New Technologies Harmonized with Global Environment

Part 1 – Activities of Environmental Industries Engineering Division

Koji Arita* and Sunao Nakamura**

* General Manager, Environmental Industries Engineering Division
** General Manager, Environmental Plant System Laboratory, Engineering Research Center

NKK is tackling with the development of environment-friendly technologies and is now supplying plants, technologies and products harmonized with nature to create rich and rewarding human environments. At the beginning, NKK started environmental businesses by means of introducing overseas technologies and improving them into advanced NKK versions, and built up the business basis as the Japan's top manufacturer of environmental plants. Recently, NKK is receiving increasingly large amounts of orders and continuously securing high profitability in this field. This paper reports the history of NKK's pioneering businesses in the environmenta

technology to replace the stoker furnace based on a new concept. The progress was not limited in the technology related to the equipment itself. As incineration facilities were increasingly built in urban areas, it was desired to use these facilities as an integral part of the urban amenities. These moves resulted in considerable progress in architectural design technology.

In order to accelerate the development work for meeting the customer requirements in a timely manner in the age of rapid social changes, in 1996 NKK established the "NKK Environmental R&D Center" at its Tsurumi Works in Yokohama. By collectively locating a series of nextsearch in this field began in 1992, with elemental experiments on the conditions for dry distillation and combustion of wastes[1].

m

pit, wastes and sub-materials (limestone and coke) feeding system, high-temperature gasifying & direct melting furnace, continuous slag tapping system, secondary combustion furnace, boiler, gas cooling tower, bag filter, and flue gas treatment system.

The results of approximate analysis of the primary wastes used for testing are shown in **Table 1**. MWS is standard municipal waste. MWL is low-quality municipal waste prepared by mixing vegetable waste with standard municipal waste, thus reducing its calorific value. CSD is car shredder dust. IA is incinerator ash. LFW is waste recovered from final landfill disposal sites, and includes plastics, however the majority is dirt and sand.

Table 1 Properties of tested wastes

therefore the final disposal volume of wastes. As shown in the table, this technology can reduce the volume of municipal wastes that need to be finally disposed of to less than 1/200 of their original volume, thus contributing to easing the loads on final disposal sites.

Table 3 Typical results for tested wastes

Refuse		MWS	MWL	CSD	IA	LFW
Temp. of molten slag		1513	1472	1599	1495	-
Slag & metal rate	kg/h0.0056 4.4(ow t)4.4(h)5(ro)5(ug)5(h t)4.4(h)0.0171 TD23					

2.3.2 Properties of product slag

Properties of slag produced by the high-temperature gasifying & direct melting furnace are shown in **Table 4**. When slag is used as a resource, its qualities are evaluated in terms of leaching of heavy metals, and the concentrations of metals are therefore important indexes.

Table 4 Properties of product slag

The use of coke in this technology ensures strong reducing power associated with melting inside the furnace, so that Fe and slag are readily separated, and heavy metals are not oxidized and are not included within the slag. Tests on leaching from slag based on the Environmental Protection Agency Notification No.46 showed that, irrespective of the types of wastes treated, leaching was within the specified limits on all items, thus satisfying the relevant environmental standards for soil. The slag recovered with this technology is of high quality, and its properties ensure that it is able to be readily recycled as a useful material.

2.3.3 Properties of product gas and combustion gas

The composition of gas produced by the high-temperature gasifying & direct melting furnace, and that of combustion gas generated by the secondary combustion furnace, is shown in **Table 5**. Treatment conditions are as shown in **Table 2**.

The primary components of the combustible gas produced from wastes that contain volatile matter such as municipal waste (MWS), CSD, and waste recovered from final landfill disposal sites (LFW) are CO and H_2. The calorific value for CSD, which has a high content of volatile matter, is 1100 kcal/Nm^3, and 251 kcal/Nm^3 for LFW, which has a low content of volatile matter. IA (Incinerator Ash) has no volatile content and the freeboard temperature is maintained with the gas produced by combustion of coke so that there is almost no combustible gas at the outlet of the melting furnace. CO concentrations of the combustion gas at the outlet of the secondary combustion furnace are less than 10 ppm, irrespective of the types of wastes treated, and this gas is readily combustible. NOx and SOx concentrations are controlled to less than 100 ppm and 10 ppm respectively, and HCl concentrations are less than 40 ppm for CSD, and 30 ppm for municipal waste (MWS). Actual measurements confirmed that concentrations of dioxins were 0.0058 ng-TEQ/Nm^3 at the smokestack outlet during treatment of municipal wastes.

These results are considered to be attributable to the ability to independently control the temperatures in the fluidized zone and freeboard zone inside the gasifying & melting furnace by controlling the air flow through the secondary and tertiary tuyeres. The lime added to adjust basicity is also considered to be effective for removing sulfur and HCl from flue gas.

Table 5 Properties of product gas and combustion gas

combustion method with high-temperature air injection (air ratio $\lambda = 1.3$) in **Fig.4**.

As shown in the figure, the NOx concentration when high-temperature air is injected is less than one-half that of the conventional combustion method. This is conceivably attributable to the fact that the primary components of the combustible gas directly above the waste layer becomes CO and H_2 due to high-temperature air injection, and thus conversion of fuel-N to NOx is suppressed. Another conceivable reason is that the localized high-temperature regions are disappeared due to the mixing effect of high-temperature air injection. As shown in **Table 6**, the concentration of dioxins in the flue gas at the incinerator outlet is controlled to less than 50% by high-temperature air injection.

Table 6 Dioxin concentration at incinerator outlet

3.4 Test results of integrated incineration and ash treatment

Actual municipal wastes, coarsely crushed to suit the small size of the incinerator, were treated for a total of 2000 hours for evaluating the performance of the integrated incineration and bottom ash treatment system. This testing verified that heat treatment without melting the ash at temperatures between 1200 and 1300˚C, and ash melting treatment at temperatures of 1300˚C or higher are both realizable. The testing also confirmed that it is possible to control the concentration of dioxins in the treated ash to less than 0.0001 ng/g-TEQ.

Lead in the ash is problematic in treating incinerator bottom ash. The behavior of lead in the treated ash was investigated. The results are summarized in **Fig.5**. As shown in the data marked with in the figure, the use of this proposed ash-melting treatment system has been shown to simultaneously satisfy both current soil standards, and future Tokyo Metropolitan Government standards, for lead. Other tests showed that the proposed system was also able to satisfy soil standards for heavy metals other than lead.

A portion of this R&D program was conducted as part of NEDO's High-temperature Air Combustion Control Technology Research and Development Project. The authors wish to express their gratitude to NEDO.

4. Conclusion

This paper has described the progress of development of environment-friendly technologies at NKK from its beginnings to the most recent developments.

The high-temperature gasifying & direct melting furnace is a resource-recovery-type technology with the three-fold advantages of (1) reducing the volume of wastes, (3) eliminating harmful substances, and (3) recovering energy. Due to these advantages, this technology is currently being rapidly adopted by local authorities throughout Japan. Since 2000, the orders received are at a level equal to