal recovery is not recommended, because of the low amounts of bottom ash and the relatively high investment cost for the installation of adequate processing equipment.

3.4 Energy

Energy recovery of a thermal plant is strongly connected to the possibility of heat delivery to nearby customers. This client base is not yet developed and therefor a judgement of an optimum configuration for the energy part of the plant is difficult.

This obvious necessity of future technical flexibility of the system results in the choice of an extraction condensing turbine.

3.5 Layout and operation

The basic parameters of 8,000 h/a operation, a bunker storage capacity of 2 weeks and one major annually revision stop seems reasonable and state of the art.

Also the design concept with only one line is supported, if organizational arrangements, e.g. partnerships with adjacent plants, guarantee a save waste disposal in case of plant shutdown. Also an emergency unit [e.g. gas burner] for full scale heat supply to the customers has to be provided.

References

[Karpf] Karpf, R.: Expert Assessment of the Flue Gas Treatment Process Implemented in the Delfzijl (NL) Waste Incineration Plant. 2015. Download: http://www.commissiemer.nl/projectdocumenten/00000688.pdf?documenttitle=3064%20Bijlage_1_9_Onderzoek_rookgasreiniging.pdf

[Löschau] Löschau, M.; Karpf, R.: Flue Gas Treatment – State of the Art. In: Thomé-Kozmiensky, K.J.; Thiel, S.: Waste Management, Volume 5. TK Verlag 2015