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A Study on Estimation of Noise Damage caused by Rupture of Butane-can(volume : 34 g)

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Abstract – It is very insecure to treat a butane can for cooking out of door. The human injury from the accidents of butane cans has been getting increased 1.5 times yearly since 2003. In this context, the Institute of Gas Technology Training in Korea Gas Safety Corporation carries out explosion experiment to make trainees to take all possible measures to ensure safe management of gas in the field by fully recognizing the hazards of gas explosion accidents. This study intends to examine the influence of such explosion experiments on the trainees witnessing nearby. The GEN exposed to the active students participating in the experiment away from 25 meters from the explosion site was 57.94 dB and the GEN to the passive students not participating away from 50 meters was 51.92 dB. According to Weber-Fechner's law for the lower value than 65 dB which is the environmental standard, it is safe from the place 15 meter far from the explosion place. The environmental standard of offices is 50 dB, and it is lower than the environmental standard if the office is 65 meter far from the explosion place.

Key words : Gas Explosion Noise(GEN), butane-can, estimation of noise damage

I. Introduction

Lately the environmental trouble of a developed country type has become a social issue, so we have not only studied the measurement technique for noise source but also made a social survey of residents who are damaged by traffic noises and every living noise to devise a measure the problem by various noises [1,2].

Especially, the noise by blasting work and explosion is irregular pollution source and sporadic noise which is disappeared at once when the occurrence is disappeared. However, the concussion and noise occurred by blasting work and explosion can e felt directly with sense [3]. The effect of these noises doesn't appear at once but appear gradually as stress gets higher or the amount or quality of sleep is limited. Continuous stress makes increasement the possibility of diseases such as a heart disease by high blood pressure [4].

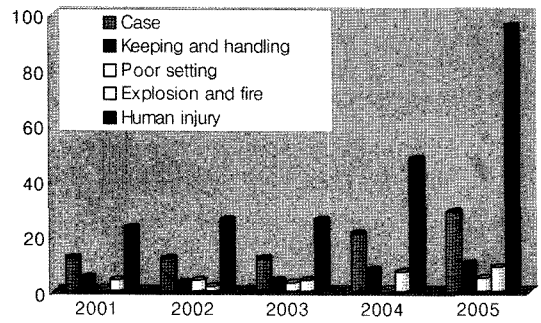

Fig. 1. The present state of accident.

Also, there have been 86 accidents of portable butane burners and joining containers (this study proposed to call it butane cans to the following) and 30 accidents (34.9%) of keeping and handling of butane cans during these five years. Also, the explosion and fire caused by a gas leak by poor setting of butane cans were 14 cases (25.0%). 26 cases (87.6%) of careless keeping and handling were explosion by rising of inner pressure, which were occurred by heating container to use the gas left with neglecting the butane cans placed around fires including keeping butane cans in portable butane burners. The human injury from the accidents of butane cans has been getting increased 1.5 times yearly since 2003 [5].

Therefore, this study is for the emergency management which is the legal professional training performed at

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Institute of Gas Technology Training and for guarantee the safety of students from GEN (Gas Explosion Noise) by the explosion experiment.

This study is to prevent the damage by GEN for the students participating in the education near the explosion place and to secure their safety by predicting the damage. Also, we wish it will be used as basic data to ensure the safety distance for experiment of gas explosion.

The students participate in this experiment directly or indirectly, and their damage is observed by dividing into two groups - active students participating in the experiment and passive students not participating but being trained at a classroom.

Also, The explosion experiment performed by this Education Center is used for the training data to guarantee safety from these kinds of accidents.

According to the recent statistics of gas accidents, the occurrence of whole gas accidents has been reduced year by year irrespective of increased demand of gas [6]. Besides, these accidents are human disasters by insensibility to safety. Hence, this Education Center performs a safety education to minimize the damage by the accident of gas explosion letting the students know the dangerousness of gas accidents by showing the power of gas explosion, and asks for thorough safety management at job sites.

II. Experiment and Calculation

2.1. Experiment Method

The damage prediction by the explosion of butane cans is predicted by the predicting method of accident damage, but this study wants to predict the damage by GEN. Therefore, we want to measure the noise of the students' place (active students) 25 meter far from the explosion place and of the classroom passive students) 50 meter far from. Also we want to compare that result with the theory formula.

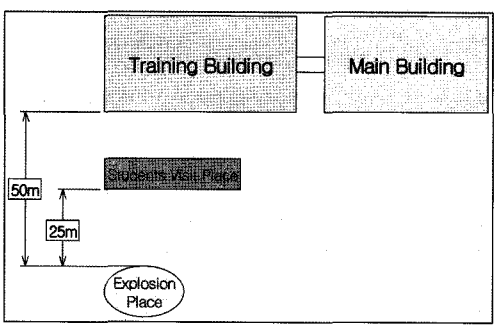

Fig. 2. Arrangement plan.

Fig. 2 is an arrangement plan for the place of explosion experiment. As the picture shows, the explosion place is 25 meter far from the watching place of active students. We thought there would be little damage by noise to other places because this education center is surrounded by mountains, so we didn't make an evaluation for the circumstance of the explosion place [7-9].

The sound environment gives many effects to us. A noise is a bad sound environment and is born with the development of a human civilization [10].

Noise pollution gives many effects to a human body like these, so nowadays there are many cases applying sound-scape. Also there are many studies on this because it is a very important issue that what kind of sound is provided to a target space with what kind of way among various sounds [11].

This study measures the level of GEN, but there is no restriction standard on that, so we checked the noise restriction value of a construction site which made a similar noise with GEN. It was under 65 dB during morning and evening (05~08, 18~22), under 70 dB during the daytime (08~18), and under 55 dB during the midnight (22~05). The noise restriction standard of a construction site uses the revised value of the following for the daytime. If the origination date of noise is under 2 hours a day, it is +10 dB and if it is between over 2 hours and under 4 hours, it is +5 dB [12].

Thus, this study regards 80 dB as a permitted value by revising +10 dB to 70 dB of the daytime (08~18) permitted value because this experiment is carried out for a short period of time of the daytime (11~13). Also we did our best to make the effect on the neighborhood minimize with exploding under one time a week yearly.

This study wants to predict and evaluate only the damage to the students by GEN caused by the explosion of remain gas of a butane can (34 g).

2.2. Background

1) Measuring place

A) Explosion place (Point A) : Measured within a 2-meter radius of explosion place of butane cans

Table 1. Noise measure value

Units: dB(A)

Date	Point	Background noise		Noise
		A level	C level	A level
5.19	A	43.5	53.5	96.9
7.06	B	41.0	52.8	68.8
7.14	C	41.7	53.6	59.5

Measuring place of a noise meter : Measured above 150 cm high from GL to the upper part

B) Active students' place (Point B) : Measured at 25 m far from the explosion place

C) Passive students' place (Point C) : Measured at 50 m far from the explosion place

The noise level measured at each point is as Table 1.

2) Measuring date

A) Date - Point A : 11:25, May 19
Point B : 11:24, July 06
Point C : 11:26, July 14

B) Weather - on measuring point A : clear
Wind speed : 1.8 m/s
Wind direction : the south wind
on measuring point B : clear
on measuring point C : clear

2.3. Calculation Formula

The sound source of gen by the explosion of butane cans is a dot sound source generally. When the sound is spread in free sound field, the decrement is decided by the distance from a sound source and sound shape (dot, line, side) [13,14].

The strength of sound I d(m) far from a dot sound source is as following formula.

$$I = \frac{w}{4\pi d^2} \quad (1)$$

I : The strength of sound (W/m^2)
w : sound energy emitted for a second (W)
d : distance from a sound source (m)

When a sound source is marked with sound power level, sound pressure level from the distance d is calculated as follows.

Sound pressure level, $SPL = 10 \log (I/10^{-12})$

$$= 10\log\left(\frac{w}{10^{-12}}\right) - 20\log d - 11 \quad (2)$$

10 log ($I/10^{-12}$) is a power level by w of original sound energy, and it is marked as PWL.

$$SPL = PWL - 20\log d - 11 \quad (3)$$

III. Results

Noise measurement was done with the measuring method of construction noise by KS A ISO 1996-1 (Description and measurement of environmental noise) [15].

Table 2. A revision ticket about effect of background noise

Units : dB(A)

Difference of background noise with measurement noise	3	4	5	6	7	8	9
Revision value	−3	−2		−1			

To analyze the measuring result exactly, we want to measure background noise, revise background noise with calculating the effect of noise decrease in the air for the distance from the noise source, and know the difference by comparing background noise with actual measured noise value.

For the revise of background noise effect, the revised value is made by adding the revised value of the following contents.

1) Revise of background noise effect

Target noise level is decided by revising background noise to the measured noise level as follows.

A) If a measured noise level is 10 dB(A) larger than background noise, let the measured noise level is a target noise level without revising background noise because background noise effect is very little.

B) If a measured noise level is 3~9 dB(A) larger than background noise, a target noise level is calculated after revising the revised value by the revision table of Table 2 to the measured noise level because there is some background noise effect.

C) If a measured noise level is under 2 dB(A) larger than background noise, a target noise level should be calculated by remeasuring under the condition that meet the above A) or B) because background noise is larger than the target noise level.

2) Rating Sound level(Lr)

To revise background noise exactly, we want to measure using a rating sound level because the noise by explosion is similar with the noise by impact.

The rating sound level is the noise level which the measured noise level by a noise meter (La) is revised by the factors giving effect on noise such as a crashing sound, pure tone sound, time and a region.

$$Lr = La \pm \text{Revised value} \quad (4)$$

The noise should be under 50 dB(A) of a rating sound level which a crashing sound (+5 dB) and the percentage(under 12.5%: −15 dB), time (06:~18:00: 0 dB), and a region (−10 dB) of the origination time of measured noise for the related time slot is revised

to a target noise level.

3) Analyze

According to the measured value (Table 1) of noise level, there is difference of 53.4 dB between level A of background noise of point A and level A of noise, and the difference is over 10 dB, so the point A is 96.9 dB without revision. Difference between level A of background noise and level A of noise of point B and C is each 27.8 dB and 17.8 dB, and the difference from the noise is over 10 dB, so the noise level of point B and C is 68.8 dB for point B and 59.5 dB for point C without revision.

Also, the difference between level A and level C is 10 dB of point A, 12.8 dB of point B, and 11.9 dB of point C, so the noise of point B and C shows an octave band of low frequency.

According to ISO recommended standard (R1999), for your reference, equal noise level is not calculated for blasting explosion which has shorter lasting time than one second in a crashing sound. Therefore, this study doesn't apply the valuation table of equal noise level but estimates only noise level.

The amount of decrease is calculated as follows by the theory of noise decrease with the measured value at point A as a noise source.

A) In case of a dot sound source

Point B

$$SPL = PWL - 20\log d - 11$$
$$= 96.9 - 20\log 25 - 11 = 57.94 \text{ (dB)}$$

Point C

$$SPL = PWL - 20\log d - 11$$
$$= 96.9 - 20\log 50 - 11 = 51.92 \text{(dB)}$$

Explosion is calculated to 57.94(dB) and 51.92(dB).

B)Valuation by Rating Sound level

$Lr = La \pm$ Revised value(–20 dB)

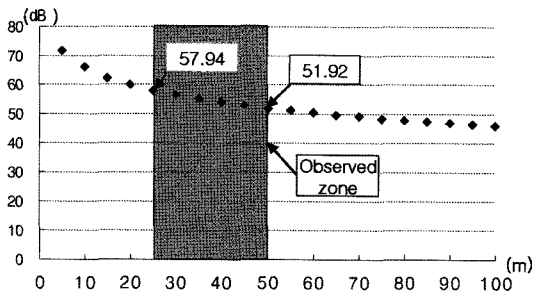

Fig. 3. Figures by Weber-Fechner's law.

Table 3. Calculate and a difference of measure

(Units : dB)

Point	Calculation	Measurement	Difference
B	57.94	68.8	+10.86
C	51.92	59.5	+7.58

Point B = 68.8 – 20 = 48.8 dB
Point C = 59.5 – 20 = 39.5 dB

On the estimate by the Rating Sound level, the permitted value is all lower than 50 dB of regulation value, and exclude effect is not applied to the calculation because of geographical condition and the shape of a fence.

Table 3 is the comparison of calculation value with actual survey of the noise level of point B and C.

On Table 3, the value which actual survey is larger than calculation value may be because of the effect by the amount of environment of neighborhood (chirp, chatter etc). The point B which is close to the education place shows bigger difference than point C.

There is a big difference on the noise level at the point of B and C between the measured value and the calculated value considered the effect of noise decrease by the distance and by the hiding. However, this thesis only considered the effect to the trainers. Therefore there is need to study on the noise level by the inner pressure of butane cans.

IV. Conclusions

The noise damage prediction by the explosion of butane cans is little in our country. According to the experiment data on the explosion of butane cans at Hantan River in 1997, the scattering distance by explosion of butane cans is 48 m maximum, but most containers are scattered between 2 m and 20 m [16,17].

Also, the power of explosion is 6 m high and about 4 m wide maximum for flame. Also 5 m from the wind direction of a styrofoam target and a window paper target were damaged by the flame and a rubber ballon of 10 m high was burst.

The damage prediction by the noise of explosion is calculated by the theory formula based on the result of noise measurement at explosion core. Also the result is compared with the real noise of the place where the active students are participating

The explosion of butane cans by outside fire makes noise in a very short time (0.15~0.21 seconds by a normal stopwatch), but disappeared at once. Also, it

doesn't give any effect to far distance.

This study predicted only the damage to students by explosion noise and got the following result.

1) The real noise to 25 m of the interested distance is 68.8 dB(A), and it shows some difference from 57.94 dB(A) gotten by the theory value. However, both of these values are smaller than 90 dB of environmental permitted value, so they are judged that there is no problem.

2) The real noise to 50 m of the interested distance is 59.5 dB(A), and it shows some difference from 51.92 dB(A) gotten by the theory value. However, both of these values are smaller than 65 dB of environmental permitted value, so they are judged that there is no problem.

3) According to W-F formula for the lower value than 65 dB which is the environmental standard, it is safe from the place 15 meter far from the explosion place. The environmental standard of offices is 50 dB, and it is lower than the environmental standard if the office is 65 meter far from the explosion place.

This study shows the best way of reducing the noise damage by the explosion of butane cans is to shunt to a further place than the damage limit distance.

The above GEN is lower than 90 dB of noise level of 8 hours exposure time a day among the permitted standards of noise restricted at Notice No.91-2 and enforcement regulation No.6 of a health measure of industry safety.

According to the permitted standard of impact noise, it is under 140 dB when the exposure number a day is 100, so it can be said that everything is safe.

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