INVESTIGATION OF SMOKE TEMPERATURE AND VELOCITY DISTRIBUTIONS IN A MODEL CORRIDOR

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ABSTRACT

Measurements of smoke temperature and velocity profiles with three difference fire powers(0.84kw, 1.3kw, 1.kw)in a model corridor. Both distributions are non-steady. The experimental results showed the temperature and velocity distributions at same position after full developed may be thought as uniform. The temperature could be calculated using a simple formula by use of velocity.

Keywords:temperature, velocity, profiles, smoke movement

INTRODUCTION

Fire smoke is very dangerous for people living in building because of its high temperature, toxicity and light-shadow. Fire statistics showed the injuries during fire accidents as far as 70% are caused by smoke not than fire. Considering smoke movement people far from the fire will also be injured. Investigation of smoke movement is very important for guide of people evacuation. The understanding of smoke properties is helpful to the design and installment of fire detectors to extinguish the fire early.

EXPERIMENTAL

1.Experiment apparatus

Model corridor made of iron is 1m long, 0.6m wide and 0.6m high as shown in Figure 1. One end is closed, and another open. Fire source located at the closed end was a gas burner. Its power can be changed. The temperature was measured by 0.3mm diameter NiCr-NiSi thermocouples. Signals were collected and sent to a computer to analyze. Velocity measurement was done using a thermo-ball anemometer with a range of 0—30m/s. The minimum is 0.01m/s. Fig.2 showed the arrangement of thermocouples and anemometer.

2.Temperature profiles

Temperature profiles were showed in Fig.3, Fig.4 and Fig.5. The results revealed that the temperature increase with the power increasing at same position. The temperature decrease with the distance from the fire increasing at same height. The maximum temperature occurs approximately 1cm from the ceiling in Fig.3. from ceiling increasing. In Fig.4,5 the maxim temperature occurs about 2 or 3cm from the ceiling. The curves of temperature

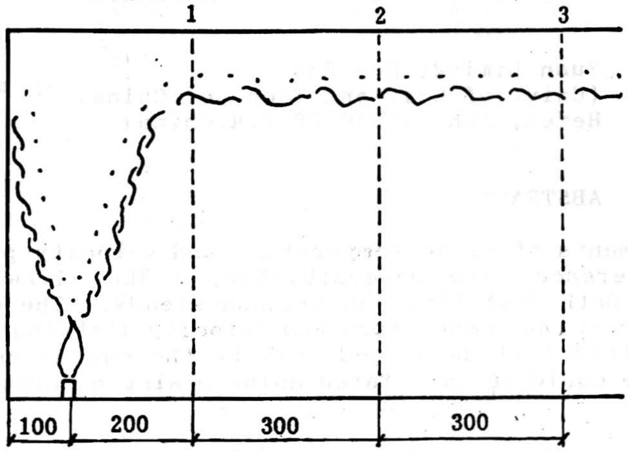

Fig.1 Experimental apparatus

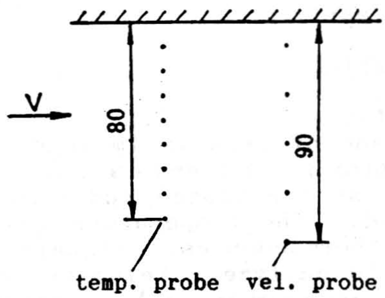

Fig.2 Arrangement of thermocouples and anemometer

profile become even with the time increasing. The temperatures at same position are nearly equal. It was more obvious in Fig.5 than in Fig.4.

3.Velocity Profiles

Velocity profiles were showed in Fig.6 and Fig.7. All the measurement were done at the position 2 in the time of 20 min. after ignition. It can be found that velocity profiles were non-steady. Velocity increases with the power increasing at same position. Velocity decreases with the distance from the fire increasing at same height [2]. The maxim velocity occurs 3cm from the ceiling. It also can be found that velocities were almost same. The velocity increases with the time increasing at same position. But the difference is not clear.

DISCUSSIONS AND CONCLUSIONS

The conclusion that velocity profile didn't vary with the time in ceiling jet is not true in the corridor according to the experimental results [1]. We could expected that temperatures and velocities are uniform respectively at the same position from Fig.5 and Fig.7 for fully developed smoke movement. In this case the temperature could be calculated from velocity by use of a formula derived from Hinkley, P.L in [2]:

$$\Delta T = 0.065\frac{Q \cdot g}{V^3 \cdot Ca \cdot \rho_a \cdot W}$$

T is temperature difference, Q is fire power, V is velocity, Ca is air specific heat, ρ_a is air density, W is corridor width.

Table 1 showed the calculation results at position 2 in the time of 20 min. Averaging velocity came from experimental results. The comparison with Fig.4 demonstrates the computation is acceptable.

Tab.1 Calculation of temperatures from velocities

power(*kw*)	0.84	1.3	1.74
ave.vel.(*m/s*)	0.28	0.29	0.304
ave.temp(°*C*)	33.9	45.8	55.5

Here we may draw the following conclusions.

A.Velocity profiles in a corridor were non-steady different from that of unconfined ceiling jet.

B.Temperature and velocity are uniform respectively at same position for fully developed smoke movement.

C. Velocity variation is few so it can be used to calculated the averaging temperature.

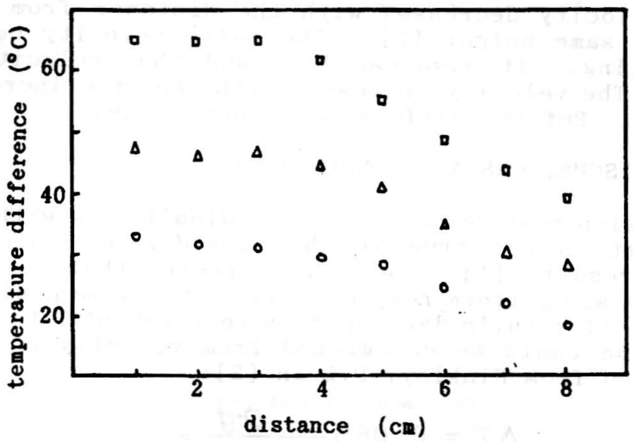

Fig.3 Temperature profiles at position 1 (5 min. after ignition)

o--Q=0.84KW   Δ--Q=1.3KW   □--Q=1.74KW

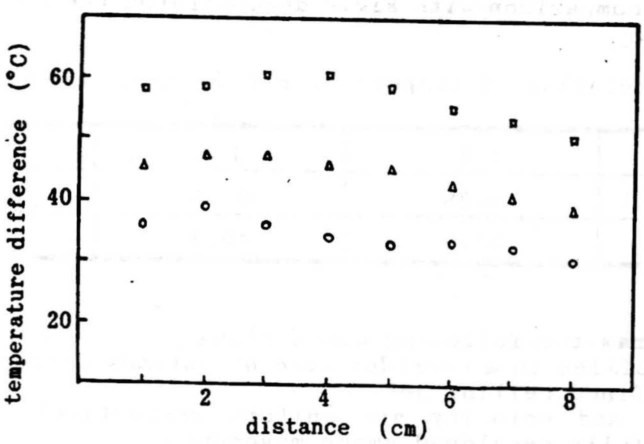

Fig.4 Temperature profiles at position 2 (20 min. after ignition)

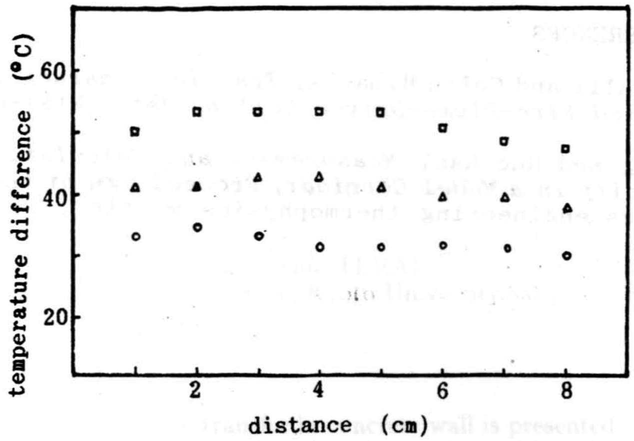

Fig.5 Temperature profiles at position 3
(40 min. after ignition)

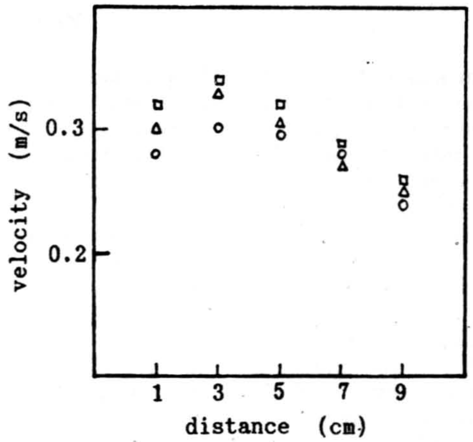

Fig.6 Velocity profiles at position 2
(20 min. after ignition)

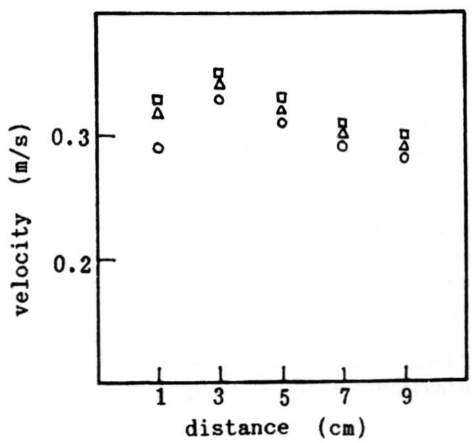

Fig.7 Velocíty profiles at position 2
(40 min. after ignition)

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