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Dynamic Modeling Under Temperature Variations for Sustainable Air Quality Solutions: PM2.5 and Negative Ion Interactions

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Abstract-

Air pollution caused by fine particles known as PM2.5 is a significant health concern worldwide, contributing to illnesses like asthma, heart disease, and lung cancer. To address this issue, this study focused on improving air purification systems using negative ions, which can attach to these harmful particles and help remove them from the air. This paper developed a novel mathematical model based on linear differential equations to study how PM2.5 particles interact with negative ions, making it easier to design more effective purification systems. The proposed model was validated in a small, controlled space, using common urban pollutants such as cigarette smoke, incense, coal, and gasoline. These tests were conducted at different temperatures and under two levels of ion generation. The results showed that the system could remove over 99%99% of PM2.5 particles in five minutes when temperatures were low or moderate. However, at higher temperatures, the system’s performance dropped significantly. This research goes beyond earlier studies by examining how temperature affects the process, which had not been fully explored before. Furthermore, this approach aligns with global sustainability goals by promoting public health, reducing healthcare costs, and providing scalable solutions for sustainable urban living.

Index Terms- negative ions; PM2.5; air purification; environmental sustainability; air quality; environmental impacts; dynamic modeling; electrostatic recombination; mass conservation; deterministic modeling; ionization efficiency; temperature variation

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