Cultura e Tecnica per Energia Uomo e Ambiente

AICARR POSITION ON HVAC SYSTEM OPERATION DURING SARS-COV2-19 EMERGENCY

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AICARR POSITION PAPERS

AiCARR is a non-profit cultural association, which creates and promotes culture and technology for sustainable well-being.
Established in 1960, AiCARR has always dealt with issues related to the conscious use of energy and natural resources as well as the innovation of energy infrastructures, both in the system and building sectors.
The fundamental purposes of AiCARR are the production and dissemination of the culture of sustainable well-being and the training and professional development of sector operators, in order to increase their qualification, their contribution to the discussion and development of sector regulations, collaboration, as self-interlocutor, with other Italian and European Associations and governmental bodies. The sectors of interest of Ai-CARR are the design of the building and plant systems, the progress and diffusion of technical standards, the innovation of plant and building technologies for the purpose of energy saving, plant maintenance, the energy requalification of existing buildings, and the use of renewable energy sources.
AiCARR has more than 2600 Members including Designers, Equipment Manufacturers, Contractors, Maintenance Technicians, University Lecturers, Researchers, Students, Officials of Bodies and Governmental Agencies and of national and international, scientific and operational Institutions. AiCARR members are, often at the highest levels, actors in the world of air conditioning and energy saving. In this sense, AiCARR's positions in the energy sector are the synthesis of the point of view of "super partes" experts.
The AiCARR position papers are the result of the joint work of experts and present the official position of the Association on topics of interest in the energy sector.
Francesca Romana d'Ambrosio
AiCARR President

INDEX

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When the Lie flies around the world, Truth is still at home tying her shoelaces
Howard Zinn in "History of the American People"

1. Foreword

Unfortunately, there is a lot of confusion about the role of ventilation and air conditioning systems in the spread of the SARS-CoV2-19 pandemic: it goes from the classic misconception of confusing this virus with Legionella, a bacterium with completely different types of growth and diffusion, to totally false information, such as unlikely heat treatment on the air terminal coils to neutralize viral loads.

AiCARR believes it is fundamental to rely exclusively on scientific evidence: any other approach can only generate confusion, if not real panic, between the sector operators and the system end users.

2. Possible diffusion of SARS-CoV2-19 via aerosol

SARS-CoV2-19 is a virus believed to be transmissible from person to person in three ways [1]:
1) by close and direct contact with an infected person;
2) by inhalation of liquid droplets produced by the infected person;
3) by contact with surfaces contaminated by the virus.
Part of the liquid droplets produced by the infected person is so small in size, in the order of tens of nanometers [3], that they are not affected by gravitational forces: they remain suspended in the air and form a bio-aerosol (CDC, 2019).
The spread of the virus through bio-aerosol is a mechanism recognized by WHO, even if not advertised (WHO, 2020a), and considered effective only over short distances, (a few meters indoors), and in the vicinity of a significant infectious source, the COVID-19 sufferer (WHO, 2020b), in which case the WHO highlights the need for ventilation. What is currently controversial is how statistically significant this contagion mechanism, bio-aerosol, is compared to direct contact and "heavy" droplets. WHO tends to minimize this importance, while the international scientific community that researches in the specific sector of the diffusion of particles, therefore of viruses, reports evidence that this occurs in other diseases of viral origin and, by analogy, may happen also in the case of SARS - CoV2-19. For these reasons, in the management of HVAC systems, the risk of bio-aerosol contagion must also be considered, following the criterion of maximum safety, indispensable in situations such as the one we are experiencing.
On the other hand, there is no doubt that increasing the fresh air flow rate will reduce the risk [2], as confirmed by studies on the control of infectious diseases (Gammaitoni et al., 1997; Kibbs et al. , 2011) and suggested by the same WHO guideline (WHO, 2009), at least for hospitals.

3. Initial assumptions

AiCARR's position is based on three initial assumptions:

1) the transmission via aerosol is the only one which may be potentially connected to air conditioning systems: the hypothesis of transmission of the virus is not demonstrated or denied with certainty and must therefore be assumed following the criterion of maximum safety;
2) the lack of evidence of the importance of the transmission for bio-aerosols in non-hospital places for people sick with COVID-19, reiterated by the WHO, suggests that other forms of contagion may be predominant, but in this regard, the scientists who support the transmission of the virus via bio-aerosol, claim that there is still a long way to go to quantify their relative importance compared to the other mechanisms, which may not be as negligible as thought;
3) it is now certain that viral infection has mainly spread due to asymptomatic carriers, who have unawares infected people they came into contact with in the workplace and in public and private spaces, and until mass epidemiological screening will allow to identify and isolate healthy carriers of the infection, every precaution that can limit the risk is not only welcome but necessary.

Therefore the following is based on the assumption that, since people are the carriers of the infection and since isolation cannot and must not last long in order to resume the necessary production activities, the control of any bio-aerosol transmission via adequately controlled ventilation of the occupied spaces can significantly reduce the risk of infection.

4. Considerations on contagion evolution

At present, the date of the end of emergency is undetermined. It is very probable that one will have to manage a transition period before returning to "normal" life, if only because:

a) the virus may not be completely eradicated in the national territory and it will be necessary to prepare for some return infections, as is happening in China;
b) in autumn and winter there could be a partial resurgence of the virus, due to the climate particularly suitable for the spread of viral diseases assimilable to the flu, such as COVID-19;
c) the restart will be slow and it will be appropriate to continue to maintain a certain social distance, using smart working, where possible, and the controlled entry into crowded places, such as supermarkets, pharmacies, public offices, cinemas, theaters, restaurants and all other facilities that sooner or later will reopen.

The human factor will also have to be considered: those who are forced to work indoors, or even just visit workspaces occasionally, will need more stringent conditions of thermal comfort and air quality than in normal conditions. A similar situation could occur in homes, where people may have to stay for more hours than usual.

In such situations it will be mandatory to use both the air conditioning systems next summer and the heating systems next winter, not only for what has been said, but also because never such as at this time should weak people be protected, first of all the elderly: it is useless not to let them out and then aggravate their situation with home temperatures too high in summer or too low in winter, especially when the dwellings are small and narrow.

5. HVAC system management for next summer and next winter

As in the second document published by AiCARR on its website [2], here we are talking about existing systems, with the exception of special applications, such as hospitals or clean rooms and laboratories, which must be specifically addressed one by one to understand what is the best strategy and which are covered in another AiCARR document.

5.1. Systems for residences

In the absence of people infected in the home, there can be no virus, therefore switching on the heating and air-conditioning systems does not affect the risk of contagion in any way.

If they were infected people in the house, their presence would determine the risk, which would not increase due to the operation of the system. In this case, the people in the apartment must take all the necessary precautions regarding personal protection and behavior. Using the system or not is therefore only a question of opportunity regarding the temperature to be kept in the environment: it is the doctor who must decide what to do.

In any situation, the premises must be as ventilated as possible; in the absence of a DOAS (dedicated outdoor air system) with adequate outdoor air flow rate, it is necessary to ventilate by keeping the windows open as much as possible. In the presence of a DOAS system, the indications given in the AiCARR document [2] must be followed.

5.2. All-air systems serving a single space

It is the case of supermarkets (always open, even in an emergency period), or of some public places frequented by many people at the same time, such as shops, shopping centers, restaurants, bars, cinemas, theaters and gyms (closed during the emergency), in which crowding determines the greatest risk, both for those who stay in the environment in their working hours, and for those who enter and stay only the time necessary to fulfil their needs. When the activities currently closed reopen, it is likely that for a certain period people flow will be strictly controlled, as is the case in supermarkets today.

In all cases it is essential to increase the outdoor air flow rate to reduce the risk (Vio, 2020), by carrying out what is proposed in the AiCARR document [2]. In particular, internal recirculation should always be closed, to increase the outdoor air flow rate. Where this is not possible for the configuration of the system, as reported in [2] in the case of roof tops, the presence of recirculation of the room air does not increase the risk of contagion.

5.3. All-air systems serving large buildings

This category includes VAV systems and systems with terminal reheat or double duct, with and without variable flow, all generally designed for medium and large buildings where the system, whatever the type, connects areas of the building between which people have no reason to move. The greatest risk of infection always remains direct contact between people. If the ownerships are different, or if the ownership is single but the movement is limited, at least between the various floors, the movement of people must be even more confined and the use of common areas must be managed very well, keeping in mind that toilets and elevators are extremely critical points.
From the system engineering point of view, it is absolutely necessary to close each air recirculation damper following the indications given in [2], to avoid propagating the contagion with the air to places where it would not be carried by the movement of people from a zone to the other.

5.4. All-air systems with zone recirculation serving few spaces under the same ownership

This is the case of small systems with one or more ducted zone recirculation terminals (therefore serving several rooms). Probably this is the most controversial case, because the aerosol propagates in all the spaces served by the system and does not remain in the rooms where the possible asymptomatic infected person stays or in any case the person who is not infected. This is certainly true, but it is equally true that it is useless to close these systems that are serving small areas, in a single property, where the greatest danger for the risk of contagion is instead constituted by the movement of individual people inside the various rooms and the common use of the toilets, where the spread of the infection is very likely.

It has been shown (Vio, 2020) that in these cases the concentration of elemental viral loads per unit of volume decreases, because it is distributed over the entire volume served by the system. The risk is lower for the single person who stays in the same room of any infected person but is extended to all the people present in the entire area served by the systems, which means less risk for more people. Anyone who cannot work from home, and therefore is inside the area where the infected person is or has been present, is in any case at risk for the other two forms of contagion referred to in paragraph 2.

This does not mean that these systems perform better than those with primary air, which will be discussed afterwards, because they diffuse aerosols everywhere. It only means that their closure does not lead to substantial risk reductions, precisely because of the inevitable movement of people.

Once again, containment must be done by controlling frequentation, promoting smart working and accurately checking the health of those who enter the premises.

5.5. Primary air systems

This category includes systems with room terminals equipped with a fan (fan coils, fan-powered terminal boxes, VRF - VRV systems), systems with chilled beams, radiant systems or any other system with recirculation in the single room. This recirculation depends on air movement induced by the fan, and on the flow of outdoor air in active chilled beams, while in radiant systems it is a function of their share of convective exchange, which can reach 50% in radiant floors in heating and radiant ceilings in cooling . Not all terminals are able to filter the air, even if in any case the normal filters are unsuitable to filter the aerosol, which is characterized by an order of magnitude of tens of nanometers [3]. Furthermore, for both normal filters and other particulate filters, there is currently no evidence on the filtration efficiency towards SARS-CoV2-19, either way. Thus, at present there can be no distinction between different terminals.
Whatever the type of system, it does not make any sense to stop the operation of the terminals, because the risk of contagion remains unchanged.
The REHVA COVID-19 Guidance document recommends switching off fan terminals and induction systems, such as chilled beams, or alternatively keeping fans always on to avoid the phenomenon of re-suspension of the virus. According to AiCARR this is not necessary: in (Vio, 2020) it is shown that even if the terminals put 15% more elemental viral loads back into circulation, which is to be demonstrated and not at all confirmed, the possible increase in risk of contagion would be completely marginal and in any case more than absorbed by a simultaneous increase in the outdoor air flow rate, according to the indications of the AiCARR document [2].
Again, to limit the risk in the coming months, the flow of people in suitably sanitized environments will have to be strictly controlled.

6. Conclusions

Air conditioning systems can help reduce contagion risks considerably if the outdoor air flow rate is increased by following the indications given in [2].

During next summer and next winter, when we are probably still in transient conditions, it will be useless and harmful to switch off any type of air conditioning and heating system: these must work to safeguard the health of people at home, at work and in public places. All the other precautions are and will be much more important, such as individual protections, behaviour and density of people in the premises.

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