Fluidized Bed Incinerator in Tongliao (Inner Mongolia, China)
– Industrial Sewage Sludge and Liquid Waste Incineration under Difficult Circumstances –

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Lonza Engineering Ltd. Basel, Switzerland (member of Lonza Group AG) and its wholly owned subsidiary Lonza Guangzhou Engineering & Consulting Co., Ltd., China provides customer oriented services with a professional and experienced engineering team. The company has more than 15 years of project management experience in China. Lonza has managed multiple and complex projects such as continuous operating plants for the production of food and feed additives as well as active pharmaceutical ingredient plants including waste gas and liquid waste treatment facilities.

In 2010 Lonza Engineering Ltd. has integrated one of the main suppliers for stationary fluidized bed incineration technology, Raschka (Germany). In Switzerland, Lonza Visp is operating such a facility since 1976 while gaining operational experience the system was continuously improved and optimized

1. Chinese market

The large, very fast growing agglomerations in several of Chinas provinces create a great demand for sludge treatment technologies. Often the industrial sewage sludge problem is of higher importance and priority. The herein discussed project describes the situation of many industrial manufacturing facilities in China.

2. Project Tongliao

The sludge and liquid waste produced in the Tongliao factory (PRC) is now being incinerated in an incineration plant at the production site. For the incineration process a Fluidized bed incinerator (FBI) has been chosen. Behind the FBI a heat recovery steam generator (HRSG), a filter and scrubber are provided for the flue gas cleaning.

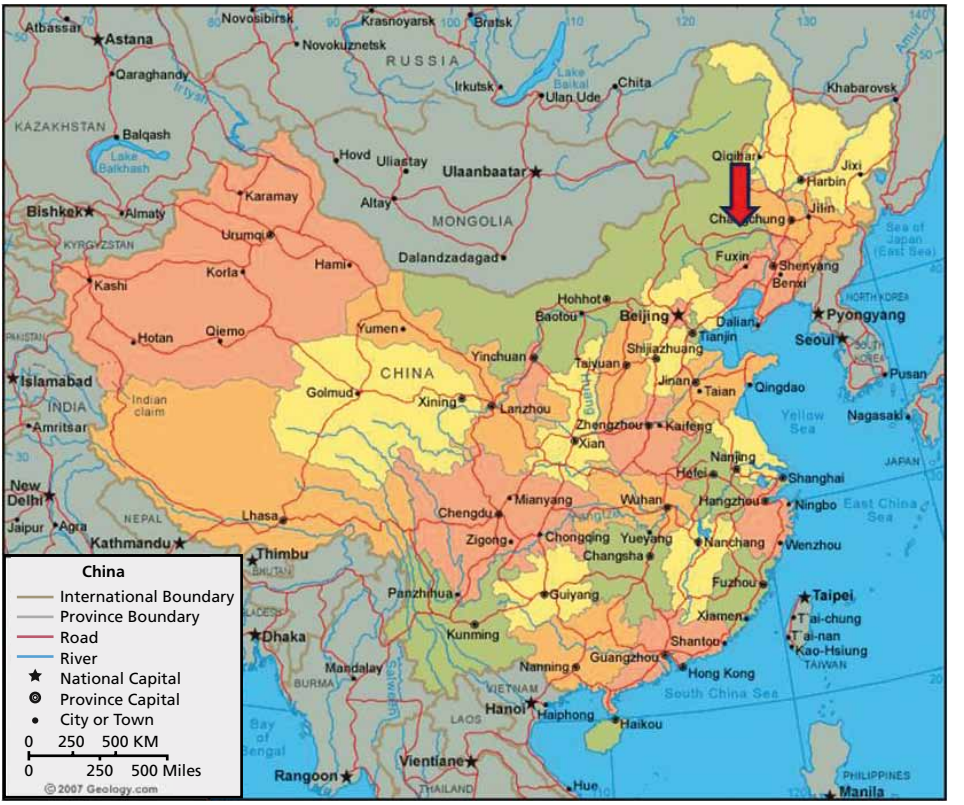

Figure 1: Map of China, topographic situation of Tongliao

The design parameters and layout of the FBI is based on the data provided by the Chinese customer. Some substantial deviations from the actual data to the initial customer input have been observed however the system is capable to run in a somewhat wider range to what was originally envisaged.

The sludge to be incinerated is already dewatered to a dry substance content of 20 %, the quantity of the dewatered sludge amounts to 3.1 t/h. The resulting calorific value (LCV) of the sludge is too low for an equilibrated heat balance of the incineration process. Therefore coal must be added to the sludge to increase the calorific value to achieve an equilibrated heat balance of the incineration process. The coal must be added in a certain portion and mixed thoroughly with the sludge to produce a homogeneous sludge-coal-mixture with constant calorific value. This pasty mixture must be free of foreign matters and solid lumps. The ash softening point of the sludge-coal-mixture must be appropriate to avoid slagging of the fluidized bed and the flue gas duct between FBI and HRSG. The particle size of the coal must be within a specified range.

Based on the LCV of the sludge, around 2.7 t/h coal is mixed with the sludge and fed to the incinerator.

The feeding of the sludge-coal-mixture into the FBI is done by a special feeding device (spreader) which serves for opening up and for even distributing the combustible across the entire fluidized bed. The combustible is conveyed to the spreader of the FBI by adequate

conveying devices; the conveying must be accurate enabling an evenly and exactly dosed feed with a maximum variation of ≤ ± 2 % .

The sludge-coal-mixture is combusted in the FBI at a temperature of 850 – 900 °C with an excess air factor of 1.4. The retention time of the flue gases in the post combustion zone after the last feeding of air is more than 2 seconds, the residual oxygen content of the flue gases will amount to 6 Vol.%. The thermal power of the incineration process amounts to 18.2 MW.

The FBI is a brick lined steel casing with an inner refractory lining and an outer thermal insulation. The main sections are the conical lower part with windbox, the nozzle bottom and fluidized bed area and the cylindrical upper part with the freeboard area.

The incineration process takes place in a fluidized bed which is suspended in an air stream coming from the nozzle bottom. The nozzle bottom is a refractory ceramic disc which is equipped with air nozzles made of heat resistant cast steel. The main part of the combustion air that is necessary for the incineration process is blown up-wards through the nozzle bottom and fluidizes a sand layer above the nozzle bottom. This part of the combustion air which is blown through the nozzle bottom is also called fluidizing air. In the fluidized sand layer (the fluidized bed) which has a temperature of about 850 °C the moisture of the sludge is evaporated and super-heated simultaneously with the incineration of the organic and the glowing of the inorganic dry substances.

Short-term variations of the calorific value (LCV) of the sludge-coal-mixture can be balanced during operation by the Injection Lances Supply (ILS). In case of too low LCV auxiliary fuel is injected or in the case of too high LCV water is injected directly into the fluidized bed. For that purpose the incinerator is equipped with eight injection lances which are submerged directly into the fluidized bed. Through these lances up to 900 Nm^3/h fuel gas can be injected into the fluidized bed. Such additional fuel represents a heating power of 4.0 MW. The incinerator has eight additional lances for burning waste liquid up to 8,500 kg/h or/and water for cooling up to 4,000 kg/h. Before injection the liquid media and/or water are mixed with air as conveying and atomizing agent. This mixing is done in a special mixing device which serves also for an even distribution of the injection mixture to all eight injection lances.

The content of the fluidized bed may increase or decrease during operation depend-ing on the condition of the combustible. A surplus of bed material can be discharged during operation by the Bed Material Discharge Device (BMDD) which is connected with the FBI at a bed material discharge socket. In case of a decrease of bed material quartz sand is fed into the incinerator. The sand for refill (50 – 500 kg/h) can be mixed into the sludge-coal-mixture

The ash resulting from the incineration process is a fine powder which is suspended as fly ash in the flue gas. The hot (850 – 900 °C) flue gases resulting from the incineration process leave the incinerator together with the fly ash through the flue gas outlet at the incinerator ceiling.

Fluidized bed incinerator (key parameters).

Height:	16.5 m
Inner diameter of nozzle bottom:	6.4 m
Surface area of nozzle bottom:	32 m^2
Clear width of freeboard area:	7.8 m
Max. thermal power:	18.2 MW
Max. furnace temperature:	1,000 °C

3. Organization

The engineering for the project was mainly done from our engineering hub in Guangzhou, Guandong province. During the realization phase, the project manager and a team of several local engineers have been moved to Tongliao for setting up the plant and training the operations team. Production support was given by specialist from Switzerland enabling the local, mostly inexperienced and untrained staff, to successfully operate the incineration facility.

4. Timelines

The project was started in the first quarter of 2011. The startup was realized in November 2011.

5. Special circumstances

One of the difficulties in this project's realization was the climatic conditions during the plant startup. Outside temperatures below -25 °C for several consecutive days in combination with unexpected quality of incineration feed lead to great difficulties with regard to solidification. Frozen coal, frozen sludge and even frozen compressed air systems required the full and concentrated efforts of the whole team to find unusual solutions and despite all these obstacles meet the goal of a successful startup before winter time.

In order to successfully acquire projects on the Chinese market and be competitive, it is necessary to have a wide and reliable network of Chinese suppliers and Chinese partners. Besides the usual quality issues with regard to the provided equipment and services, the Tongliao project showed also the design limitations of the so far applied peripheral technologies like conveying systems, energy supply (compressed air, condensate system and waste liquid system), storage systems, building insulations and solid discharging systems.

The provided infrastructure on the site is also suffering from the circumstances and therefore, stable and continuous supply of energies could not be assured in any case.

Special measures have been taken to overcome the problems.

- Add full cover and more insulation to the facility (preventing ice formation on an incinerator operating at 900 °C)
- Special design for steam traps
- Heat tracing of *all* liquid pipes with steam or hot water
- *external heating* of steam and condensate system during shut down time
- Use dry nitrogen or extra dry air, independently for instrument air

6. Since Start up

The above measures and many small changes also to the site's infrastructure system have supported the successful start and the successful operation so far. Today the plant is operating already with changed fuel specifications (coal). The incinerator's design was made sufficiently flexible to handle these changes. Liquid waste streams and coal are much different in composition and heat value compared to the originally provided data from customer. This is not unusual and has often been experienced, also in the western world. Close cooperation between the customer and Lonza Engineering assures, that necessary plant modifications can be carefully assessed and reviewed before realizing new design adaptations.

7. Outlook, future prospect

The fluidized bed incineration plant in Tongliao has again shown the robust and flexible design approach of the fluidized bed incineration technology. It has also clearly shown the design limitations of the common peripheral technologies applied to the given circumstances. By overcoming these hurdles and making this project a success, we will be able to further provide more and more efficient and competitive solutions for sludge incinerations. The great prospects of the Chinese market for fluidized bed sludge incineration technology makes us confident that the Tongliao project is an important milestone for future growth in this field. If such an incinerator can be built and successfully operated under these circumstances, it can probably be built everywhere in the world.

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