German GHG Mitigation Lighthouse Project MBT Plant Gaobeidian (PR China)

Florian Kölsch, Mathias Ginter, Klaus Fricke

Technical University Braunschweig, AWN Umwelt GmbH, Buchen, Germany

Abstract

In June 2009, the German Federal Ministry of Environment granted a fund to the German company AWN Umwelt GmbH (Buchen) to establish a mechanical biological treatment plant in the City of Gaobeidian (PR China). The facility is seen as a lighthouse project for GHG mitigation. In July 2009 the project work was launched. Detailed engineering design has been finalized by Pöyry Environment by October 2009 and the construction works were tendered. The site clearing and the construction of provision infrastructure was finalized by December 2009. In January 2010 the construction of the facility was started and will be finalized by April 2010. It is expected that the facility will run on full operation in summer 2011. Emission reductions of approximately 8.000-25.000 t CO_2eq per year are expected

Keywords

MBT, CDM, waste treatment, emission reduction, China, MSW

1 Introduction

Experts estimate that 8 to 12 % of greenhouse gas (GHG) emissions in developing and emerging market countries are due to waste management activities. The major sources are methane emissions from disposal of untreated municipal solid waste, which in those countries contains a large portion of degradable organics. Biological waste treatment is an effective technology to stabilize organics and to minimize decay processes in landfills. The MBT plant in Gaobeidian (Hebei province, PR China) is a pilot waste management project to demonstrate this technology in China.

The project is administered by AWN Umwelt GmbH, a German waste management company partly public owned by AWN (Abfallwirtschaftsgesellschaft Neckar-Odenwald-Kreis) based in Buchen. AWN Umwelt has already established a joint venture for the construction of a sewage treatment plant in Gaobeidian The project was recently finalized and started operation. In the summer 2006 AWN Umwelt and the Municipality of Gaobeidian decided to prepare a similar project for the improvement of the waste disposal in Gaobeidian. The treatment facility is under construction and will open in Summer 2011.

Figure 1: Location of Gaobeidian

The project aims on reducing emissions from waste disposal activities, particularly emissions of methane to reduce the GHG release to the atmosphere by means of biological treatment. With an annual treatment capacity of 40.000 t municipal solid waste the total emission reduction is expected to amount to 80.000 – 250.000 t CO_2equivalents during a 10 years period.

2 Methodology

In a first step the technical, economic and legal conditions were investigated in a feasibility study funded by the PPP facility of KfW development bank, an endowment fund for the support of public private partnership projects financed by the German Ministry of Economic Cooperation and Development (BMZ). The technical and organisational execution of the study was assigned to the department of Waste and Resource Management of the Technical University Braunschweig. The study was prepared between September 2006 and February 2008. Based on the study AWN Umwelt applied for funding from the International Climate Initiative (IKI) of the German Ministry of Environment, Nature Conservation and Nuclear Safety. In June 2009 the German Government approved the grant. The implementation of the project was launched in July 2009. Detailed engineering and the approval process was finalized in December 2009. The facility is currently under construction, which is expected to be finalized by April 2011.

3 Technical investigations

During the feasibility study several technical investigations were carried out by experts from Technical University Braunschweig, AWN Umwelt and Pöyry Environment Witzenhausen. Data on waste generation and waste composition were examined. The department of waste management of Gaobeidian municipality collects annually approximately 50.000-60.000 t municipal solid waste. The collection is carried out by different collection systems, predominantly by underground drop-off containers and multi-chamber containers that are located at the roadside. The waste disposal site was located near to the city in an exploited clay pit, but has been shifted to a new site next to the future MBT plant located about 10 km outside Gaobeidian. The old disposal site had no technical barriers and was operated on the poorest technical level as a dumpsite. Dozens of waste pickers are irregularly active on the site (figure 2).

Figure 2: Waste pickers at Gaobeidian city landfill

The composition of the waste was determined by means of hand assorting a 250 kg waste sample. The sample was screened by 40 mm and 10 mm sieves. The sieve overflows were sorted by hand into groups of materials. The material that passed the 10 mm filter has been analysed in the laboratory. Table 1 shows the waste composition distinguished by material groups, which constitutes approximately 55 % of the waste weight.

Table 1: Waste composition

Material group	**Portion [dry mass %]**
Organic	28 %
Plastic foils	8,5 %
Coal	8,5 %
Stones	5 %
Paper	3 %
Textiles	1,5 %
< 10 mm	45,5 %

Plastic bottles, metals, rag paper, glass bottles and wood were not found. Regarding to a biological waste treatment there is a particular interest for the portion of the organic group as well as possible disturbing materials. In the fraction < 10 mm the organic fraction is 16%, measured as loss on ignition. Thus the entire organic portion amounts to approximately 35 mass-%, significantly less than the common value for developing countries (usually: 50-70 mass-%). Disturbing materials were not found in the waste. The high ash portion, which originates from burned out coal elements from simple cook places, showed up to be slight in pollutants.

Figure 3: Actively aerated windrow for MSW

The suitability of the potential biological treatment procedures under the given boundary conditions (local situation, climate, waste composition) was examined in three different pilot plants:

- Passively aerated heaps (so called chimney effect system)
- Actively aerated windrow heaps for MSW
- Actively aerated composting windrows for biowaste

The results of the biochemical stability of the fraction < 40 mm before, during, and after the actively aerated windrow treatment are listed in table 2. The respiration activity of the input material measured as AT_4 (respiration during 4 days) amounts to 25 mg O_2/kg, the loss on ignition amounts to 18%, the TOC to 8%. Table 2 illustrates the development of the parameters over the treatment period. The respiration activity dropped significantly down to 1,9 mg O_2/kg after two weeks of treatment reflecting the comprehensive stabilization of the organics. The output material meets the German standards for waste disposal.

Table 2: Evaluation of the biochemical properties – actively aerated window for MSW

	Input	**after 14 days (active)**	**after 6 weeks (active)**
	13.10.06	2.11.06	13.12.06
AT_4 [mg O_2/kg]	25,2	1,9	0,9
oDS [mass %]	18,1	14,2	14,3
TOC [mass %]	8,2	5,1	5,2
TOC in the eluate [mg/l]	639	160	270

The results were not fully satisfying. Though the quality of output material was welcomed, the total mass of converted organics was small due to low input concentration. For the large scale application it was anticipated to increase the portion of organics in the input material by either segregating non-organic waste or by separation of organic waste before treatment. Since a separate source collection is not feasible in Gaobeidian a test was carried out for hand assorting of organic materials. A biowaste acquisition campaign was launched at the dumpsite. During a period of 5 weeks biowaste was accepted against incentives. The collected organics were placed immediately on the composting heap. Larger quantities of biowaste were delivered by both waste pickers and residents at a rate of 6 €/t. Thus there is an economical bench mark for the separate source collection for biowaste available.

Figure 4: Delivery of market waste by local resident

4 Design

Based on the technical investigations a design for the MBT plant was prepared by Pöyry Environment Witzenhausen. The MBT plant consists of a mechanical and a biological treatment step. The mechanical treatment aims on segregating of valuable goods (paper, synthetics) and on enrichment of the organic fraction. The waste stream is split into three fractions (fine, medium, coarse). Middle and coarse fraction are being directed to hand assorting stations. Based on the waste analysis it is expected, that the medium fraction after assorting consists mainly of slightly clean organic. This portion may be converted into compost. The fine fraction will undergo biological treatment as well prior to final disposal. This fraction may be also useful as amendment for landfill cover, where it acts as methane oxidation layer. The coarse fraction will be either crushed and fed to the waste stream again or directly disposed at the landfill site. The design of the delivery and pretreatment plant is shown in figure 5.

The biological treatment will be carried out as an aerobic, actively ventilated stabilization. The process will run partly under roof and partly in open air areas. The triangular windrow heaps will be frequently turned by means of mobile equipment as shown by example in figure 6. The output material will be disposed at the adjacent new landfill, which recently started operation.

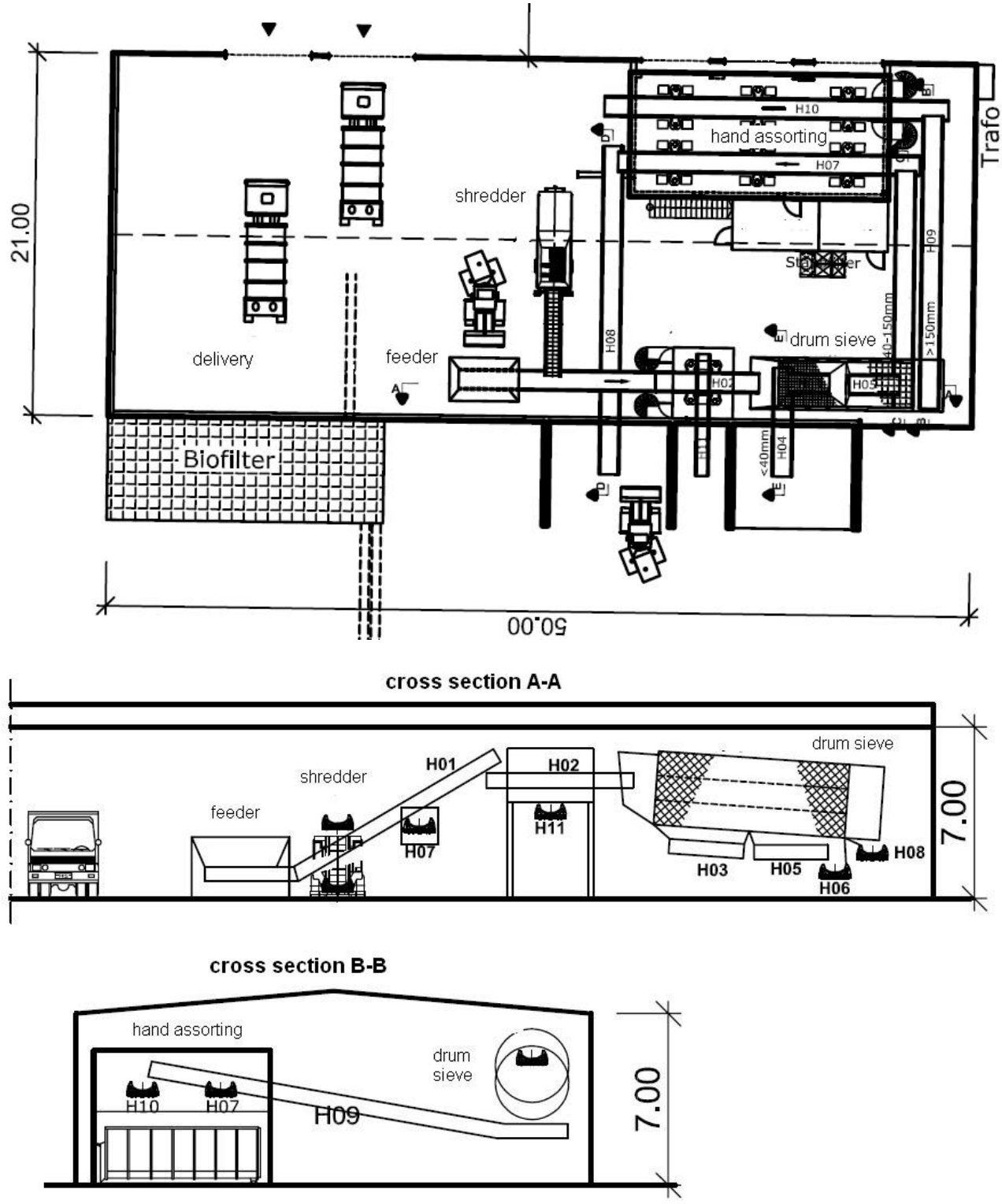

Figure 5: Delivery and mechanical treatment

On a longer view the economic benefits of the plant will be increased particularly by means of reutilization of the stabilized biomass for methane oxidation layer (special landfill cover), as soil amendment, or as fertilizer in agriculture, if possible. To achieve this goal the waste flux management needs to be refined in order to minimize pollutants and harming matters in the organic waste fraction.

Figure 6: Windrow heap under roof with revolving machine (example)

Figure 7: Lay out of the MBT plant Gaobeidian

The annual treatment capacity amounts to 40.000 t. If necessary, the capacity can be significantly increased by introducing two working shifts. The location still provides contingency area for an expansion of the biological treatment. Figure 7 illustrates the lay out of the facility.

5 Climate mitigation

The generation of methane in the landfill will be dramatically reduced by disposing stabilized biomass instead of untreated waste. The emission reductions were calculated using the methodologies of UNFCCC, which are relevant for CDM projects. Since the facility has been financed by national revenues from carbon trade a registration as CDM project is not permitted. Nevertheless, it is anticipated to verify the emission reductions in a similar procedure. Thus, the calculation of the baseline as well as the monitoring of project emissions is required.

The methodology AMS III.F (Avoidance of methane production from decay of biomass through composting) serves as the base of the baseline study and the monitoring concept for the Gaobeidian MBT project. For calculations an specific tool is available, the „ Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site".

In the greenhouse gas balance of the whole project, the emissions which result from the project itself must be considered as a negative influence. Therefore all CO_2 emissions from power or fuel consumption of motor vehicles and electric machines are considered. The calculation algorithms for both scenarios - baseline and project – are, as far as possible, given by the existing methodologies and tools. For the calculation of the methane emissions by the disposed waste, a biological decay of the deposited waste is modelled over several years by a layer model. With this model the highest methane emissions in a layer emerge during the first years and show in the subsequent years a regressive behaviour. Table 3 shows the ex ante calculated emission balance for the project Gaobeidian during one period of 10 years. The projected amount of emission reductions result in 83,812 t CO_2-equivalentes for the project period of 2011-2020. The calculation does not include any of the planned measures to increase the organic fraction prior to the biotreatment. The baseline calculations represent only a prognosis, the amount of real reductions can diverge strongly. It depends on the plant capacity, the waste composition, the resource input, and other factors. In fact, the amount of emission reductions may even become three times higher resulting in approximately 250.000 t CO_2-equivalents.

Regarding the monitoring process, all data that were used for the determination of the emissions, have to be determined ex-post, if not constant. Based on the monitored data the real emissions during the lifetime of the project will be recorded. To these data belong e.g. the power or fuel consumption, as well as the waste composition, which has to be examined several times in the year. Table 3 provides the breakdown of expected emission reductions over the first ten years of operation.

Table 3: Ex ante emission calculations for the MBT Gaobeidian

Year	Baseline emissions [Mg CO_2eq]	Project emissions [Mg CO_2eq]	Emission reductions [Mg CO_2eq]
2011	2339	497	1842
2012	4376	537	3839
2013	6156	577	5579
2014	7714	616	7097
2015	9081	655	8426
2016	10284	694	9590
2017	11345	732	10613
2018	12283	770	11513
2019	13114	807	12306
2020	13852	845	13007
Total	**90541**	**6729**	**83812**

6 State of implementation

On 3rd of July 2009 the establishment of the MBT was officially launched in a ceremony by laying the first stone. After the clearing of the construction site the local counterpart had turned the area into a festival zone with stage, flowers, dragons, balloons and red carpets. On a 3 x 15 m sign the future plant was visualized. German and Chinese stakeholders from the municipality, province and national government, project developers and the donor joined the event. Several hundred spectators from the region gathered as audience. Finally fire works crowned the opening.

The execution of the project proceeds quickly. In accordance with the Chinese regulations a feasibility study and an environmental impact assessment was carried out and finalized by the end of October 2009. The official permit was granted by November 2009. Site clearance and construction of access and supply infrastructure was launched immediately but suffered from harsh weather conditions in January/February 2010. The main construction works of the facilities started in April 2010.

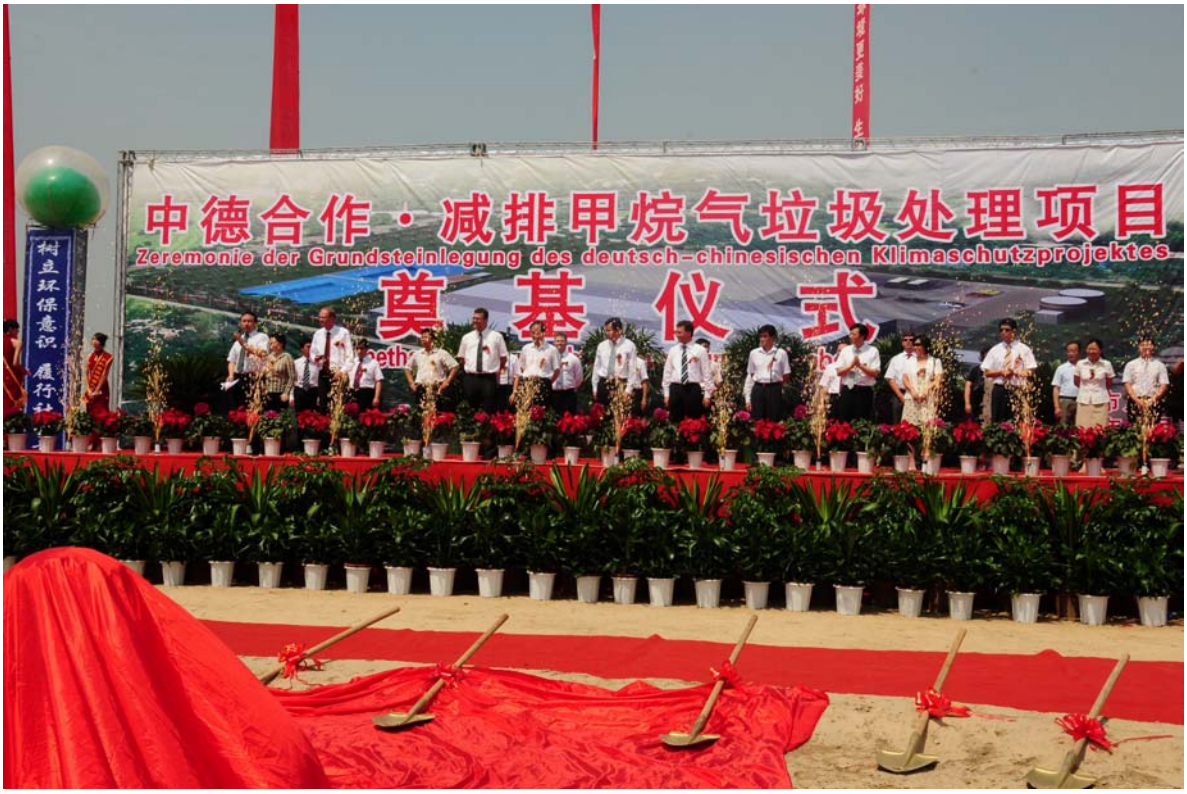

Figure 8: Opening ceremony

Figure 9: Facility compounds - biological treatment (in front), delivery (background)

All major civil constructions of the plant (delivery/mechanical treatment, biological treatment, administration, entrance) are nearly finalized. Figure 9 shows the current situation on site. The construction works are expected to be completed by April 2011, pilot operation shall subsequently.

7 Acknowledgements

The project developers appreciate the funding from the International Climate Imitative (IKI) by German Federal Ministry of Environment, Nature Conservation and Nuclear Safety. The International Climate Initiative is financing climate protection projects in developing and newly industrialising countries and in transition countries in Central and Eastern Europe since 2008. Through this, the Federal Environment Ministry is making an effective contribution to emission reductions and adaptation to climate change. This new form of environmental cooperation complements the government's existing development cooperation. Funding of 120 million euro per year is available for the International Climate Initiative from the revenues of the sale of emission allowances. A decision by the German Bundestag (parliament) forms the basis of this worldwide investment in climate protection. When selecting projects, the Federal Environment Ministry attaches great importance to the development of innovative and multipliable approaches that impact beyond the individual project itself and are transferable. Through targeted cooperation with partner countries the Climate Initiative provides important momentum for negotiations on an international climate agreement for the post-2012 period. One focus of the International Climate Initiative lies in the areas of promoting a climate-friendly economy. In this field the goal is to support partner countries in establishing a climate-friendly economic structure that prevents climate-damaging greenhouse gas emissions where possible. This support covers areas such as increasing energy efficiency, expanding renewable energies, reducing environmentally harmful greenhouse gases and investment-related measures, know-how transfer and policy advice in the partner country.

Author's address*:*

Dr.-Ing. Florian Kölsch
Dr. Kölsch Geo- und Umwelttechnik GmbH
Gliesmaroder Straße 100
D-38106 Braunschweig
Telefon +49 531 2094133
Email: office@dr-koelsch.de
Website: www.dr-koelsch.de