講演番号	199

Study on Ventilation Volume of EV in the case of Transport for COVID-19 Patient (Part5)

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At this report, it supposed that automobile ventilation facilities have been developed to consider the international environmental standards. It focused on the transport for COVID-19 patients in this report. Cabin ventilation was important in this case. Firstly, it focused on the ventilation volume 30 m^3/h/person in room. However, the calculated reason was not clear. Here, it considered that ventilation volume was in cabin instead of room. First stage, it focused on the carbon dioxide discharged volume. It researched the reference. 15×10^{-3} m^3/h/person was predicted in cabin. Second stage, it predicted that ventilation volume was 26 m^3/h/person. Third stage, it supposed that ventilation volume was 130 m^3/h at the outside air inducing method in cabin. Lastly, it recommended that the two cases of transport for COVID-19 patients, first one was outside air inducing method, second one was the small opening window method.

Here, Mark C_D, V and g were Drag coefficient 0.3, Car speed [m/s], and Gravitational acceleration 9.8 [m/s^2] respectively. Calculation condition concept was shown in Fig.1. It predicted that window sizes were 0.03 m height and 0.6 m length. Vehicle speed was 40 km/h (11.1 m/s).

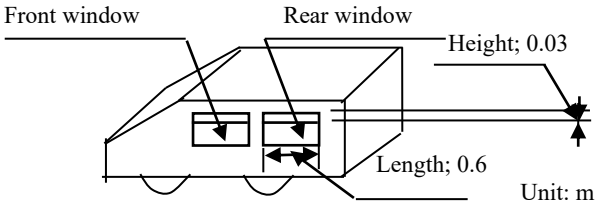

Fig.1 Calculation Condition Concept

Air circulation conditions were shown in table.1.

Table1. Air circling conditions

Air circling condition	Conditions			
	Window glass	Outside air intake	Enforced ventilation fan system	Air exit
Outside air inducing	close	open	operation	open
Opening window	open	close	non-operation	open

Firstly, the carbon dioxide discharged volume (Q) was predicted in cabin. Next, the ventilation volume (k) was asked by equation (1).

$$K = Q / (C(t) - C_B) \quad (1)$$

Q：Carbon dioxide discharge volume per hour per person
15×10^{-3} [m^3/h/person] (Sitting condition on chair)

C(t)：Carbon dioxide concentration in cabin
1000 ppm＝0.001

C_B：Carbon dioxide concentration at atmosphere
423.9 ppm＝0.0004239 (average value in 2024)

$$K = 15\times10^{-3} / (0.001 - 0.0004239) = 26.0 \quad [m^3/h/person]$$

First stage: The window glass was closed at driving and ventilation volume was induced by the enforced ventilation fan system at about 50 percent ability. It was called the predicted ventilation volume(V0).

$$V0 = 26\ m^3/h/person \times 5persons = 130 \quad [m^3/h]$$

Second stage: The enforced ventilation fan system was switched off and the window glass was opened at driving. The opening window size was 0.03 m height and 0.6 m length at the driving side and the rear seat side.

Ventilation volume(V1) was asked by the submitted equation.

$$V1 = (0.5 * C_D * V^2 / g) * L * H \quad [m^3] \quad (2)$$

Here, if this value(V1) was over the predicted ventilation volume. V1 was equal to the predicted ventilation volume(V0). Calculated reason was following.

$$V2 = (0.5 * C_D * V^2 / g) * L * H - (V1-V0) = V0 \quad [m^3] \quad (3)$$

$$V1 = V2 = V0$$

1) Opening window number; 1 (rear side)

It was asked that the outside air invasion volume per second(V1).

$$V1 = (0.5 * 0.3 * 11.1^2 / 9.8) * 0.6 * 0.03 = 0.0339 \quad [m^3/s]$$

$$V3 = V1 * 3600 = 0.0339 * 3600 = 122.0 \quad [m^3/h]$$

This was smaller than the predicted ventilation volume (*130 m^3/h*). So that, it was decided that V3 was 122.0 [m^3/h].

2) Opening window number; 2 (driver side, rear side)

Outside air invasion volume per second (V1) at one window.

$$V1 = (0.5 * 0.3 * 11.1^2 / 9.8) * 0.6 * 0.03 = 0.0339 \quad [m^3/s]$$

$$V3 = V1 * 3600 * 2 = 0.0339 * 3600 * 2 = 244.0 \quad [m^3/h]$$

This value was passed the predicted ventilation volume (*130 m^3/h*). So that, it was decided that V3 was the predicted ventilation volume.

$$V3 = 130 \quad [m^3/h]$$

It was examined that the relation between the ventilation volume and windows number in the case that opening window height was from 0.01 to 0.03 m. The results were shown in Fig.2.

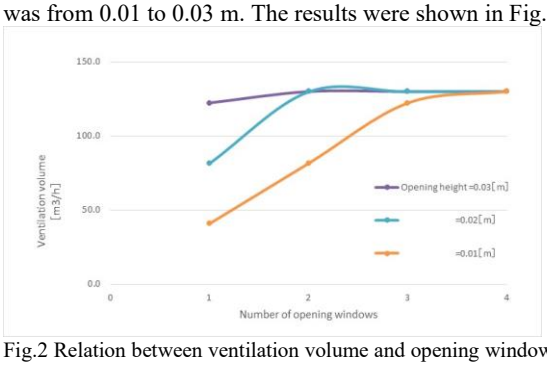

Fig.2 Relation between ventilation volume and opening windows number.

It recommended that the opening window height was 0.03 m at one window, 0.02 m at two windows respectively. Lastly, two cases were recommended that transport for COVID-19 patients, first one was outside air inducing method, second one was the small opening window method.