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A COMPUTATIONAL APPROACH IN DESIGNING NEW PAINT SCRUBBER WITH IMPROVED EFFICIENCY

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ABSTRACT

The lustrous look of its freshly painted finish is perhaps the first impression a customer perceives from a new vehicle. However few people realize that automobile manufacturers lose 70 million pounds of sprayed paint annually. The paint particles which fails to reach the target surface after being sprayed, are directed to the paint scrubber system forced by the spray booth downdraft. Capturing these so-called overspray particles in an efficient and economically feasible way is the fundamental process occurs in the paint scrubber system.

From the fluid dynamics point of view, the flow inside a spray booth can be described as three-dimensional turbulent multiphase flow in complicated geometries, in which the interaction between phases and the incidence of the gravitational and electrostatic forces acting on the purposely-charged paint particles cannot be neglected. Due to the complexity of its flow structure, the design of current spray booths largely depends on experience and trial-and-error approaches. Moreover, any new design alternative must be constrained to simple shapes and standard manufacturing processes to make it economically feasible.

This paper studies the automotive paint scrubber design principles and presents a computational approach to improve the system efficiency. Accordingly, a new paint scrubber is designed during the R&D Project based on limited space, lower operation cost, higher paint particle capturing efficiency, noise reduction in the spray booth area, and uniform up-stream flow in the spray booth criteria. Computational Fluid Dynamics is used to study the discrete-phase and multi-phase flow phenomena inside the automotive spray booth and scrubber and identify the main mechanisms influencing the over spray capturing efficiency, pressure drop, and water consumption rate in two widely-used commercial automotive scrubber designs. The new presented design demonstrated significant supremacy over its rivals.

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