Computational Fluid Dynamics in Action: Optimizing Electronic Nose System Performance Through CFD-Simulated Gas Chamber Design

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The electronic nose system is a remarkable technological advancement that replicates the olfactory capabilities of humans and animals using electronic sensors. These sensors generate electrical responses that correspond to the presence and concentration of specific analyte gases, making them invaluable in various applications, including environmental monitoring, quality control in the food industry, and even medical diagnostics. In our pursuit of optimizing the performance of an electronic nose system, we turned to Computational Fluid Dynamics (CFD) simulation. This sophisticated tool is employed by engineers and scientists to comprehensively understand, predict, and fine-tune fluid flow behaviors within both closed and open systems. Specifically, we harnessed the power of CFD simulation in the design of a gas chamber intended to house the sensor array within the electronic nose system. The gas chamber plays a pivotal role in ensuring the accuracy and efficiency of the system. It serves as the environment where analyte odor molecules interact with the electronic sensors, ultimately leading to the generation of electrical responses

The gas chamber itself was designed, featuring a diameter of 20 mm and a length of 100 mm. The pressure conditions were simulated at 75 kPa, providing the necessary suction to the analyte gas. Our CFD simulation approach was meticulously crafted to achieve uniform and streamlined flow of these analyte odor molecules throughout the gas chamber. To attain this, we designed a finely calibrated array of small cylindrical holes, each with a diameter of 0.8 mm. These holes were strategically distributed across the cross-section of the main cylinder at the chamber's inlet. We carefully fine-tuned the number of these cylindrical holes as well as diameter of these holes to achieve an even more streamlined and uniform flow of air. Through a series of simulations and optimizations, we determined that the most effective chamber design incorporated an air inlet with a diameter of 5 mm, complemented by a matching 5 mm outlet.

In summary, the use of CFD simulation in the design of the gas chamber for our electronic nose system is instrumental in ensuring the system's precision and reliability. By carefully orchestrating fluid dynamics within the chamber, we have elevated the system's performance, making it a valuable tool for a wide range of applications where the detection and analysis of analyte gases are paramount.