A Study Dust Abatement by Combustion

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Synopsis

This paper deals with the abatement of the dust, which is produced from combustion of wood which is used in the process in the manufacture of "Bizen Yaki", by means of combustion.

The experimental furnace disposal for after combustion, is added to "Nobori Gama". The measurements are done at both states without and with the furnace disposal.

The results of the experiments show that process exhaust gases containing combustible dust can be destroyed effectively by the furnace disposal and the obtained dust abatement efficiency is about 80%.

1. Introduction

It is considered that imperfect combustion in fuel-fired furnaces produce the emission of combustible contaminants, and the best way to prevent it, is to carry out perfect combustion. But a some of the metal heating furnaces, incinerators and ceramic practice where wood is used as fuel, emit combustible contaminants inevitably. Nuisance abatement by combustion is described and reported in many references. [1,2] But, fixed tables of autogenous ignition temperature or time, for the design of furnace system, do not exist.

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In this paper, by means of combustion the abatement of the dust which is produced from the process in the manufacture of "Bizen Yaki" is studied experimentally.

2. Process in the manufacture of "Bizen Yaki" and Emitted Particles

The furnace "Nobori Gama" for the manufacture of "Bizen Yaki" is shown in Fig. 1. It consists of four manufacturing chambers, those are "Udo", "Ichiban", "Niban" and "Kedo", "Kemuriasobi", which is effective to make the furnace pressure uniform and goods are not manufactured in it, flue and stack. The total volume of four manufacturing chambers is about 14 m³. The manufactured goods are made by sintering at about 1,200 °C in every chamber. Time of one operating process is about 160 hours. Firstly for 40 hours, L. P. G. is fired mainly, and then only wood is fired. The fuel wood is pine deal. One block of it is about 700 g weight, 60 cm length, and property is shown in Table 1. Fuel wood is thrown into "Udo" from front door about every ten minutes, and amount of it is about 11 - 13 Kg a once. The property of emitted particles is shown in Table 2. Size range in Table 2 is adopted from

![Diagram of Nobori Gama](image-url)
Table 1 Property of fuel wood

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower heating value [Kcal/Kg]</td>
<td>4,330</td>
</tr>
<tr>
<td>Combustible content [%]</td>
<td>90.59</td>
</tr>
<tr>
<td>Ash [%]</td>
<td>0.62</td>
</tr>
<tr>
<td>Moisture content [%]</td>
<td>8.79</td>
</tr>
</tbody>
</table>

Table 2 Property of particles

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower heating value [Kcal/Kg]</td>
<td>6,710</td>
</tr>
<tr>
<td>Combustible content [%]</td>
<td>97.23</td>
</tr>
<tr>
<td>Ash [%]</td>
<td>2.77</td>
</tr>
<tr>
<td>Ignition temperature [°C]</td>
<td>420</td>
</tr>
<tr>
<td>Particles size [μ]</td>
<td>0.02 - 300</td>
</tr>
</tbody>
</table>

reference [3], because some of them join together and so mass-median diameter of a particle is not able to be measured accurately.

3. Experimental Apparatus and Procedure

A schematic diagram of the experimental apparatus is shown in Figs. 2 and 3. The material for furnace construction is refractories of SK-32. In the center of the furnace, to avoid short path from "Kedo" to flue, bridge wall is built, and is used for regenerator. The thirdly air is induced to flow into the combustion chamber at atmospheric pressure by action of the draft provided by the combustion system itself.

Gas fired equipment generally is found to produce a minimum of air pollution, and so the gas-burner is adopted to combustion the dust. The fuel used on the experiment is L. P. G. (Butane 70%, Propane 30%, Heating value 12,000 Kcal/Kg). Schematic diagram of fuel pipeline of
L. P. G. is shown in Fig. 4. To obtain uniformity of the furnace temperature, the gas-burners are installed both side of the furnace walls, and fuel consumption is controlled by one flow control valve only.

Dust content is measured according to J. I. S. Z-8808 "Method of Measuring Dust Content in Stak Gas". The used filter paper is made of quartz fiber and is cylindrical. To avoid the effect of loss in weight at high temperature, it is used after heating for 3 hours at 800 °C. As gas flow in stack is turbulent and particles size is very small, dust content is measured at the center of the cross section of the stack, as shown in Fig. 1.

When dust emission from the stack become visible, the experimental furnace is operated and the temperature is raised until it become unvisible. According to the raise of operating temperature of "Udo", the temperature of the experimental furnace raise, but consumption rate of L. P. G. is not changed. Again dust emission become visible, then the temperature of the experimental furnace is raised by addition of L. P. G. consumption. To retain the state that dust emission from the stack is unvisible, observing by a video camera, L. P. G. consumption and firstly, secondary and thirdly air are controlled.

4. Experimental Results and Discussion

4.1 Dust Emission

The rate of dust emission versus the elapsed time of the operating of the manufacturing furnace is shown in Fig. 5. Before the experimental apparatus is installed, the maximum rate of the dust emission is 2.4 g/Nm³, after installing, when it is operated normally, it is 0.3 g/Nm³. The efficiency of the experimental apparatus is unable to obtain accurately, because it is difficult to measure dust content in gases before and behind the passage of the experimental furnace. But
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4.2 The Dust Combustion

The relation between the dust emission, the residence temperature and the holding time at the experimental apparatus is shown in Fig. 6. Comparing the dust emission each other at two conditions, one is the low residence temperature and the long holding time, and other is the high residence temperature and the short holding time for wast gases at the experimental apparatus, the difference is not obvious.
4.3 Effect of Experimental Apparatus on Manufacturing Chamber

The furnace pressure and temperature before and after the apparatus is installed on every measuring position are shown in Fig. 7. Between "Udo" and "Kedo", the furnace pressure and temperature is approximately equal before and after the installing.

Fig. 7 The furnace pressure and temperature before and after installing.

- "Udo" and "Ichiban"
- "Niban" and "Kedo"
- "Kemuriasobi" and installed furnace
- Flue and Stack

Fig. 8 The temperature of "Udo", "Kemuriasobi" and stack versus the elapsed time.
The temperature of "Udo", "Kemuriasobi" and stack versus the elapsed time is shown in Fig. 8. The maximum temperature of waste gases is about 400 °C at "Kemuriasobi" and 550 °C in stack before the apparatus is installed.

The pressure of "Udo", "Kedo" and stack versus the elapsed time is shown in Fig. 9.

Exhaust gas flow rate, excess air ratio to wood, gas flow rate of stoichiometric combustion from Rosin formula and fuel consumption before and after installing are shown in Figs. 10 and 11 respectively, versus the elapsed time. Before the furnace is installed, the exhaust gas flow rate increase with temperature and pressure of stack. After the furnace is installed with the burner operating, the exhaust gas flow rate increase rapidly and excess air ratio to wood for Rosin formula increase too. The manufacturing furnace is affected considerably with it and this is uneconomical in fuel consumption. For the state that the dust emission is unvisible, when thirdly air is introduced, after several minutes it become visible. This is considered that cooling surface of heat transfer increase and cooling air is induced to the flow of the chamber.

5. Conclusion

Using the process in the manufacture of "Bizen Yaki", combustible contaminants abatement by furnace disposal for after combustion is examined and...
following results are obtained.

1. For the most part, combustible contaminants can be destroyed effectively by furnace disposal.

2. It is considered that the furnace disposal which is designed in low residence temperature and long holding time to care of heat transfer and ignition temperature of dust, is economical in fuel consumption.

3. On the point of view of fuel consumption and operating of manufacturing furnace, air rate introduced from burner attending hole is to be controlled carefully enough.
Acknowledgment

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Reference

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(2) S. Yagi and T. Kunii: "Kōgyō Yōro", Kyoritsu Shuppan (1962), 264