FACULTY OF MECHANICAL ENGINEERING

BMM4783 COMPUTATIONAL FLUID DYNAMICS

PROJEC TITLE:

Effect of Tube Inclination Angle on the Thermal-Hydraulic Performance of Arrays of Flat Tube Banks using CFD

DURATION	Six weeks (from week 8-13)
DEADLINE	Week 13
NAME AND MATRIC NO.	1.
	2.
MARK DISTRIBUTION	100 marks for presentation , 100 marks of report

1. Objective

The Purpose of this CFD project is

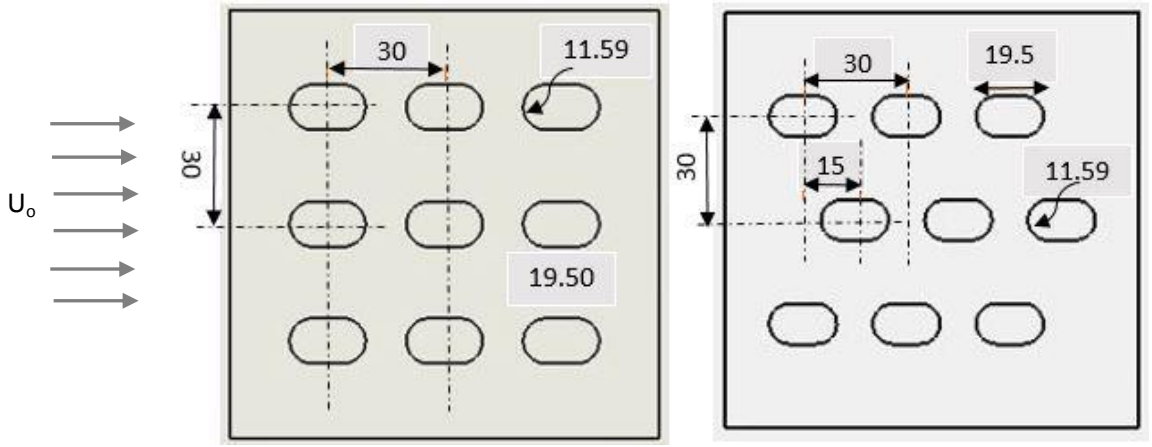
- to simulate effect of flat tube inclination angle on the flow and heat transfer behavior air flowing over arrays of tube banks arranged in inline and staggered manner following the “CFD process” you studied during the lab classes.
- to conduct validation of friction factor and Nusselt number simulation results with provided experimental data.

You will use post-processing tools (streamlines, velocity vectors, contours) to visualize the flow fields. Moreover, you are required to analyze the differences between CFD and experimental data and present results in a CFD Lab report.

2. Problem Description

The problem to be analyzed is **effect of tube inclination angle** α on the steady flow of air over the tube banks shown in Fig. 1. First, simulate for the case $\alpha = 0^o$

and validate the model by comparing the simulation results with the provided experimental data (for α = 0^o). Once the model is validated, continue the simulation for all inclination angles. For the analysis, the tube surfaces are considered to have fixed surface temperature of 100 ^{o}C and the air flows over the tube surfaces at constant velocity of 2.8 m/s. Take note that you need to used either symmetry or periodic boundary conditions to reduce computational. You also need to simulate for at least four inclination angles shown in Fig. 2 for your analysis. Other useful dimensions are presented in Table 1.



(a) (b)

Fig.1. Schematic diagrams for cross-section of fin-and-tube heat exchanger with (a) in-line and (b) staggered arrangements (all dimensions are in mm)

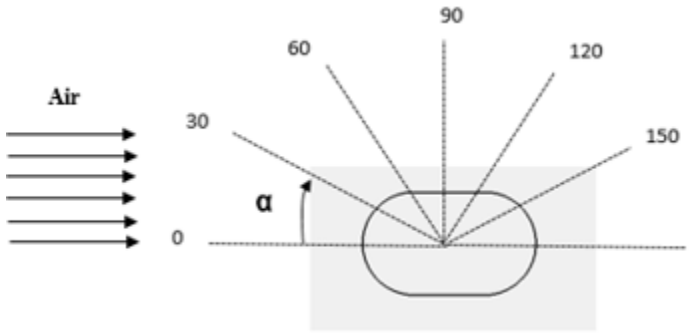


Fig. 2. Angles of attack for the flat tube against the incoming air

Table 1. Computational domain geometric details

Name	Value (mm)	Symbol
Tube transverse pitch	30	P_t
Tube longitudinal pitch	30	P_l
Tube diameter	11.59	D
Tube hydraulic diameter	15.1	D_h
Tube and fin material	-	Aluminum (al)

3. Expected Results

Your analysis should include at least the following:

- Mesh independency test
- Comparison of experimental and simulation data for friction factor and/or Nusselt number including percentage errors.
- Residual plots and contour of stream functions.
- Variation of friction factor and Nusselt number with tube inclination angle in xy plot
- Variation of temperature distribution along the flow direction in xy plot
- Contours, velocity vectors, etc.
- Other data

Note:- All results included in the report should be discussed in detail.

4. Report

Strictly follow the provided guideline for report preparation.