



Experimental Study on Gas Temperature During Fire in a Compartment with a Sloped Roof Vent

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Abstract. Twenty-two experiments have been conducted, with six different sloped roof vent areas, three fire source areas, and five door sizes, in a model-scale compartment with geometric dimensions of 150 cm length by 80 cm width by 150 cm height, to explore fire growth behavior and the temperature distribution in a compartment with a sloped roof vent (natural ventilation). It has been found in the experiments that, with increase of the sloped roof vent area, the maximum mass burning rate decreases gradually and the total combustion duration increases, in the condition of equal weight of total fuel in each test. This phenomenon demonstrates that the influence of the weakening effect owing to more energy loss via the roof vent is stronger than the strengthening effect due to combustion acceleration by enlarging the roof vent area, in the current experimental configuration. Moreover, the relationships between the average gas temperature rise and the roof vent area, as well as between the average gas temperature rise and the ratio of the roof vent area to total vent area, in the steady fire stage are summarized and quantified. In addition, it is found that, even when the roof vent area reaches 6.7 % of the floor area, the smoke layer height descends quickly, which poses a challenge to human evacuation.

Keywords: Sloped roof vent, Model-scale experiments, Gas temperature, Pool fire, Smoke layer

1. Introduction

It is of great importance to understand the behavior of compartment fires for the purpose of predicting the impact on structural elements and the dynamics of fire growth [1]. In a burning room, with natural convection only, vent flows through openings are the result of buoyancy forces generated from the temperature difference between the fire compartment and the cold ambient environment. Moreover, ventilation in a compartment has an effect on the amount of fuel that can be burned simultaneously in fire. Hence, the airflow into (and out of) the compartment has a

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significant influence on various aspects of the fire, such as the amount of fuel that can be burned, the gas temperature, and the gas layer thickness. As a consequence, the size and the shape, as well as the location and inclination angle, of the vent may have a significant impact on the spreading behaviors of compartment fire [2].

In recent years, fire protection concerns for enclosures have increasingly been addressed based on experiments, theoretical analysis, and numerical simulations. Fu and Hadjisophocleous [3] developed a fire growth and smoke movement model for a multicompartment building, which is indeed helpful in evaluating the risk from fires in buildings. Yüi et al. [2] studied the characteristics of vent flows in a reduced-scale post-flashover fire compartment with a door opening and a roof vent based on a series of reduced-scale experimental fires. Their experiments showed that the mass flow rate of air into the compartment increases linearly as the size of the roof vent increases. Kumar and Naveen [4] conducted experiments in which three different fuel trays and two different fuels were adopted, with and without cross-ventilation, to study the effect of cross-ventilation on the burning rates and the temperature profiles at different locations in the hot gas layer in the compartment. Merci and Vandeveldel [5] and Merci and van Maele [6] carried out a series of full-scale fire tests and numerical simulations for a small compartment with an open door and a horizontal roof vent to investigate well-ventilated fire, performing a parametric study that covered a range of total fire heat release rates, fire source areas, and roof ventilation opening areas. Chen et al. [7] conducted 61 model-scale experiments using polymethyl methacrylate (PMMA) fuel in a small-scale compartment with interchangeable lining materials and an adjustable vent. Correlations of the maximum gas temperature with the first- and second-order gradients during fire growth were investigated. Besides, the correlation between the maximum gas temperature and fire growth when the gas temperature is less than 300 °C was explored, which is definitely of great significance to predict the maximum gas temperature in a fire. In addition, Tang et al. [8] investigated the impact on mean flame height and smoke temperature profile of the geometry of windows (opening factor) and heat release rate (HRR) based on a series of model-scale experiments.

In general, the above-described research has greatly contributed to help understand fire growth and smoke movement behaviors. However, those previous studies mainly focused on buildings with vertical wall openings and/or horizontal openings, such as a door, window or horizontal roof opening, while in practice, sloped roof vents have been widely used. Up until now, whether sloped roof vents have a remarkable impact on fire behaviors remains unclear, and whether sloped roof vents have a similar impact to vertical and horizontal openings, and to what extent, also remains unclear. In order to understand the above issues, a series of fire experiments in a model-scale compartment with a sloped roof vent and a door opening were carried out. In these experiments, the sloped roof vent size, fuel pan area (or fire load), and door height were varied, allowing the influence of the roof vent area to be experimentally revealed. Moreover, observations made during the experiments are described, and the summarized results presented.

2. Experimental Setup

A model-scale compartment with sloped ceiling was constructed for the experiments, having internal dimensions of 150 cm length (x -direction) by 80 cm width (y -direction) by 150 cm height (z -direction) as shown in Figures 1 and 2. For the experimental compartment, the wall is 120 cm high, while the inclined roof occupied a height of 30 cm, with an inclination angle of $\alpha = 36.5^\circ$. The wall and ceiling of the compartment were made of calcium silicate board with thickness of 0.8 cm. Also, four steel pillars, located at the four corners of the compartment respectively, with sectional dimensions of 5 cm by 5 cm, were employed to fix and hold the calcium silicate boards. In addition, for the sake of reducing unnecessary energy loss, the wispy gap between calcium silicate boards at the wall corners was packed with asbestos.

Twenty-two experiments were conducted, as presented in Table 1, with six different sloped roof vent areas, three fire source areas, and five door heights, to explore fire growth behaviors and the temperature distribution.

2.1. Ventilation Vents

Natural ventilation and smoke extraction for the compartment were provided through two openings. The first opening was a rectangular door located in the south wall, with a distance between the door opening center and the west wall of 75 cm (so, the distance between the door opening center and the east wall is also 75 cm). In the tests, the geometrical dimensions and location of the door were constant in the first 18 experiments, but the geometrical dimensions varied (40 cm \times 20 cm, 40 cm \times 40 cm, 40 cm \times 80 cm, 40 cm \times 100 cm) in the last four experiments (Table 1) in order to explore the influence of door height.

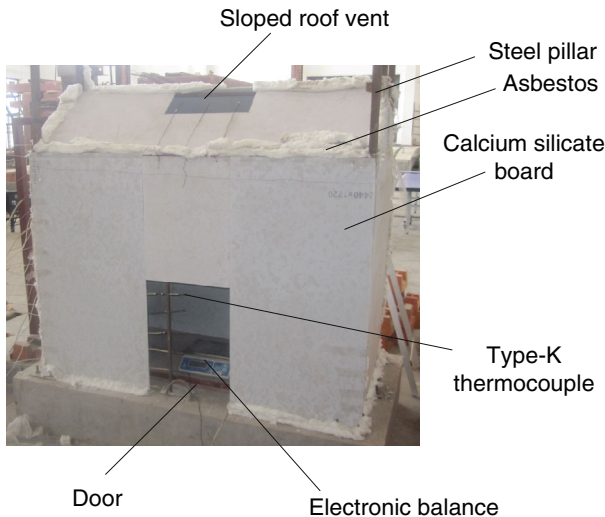
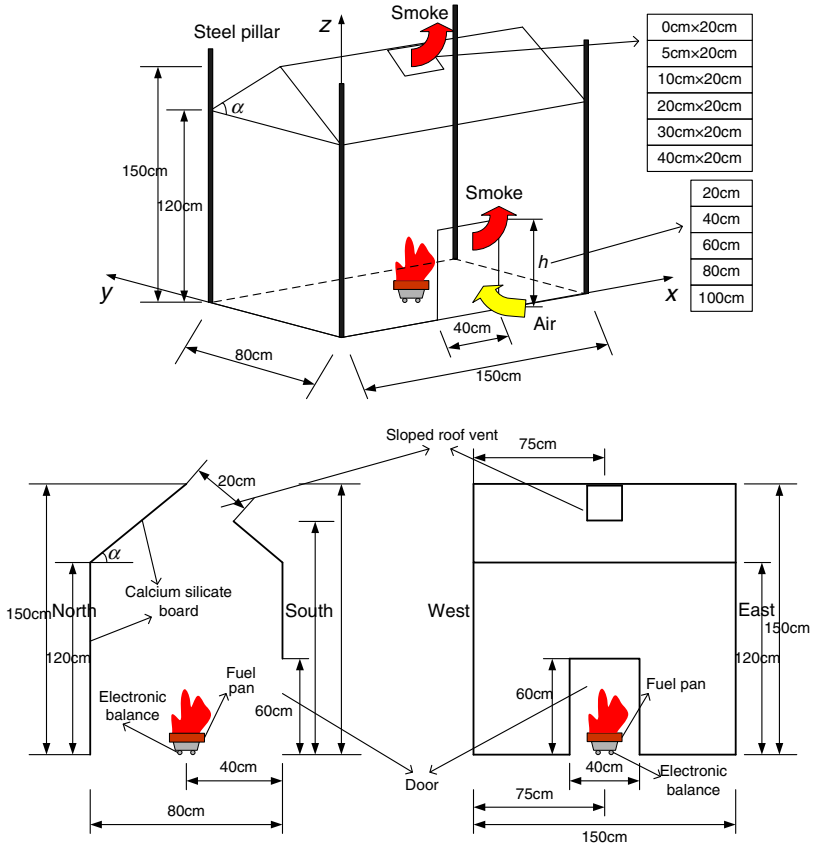


Figure 1. General view of the experimental setup.



Remarks: During some of the tests, the smoke may only flows out from roof vent

Figure 2. Geometry of the experimental setup.

**Table 1
Vent Size and Fuel Pan Size in Different Experiments**

Test	Roof vent (cm × cm)	Door size (cm × cm)	Fuel pan size (cm × cm)	Test	Roof vent (cm × cm)	Door size (cm × cm)	Fuel pan size (cm × cm)
1	0 × 20	40 × 60	30 × 30	12	40 × 20	40 × 60	20 × 20
2	5 × 20	40 × 60	30 × 30	13	0 × 20	40 × 60	10 × 10
3	10 × 20	40 × 60	30 × 30	14	5 × 20	40 × 60	10 × 10
4	20 × 20	40 × 60	30 × 30	15	10 × 20	40 × 60	10 × 10
5	30 × 20	40 × 60	30 × 30	16	20 × 20	40 × 60	10 × 10
6	40 × 20	40 × 60	30 × 30	17	30 × 20	40 × 60	10 × 10
7	0 × 20	40 × 60	20 × 20	18	40 × 20	40 × 60	10 × 10
8	5 × 20	40 × 60	20 × 20	19	20 × 20	40 × 20	30 × 30
9	10 × 20	40 × 60	20 × 20	20	20 × 20	40 × 40	30 × 30
10	20 × 20	40 × 60	20 × 20	21	20 × 20	40 × 80	30 × 30
11	30 × 20	40 × 60	20 × 20	22	20 × 20	40 × 100	30 × 30

During the tests, hot smoke flows out of the compartment (if the smoke layer descends to the soffit of the door opening) and fresh air flows into the compartment through the door.

The other opening was a sloped roof vent, as shown in Figure 2. In the experiments, the area of the sloped roof vent A_{roof} was adopted as 0 cm \times 20 cm (no roof vent), 5 cm \times 20 cm, 10 cm \times 20 cm, 20 cm \times 20 cm, 30 cm \times 20 cm, and 40 cm \times 20 cm, respectively, for the first 18 tests, as listed in Table 1. In order to adjust the roof vent area easily, the roof vent was completely or partly covered by a movable cover plate. In the last four tests, the roof vent was fixed at 20 cm \times 20 cm, since their purpose was to explore the impact of door height (or door size).

2.2. Fire Source

A pool fire was selected as the fire source in the experiments, and a fuel pan was used to hold the fuel (methyl alcohol, CH_3OH), being positioned in the center of the compartment. Three fuel pan sizes (A_f) were adopted, namely 30 cm \times 30 cm, 20 cm \times 20 cm, and 10 cm \times 10 cm (length \times width), as shown in Figure 2 and Table 1. Moreover, the height of the fuel pan was 6 cm in each case. In order to maintain similar total combustion duration in each test, 1.0 kg, 0.445 kg, and 0.111 kg methyl alcohol was used for the above three fuel pans.

An electronic balance, with time accuracy of 1 s and mass accuracy of 0.1 g, was placed below the fuel pan and connected to a computer to record the weight variation of methyl alcohol during the fire tests.

2.3. Temperature Measurements

Sheathed type K thermocouples, with error margin of ± 0.5 °C, were used to measure the gas and air temperature in the tests, as indicated in Figure 3. Two thermocouple trees were employed, consisting of 13 and 16 equally spaced (10 cm) thermocouples over the height of the compartment, respectively, for the purpose of studying the characteristic of the gas distribution vertically. Thermocouple tree A (TTA) was numbered T1 to T13, while thermocouple tree B (TTB) was numbered T17 to T32. Specifically, TTA was installed close to the south wall, with equal distance from the west wall and the east wall, while TTB has placed at a distance of 30 cm from the west wall, likewise with equal distance to the north and south walls. Because of the large distance of TTA from the nearest pillar (in the tests, the pillars also help fix and hold the thermocouples), a vertical supporting tube was installed 65 cm from the pillar to help hold the thermocouples in place. Besides, three thermocouples (numbered T14 to T16) were fixed at the location of the sloped roof vent, in order to measure the temperature of the exiting gas.

For the 22 tests, the ambient temperature (T_{amb}) was around 25 °C, and the influence of ambient temperature is considered negligible in this paper. Besides, the experiments were conducted indoors with closed windows, and the velocity of air flow was low (0 m/s to 0.1 m/s according to measured results); as a result, the influence of wind is not taken into account in the tests either. In addition, in each test, the duration of fuel addition to the fuel pan was limited to less than 1 min,

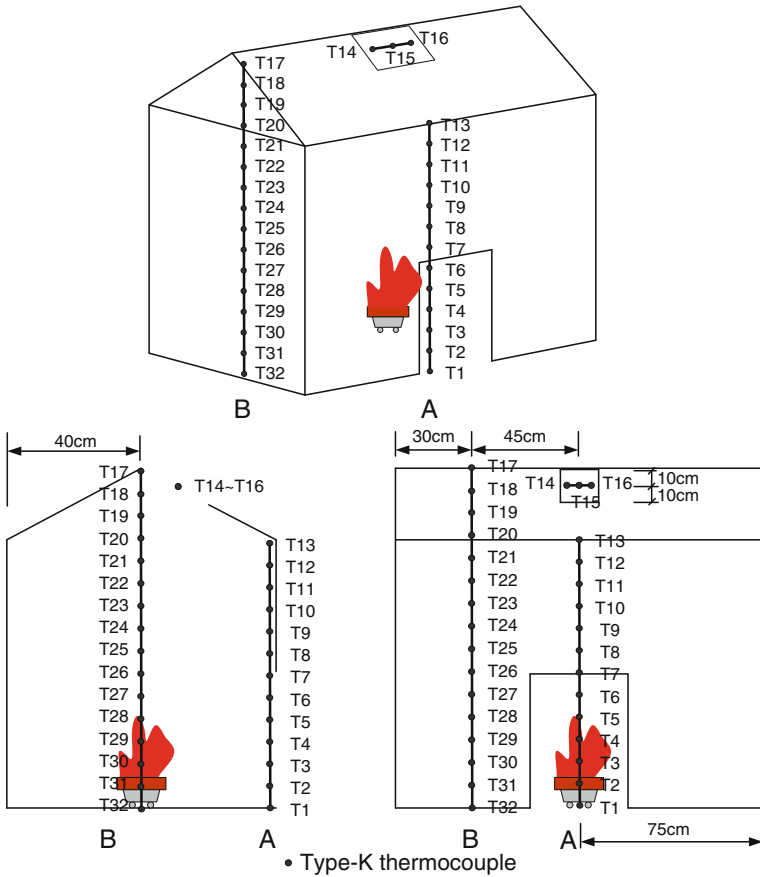


Figure 3. Positions of the thermocouples.

to reduce evaporation loss. In this way, the impact of evaporation loss can be reduced to an acceptable extent.

3. Results

The pattern of the growth phase was similar for all 22 experiments. In particular, the duration of each experiment was about 13 min, to ensure a steady thermal state (actually, a steady state was observed in 3 min for most experiments). In the following, the test results are presented and analyzed subsequently.

Figure 4 shows the temperatures measured at different heights by TTA and TTB, for a 20 cm × 20 cm sloped roof vent and 40 cm × 60 cm door size, for different fuel pan areas. As can be seen from Figure 4a, c, e, the measured temperatures could be obviously separated into two groups. The measured temperatures T7 to T13 were obviously higher than the others during the steady burning stage, and the measured temperatures T1 to T5 were almost equal to the ambient

temperature, indicating that the height of the interface between the cold air layer and the hot gas layer was close to the height of thermocouple T6, which was located 50 cm above the ground. This smoke layering phenomenon can also be observed in Figure 4b, d, f.

The measured gas temperature in the hot gas layer was slightly inhomogeneous, as shown in Figure 4. The maximum gas temperature was measured by T18 rather

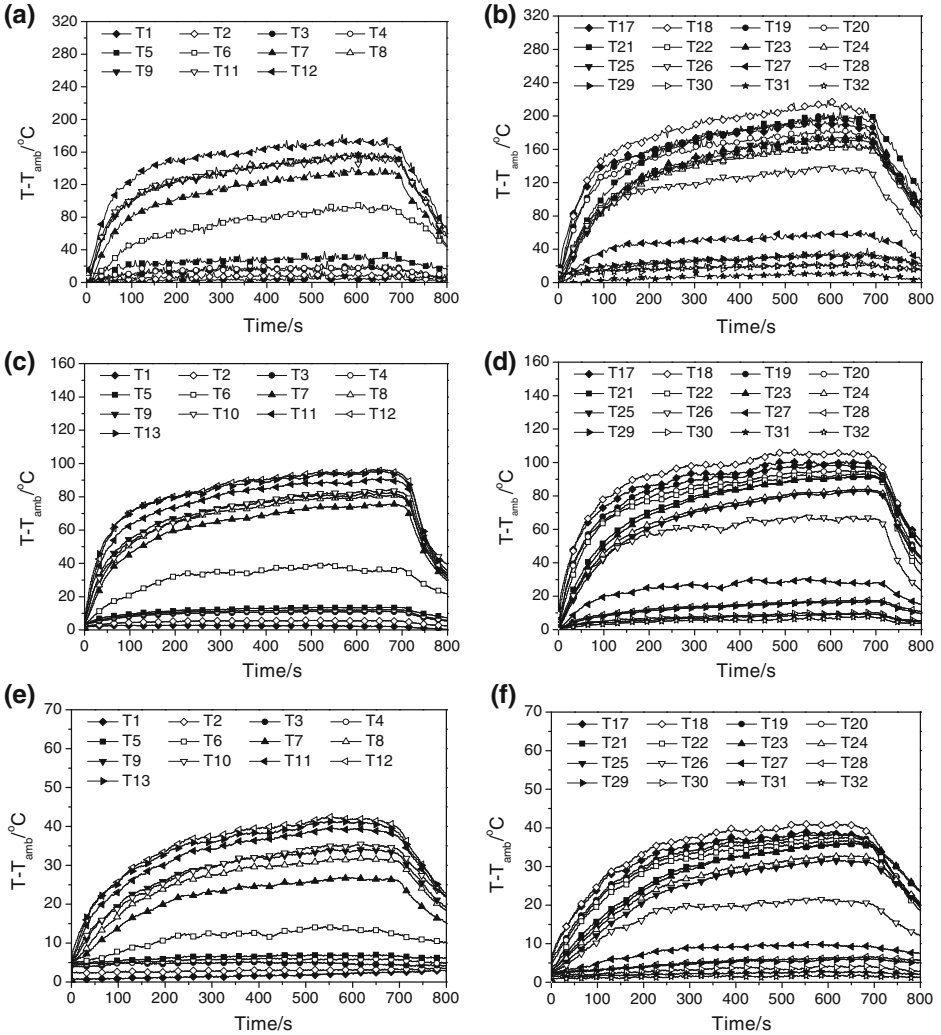


Figure 4. Measured temperatures with 20 cm x 20 cm sloped roof vent: (a) 30 cm x 30 cm fuel pan, TTA; (b) 30 cm x 30 cm fuel pan, TTB; (c) 20 cm x 20 cm fuel pan, TTA; (d) 20 cm x 20 cm fuel pan, TTB; (e) 10 cm x 10 cm fuel pan, TTA; (f) 10 cm x 10 cm fuel pan, TTB.

than T17 for all tests. As a result, it is reasonable to consider the measured result of T18 to be the maximum gas temperature, as discussed in Sect. 4.1.

It should be pointed out that there were some failures for thermocouples T10 and T13 during the first six tests (tests 1–6) with the 30 cm × 30 cm fuel pan and 40 cm × 60 cm door. As a consequence, the measured temperatures T10 and T13 are absent from Figure 4a.

4. Analysis and Discussion

4.1. Influence on Gas Temperature

The maximum temperature rise ($T_{18} - T_{amb}$) for different sloped roof vent areas (for door size of 40 cm × 60 cm) is shown in Figure 5. Thermocouple T18 was fixed at the same height, but the measured temperatures of T18 are quite distinctive for each sloped roof vent area. Specifically, when the fuel pan and sloped roof vent were fixed at 30 cm × 30 cm and 0 cm × 20 cm (or no roof vent), respectively, the maximum temperature exceeded the ambient temperature by about 330 °C. However, with increase of the roof vent size, the maximum smoke temperature rise was approximately 280 °C, 240 °C, 200 °C, 160 °C, and 140 °C, respectively, for the same fuel pan. In other words, the gas temperature exhibited a negative correlation with roof vent size, which is similar to the results presented in Ref. [5], but contrary to those presented by Yii et al. [2]. In the following, the above fire behavior revealed in our tests is discussed in detail.

The mass burning rate for different sloped roof vent areas (with fuel pan area fixed at 30 cm × 30 cm) is presented in Figure 6. It can be seen from this figure that, as the sloped roof vent area increases, the maximum mass burning rate drops and the total combustion duration increases (the total weight of fuel in each test being equal: 1.0 kg).

According to the above experimental results, we can summarize the following mechanism: in our experiments, when the roof vent is enlarged, it is easier for heat to spill out of the compartment, and therefore the smoke temperature will be lower, thus the energy radiated from the hot gas would reduce, weakening the acceleration effect of combustion (due to radiation from the upper layer) and increasing the total combustion duration, even though the ventilation has been improved.

However, unlike our tests, a larger sloped roof vent led to higher gas temperature in Ref. [2], because with the enlargement of the roof vent, the outflow rate increased, leading to an increased inflow rate. As anticipated, the burning rate of the fuel accelerates with the increase of ventilation. Therefore, the gas temperature is higher, even though more heat spills out of the larger roof vent.

The reason why the results measured in our experiments are different from those in Ref. [2] can be explained as follows. The fuel in our tests is CH₃OH, with stoichiometric ratio of 1.5 kg oxygen per kilogram fuel, and the maximum mass burning rate is about 1.64 g/s, while Yii used heptane (C₇H₁₆) as fuel, which needs approximately 3.52 kg oxygen when 1 kg heptane is combusted, and the lowest mass burning rate is 7.0 g/s. Besides, in our tests, the size of the door

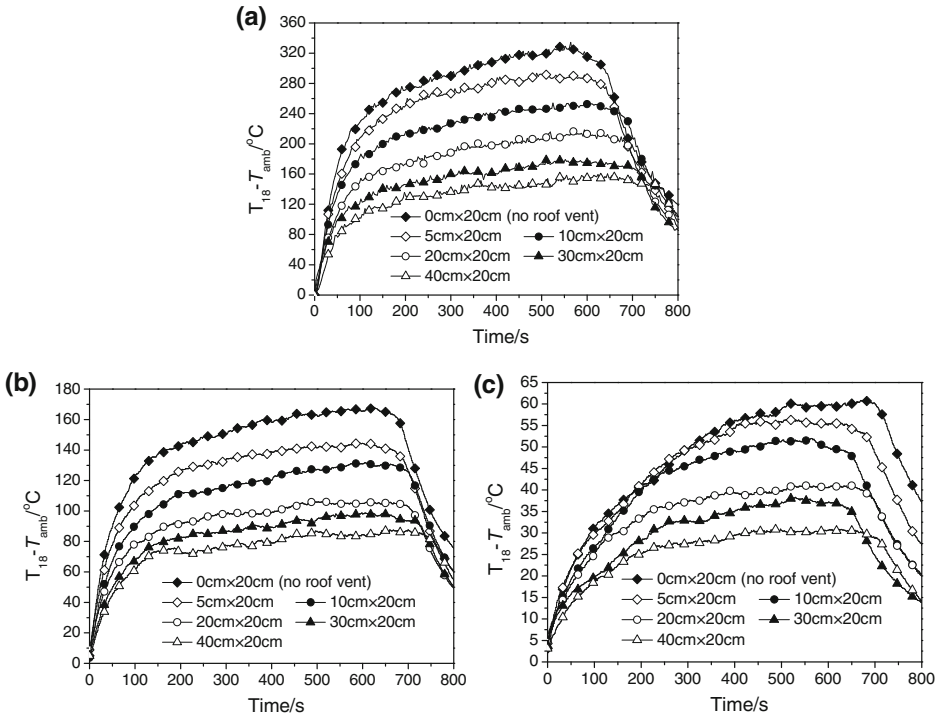


Figure 5. Maximum temperature rise ($T_{18} - T_{amb}$) with different roof vent areas for: (a) 30 cm × 30 cm fuel pan, (b) 20 cm × 20 cm fuel pan, and (c) 10 cm × 10 cm fuel pan.

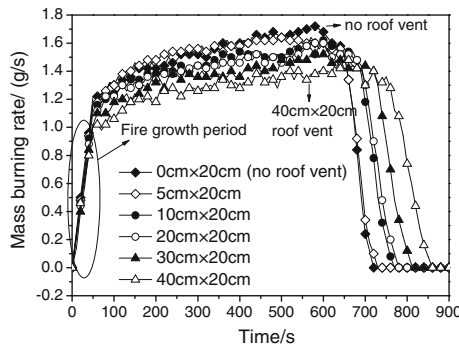


Figure 6. Mass burning rate with different sloped roof vent areas (with 30 cm × 30 cm fuel pan).

(60 cm × 40 cm) is larger than that in Yii’s tests (45 cm × 25 cm), compared with the other dimensions. Thus, Yii’s tests are much more likely to rely on fresh air, compared with the experiments presented in this paper. Also, we can say that the

combustion in our tests is mainly well ventilated, while it is ventilation limited in Ref. [2], according to the test results. Consequently, the outflow rate plays a decisive role in determining the gas temperature in Yii's tests. In contrast, in our experiments, the outflow rate only slightly influences the gas temperature, whereas the heat loss from the roof vent has a strong impact on the gas temperature.

Overall, whether the gas temperature increases as the sloped roof vent area increases depends on the relationship between the strengthening effect due to the acceleration of combustion and the weakening effect resulting from the greater energy loss through the roof vent.

The influence of the sloped roof vent area on the average temperature rise in the smoke layer is visualized in Figure 7. This average temperature rise $T_{s,av} - T_{amb}$ is determined from the mean temperature at heights $z = 60$ cm and higher, between 500 s and 600 s, during which the thermal exchange remains relatively balanced. Table 2 provides an overview of $T_{s,av} - T_{amb}$ for all the scenarios with 60 cm door height. From this figure, it can be seen that $T_{s,av} - T_{amb}$ decreases with increase of A_{roof} , which can be quantified (using OriginPro 7.5 software) as

$$T_{s,av} - T_{amb} \sim A_{roof}^{-0.28}. \quad (1)$$

In addition, the relationship between $T_{s,av} - T_{amb}$ and the ratio of the roof area to the total vent area (A_{roof}/A_{vent}) can also be quantified, as follows:

$$T_{s,av} - T_{amb} \sim (A_{roof}/A_{vent})^{-0.30}. \quad (2)$$

It can be seen from Eq. (1) that the exponent (-0.28) approaches the exponent (-0.24) quantified in Ref. [5] as well as the exponent (-0.21) in Ref. [6]. The main reason is that the smoke layer is quite thick compared with the compartment dimensions. This illustrates that the gas temperature shows weak dependence on the inclination angle of the roof opening (sloped versus flat roof vent) when the smoke layer is thick. Since the experimental setups (structure dimensions, vent size, heat release rate) of the two series of experiments differ, the exponents also differ, but they are essentially the same.

The parameter A_{roof}/A_{floor} in our tests varies between 0 % and 6.7 % [(40 cm \times 20 cm)/(150 cm \times 80 cm) = 6.7 %], which is in accordance with common buildings, except for some special buildings.

The results for the maximum temperature rise and average gas temperature rise for different door sizes are shown in Figures 8 and 9. It can be seen from these figures that the influence of the door size has the following characteristic: when the door size is relatively small (smaller than 40 cm \times 60 cm), the average gas temperature rise in the stable stage (500 s to 600 s) increases with increase of the door size; however, when the door size is relatively large (larger than 40 cm \times 60 cm), it decreases with increase of the door size, which is quite different from the influence of the roof vent size (the larger the roof vent size, the higher the average gas temperature rise). According to the experimental results, it can be inferred that, when the door size is small, the fire is vent limited, whereas, as

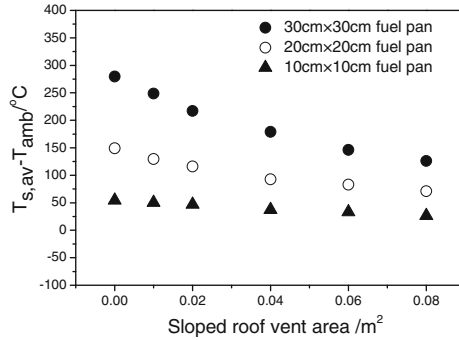


Figure 7. Influence of sloped roof vent area on hot-layer average temperature rise.

Table 2
Hot-layer Average Temperature Rise ($T_{s,av} - T_{amb}$)/°C

Sloped roof vent size	0 cm × 20 cm	5 cm × 20 cm	10 cm × 20 cm	20 cm × 20 cm	30 cm × 20 cm	40 cm × 20 cm
30 cm × 30 cm fuel pan	279.6	248.7	217.1	179.1	146.3	125.9
20 cm × 20 cm fuel pan	149.0	129.6	116.1	92.7	82.9	70.9
10 cm × 10 cm fuel pan	54.3	50.2	47.0	37.4	33.1	26.6

the door size is enlarged, the ventilation condition is improved, and the gas temperature increases, despite the greater energy loss through the larger door vent. This means that, when the door size is small, the improved burning rate is sufficient to offset the energy loss increase due to the larger door size. However, when the door size is relatively large, the weakening effect as a result of the greater energy loss through the door will exceed the strengthening effect due to the acceleration of combustion, and consequently the gas temperature rise will be smaller instead.

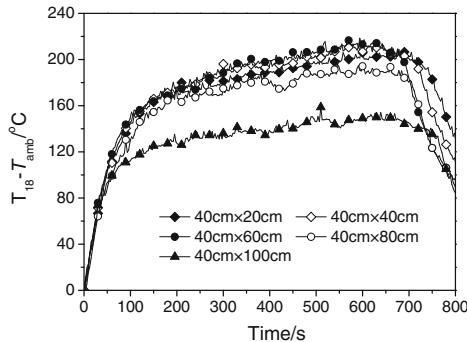


Figure 8. Maximum temperature rise ($T_{18} - T_{amb}$) for different door sizes.

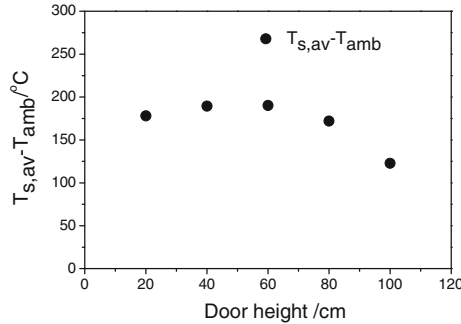


Figure 9. Influence of door size on hot-layer average temperature rise.

As a result, we can draw the conclusion that the fire is mainly ventilation limited when the door height is less than 60 cm, whereas the fire gradually becomes well ventilated as the door height becomes greater than 60 cm in our tests.

4.2. Influence on Smoke Distribution

Figure 10 shows the gas temperature profile vertically at 150 s and 600 s, respectively. It is clear that the temperatures measured by the thermocouples below the height $z = 50$ cm are much lower than those above $z = 50$ cm. In addition, the temperatures measured above $z = 50$ cm are similar to one another, indicating that gases in the compartment have been obviously layered, as shown in Figure 4 in Sect. 3. By comparing the figures in each row, one can see that the thickness of the smoke layer does not vary considerably from 150 s to 600 s, indicating that the smoke thickness has reached a relatively steady condition before 150 s even if the roof vent area reaches 6.7 % (for the 40 cm \times 20 cm roof vent) of the floor area. The dimensions of our test structure are 150 cm \times 80 cm \times 150 cm, which is about 1:3 to a real room. According to the Froude similarity criterion, one has $t_m/t_p = (L_m/L_p)^{1/2}$ (where t_m denotes the time required for model-scale tests, t_p represents the time required for a full-scale structure, L_m is the dimension of the model-scale structure, and L_p is the dimension of the full-scale structure), based on which it can be calculated that 150 s in the model-scale experiments is approximately equivalent to 260 s in full-scale tests; That is to say, the gas layer may decrease to a low height in less than 4.5 min. This analysis highlights that the available safe egress time in a compartment fire may be short, as the smoke layer may descend to a low height in a short time, possibly resulting in serious casualties from a fire.

Furthermore, it was found that the fuel pan area had little impact on the smoke layer thickness, since the smoke layer thickness remained almost constant (at about 100 cm), comparing the figures in each column. This rule also holds for the heat release rate (HRR), since the HRR is directly proportional to the fuel pan area for a well-ventilated fire.

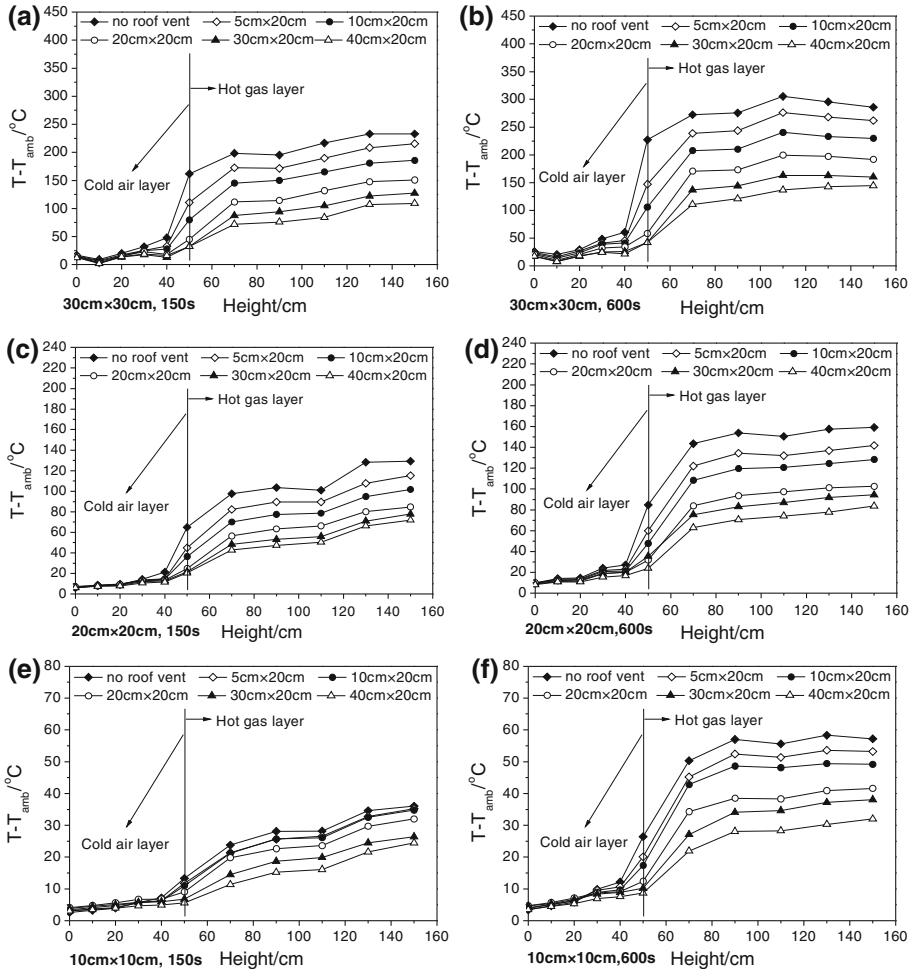


Figure 10. Gas temperature fluctuation vertically at 150 s and 600 s: (a) 30 cm × 30 cm fuel pan, 150 s; (b) 30 cm × 30 cm fuel pan, 600 s; (c) 20 cm × 20 cm fuel pan, 150 s; (d) 20 cm × 20 cm fuel pan, 600 s; (e) 10 cm × 10 cm fuel pan, 150 s; (f) 10 cm × 10 cm fuel pan, 600 s.

However, this phenomenon is probably an artifact of the specific ventilation conditions in the setup, which probably overwhelm some other effect (i.e., ventilation from one side for a relatively large fire in a relatively small compartment). It should be noted that a steady smoke layer may not result in a fire with low enough fire load and/or large enough roof vent. However, here we consider fire behaviors in a fire accident, and therefore do not consider this circumstance herein.

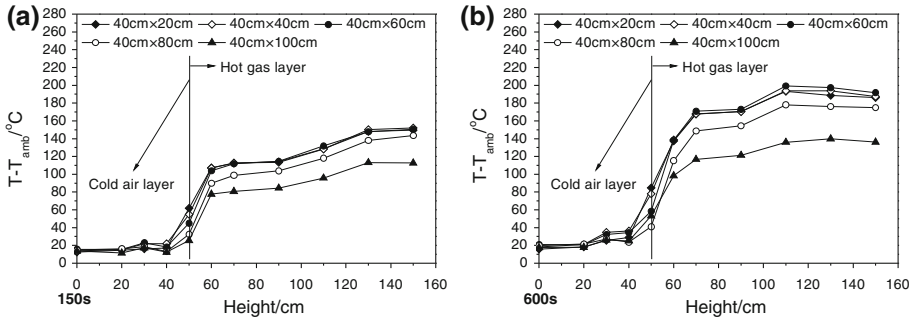


Figure 11. Gas temperature profile vertically at 150 s and 600 s for different door sizes.

One can notice that the height of the gas layer ($z = 50$ cm) is just below the top of the door opening (60 cm) with the different roof vent sizes. To explore whether the door height has a decisive impact on the smoke layer thickness, it is significant to consider the gas layer height for different door heights, as illustrated in Figure 11. It can be seen from this figure that the height of the gas layer is always about 50 cm as the door height increases from 20 cm to 100 cm. This illustrates that the door height has little influence on the smoke layer thickness in this test structure. Moreover, we can safely draw the conclusion that it is not the door height (60 cm) that leads to the 50 cm smoke layer height for varying roof vent sizes and fuel pan areas.

Of course, we cannot measure the exact value of the smoke layer thickness for different door heights, because the separation between two thermocouples is 10 cm, but Figure 11 illustrates that door height has little impact on the smoke layer thickness in our experiments.

5. Conclusions

Twenty-two experiments were conducted with six different sloped roof vent areas, three fire source areas, and five door sizes, in a model-scale compartment with geometric dimensions of 150 cm length by 80 cm width by 150 cm height, to explore fire growth behaviors and the temperature distribution characteristic in buildings with sloped roof vents (natural ventilation). The test results are presented and analyzed, revealing some interesting results as follows:

1. The experiments revealed that, with increase of the sloped roof vent area, the maximum mass burning rate decreases and the total combustion duration increases when the total weight of fuel in each test is equal. This is due to the fact that, as the sloped roof vent area increases, the heat loss through the roof vent increases and the gas temperature decreases consequently, leading to a reduction of the energy radiated from the hot gas to the unlit fuel; as a result, the mass burning rate decreases, even though more fresh air flows into the

compartment. In a word, the fire in our tests was mainly well ventilated even when there was no roof vent, and when enlarging the roof vent, the gas temperature was lower, even though ventilation was improved.

2. The relationship between the average temperature rise of the smoke layer and the sloped roof vent area, as well as the ratio of the roof area to the total vent area, in the steady fire stage (from 500 s to 600 s) is summarized, being quantifiable as $T_{s,av} - T_{amb}$ proportional to $A_{roof}^{-0.28}$ and $T_{s,av} - T_{amb}$ proportional to $(A_{roof}/A_{vent})^{-0.30}$ in the conditions investigated in this work. The exponents are essentially the same as in Merci's tests [5, 6], placing them in context with existing data.
3. The experiment is considered to be successful in giving a clear picture of gas layering in the compartment, even if the mass burning rate is low (approximately 0.2 g/s). Additionally, it is determined that the smoke layer descends to a low height in less than 150 s, which is equivalent to about 260 s in a full-scale structure, even if the roof vent area reaches 6.7 % of the floor area. This behavior highlights that the available safe egress time in a compartment fire may be short, possibly resulting in serious casualties in a fire accident.

In this work, a series of experiments were carried out to investigate the fire behavior in a compartment with a sloped roof vent, and the impact of the sloped roof vent area is presented and discussed. However, the influence of the inclination angle has not been explored due to the limited test equipment, so further relevant study is also necessary.

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