Consideration of Analysis Accuracy of Box Fan using TCFD

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Introduction of DMW Corporation

MISHIMA PLANT
Shizuoka Pref.

HEAD OFFICE Tokyo

and 14 Regional Offices in Japan

Manufacturing and sale of
- Pumps
- Fans, Blowers, Turbo-compressors
- Valves
- Environment Equipment
- Electric Control / Monitoring System
- Others

Mt. Fuji

International Network

Subsidiaries:

DMW India Pvt. Ltd., Mumbai

Offices:

Abu Dhabi

Dalian, China

Houston, U.S.A.

Singapore

Background

A lot of turbomachinery companies use ANSYS CFX. Sometimes, CFX results are a lot different from experimental results.

In this case, it is occasionally difficult to improve the analysis accuracy by changing a mesh model, a turbulence model, and so on.

In this study, the analysis accuracy of TCFD is considered using the benchmark which is not simulated using ANSYS CFX with accuracy.

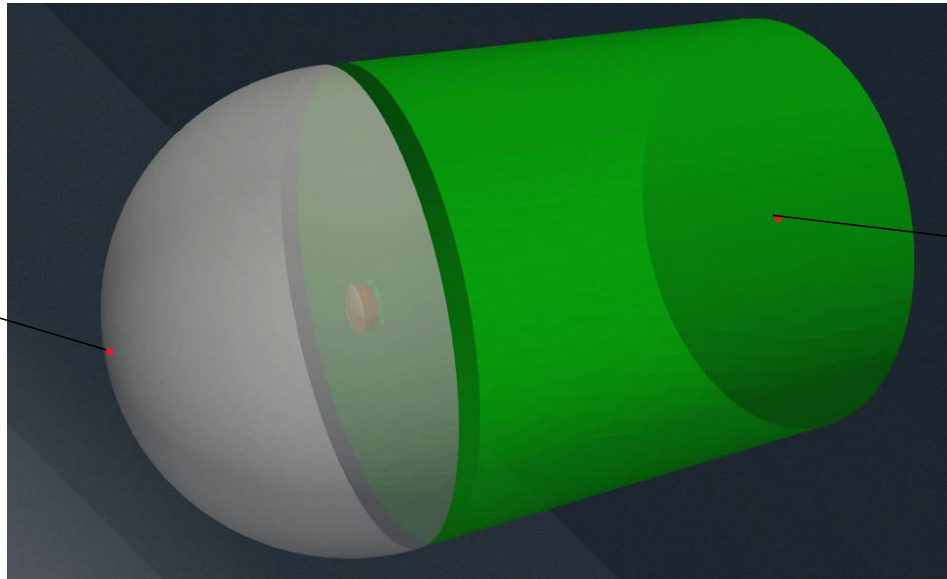This box fan benchmark is provided by the Industrial Committee for Supercomputing Promotion (ICSCP). http://www.icscp.jp/ (Japanese)

Box Fan

Casing   Boss   Motor cup   Strut   Blade
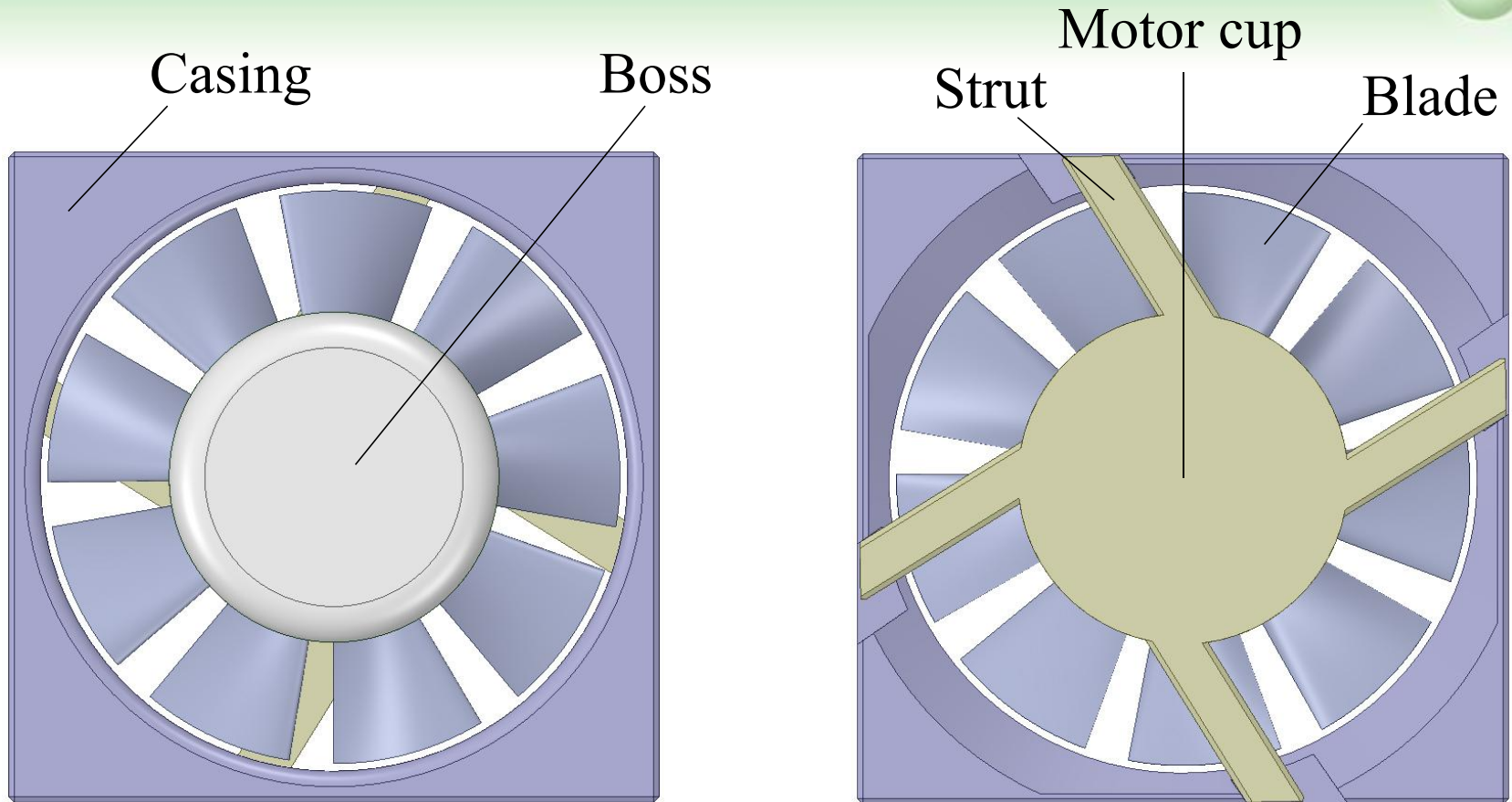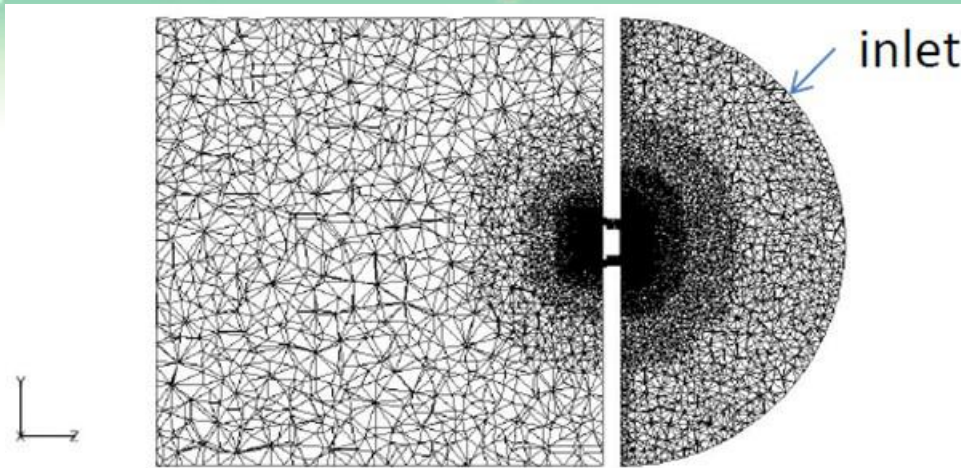
Rotational speed : 3000min^{-1}

Sampling Point of Pressure

P_{inlet} :
(0, 0, 0.572)

P_{outlet} :
(0, 0, -1.1)

Pressure Difference (Pa) = P_{outlet} - P_{inlet}

Analysis Model and Condition (CFX)

Mesh Model by ICEM
(13M Cells, 3M Nodes)

Case	Flow Rate（m³/min）
B01	2.3600
B02	2.2612
B03	2.1862
B04	2.0585
B05	1.8422

Software : ANSYS CFX Ver.18.2

Turbulence Model : SST, ke

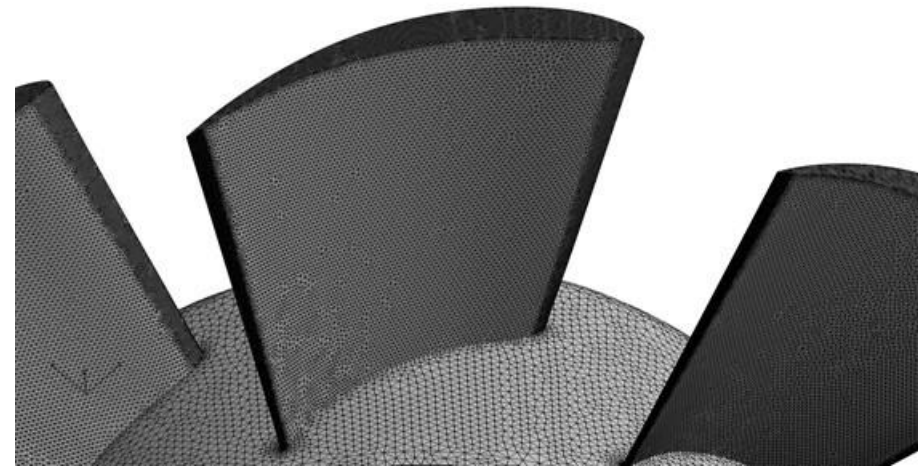Fluid : Air

Rotor-Stator Interface : Frozen Rotor
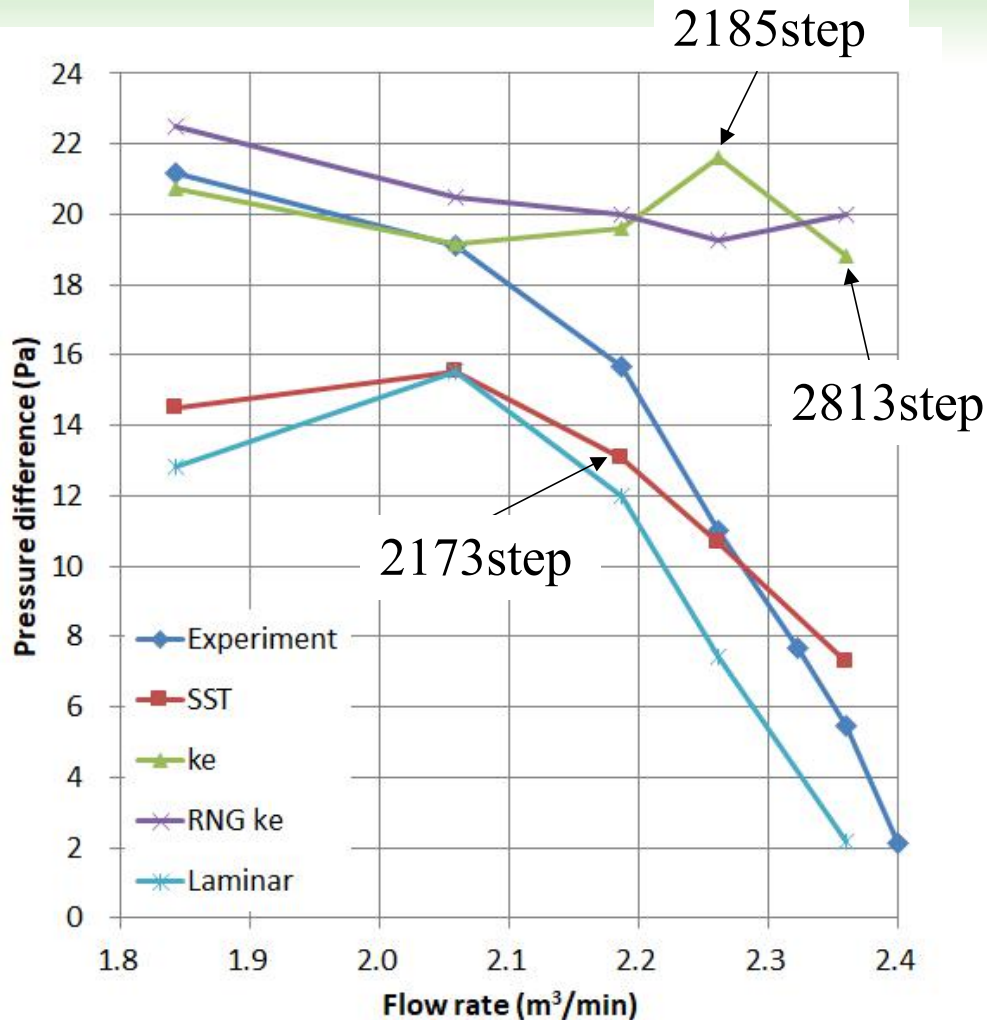
Wall Function : Automatic (SST), Scalable (ke)

Analysis Type : Steady State

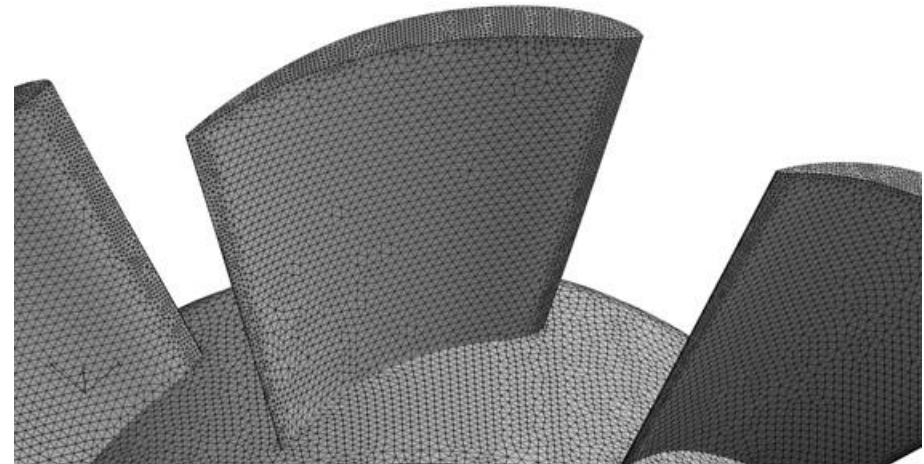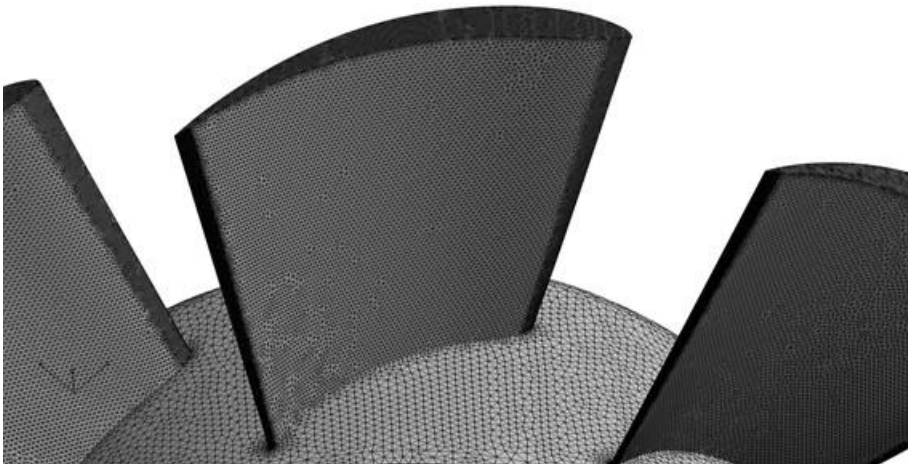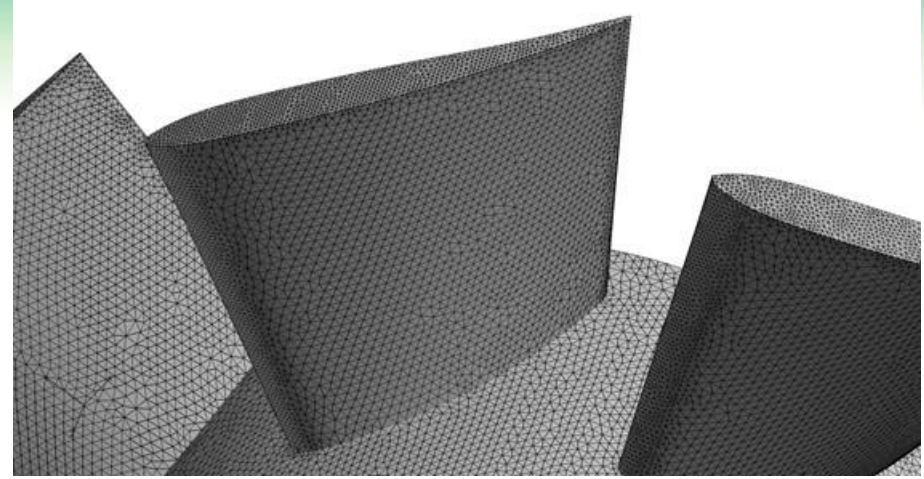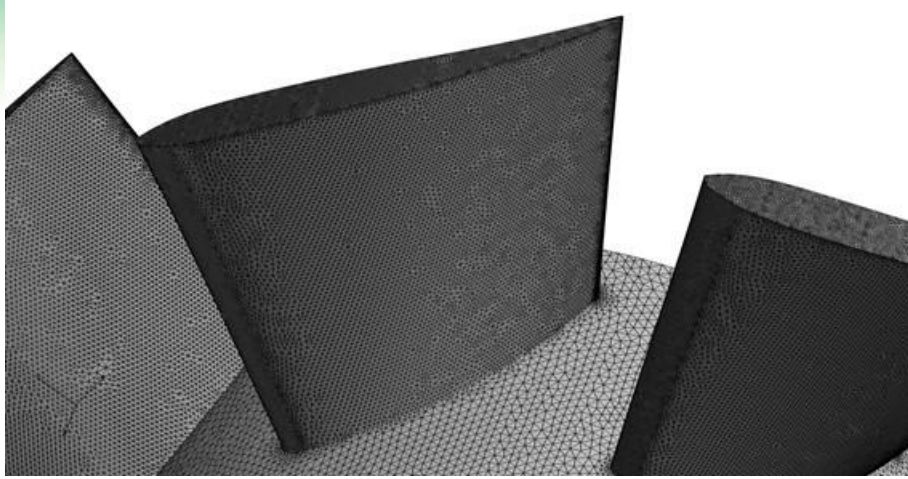# Mesh on Blade Surface
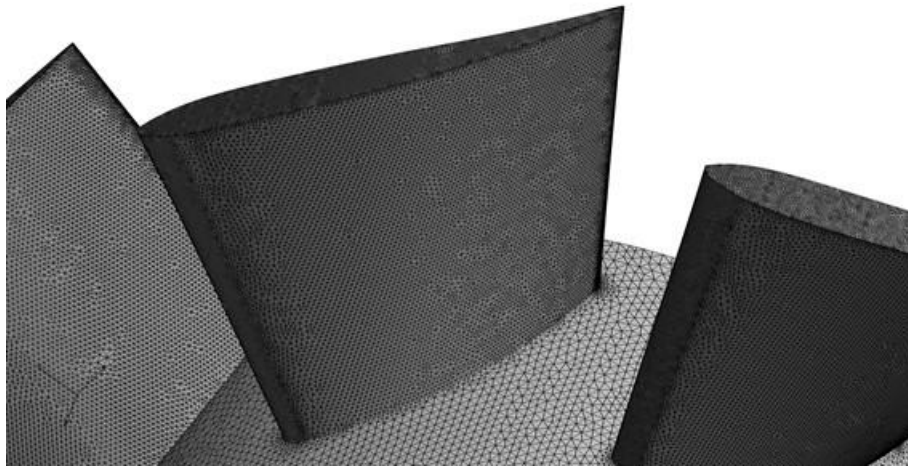
Suction Side

Pressure Side

Analysis Result by CFX

Convergence criteria: RMS values of the velocity (u, v, w) and the pressure are less than 1.0 x 10^{-4}.

Calculation is basically conducted until 5000 step. The number on the graph means the convergent step.
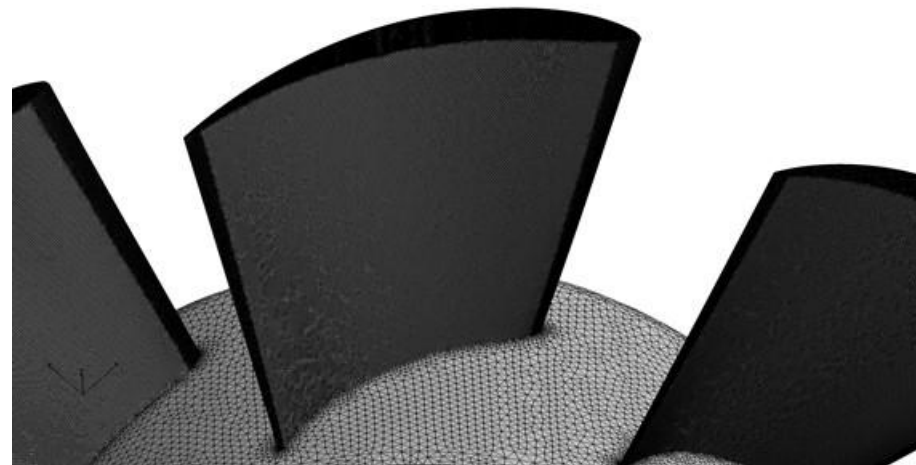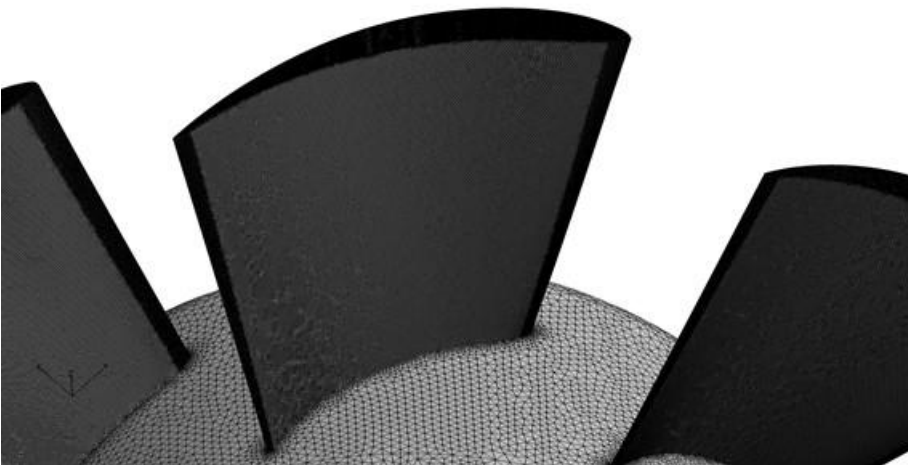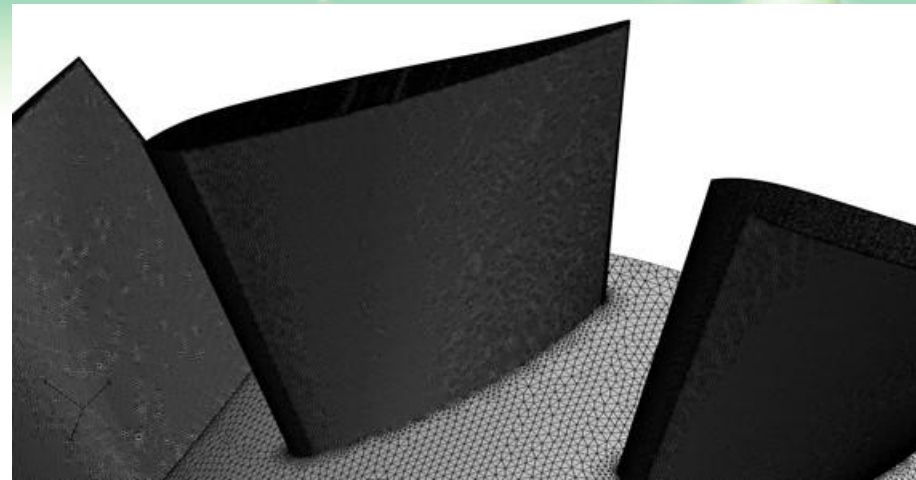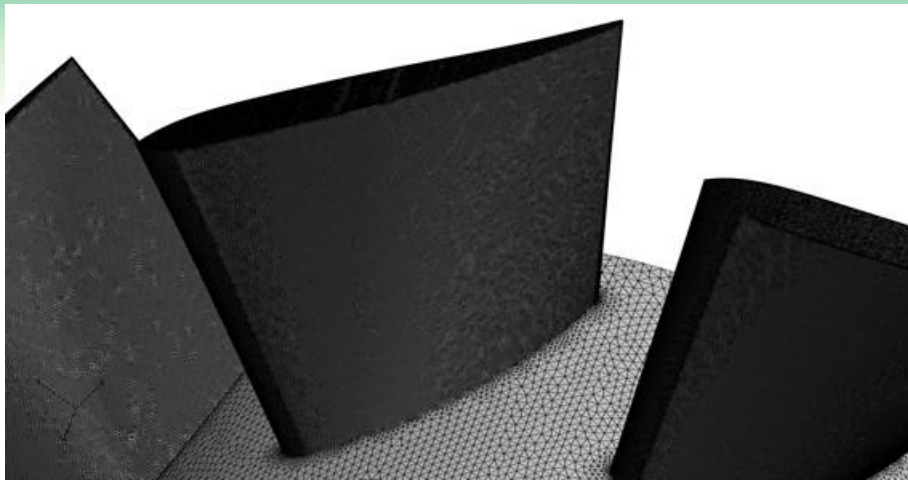
Mesh on Blade Surface

Original

0.5 times

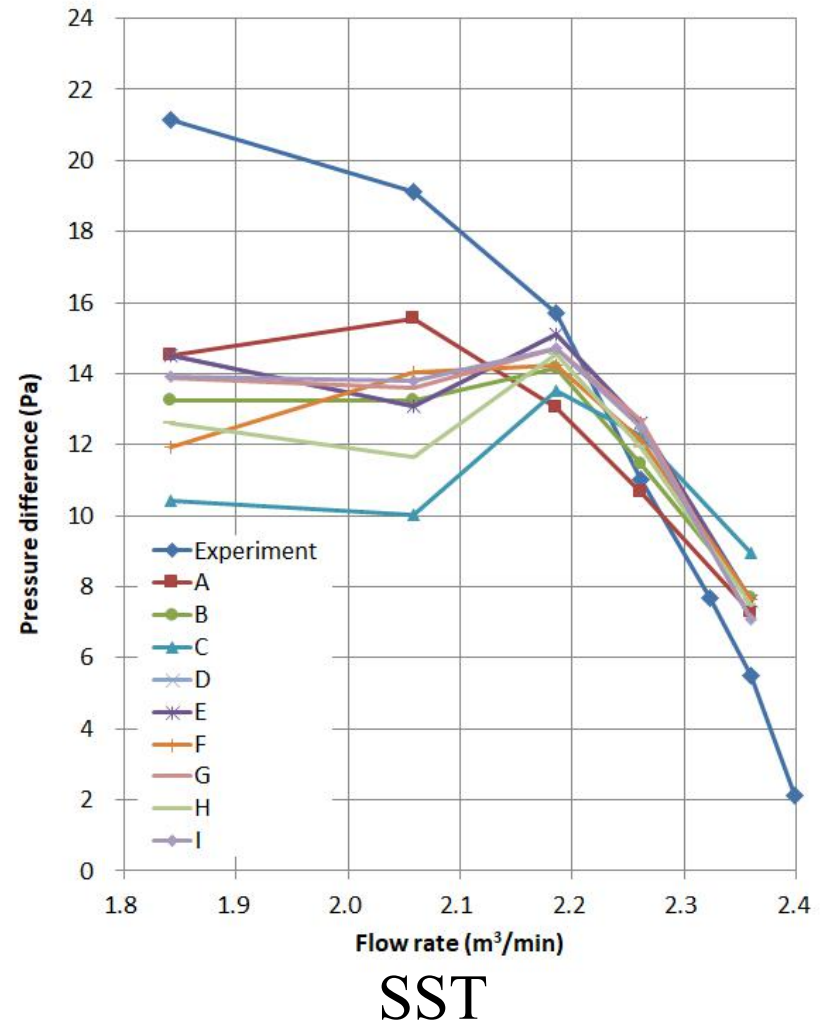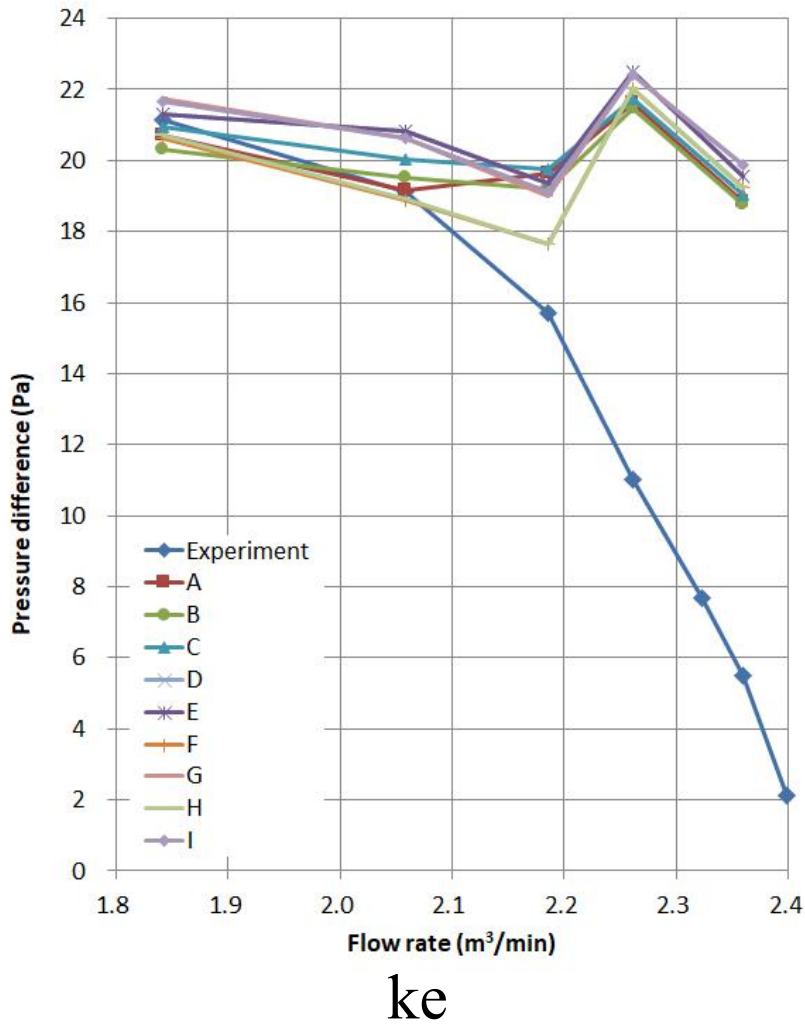# Mesh on Blade Surface

2 times

3 times

※Improved blade surface mesh only

Specification of Mesh Models

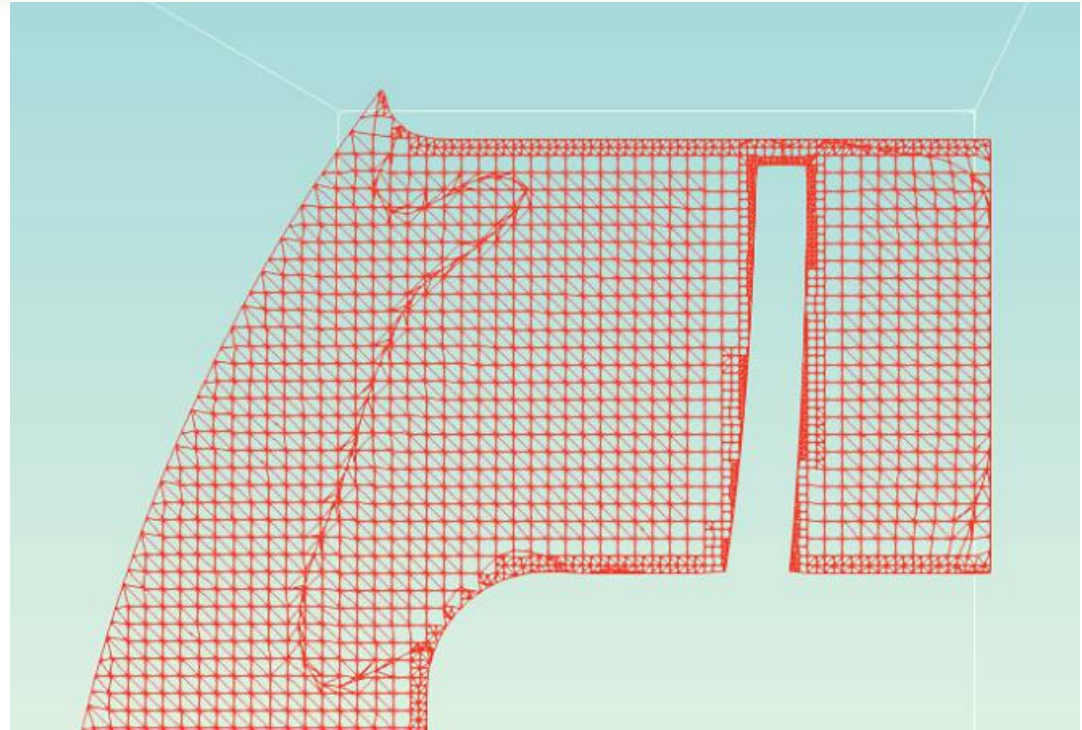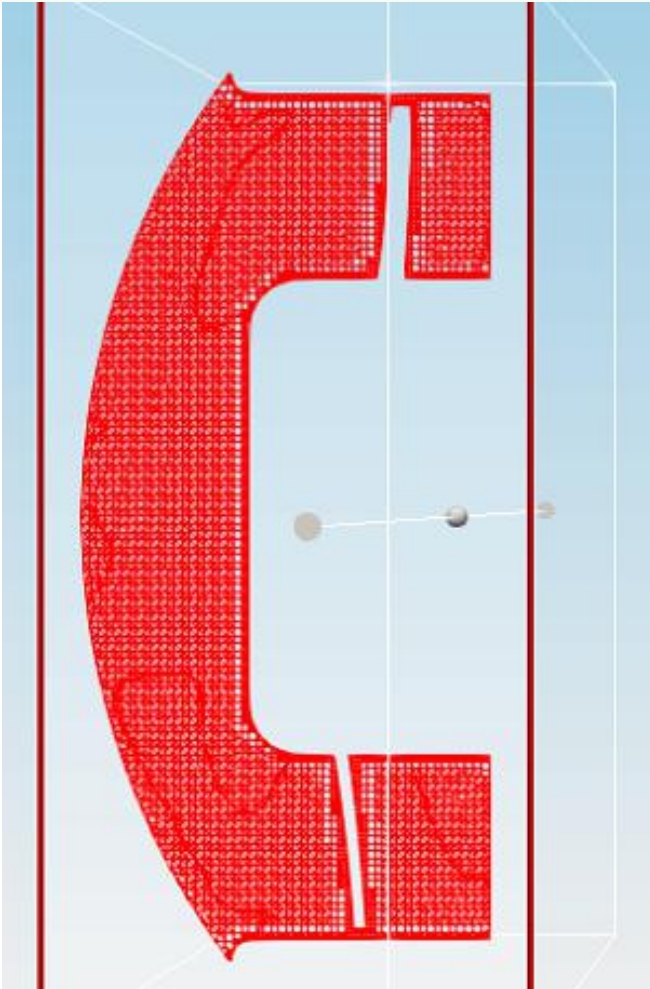|	Number of Mesh on blade surface	Initial height	Height ratio	Number of prism layers
A	Original	0.065	1.2	4
B	0.5x	0.065	1.2	4
C	1x	0.065	1.2	8
D	1x	0.0325	1.2	8
E	1x	0.0325	1.1	8
F	2x	0.065	1.2	4
G	2x	0.0325	1.2	8
H	3x	0.065	1.2	4
I	3x	0.0325	1.2	8

Analysis Results (CFX)

ke

SST

It is almost impossible to conduct this analysis with accuracy by CFX.

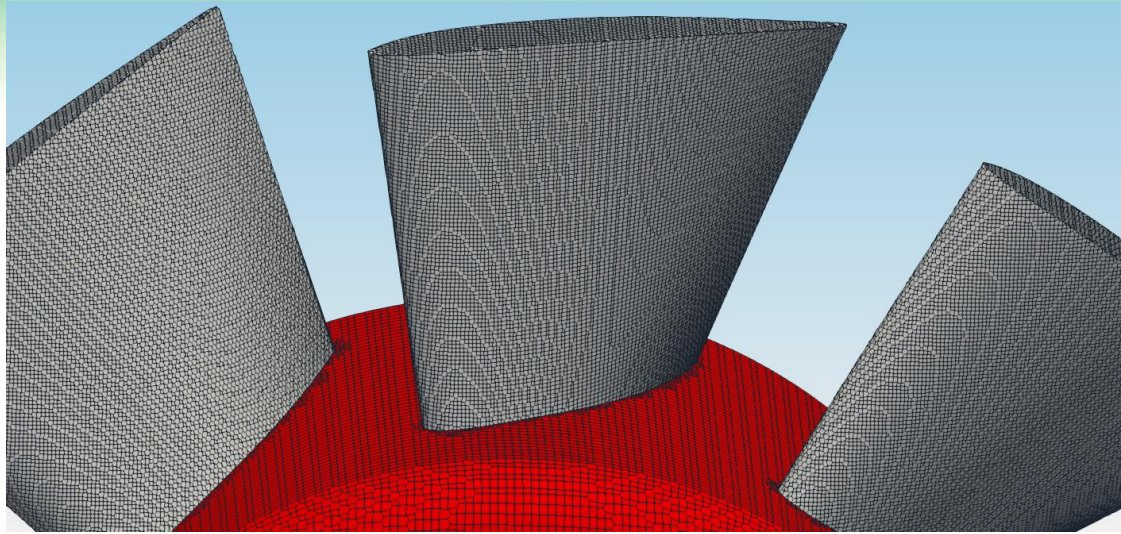# Mesh Model made by TCFD

3.2M cells
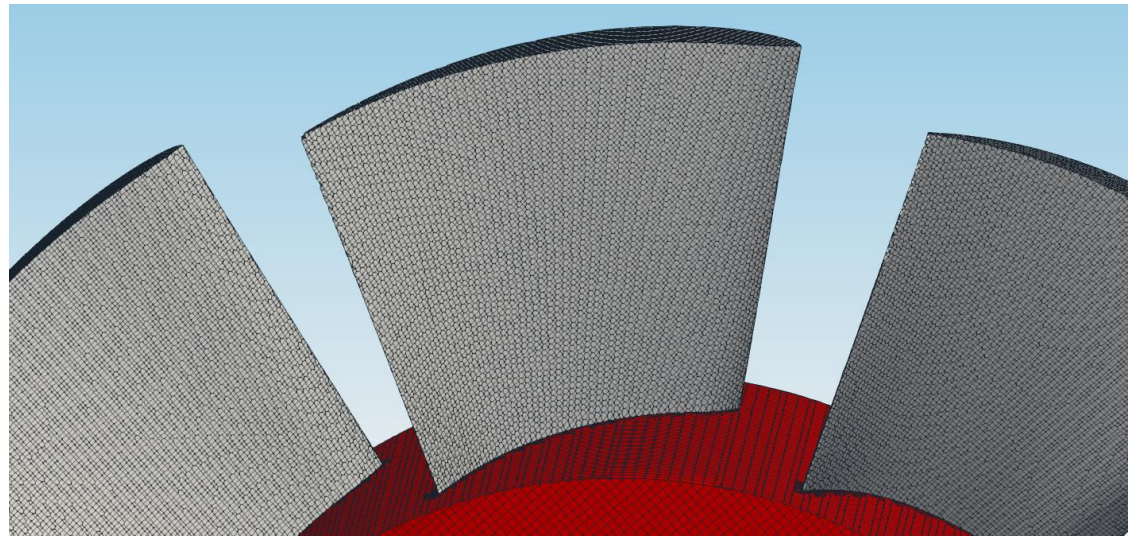This mesh model is made by TCFD.

Mesh on Blade Surface

Suction Side

Pressure Side

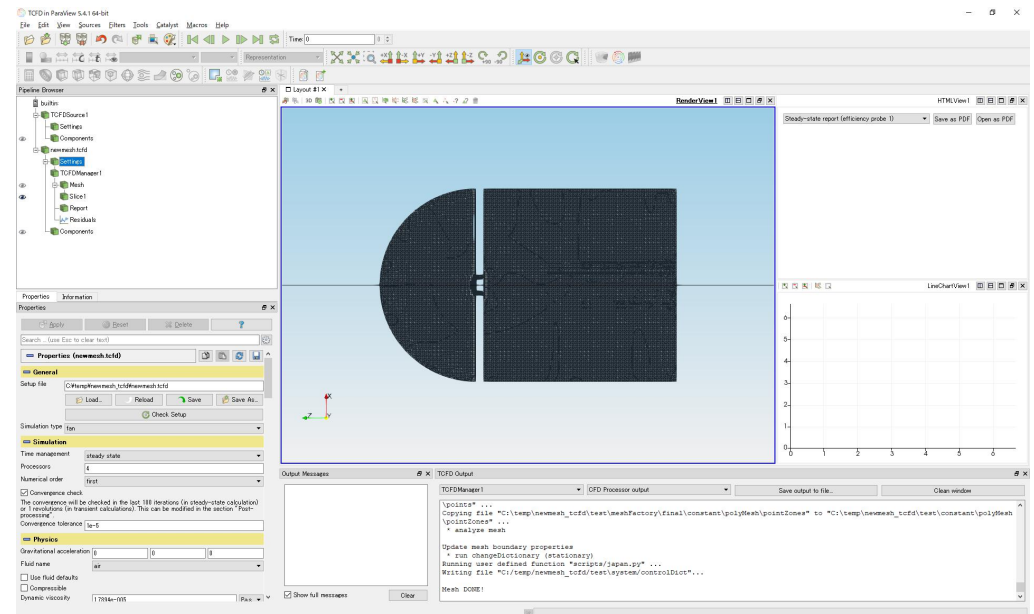# Analysis Condition (TCFD)

Software : TCFD Ver.18.10

Turbulence Model : SST
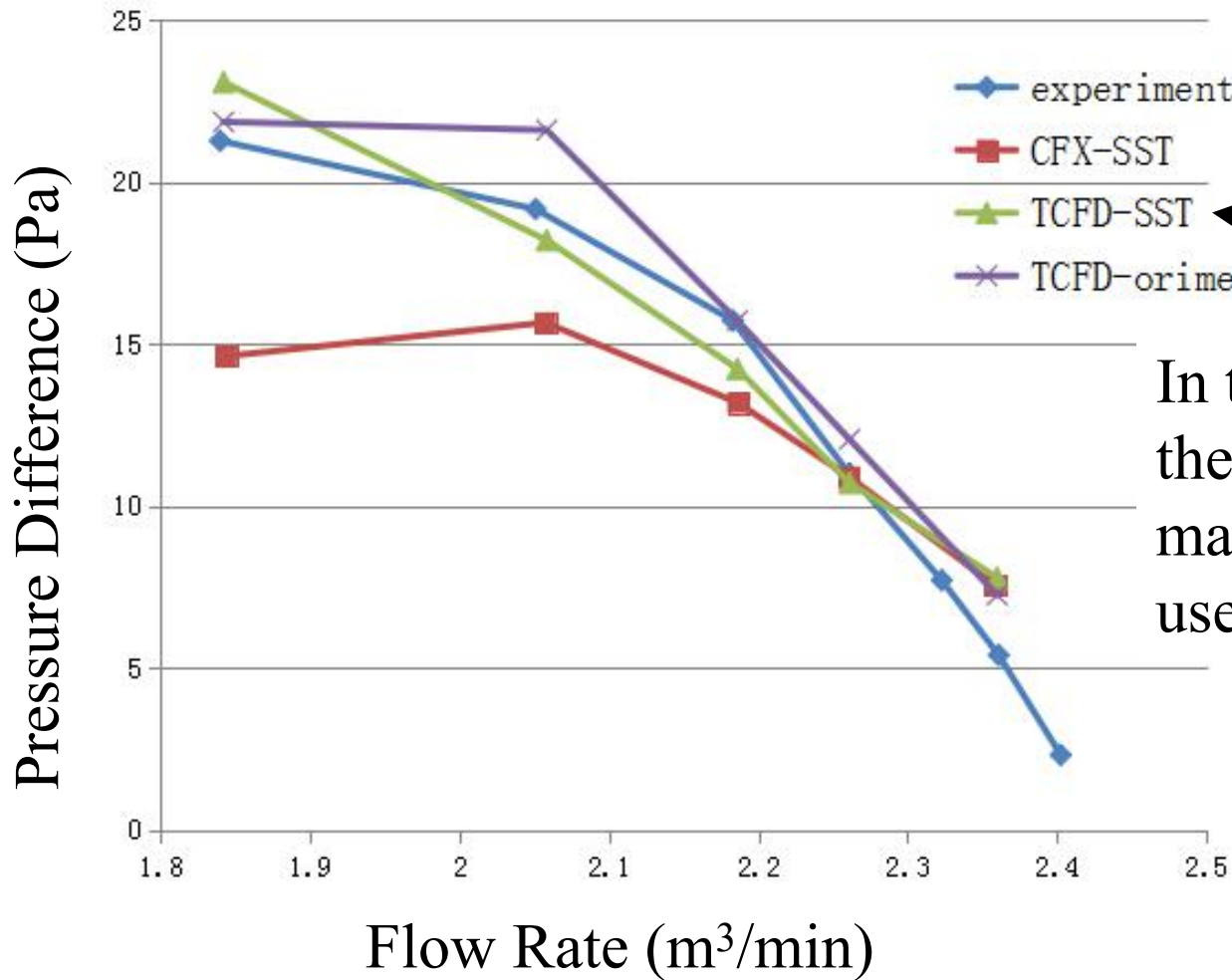
Fluid : Air

Rotor-Stator Interface : Mixing Plane

Wall treatment : Standard wall functions

Analysis Type : Steady State

Comparison of Results

In this analysis, the mesh model made by ICEM is used.

Consideration of Wall Time

	Solver	Turbulence Model	Mesher	Wall Time (times)
CFX-SST	CFX	SST	ICEM	1x
TCFD-SST	TCFD	SST	TCFD	0.5x
TCFD-orimesh	TCFD	SST	ICEM	1.5x

In the case of TCFD analysis, it is better to make a mesh model by TCFD.

Conclusion

- Analysis accuracy of ANSYS CFX and TCFD is considered.

- According to the result of ANSYS CFX, pressure difference is underestimated in the lower flow rate range. This trend is not improved by changing the mesh model, turbulence model, and so on.

- According to the result of TCFD, analysis accuracy is better than ANSYS CFX.

Future work

TCFD will apply to pump simulation.