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Opinion: To UV, or not to UV – That is the question

The Society of Light and Lighting

The COVID-19 pandemic has seen a rush of initiatives to stem the spread of SARS-CoV-2, the coronavirus that causes the disease. Ultraviolet radiation (UVR) has been promoted as a panacea, both for the workplace and the home. However, we suggest caution.

UVR sources have been available for disinfection for many years, the main one being the low-pressure mercury lamp, with the primary emission at 253.7 nm in the UV-C part of the spectrum. It is important to recognise that UV-C from the extra-terrestrial solar spectrum is blocked by the Earth's atmosphere. Therefore, humans and indeed all life on Earth have evolved in the absence of this short wavelength radiation. Our knowledge of the impact of UV-C exposure comes from cell and animal studies, with the occasional accidental exposure of people. This contrasts with situations where people may be intentionally exposed.

Recently, 222 nm (and lower) wavelength UV-C sources are being promoted for use in the workplace, on public transport and other occupied areas. This is a complete change of philosophy. For mercury lamps, all efforts are made to avoid human exposure – not least because one consequence of overexposure is photokeratitis, which is like having sand rubbed into your eyes. Symptoms appear about 24 hours after an acute exposure and subside a further 24 hours later. Most people ensure they never have to experience it a second time.

As the UV-C wavelength is decreased, the penetration depth into human tissue decreases. Theoretically, and in animal models, the penetration depth of 222 nm is so low in skin that only the top layers of dead skin are affected. Likewise, the tear film covering the cornea should substantially reduce the risk of photokeratitis.

What are the implications of working or living in an environment bathed in 222 nm UV-C? The short answer is that we do not really know. Legislation will require that the exposure of an individual is kept below an exposure limit set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The unweighted radiant exposure across a day should not exceed 230 J m^{-2}, compared with 60 J m^{-2} for 253.7 nm UV-C. Of course, this assumes that the source is only emitting 222 nm; if there is leakage of other wavelengths, they will change the assessment. From recent evidence about the sensitivity of the RNA in SARS-CoV-2, it should be possible to deactivate this virus at exposure levels below the exposure limit for the skin and eye. However, consideration needs to be given to the radiant exposure to people across the space and whether adequate inactivation can be achieved. For example, a source mounted on the ceiling will be close to peoples' heads, but some distance from the floor.

It is also worth considering what the 222 nm UV-C may do to everything else in this space. It will not discriminate between harmful and beneficial RNA and DNA – if it can get to it. There is little known about the long-term impact on the infrastructure of buildings and their contents. 253.7 nm is quite good at photodegrading many plastics. Does 222 nm do the same? There may be chemical agents in the air or on the surfaces that will undergo chemical reactions triggered by 222 nm. Are they going to be hazardous for room occupants?

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These concerns need to be balanced against a potential weapon against the spread of COVID-19. Perhaps, it is worth the risk in some situations – at least to get the world population through the pandemic? The concern would be the continued use of this technology into the future without more detailed public health assessments, especially if personal exposures are repeatedly close to the exposure limit.

Let us remember that life evolved, as we know it, in the absence of continuous exposure to UV-C from the sun. Perhaps that tells us something?

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