The Garbage Accumulation Pit Fire Monitoring System, Utilizing Infrared Thermography, Is Used to Detect Rises in Temperature Inside Garbage Accumulation Pits, to Prevent the Occurrence of Fire Disasters

Combustible garbage discharged by households and businesses are collected by garbage collection trucks and accumulated in the garbage accumulation pits, located in garbage disposal plants, where they are incinerated. Cases have been reported when the garbage gathered in a garbage accumulation pit ignited for some reason, which led to fire disasters, bringing about a large amount of damage to the garbage disposal plants. The garbage accumulation pit fire disaster monitoring system, introduced here, has been developed and delivered to garbage disposal plants for the purpose of offering support for rapidly extinguishing fires by providing an early forecast through the detection of rising temperatures of garbage accumulated in the garbage accumulation pit. The developed garbage accumulation pit fire monitoring system utilizes an infrared thermography system (TVS) developed by Nippon Avionics, which is installed along the perimeters of the garbage accumulation pit for the purpose of monitoring the temperature of the garbage. The system also partitions the garbage accumulation pit into blocks, making it possible to detect a rise in temperature through measurements taken by the TVS, reporting the location where the temperature rise is occurring, as well as the amount of rising temperature, to the central monitoring device as an alarm output, thereby preventing the occurrence of a fire disaster. A case study of this system, which has been delivered, is introduced in this paper.

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Introduction

A common processing route for garbage discharged from households and businesses is shown in **Fig. 1**. Discharged combustible garbage is collected by garbage collection trucks and transported to a platform (1) at the garbage disposal plant and then temporarily accumulated in a garbage accumulation pit inside the garbage disposal plant. The garbage accumulated in the garbage accumulation pit is then thrown into the garbage hopper by a crane (2) and then incinerated.

Incidents have been reported of fire disasters triggered by ignitions that for some reason occurred in the garbage gathered in the garbage accumulation pits. A fire disaster occurring in a garbage accumulation pit can lead to enormous losses including the loss of the garbage disposal plant, loss of life and interruptions to operations, thereby creating a major social problem.

The system introduced in this paper has been developed and delivered to garbage disposal plants to enable support for rapidly extinguishing fire by detecting ignition inside the garbage accumulation pit as early as possible in order to prevent damage as a result of fire disasters in garbage accumulation pits.

Summary of System

A summary of the system is described, based on the schematic block diagram shown in **Fig. 2**.

Infrared thermography devices (hereinafter referred to as "TVS") developed by Nippon Avionics are installed at locations where it would be possible to take temperature measurements of an entire region inside a garbage accumulation pit and used to take temperature measurements of the surface temperature of garbage inside the garbage accumulation pit at all times. The interiors of the garbage accumulation pits are divided into blocks and temperature measurements are taken

* As the products introduced in this article are mainly sold for the domestic market, some figures feature explanations by the Japanese Language.

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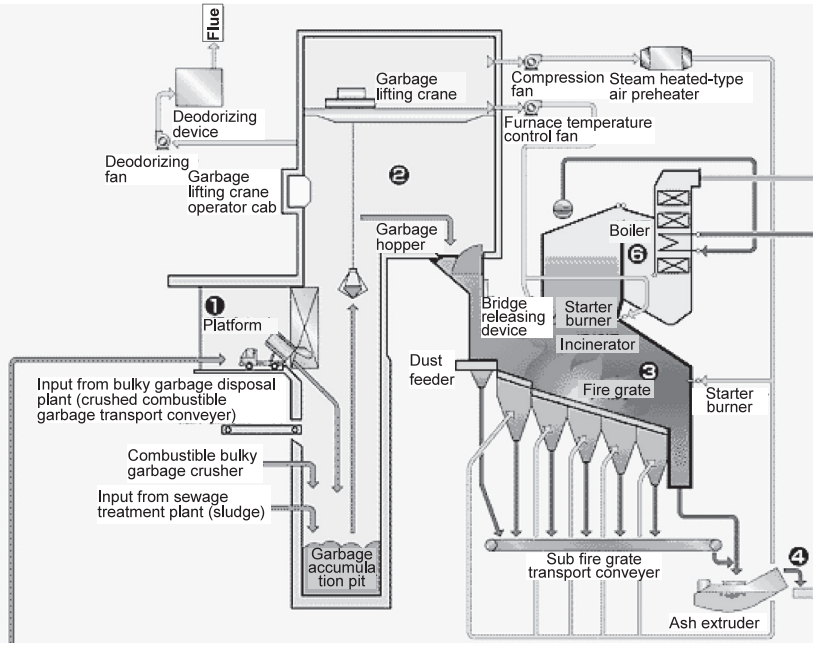

Fig. 1 Combustible garbage incinerating facility at garbage disposal plant.

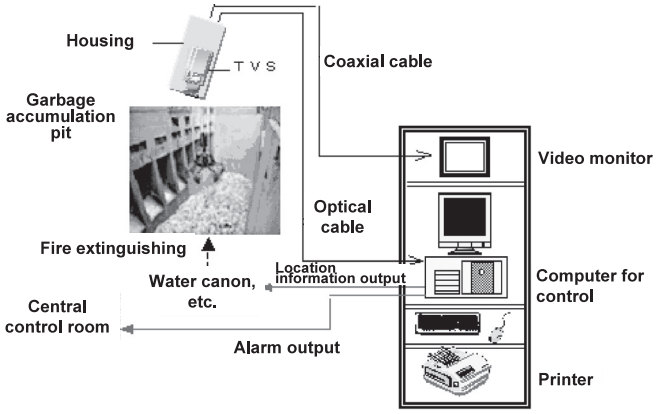

Fig. 2 Schematic block diagram.

for each individual block. Thermalgraphical data obtained from these measurements are output by two systems, analog and digital. Digital data is sent to the computer for control via an optical cable. When the internal temperature of the garbage accumulation pit rises above a set temperature, a warning alarm is issued to the monitor of the computer for control and also sounded in the central control room. Since the interiors of the garbage accumulation pits are divided into blocks and temperature measurements are taken for each block, information on the block location that indicates which location (block) in the garbage accumulation pit is experiencing an abnormal temperature (ignition) is also provided with the alarm. This makes it possible to rapidly and accurately pin point the fire to be extinguished using devices, such as a water canon inside the garbage accumulation pit.

Analog data is sent to a video monitor as a video signal via a coaxial cable. The video monitor displays a live thermalgraphical image of the garbage accumulation pit.

System Configuration

The basic configuration of the system is shown in **Table**.

1) TVS: An adequate number of units are installed to ensure that the observation range is entirely covered, according to the size of the garbage accumulation pit.

TVS-200 units from Nippon Avionics, produced domestically in Japan with the adopted non-cooling two-dimensional sensor, are used as the TVS. **Photo** is provided showing the external view of a unit.

2) Lens: The specification of the lens is determined to ensure that the observation range is entirely covered, according to the size of the garbage accumulation pit. The standard lens is a wide angle 2x magnification lens, whereas a 2.6x magnification lens is available for special orders.

3) Housing: TVS units are installed in housings with special

Table System configuration.

No.	Description	Remarks
1	TVS	TVS-200 manufactured by Nippon Avionics
2	Wide angle lens	2x and 2.6x magnification lenses manufactured by Nippon Avionics
3	Housing	"Dust-proof and drip-proof housing manufactured by Nippon Avionics for TVS units, thermoelectric or air cooled-types."
4	Factory computer	Computer for control
5	Printer	"Output temperature measurement data, etc."
6	Application software for garbage accumulation pit monitoring system	Ignition monitoring control and TVS remote control
7	Real-time image transfer kit	"Thermalgraphical image data transfer interface complying with IEEE1394 standard, manufactured by Nippon Avionics"
8	Optical cable	Transfers thermalgraphical image
9	Video monitor	Displays thermalgraphical image video (analog)
10	Coaxial cable	Outputs thermalgraphical video image signal
11	Power cable	"Power source for TVS units, etc."

Photo External view of TVS-200 unit.

specifications for environmental resistance, such as dust-proof or drip-proof qualities, as well as to withstand cooling.
4) Computer for control: A factory computer is used out of consideration for reliability and environmental resistance for continuous operations over long periods of time. Application software dedicated to the operation of the system is installed. Furthermore, a printer is connected to the computer so that it is possible to output temperature measurement log data and temperature variation graphs.
5) Others: TVS units are connected to the computer for control via interfaces that comply with the IEEE1394 standard. Thermalgraphical images captured by TVS units, as well as temperature measurement data, are sent to the computer for control as digital data via an optical cable. The data is stored in the hard disk and also displayed on the monitor of the computer for control. Furthermore, the analog video signal of the temperature measurement image is also sent via coaxial cable and displayed on the video monitor.

Functions of the System

Examples of functions available with the system are described below:

(1) Ignition Monitoring

Ignition monitoring inside the garbage accumulation pit, which is a basic function of the system, is described below.
Ignition monitoring is performed on the main screen of the application software.
1) Screen Configuration
An example of a screen display is shown in **Fig. 3**. The screen configuration for this screen display example is as follows:
① Display of Garbage Accumulation Pit Internal Thermalgraphical Images
Displays real-time thermalgraphical images from TVS units that capture the condition of the garbage accumulation pit.
② Display of Temperature Measurement Data (Block Divisions)
Displays data of the temperature measurements from inside the garbage accumulation pit. The temperature is displayed for each block of the garbage accumulation pit division. An image of a block division inside the garbage accumulation pit is shown in **Fig. 4**.
The upper row of the temperature display indicates the maximum temperature inside the block, while the lower row indicates the temperature difference between the past and current temperature measurement data.
Colored characters are used to display temperature changes and the window shown in **Fig. 5** pops up on the screen when an ignition forecast or detection occurs.
③ Alarm Setting Information Display
Displays the temperature set for the ignition forecast and detection in the alarm setting of the system, as well as the maximum temperature value for measuring temperatures inside the garbage accumulation pit.
④ TVS Setting Information Display

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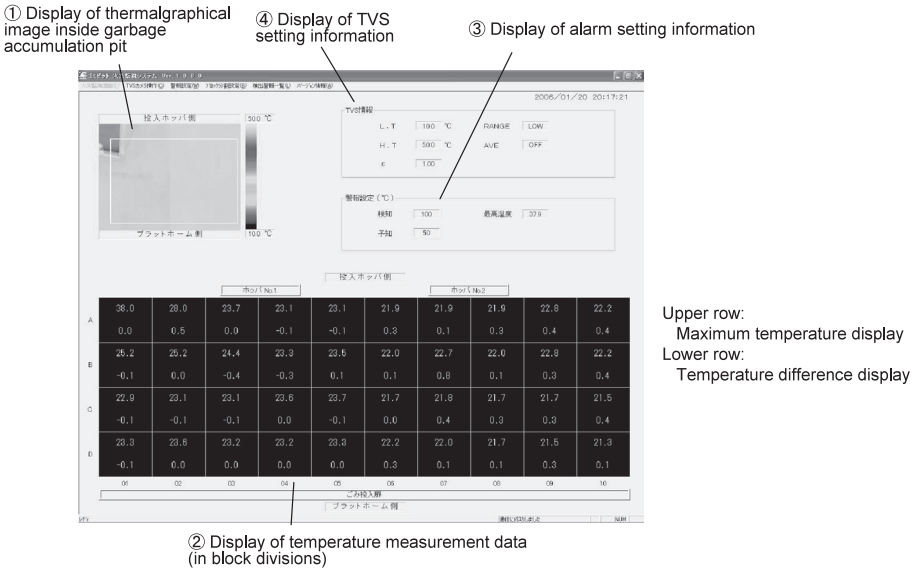


Fig. 3 Example of monitoring screen display.

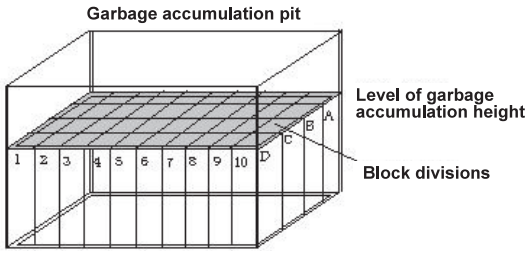


Fig. 4 Image of block divisions inside garbage accumulation pit.

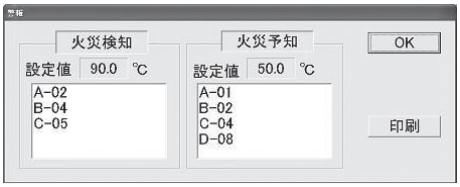


Fig. 5 Alarm display window.

Displays the values set for the TVS remote control of Section (3).

2) Ignition Forecasting and Detecting Functions

The system is equipped with a two-phase warning function that emits ignition forecasts and ignition detection alarms in order to ensure early and assured detection of ignition inside the garbage accumulation pit.

① Ignition Forecast

Ignition is forecast by monitoring the change in the surface temperature (temperature rise) of garbage inside the garbage accumulation pit in order to detect ignition early.

Ignition is determined when the difference in temperature (temperature difference) between the currently measured temperature value and previously measured temperature value in a block exceeds the set forecast temperature value.

② Ignition Detection

The temperature is considered to be abnormal when the temperature on the surface of the garbage rises above a certain temperature, which is the case immediately preceding ignition and this results in ignition detection.

Once the maximum temperature inside a block exceeds the set value for a detection temperature, then ignition is considered to have taken place.

When an ignition is forecast or detected, an alarm is output by the computer for control to the central control room.

(2) Display of Temperature Variation Graph

A log of the temperature measurement data is shown in a graph. It is possible to display graph temperature variations of all blocks relating to the maximum temperature and temperature difference for any arbitrary block resulting from the division of the garbage accumulation pit.

An example of a display screen is shown in **Fig. 6**.

(3) TVS Remote Control

It is possible to remotely control the settings of the TVS units using the remote control screen, such as the following functions:

- Update displayed upper and lower temperature limits
- Update measurement point locations and display temperatures at the measurement point

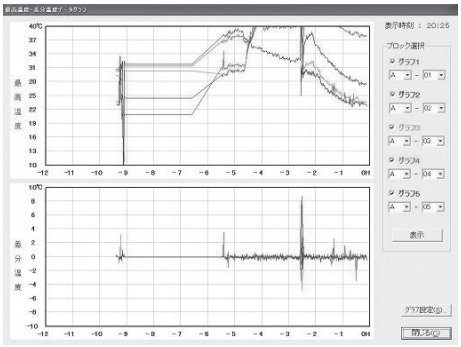


Fig. 6 Example of temperature variation graph display.

Fig. 7 Example of TVS remote control screen display.

- Select display colors
- Update temperature display units

An example of a control screen display is shown in **Fig. 7**.

Implementation to Other Fields

Our garbage accumulation pit fire monitoring system has been delivered to garbage disposal plants operated by municipal governments throughout Japan and has accurately detected the ignition of combustible garbage early, thereby preventing fire disasters from occurring.

As a system that uses TVS, it can be considered for implementation in various other fields for the purpose of preventing disasters and accidents.

For example, when a torpedo car for transporting molten iron in steel mills deteriorates thermal leaks to its exterior increase. A similar system is being used to forecast and detect incidents arising from the deterioration of torpedo cars.

Furthermore, our system is also being implemented as a system for monitoring volcanoes, which is used to limit the disaster damage from eruptions.

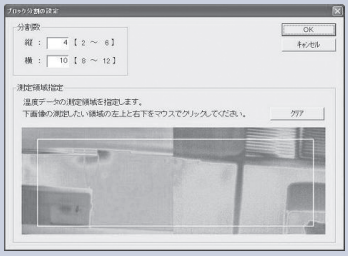
Conclusion

A garbage accumulation pit fire disaster monitoring system, used for the purpose of preventing disasters and accidents, has been introduced in this paper. Systems with TVS, however, can be used for similar disaster prevention purposes in various other fields and we intend to continue with our proactive action in the future to spread implementation of the system.

FOCUS POINT

• Block Divisions Inside Garbage Accumulation Pit

The system divides the garbage accumulation pit into blocks and temperature measurement data is displayed in units for these individual blocks (an example of a screen display in Fig. 3 shows a total of 40 blocks comprised of four blocks in a lengthwise direction and ten blocks in a widthwise direction). Settings are performed in the setting screen shown in the figure below. The setting for monitoring the region inside the garbage accumulation pit is performed by selecting an area on a thermalgraphical image with a mouse and then entering the number of lengthwise and widthwise divisions to be applied on the selected area.



The number of divisions set relate to the garbage incineration system and the number of block divisions must be the same number as the block divisions used for controlling the crane that transports garbage to the incinerator. The height of garbage accumulation can vary depending on the location of the block inside the garbage accumulation pit, thus information relating to the garbage height must be manually entered for each individual block, based on the garbage collection location of the crane. Temperature measurement data is compensated based on this height information. It is possible to obtain temperature measurements with a higher accuracy by compensating temperature measurement data.

For inquiries, please contact:

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