International Conference on Architecture and Civil Engineering 2018

ISBN	978-81-933584-5-0	**VOL**	01
Website	www.coreconferences.com	**eMail**	mail@coreconferences.com
Received	15 – January – 2018	**Accepted**	10 - February – 2018
Article ID	CoreConferences007	**eAID**	CoreConferences.2018.007

A Development of Accident Prediction Technique based on Monitoring Data for the Area of Dense Energy Consumption

Jung Hoon Kim[1], Young Gu Kim[2], Young Do Jo[3]
[1,2,3]Institutes of Gas R&D, Korea Gas Safety Corporation, Republic of Korea

Abstract-*Accident likelihood is growing due to a correlation for gas and electricity installed in the area of dense energy consumption like traditional market and underground shopping center. In order to prevent and respond accident risks related to gas and electricity in this area, it should be monitored and predicted for risk factors of gas or electricity by developing safety management system. In this study, the method of accident prediction development related to gas risk was proposed in the area of dense energy consumption. From statistical data of risk factors in the area of dense energy consumption, temperature as risk factor except gas leak in gas use has been extracted. General aspects of temperature changes and associated theories were investigated to analyze characteristics of temperature data. In addition, to check the changes in temperature due to convection around the burner, related experiments were carried out. Through such investigations and experiments, the change characteristics in temperature data related to fire prediction were derived and algorithm was developed to apply them to the development of energy safety management systems.*

I. Introduction

The areas of dense energy consumption are traditional market and underground shopping center etc. which have a large floating population with facilities of gas and electricity. Accident risks related to gas and electricity are explosion (35.6%), leak (16.8 %) and fire (26.1 %) during the most recent 10 years [1].

In order to prevent and respond accident risks related to gas and electricity in this area, it should be needed to develop safety management system based on internet of things (IOT) which executes sensor data collection and data analysis for accident prediction and safety control etc. [2,3].

In this study, the method of fire accident prediction technique related to gas usage in the area of dense energy consumption was proposed for safety management system. From statistical data of risk factors in the area of dense energy consumption, A temperature as risk factor except gas leak in gas use has been extracted. A characteristic analysis of risk factor was carried out by temperature variation tests and related law. Accident prediction algorithms using temperature data were developed based on these characteristics for application to safety management systems.

II. Statistical Data of Risks Factor in the Area of Dense Energy Consumption

In this study, the method of fire prediction model development in the area of dense energy consumption was proposed for safety management system. Accident ranking of risk factors was analyzed by using statistical fire data in traditional market and underground shopping center of Korea during the last 9 years as Table 1 [4].

Upper risk factors are mostly electrical factor, carelessness, mechanical factor. Risk factors related to gas are carelessness (preparing food) (seventh), carelessness (adjacent position of the flame) (14th). In traditional market and underground shopping center, fire occurs near the burner but no safety management is made. To prevent from these accidents and other fires, a temperature sensor should be installed around the gas burner to avoid fire and gas-related explosion accidents.

Table 1 Statistical data of fire in Korea during the last 9 years

Accident Ranking	Upper Risk Factor	Lower Risk Factor	Traditional Market Accidents	Underground Shopping Center	Sum
1	Electrical factor	Short circuit due to deterioration of insulation	78	4	82
2	Unknown	Unknown	77	1	78
3	Electrical factor	Unidentified short circuit	75	1	76
4	Carelessness	Cigaret ends	45	8	53
5	Mechanical factor	Overheating/ Overload	40	0	40
6	Electrical factor	Overload / Over-current	34	4	38
7	Carelessness	Preparing food	31	3	34
8	Arson	Arson suspicion	29	1	30
9	Electrical factor	Etc.	20	4	24
10	Electrical factor	Short circuit due to tracking	23	0	23
11	Electrical factor	Short circuit due to compression damage	20	1	21
12	Electrical factor	Short circuit due to misconnection	18	1	19
13	Carelessness	Etc	19	0	19
14	Carelessness	Adjacent position of the flame	15	0	15

III. **Characteristic Analysis of the Risk Factor in the Area of Dense Energy Consumption**

Using the burner will increase the ambient temperature and cause a different pattern of temperature increase in the event of an accident. Therefore, it is important to consider statistical factors or characteristic factors that may reflect the pattern of temperature changes.

Most gas use facilities in the area of dense energy consumption are interior spaces. Change pattern characteristics are needed to account for the different ambient temperature changes depending on the surrounding environment (ventilation system, internal structure near the burner, number of internal personnel, heating and cooling facility, and fire power of the burner).

Accurate temperature forecasting requires long-term on-site data collection. Since the pattern of temperature changes or the magnitude is different from normal, these characteristics should be applied in the event of an accident(overheating, fire, etc.).

Temperature changes around the burner generally take place from the start of cooking to the point of boiling (①-② Figure 1). There is a boiling point from the point of boiling to the point of burning as shown in ②-③ Figure 2. Ambient temperature tends to be similar to the inner temperature in pot but is variable according to time.

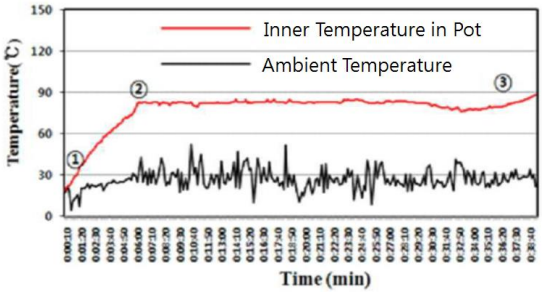

Figure 1. Changes of inner temperature in pot and ambient temperature

Newton's law of cooling enables larger time-heating energy changes depending on the size of the fire. In addition, the closer it is to the burner fire, the bigger it becomes.

$$\frac{dQ}{dt} = h \cdot A\big(T_{env} - T(t)\big) = -h \cdot A\Delta T(t)$$

Q: thermal energy, h: heat transfer coefficient, A: the area of heat transfer targets, T_{env} : ambient temperature, T: a surface temperature of heat transfer targets. If the burner and the temperature sensor are close to each other, the effect of convection directly on the changes in the temperature around the burner will benefit from temperature detection. In the case of remote distances, it is necessary to consider the installation of temperature sensor, since rapid burning or temperature change around the burner is difficult to detect.

When using the burner, the temperature will always increase, and if there is an accident, the different pattern of temperature increase will occur. These characteristics can be used to predict accidents.

IV. Experiment of Temperature Variation According to A Distance Between Fire and Steel Plate

When portable butane gas stove is operated using oversized grill, it is tested for temperature change at the top and bottom of the container, container retention cover in the burner, and butane containers in accordance with the burn time. Figure 2 shows temperature measurement location in this test.

Figure 2. Temperature measurement locations

It is required to verify the characteristics of temperature change for fire caused by overheat to check the parts related to convection. It can be seen that the temperature changes with the distance between oversized grill and portable butane gas stove cover(cover) become more variable as the distance approaches in Figure 3. We can confirm the results of these experiments are consistent with Newton's law of cooling.

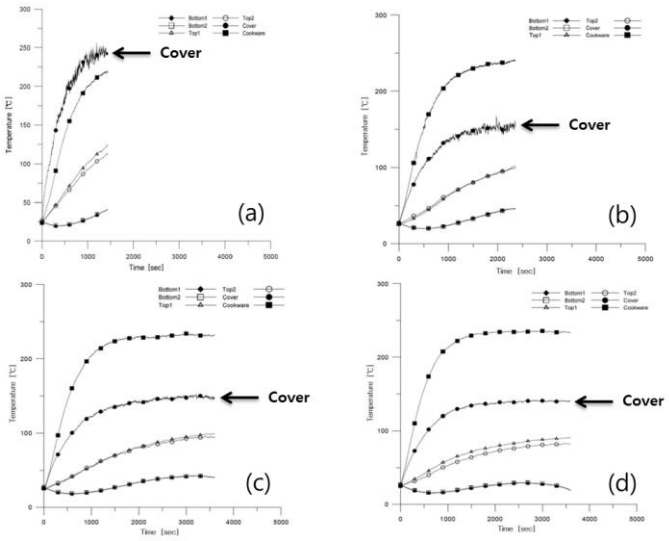

Figure 3. Experiment Temperature according to a distance between hot grill and cover: (a) 12.34 mm, (b) 24.06 mm, (c) 28.49 mm, (d) 33.59 mm

V. Development of Accident Prediction Technique Considering Experiment Results

After the analysis of the risks associated with gas use in the area of dense energy consumption using statistical data, the relevant accident risks, except gas leakage, are related to temperatures. To prevent such accident hazard, the radio temperature sensor may be installed around the burner to develop and utilize a prediction model considering the characteristics of temperature data change. A predictive method was developed using algorithms such as Figure 4, taking into account the temperature change data (slope) measured at the site, fire hazards limit temperature, temperature variability and rapid rise temperature data, etc.

Temperature data are monitored in real time from the energy safety management system server that collects data from IOT sensors and utilized as statistical characteristics values of ordinary temperature data with reference data for a given time period. Where real-time temperature data is greater than 1 step warning temperature (set value or ordinary temperature statistical value), the time to reach the limit is predicted by regression analysis, and where small, initial fire is considered.

An algorithm inform the energy safety management system that the pattern of temperature changes being monitored is in a fire indication if the pattern differs from the usual one, and if not, it is in a fire safety condition.

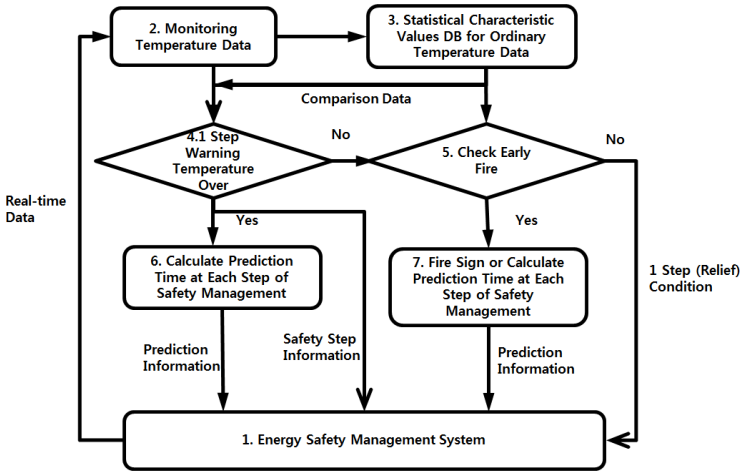

Figure 4. Accident Prediction Algorithm based on Temperature Data

VI. Conclusions

Accident likelihood is growing due to a correlation for gas and electricity installed in the area of dense energy consumption. To prevent and respond accident risks related to gas and electricity in this area, it should be needed to develop safety management system which executes sensor data collection and data analysis for accident prediction and safety control etc. In this study, the technique of fire prediction in the area of dense energy consumption was developed for safety management system. To analyze the characteristics of the temperature data, we investigated and analyzed the typical temperature changes and associated theoretical equation. In addition, the experiments were performed to verify the temperature changes caused by convection around the burner. Main characteristics of temperature data variation are linear/nonlinear relation and variability over time which can be applied to accident prediction or fire indication decision. Then, the algorithm of prediction technique was developed for safety management system. The verification test of the algorithm for accident prediction technique will work in the future.

References

1. Gas Accident Year book, Korea Gas Safety Corporation, 2015.
2. Z.L. Tan, and C.L Zhang, "Construction of the safety management system for urban underground business district with the application of IOT," *Service Systems and Service Management* (ICSSSM). Hong Kong, pp. 743-746, July 2013 [*10th International Conference on Service Systems and Service Management*, 2013].
3. C.A. Zhou, C. Chen, and H. Ren, "Comprehensive Evaluation on Multiple Constraint Elements of City Underground Space Development and Utilization Based on Analytic Hierarchy Process and Fuzzy Comprehensive Evaluation Method," Applied Mechanics and Materials. London, vol. 357-360, pp. 2754-2758, August 2013.
4. Statistical Yearbook of Emergency Management, Disaster Integration Management of Korea, 2007-2015.