ID: 2016-ISFT-435

A Study on the Uniformity Enhancement of Equipment Fan Filter Unit Outlet Air Velocity

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Abstract: *A cleanroom is an uncontaminated space which controls the existence of environmental pollutants such as dust, airborne microbes, aerosol particles under regulation level. Cleanroom used in semiconductor industry is ineffective since it should control a large space. Therefore, mini-environment is used to make a small space clean.*

EFU is an air conditioning device in mini-environment system which is a kind of clean room to offer positive indoor pressure by supplying clean air. Uniform wind velocity at the exit of the unit is required to have high productivity. In this study, improving the uniformity of outlet air velocity is studied by the two models with different internal flow paths. The research verifies and compares the results of a test and CFD simulation.

Keywords: *Velocity distribution, Fan, Cleanroom, Filter, Mini-environment*

1. INTRODUCTION

Cleanroom is an uncontaminated space which controls the existence of environmental pollutants such as dust, airborne microbes, aerosol particles under regulation level. Cleanroom is used in semiconductor industry could cause pollution because of its unstable airflow. Therefore, Mini-Environment System should be built by using EFU (Equipment Fan Filter Unit) within it. Uniformity of the outlet air velocity is very important for coating processing technology in cleanroom. We intended to generate data for performance comparison and identify areas of improvement in the unit outlet air velocity [1-3].

2. DESCRIPTION OF EFU (EQUIPMENT OF FAN FILTER UNIT)

EFU (Equipment of fan filter unit) some kind of fan filter unit, includes HEPA filter, fan, and motor. It is developed for the one of the mini-environment system components. It installed ceiling of cleanroom and maintains indoor air quality cleanly. Uniformity at the EFU exit and reaching proper airflow is important in design of EFU. 18 points are monitored and uniformity is defined as the relative standard deviation (RSD), namely, the ratio of standard deviation (SD) to the average of the measured point.

[3] This paper focuses on the comparing experiments to simulations for maximizing uniformity of the outlet air velocity.

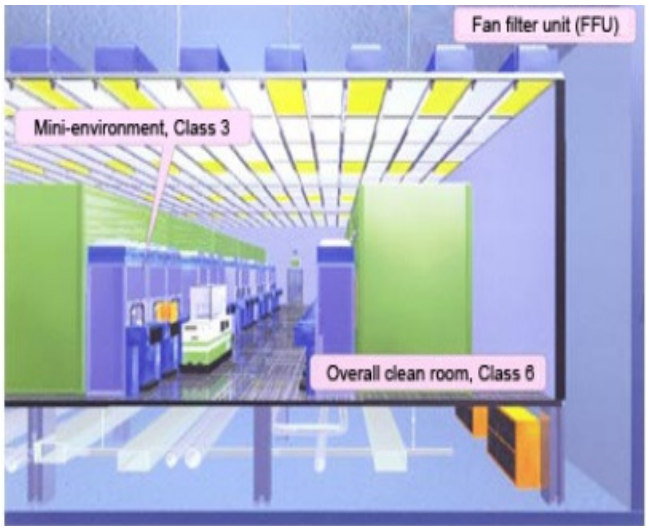

Fig. 1. Mini-environment

Fig. 2. EFU

3. COMPARISON EXPERIMENTS AND SIMULATION

In this study, the individual 1177x577x102 mm EFU was connected with outlet chamber and a three-dimension ultrasonic anemometer. Fig. 2 shows the measurement device layout. Airflow speed was measured at 50 mm under the filter. The rotational speed of a fan was carried out 740, 840, 940, and 1020 rpm.

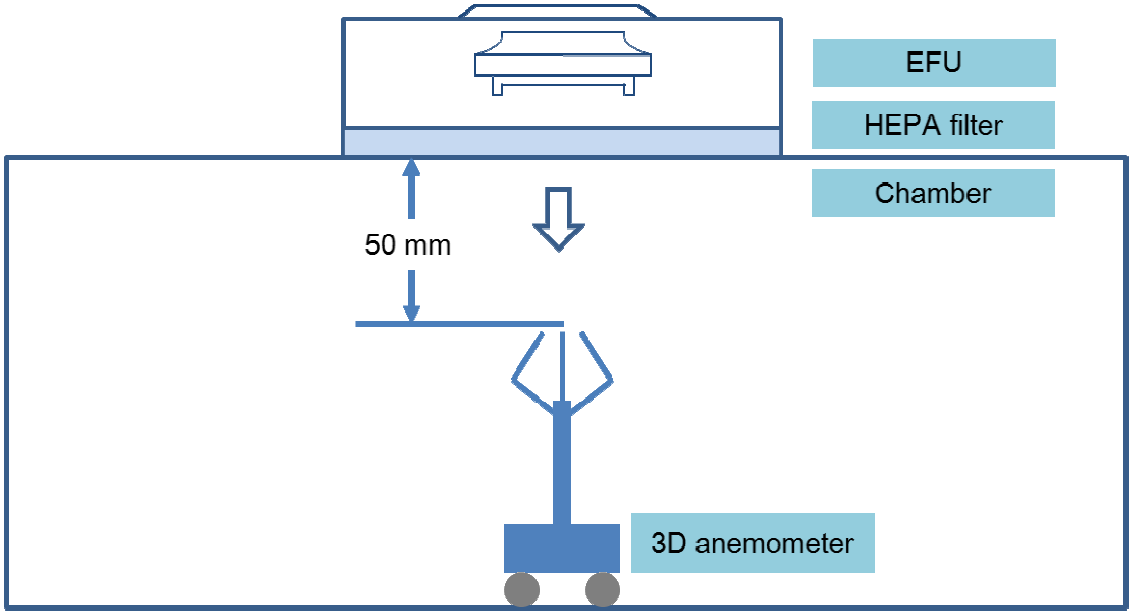

Fig. 3. Laboratory measurement layout.

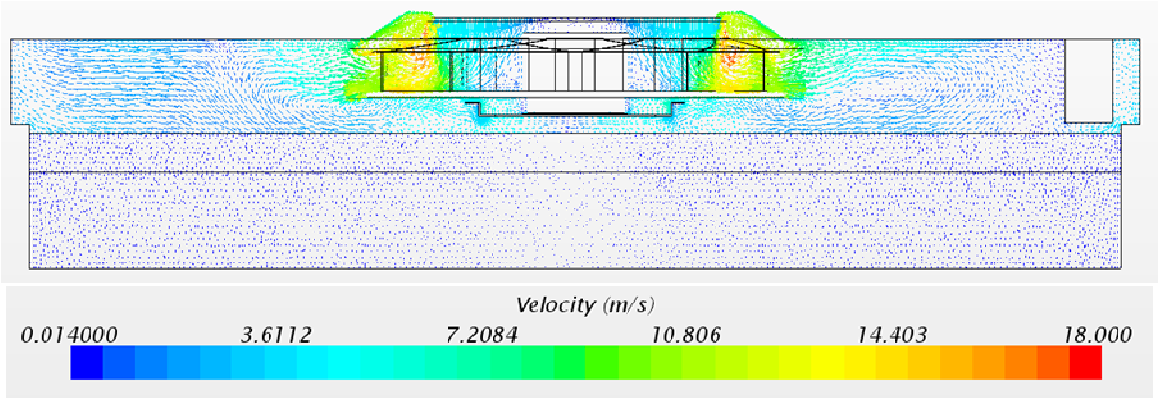

Fig. 4. Vector velocity of EFU

A three-dimensional steady state isothermal CFD model of EFU is developed for this study. Lattice was generated by using STAR CCM+ and approximately 2 million polyhedral lattices were used in the analysis, turbulent model used k-ε standards. Condition for inlet and outlet of air flow meter is an atmospheric pressure. The rotational speed of a fan was carried same with experiments.

TABLE 1: Outlet air velocity according to rpm

RPM	Experiment (m/s)	Simulation (m/s)	Error (%)
740	0.261	0.266	-2.00
840	0.318	0.316	-0.72
940	0.363	0.364	-0.14
1020	0.404	0.398	1.56

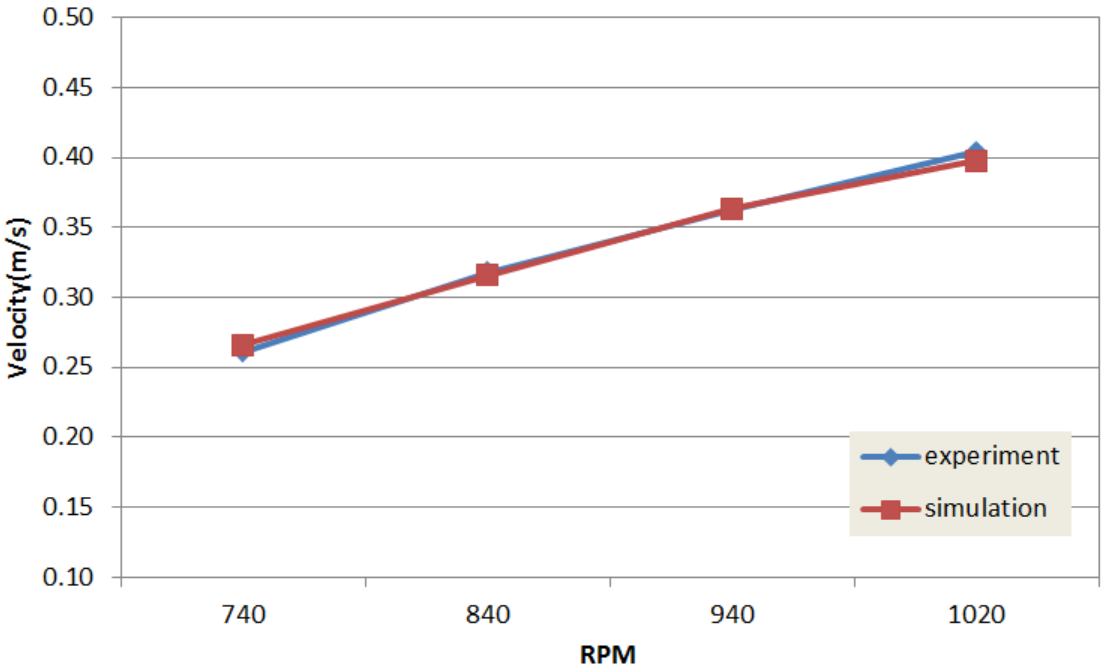

Fig. 5. Comparison of outlet air velocity (experimental vs simulation).

4. CONCLUSIONS

Laboratory testing of EFU performance can provide useful data for users to understand the performance of EFU. In order to predict the air volume of EFU, the outlet air velocity analysis using CFD was conducted. And verified that its result complied well with the error of 2.0% in outlet air velocity, and 8.0% in air flow rate, exhibited to be reasonable to predict the air velocity characteristic of EFU.

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