Indian Institute of Technology, Kanpur

National Wind Tunnel Facility

Enquiry No., NWTF/IITK/2017-18/01

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Closing Date: April. 25 , 2017

Tender Inquiry for Design Optimization of Cooling Tower Fans

Sealed Quotations (price and technical separate) are invited on the following address from the reputed Vendors who have previous experience in carrying out work as per the specifications given below.

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Tender Specifications for "Design Optimization of Cooling Tower Fans" are given below.

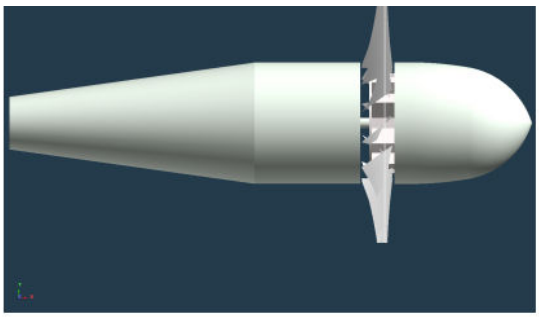
1. Introduction

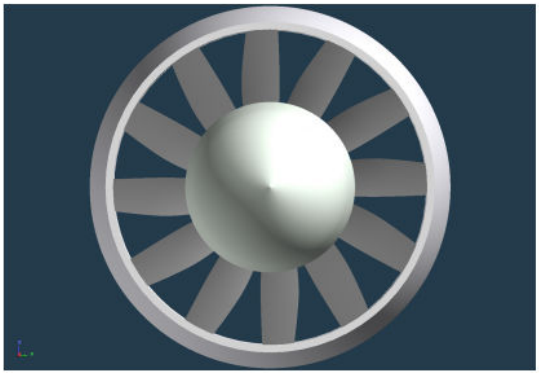
IIT Kanpur (IITK) has received a project for design and development of efficient cooling tower fans. IITK will be testing the fan blades in an experimental set-up. However, the customer also requires that the blade designs be simulated and matched with the experimental data. Once the simulation methodology is proven, new designs are to be generated and optimized for performance and efficiency. The cooling tower fans are large with diameters up to 10m. It is required to do the simulations such that new designs can be arrived at.

2. Vender Qualifications

As part of vender qualification, IIT Kanpur will be sharing NWTF fan blade CAD model, and CFD results like pressure field, velocity vectors, power required to rotate the fan at 450 RPM and static pressure prediction across the FAN at 450 RPM will be required.

The static pressure measured for the same RPM 450 RPM and Power consumed will be shared IITK after receipt of CFD results. The side view and front view of NWTF fan blade is given below.

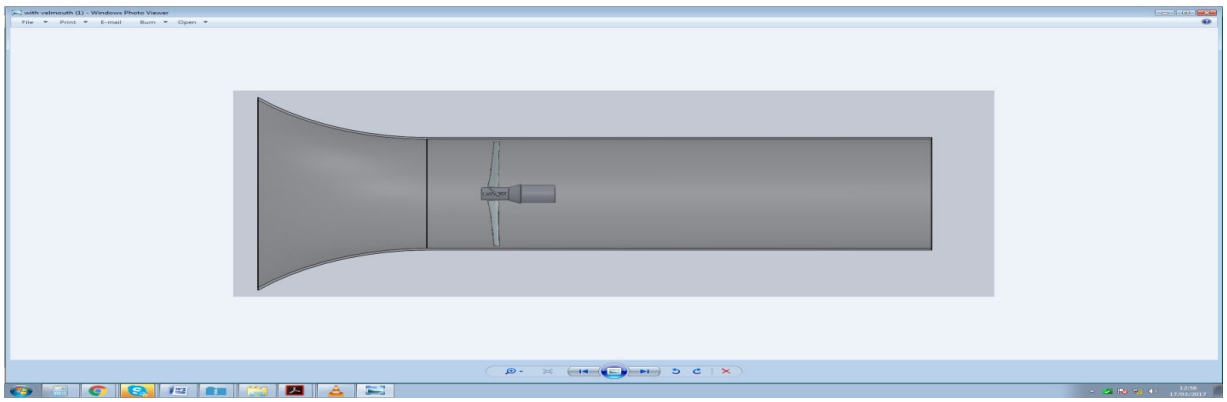




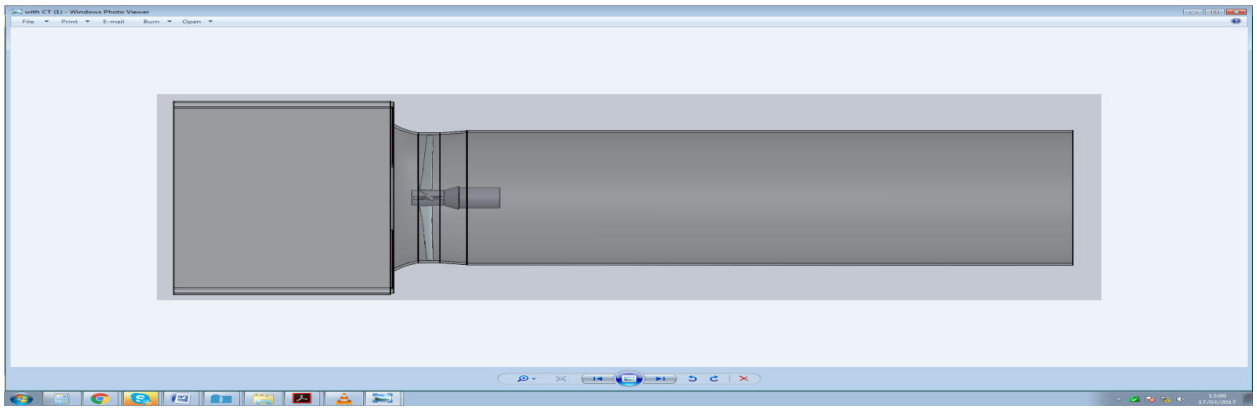
3. Cooling Tower Details

Cooling tower fan are of three design, and number of blades are 4 in one design, and 6 in two designs.

At 1:10 scale typical diameter at fan section is 1 m, upto 3 time the diameter straight length is kept so that flow parameter can be compared with experimental results. The flow parameters will be measured two meters downstream of fan section.



Ideal setup: Typical fan blade enclosed in duct with bell-mouth.



Real setup : Typical fan blade enclosed in duct with Cooling Tower fills (meshes) in front rectangular section.

The Rectangular part will be blocked from front so that air enters only from side , and it will have fills which produce static pressure loading.

4. Project – Scope of Work

The project should be done with two level simulation methodology and these are given in separate subsections below along with the scope of work.

4.1 Design/Analysis using Axial Fan Theory

Solidity ratio of the fans is small and will always be below 10 percent. The cooling tower fans are ducted and will be experimentally tested for size of 1:10. It is desired that using the fan design theories like Blade Momentum theory (actuator disk), performance of the fan is estimated. This performance will be matched with the experimental data as generated by IITK. Vendor must give suitable justification of the result generated by these codes vis-à-vis the experimental data. A total of three geometries will be simulated. The off-design conditions will be for 6 sets of RPM and 11 blade setting angles or total of 66 simulations per geometry, hence total 198 simulations for three geometries. Plots of pressure vs. flow rate, efficiency vs. flow rate and power vs. flow rate should be submitted as these plots are important for the power plant operation.

4.2 Computational Fluid Dynamics Analysis of Blades

A total of three configurations as given above need to be simulated and the data should be matched with experimental. In case the data is not matching, the simulations should be repeated till a satisfactory matching is achieved and the results can be explained physically to the review committee of IITK. For each of the configuration the simulation must be done for five sets of RPM and three blade setting angles or total of 15 simulations per geometry. Hence the total simulations for the existing geometries will be 45. The conditions of simulations will be given by IITK after the conclusion of contract. Simulation matrix may be different for different blades. In all simulations, RANS based code with appropriate turbulence models should be used. Correctness of simulation methodology will be ascertained in the data matching with experimental.

The quote should be inclusive of:

a. Pre-processing: CAD model generation from 2D drawings or scan data, geometry clean-up etc.
b. Mesh independence study to resolve clustering and mesh density issues
c. Report on the mesh independence and best practices to be adopted
d. All the simulations as given in the matrix above
e. Post-processing of simulation results as per IITK guidelines (to be given at the time of contract)
f. Report preparation and presentation of results

4.3 Fan Optimization

After the three geometries, have been simulated, one of them (having worst performance) will be chosen by IITK for optimization. The optimization conditions will be given at the time of signing of contract, but mostly it will be for increasing the flow rate for a given power consumption. Newer shapes of the blade can be generated using fan design code and optimized profile needs to be given. Apart from the profile, off-design conditions need to be generated for the optimized shape for different RPMs, Flow Rates, and blade setting angles. The RPM, Flow Rate, and Blade setting are to be varied for five sets for each. Therefore, total optimized fan performance data points needs to be 125 (5x5x5). A graph will be generated for all the 125 data points for pressure vs. flow rate, efficiency vs. flow rate and power vs. flow rate.

After the blade design using fan code, Computational Fluid Dynamics analysis needs to be done with the proven methodology for specified 15 cases by IITK. In case the blade is not found suitable in the analysis, design changes will be done and the simulations will be repeated. The new fan will be subsequently tested at IITK and the CFD results needs to be validated.

Finally for the optimized fan, full scale performance prediction will also need to be done, and results presented in the form of pressure vs. flow rate, efficiency vs. flow rate and power vs. flow rate.

5. Inputs, Terms and Conditions

1. Fan Models CAD, as assembled inside a duct of internal diameter 1000 (1:10 scale) will be provided by IITK.
2. CAD data at full scale will also be provided by IITK.
3. RPM and blade setting angle conditions will be specified by IITK.
4. Exact testing conditions will be given in the experiment for matching of data.
5. Any other data related to the test set-up and procedure will be given. However, the experimental results will be shared by IITK only after CFD results are received at IITK. CFD tuning need to be done by you.
6. In case the vendor does not wish to use Fan code, all 198 simulations can be done using Computational Fluid Dynamics.
7. All the data generated will be property of IITK. Data must be kept confidential.
8. In the tender, vendor must give details of the previous work carried out on cooling tower fans. Vendor should also give details of the team that will carry out the work for IITK to technically evaluate the tender.

6. Outputs and Deliverables

Following outputs will be given by the Vendor

1. Surface and volume mesh of all fans in ISO standard format
2. Standard simulation procedure need to be explained that should include mesh independence study, choice of turbulence model as applicable, convergence criterion etc. Similar explanation needs to be given for fan code
    a. Valid reasoning for taking assumptions during the course of CFD investigation need to be explained in the technical report
3. CFD studies & validation through experimental results of scaled down (1:10) physical model for the 03 nos. of fan need to be carried out. IIT Kanpur will share the experimental results for CFD validation.
4. Evaluation of performance of given design of fans and based on CFD results of 03 nos. of fans studied, worst performing fan will be taken as design modification/optimization case. This will be decided by IITK.
5. CFD studies of full scale optimized fan.
6. The modified/optimized fan design thus developed shall be fabricated by IIT Kanpur at 1:10 scale down model and will be tested in NWTF. The results should match with experiments. In case there is any discrepancy, CFD team need to redo the simulations.
7. Outputs for each blade should contain power, efficiency, torque, pressure distribution, flow rate.
8. Along with the aerodynamics of the optimized fan, natural frequencies need be calculated such that design can be submitted by IITK to customer.
9. Solidity ratio, Beam pass frequency and blade pass frequency need also be reported.
10. All the reports need to be provided in three hard copies and all the solution data and reports to be provided in soft copy in storage medium.
11. Vendor needs to be available to explain the results to IITK for a period of at least 6 months.
12. Vendor needs to present the results to review committee and successfully defend it for the acceptance

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