Cross-infection risk between two people standing close to each other at different room temperatures

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If we look at the exhalation flow from a person standing in a room with Mixing Ventilation and an air temperature T_a of 21°C, we will see that the exhalation will take an upward direction. The reason is that the pulsating exhalation flow has an initial temperature T_{exh} of 34°C. The exhalation will be entrained with room air in a forward movement and will decrease at temperature level, but it will keep a temperature higher than the surroundings and therefore have an upward movement, in principle to the ceiling level, **Figure 1**.

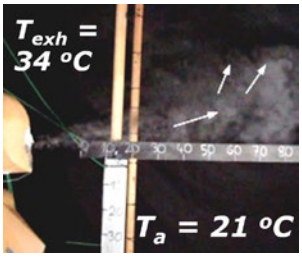

Figure 1. Pulsating exhalation flow in surroundings with fully mixed flow. Liu et al. (2009)

The horizontal length of the exhalation flow is a function of the temperature difference $T_{exh} - T_a$. If the temperature difference is large, as in cold surroundings, we will obtain a short length, but we will on the other hand have a substantial length in hot surroundings. The horizontal lengths will also depend on the person's activity level and on activities such as speaking, singing, coughing etc.

Things are different in a room with stratified flow as in the case of Displacement Ventilation. **Figure 2** shows that the exhalation will be stratified at a certain height, which could be just above the height of a person's mouth. The increased temperature versus height will lock the exhalation at a certain height.

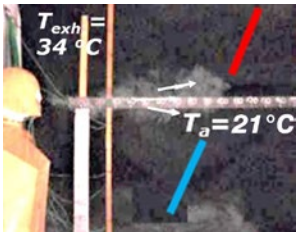

Figure 2. Pulsating exhalation flow in surroundings with stratified flow. The room temperature at the height of the mouth is 21°C. Liu et al. (2009)

When we conduct research, we often investigate the usual situations. For example, we consider the room temperature to be at comfort level, around 21°C. This is not the case in many practice situations where it could be more than 34°C in the summer in some countries and it could be 10°C in shops, for example, handling foods.

A COBEE 2022 conference paper shows new experiments with different room temperatures, Nielsen et al. (2022). The paper shows that the different lengths and directions of exhalation, obtained at different room temperatures, will influence the cross-infection risk between two people standing close to each other.

The paper shows that hot surroundings do increase the cross-infection risk to a high level at high room temperatures. It also shows that the cross-infection risk between two people standing close to each other will decrease in cold surroundings.

Figure 3 shows video stills of the exhalation flow from the index manikin. The exhalation flow is primarily governed by momentum in the first part, independent of the surrounding room temperature. It is obvious that the buoyancy effect changes the movement in an upward direction for the room temperatures 17°C and 25°C in the later flow.

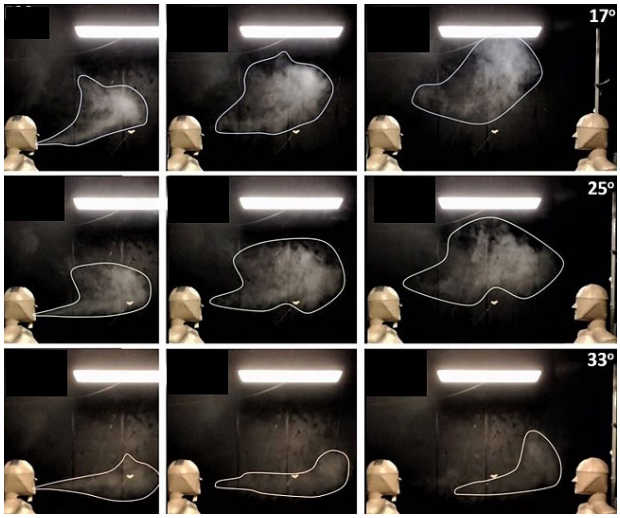

Figure 3. Exhalation flow from an index manikin standing 1.0 m in front of a susceptible (target) manikin Each row shows the flow at one of the three room temperatures: 17°C, 25°C and 33°C.

When the room temperature is 33°C, there will be almost isothermal surroundings due to an exhalation temperature of the same level and the buoyancy effect will not be present. The horizontal direction seems to be blocked by the thermal plume from the target manikin. **Figure 3** shows that the growth rate of the vertical height of the exhalation flow is reduced in the T_a = 33°C case, indicating that it is a stratified flow with a reduced turbulence level.

The cross-infection risk is increased from 2 to 6, expressed as normalized exposure in case of mixing ventilation, when the room temperature increases from 23 to 33°C. (Distance between persons are 0.35 m). ■

Literature: please see the online version at rehva.eu