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The formulae $\frac{\partial \rho U_i}{\partial t}+\frac{\partial}{\partial x_j}(\rho U_i U_j)=-\frac{\partial P}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu\frac{\partial U_i}{\partial x_j}\right)+g_i(\rho-\rho_0)$ *for building* $\frac{\partial}{\partial x_j}(\rho \overline{U}_i \overline{U}_j)=-\frac{\partial P}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu\frac{\partial \overline{U}_i}{\partial x_j}-\rho\overline{u_i' u_j'}\right)+g_i(\rho-\rho_0)$ *state of the art* $\frac{\partial}{\partial x_i}(\rho \overline{U}_i \overline{H})=\frac{\partial}{\partial x_i}\left(\lambda\frac{\partial \overline{T}}{\partial x_i}-\rho\overline{u_i' h'}\right)$ *biomedical research facilities.*

Leaching Biocides and Antimicrobials in Architectural Finishes

Covid's emergence in early 2020 added unfamiliar terms which had previously only found use in infection-control settings, such as "high-touch surfaces," to the broader lexicon. In response, the construction industry exploded with new and newly purposed architectural surfaces with a focus on infection control, specifically via indirect transmission mechanisms (e.g., touching surfaces previously touched by an infected person, potentially transferring viable pathogens). This article explores how the misapplication of certain architectural finish selections which tout biocidal and anti-microbial properties may have unintended effects.

Antimicrobial Architectural Finishes

These surfaces exhibit properties which inhibit the growth of microorganisms (some molds, fungi, bacteria, viruses, etc.). They work by having a material or coating that is toxic to microorganisms; adsorbing a peptide or polymer to the surface of a microorganism, changing its structure and ion exchange behavior; or utilizing a mechanism such as oxidative properties which tend to disrupt the cellular membranes of certain pathogenic organisms, inhibit nutrient uptake, or even rupture these membranes to render the microorganism inert. Other mechanisms exist and are exploited by various materials on the market.

Most antimicrobial agents can be sorted into two basic groups: unbound (where the antimicrobial agent is applied as a sanitizing wash or comprises a leaching coating); and bound (where the antimicrobial agent is molecularly bonded to the surface)[2].

Unbound Agents: include disinfecting washes, such as isopropyl alcohol, ethyl alcohol, quaternary ammonium (or quats), hydrogen peroxide, etc., as well as leaching materials/coatings, including certain heavy metal ions (frequently silver, copper, titanium dioxide, etc.). Unbound agents leach from the surface they are applied to, creating a zone of microbiological inhibition, and are metabolized by the microorganisms, rendering them inert.

There are several potential unintended consequences with leaching agents, including mobility, which is the transfer of the area of microbiological inhibition from the targeted surface to another through physical contact (these agents are frequently applied to high-touch surfaces, increasing the likelihood of unintentional transfer). Agent mobility is unlikely to have a negative impact in a patient care room, but in a laboratory studying the efficacy of a novel antibiotic, the science could be impacted by the unintended transfer of materials with antibiotic properties, potentially contaminating samples being studied. Another concern is that, as the antimicrobial agent is leached from the surface, the efficacy of that surface to impair microbial activity declines over time, on a scale of minutes to hours in the case of washes.[2,3]

Declining efficacy can contribute to emerging resistance to what was once an effective dose. As leaching progresses, there is less and less available biocidal agent available on the surface until the effectiveness of the available agent falls below the threshold needed to achieve the desired log kill of a pathogen. At this point, the available biocidal level may remain effective against weaker strains of this

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pathogen and other microorganisms in the environment. However, this promotes the growth and proliferation of microorganisms that are resistant to the agent at higher levels of the biocide and may result in increasingly difficult-to-control colonies. In the worst case, it may make infections of this microorganism more difficult to treat (MRSA and similar).

Bound Agents: include surfaces where the biocidal properties are chemically bonded to or suffused through the material. Unlike unbound agents, these materials may remain effective over considerable timelines (until worn away, subjected to oxidation/reduction, photodegradation, etc.) and achieve their biocidal effects by impacting the physical integrity of the microorganism. While bound agents are much more reliable, with minimal transfer potential, they are still subject to degradation. Few architectural finish surfaces are sampled, incubated, and tested to surveil for declining efficacy, which would necessitate replacement or initiation of or increase in the use of unbound agents as washes to maintain acceptably low pathogen levels. Failure to enroll high risk surfaces in a surveillance and replacement program may create a false sense of security that these surfaces are continuing to inhibit microbial growth.[1,2]

Conclusion

The use of antimicrobial and biocidal architectural finishes will likely continue to proliferate. Designers and reviewers should be aware that silver, copper, zinc, chitosan, and quaternary ammonium compounds (the most typical bound agents) have a limited effective lifespan. There is no substitute for an application cleaning and disinfection program, despite the marketing claims often associated with antimicrobial finishes. In applications such as high containment laboratories, aseptic processing facilities, operatories, etc., where aggressive sanitizing chemicals (e.g., peracetic acid, high molarity hydrogen peroxide, etc.)[1] are used regularly, unbound agents will likely degrade rapidly. A final cautionary note is that designers should scrutinize products made of materials, such as copper, which are reasonably touted for their biocidal properties but which are coated with urethanes or other coatings to prevent their oxidation, which effectively encapsulates them and renders the base material properties ineffective.

References

1. The National Institutes of Health (NIH). *Design Requirements Manual,* https://www.orf.od.nih.gov/TechnicalResources/Pages/DesignRequirementsManual2016.aspx Particularly Section 13.19.21 Finish Selection for Cleanability and 13.19.3 Cleaning, Sanitizing, and Disinfecting Chemicals.

2. Rosenberg M, Ilić K, Juganson K, Ivask A, Ahonen M, Vinković Vrček I, Kahru A. Potential ecotoxicological effects of antimicrobial surface coatings: a literature survey backed up by analysis of market reports. PeerJ. 2019 Feb 11;7: e6315. doi: 10.7717/peerj.6315. PMID: 30775167; PMCID: PMC6375256.

3. Chen C, Enrico A, Pettersson T, Ek M, Herland A, Niklaus F, et al. (September 2020). "Bactericidal surfaces prepared by femtosecond laser patterning and layer-by-layer polyelectrolyte coating". Journal of Colloid and Interface Science. 575: 286–297. Bibcode:2020JCIS.575.286C. doi: 10.1016/j.jcis.2020.04.107.

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