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Indoor Air Purification Using Electrostatic Fields Without Traditional Air Circulation

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Abstract:

Portable air cleaners and heating, ventilation, and air conditioning (HVAC) systems can effectively reduce indoor air pollution, but their efficiency depends on adequate air circulation. Such systems treat only a fraction of a room's air volume per cycle, leading to gradual, fractional dilution rather than immediate purification. Consequently, the removal of pathogenic particles through these methods may require significant time and moderate air movement. In addition to filtration, air sanitizers such as ultraviolet light, ozone, or chemicals can help destroy pathogens and neutralize certain pollutants in indoor air. However, these methods often require air circulation and may carry side effects.

As an enhancement or alternative to traditional air purifiers, a planar high-voltage plate system can safely and directly remove pathogenic particles from indoor air without the need for air circulation.

In this study, we conducted experiments in a controlled test room to evaluate the effectiveness of indoor air purification using electrostatic fields. We measured airborne particle concentrations and contamination reduction based on electrostatic attraction, both with and without the charging of particles. In this setup, charging was achieved through unipolar ionization using a high-voltage corona needle.

Results indicated that the electrostatic field alone, without particle charging, was ineffective. However, when unipolar ionization was combined with the high-voltage panel system, a relatively fast purification effect was observed. Our experiments demonstrate that indoor air can indeed be effectively purified without air circulation, making the high voltage panel system versatile for applications across various industry sectors.

The method proved effective in capturing both small particles (< 5 µm) and large particles (≥ 5 µm,) suggesting its potential for sustained pathogen reduction in environments like hospitals and public spaces. Additionally, this approach offers the benefit of extremely low energy consumption for purification of indoor air.

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