Volume 3, Issue 6, June 2017 **ISSN NO: 2454 - 7514**

North Asian International Research Journal Consortium

North Asian International Research Journal

Of

Science, Engineering and Information Technology

IRJIF IMPACT FACTOR: 3.821

NAIRJC JOURNAL PUBLICATION

North Asian International Research Journal Consortium

Welcome to NAIRJC

ISSN NO: 2454 -7514

North Asian International Research Journal of Science, Engineering & Information Technology is a research journal, published monthly in English, Hindi. All research papers submitted to the journal will be double-blind peer reviewed referred by members of the editorial board. Readers will include investigator in Universities, Research Institutes Government and Industry with research interest in the general subjects

Editorial Board

Address: -North Asian International Research Journal Consortium (NAIRJC) 221 Gangoo, Pulwama, Jammu and Kashmir, India - 192301, Cell: 09086405302, 09906662570, Ph. No: 01933-212815,
Email: nairjc5@gmail.com, nairjc@nairjc.com, info@nairjc.com Website: www.nairjc.com

DESIGN & ANALYSIS OF IMPELLER OF CENTRIFUGAL PUMP

[1] NITIN JADHAV, [2] LAWATE ROHIT, [3] DAWARE SAGAR, [4] MALPOTE SOMNATH, [5] KHARE PRAVIN & [6] KUTE SHRIHARI

Nutan Maharashtra Institute of Engineering and Technology, Talegaon Dabhade, Department of Mechanical Engineering, Savitribai Phule Pune University, India

Abstract— ***Centrifugal pump is one of the most widely used devices to transport fluids in industries and buildings. A lot of research has been carried out to make it more efficient. With the development of Computational Fluid Dynamics (CFD), the parametric study of a centrifugal pump has become much easier and the complex internal flow can be well predicted to expedite the pump design procedure. The primary objective of this work is to analyze the effect of outlet angle of six blades of a radial flow impeller on the hydraulic performance of an impeller using three-dimensional steady-state analysis with the help of commercial CFD software Ansys-15.0. In this analysis, we used Vista CPD for development of blade profile with different outlet angles 22.5,30,38 degrees keeping the inlet angle constant. This paper involves, Investigating the effect and distribution of streamline velocity and pressure within a pump having the following specification, Head-20m, Flow rate-280m^3/hr, RPM-1450. The calculations are performed only on the impeller blade. Three dimensional Navier-Stokes equations are numerically solved by adopting k-ε turbulence model, using finite volume methods based CFD code. The results revealed that at design point by increasing impeller outlet angle, performance of the pump increases.***

Keywords: ***Design of Impeller, Centrifugal Pump, Vista Cpd, Streamline Velocity, Pressure.***

I. INTRODUCTION

Centrifugal pump works on the principle of forced vortex flow and convert energy of a prime mover (electric) energy into kinetic energy and then pressure energy by two main parts of the pump impeller and volute. It is one of the most common used devices for various purposes such as industries, domestic, power plant, agriculture, water supply, transport, oil refineries, and buildings. It is very important that centrifugal pump should work efficiently because of its vast application. Since performance of pump is affected by velocity triangle, and depends on the blade inlet or Outlet angle. Blade inlet and outlet angle is most important parameters for the impeller of the centrifugal pump, which influence on the pump head, efficiency, discharge and so on. In this paper, the effect of blade outlet angle on the performance and internal flow of an impeller, with different blade outlet angles is numerically calculated using commercial tool for designing Vista-CPD and for solver CFX. The calculations are performed only on the impeller and volute instead of the complete pump.

II. DESIGN OF IMPELLER

CENTRIFUGAL PUMP DESIGN

The design of centrifugal pump is divided in two categories: Impeller Design and Volute Design. The detailed procedure of single volute casing and impeller design can be found in different literature; in this paper vista CPD for the design of centrifugal pump is used. The duty parameters required by the pump are assumed to be:

1. Head = 20 m,
2. Flow rate = 280 m3/hr,
3. RPM = 1450,
4. Density = 1000 Kg/ m3,
5. Trailing blade angles=22.5, 30, 38.

A. IMPELLER DESIGN USING VISTA CPD V15

Input variables are necessary for the pump design. Here we have given head, volume flow, rotational speed and trailing blade angle as input parameters. Various windows show the design parameters, like the angle and thickness distribution. The following fig-1 shows the entire workflow from input values in Vista CPD to final results by Vista design module. This way, manipulation of the geometry in BladeGen or Blade Editor will be possible and all the next steps will be automatically generated and results produced.

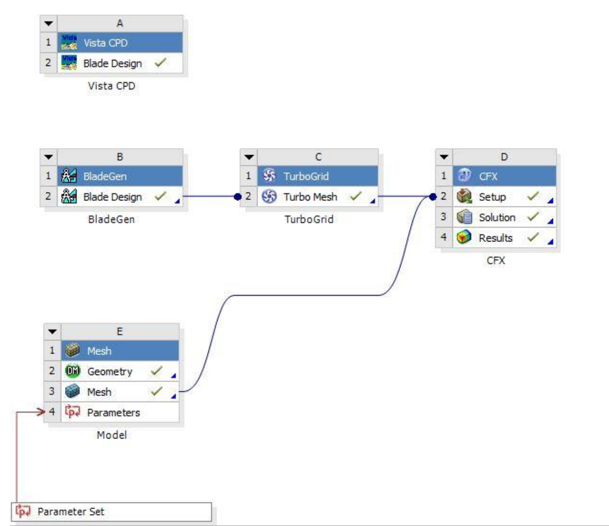
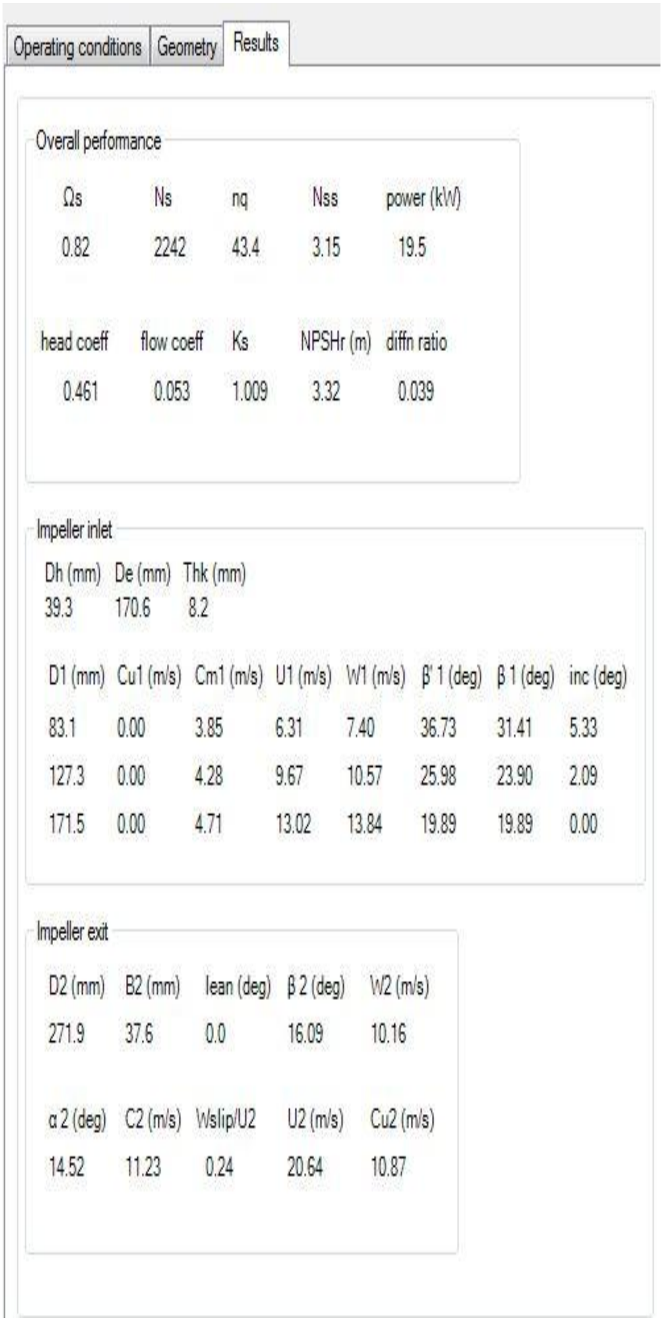


Figure 1 flow chart of project

We have taken three different trailing blade angles 22.5, 30 and 38 degrees and generated blade profiles for analysis. Following are the results obtained for impeller of trailing blade angle 22.5



Operating conditions | Geometry | Results

Overall performance

Ωs	Ns	nq	Nss	power (kW)
0.82	2242	43.4	3.15	19.5

head coeff	flow coeff	Ks	NPSHr (m)	diffn ratio
0.461	0.053	1.009	3.32	0.039

Impeller inlet

Dh (mm)	De (mm)	Thk (mm)
39.3	170.6	8.2

D1 (mm)	Cu1 (m/s)	Cm1 (m/s)	U1 (m/s)	W1 (m/s)	β' 1 (deg)	β 1 (deg)	inc (deg)
83.1	0.00	3.85	6.31	7.40	36.73	31.41	5.33
127.3	0.00	4.28	9.67	10.57	25.98	23.90	2.09
171.5	0.00	4.71	13.02	13.84	19.89	19.89	0.00

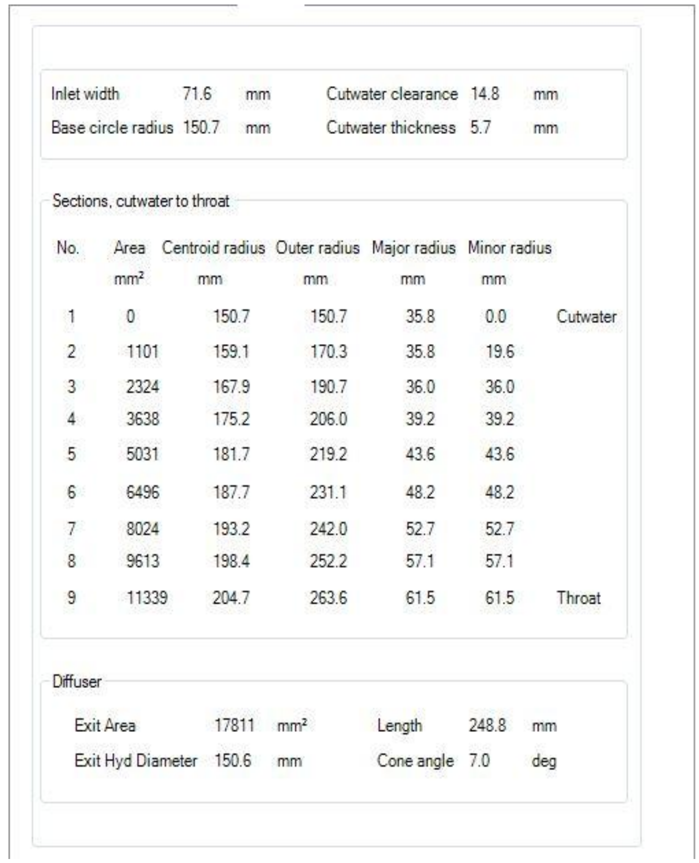
Impeller exit

D2 (mm)	B2 (mm)	lean (deg)	β 2 (deg)	W2 (m/s)
271.9	37.6	0.0	16.09	10.16

α 2 (deg)	C2 (m/s)	Wslip/U2	U2 (m/s)	Cu2 (m/s)
14.52	11.23	0.24	20.64	10.87

Figure 2 Input design parameters of pump using Vista CPD software.

Following are the results obtained for volute casing-



Inlet width	71.6	mm	Cutwater clearance	14.8	mm
Base circle radius	150.7	mm	Cutwater thickness	5.7	mm

Sections, cutwater to throat

No.	Area mm²	Centroid radius mm	Outer radius mm	Major radius mm	Minor radius mm	
1	0	150.7	150.7	35.8	0.0	Cutwater
2	1101	159.1	170.3	35.8	19.6	
3	2324	167.9	190.7	36.0	36.0	
4	3638	175.2	206.0	39.2	39.2	
5	5031	181.7	219.2	43.6	43.6	
6	6496	187.7	231.1	48.2	48.2	
7	8024	193.2	242.0	52.7	52.7	
8	9613	198.4	252.2	57.1	57.1	
9	11339	204.7	263.6	61.5	61.5	Throat

Diffuser

Exit Area	17811	mm²	Length	248.8	mm
Exit Hyd Diameter	150.6	mm	Cone angle	7.0	deg

Figure 3 Output parameters using Vista CPD software.

III. MESH GENERATION

Once the pump geometry has been specified and a mesh has been created automatically, where the flow equations need to be solved.

Table 1

Number of Nodes:	256322
Number of Elements:	367933
Tetrahedra:	115941
Wedges:	76570
Hexahedra:	175422

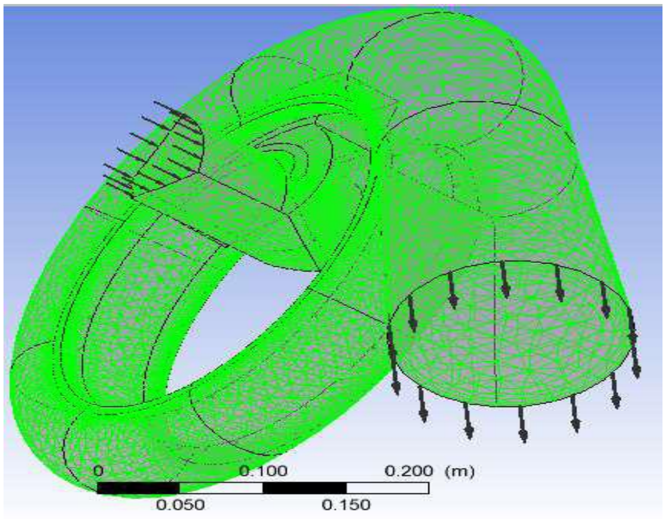


Figure 5 meshing

IV. SIMULATION OF CENTRIFUGAL PUMP

After meshing the model of impeller CFD code CFX-15 is used for simulation of the model. The boundary conditions are applied for solving the problem. The performance results are obtained at different outlet vane angle.

Assumptions

Several assumptions were made while simulating the model.

- Steady state condition
- Constant fluid properties
- Fluid flow is incompressible

Boundary conditions

Mathematical solutions are determined with the help of boundary conditions. These conditions specify the flow and thermal variables on boundaries of the model.

Impeller has various components like inlet, outlet, blades, hub and shroud. The inlet was defined as the total pressure and the outlet was mass flow rate. The other components were given as the wall boundary conditions. Rotation was given to the rotating faces of the impeller with no slip condition. The fluid domain given was of water as fluid with density $1000Kg/m^3$.

V. RESULTS AND DISCUSSION

Three impellers were analysed using CFX-15 of different outlet vane angles. Streamline is generated in the impeller. Fig6 shows the streamline velocity distribution for outlet vane angle 22.5⁰. Fig7 shows the streamline velocity distribution for 30⁰ outlet vane angle. Fig8 shows the streamline velocity distribution for outlet vane angle 38⁰.

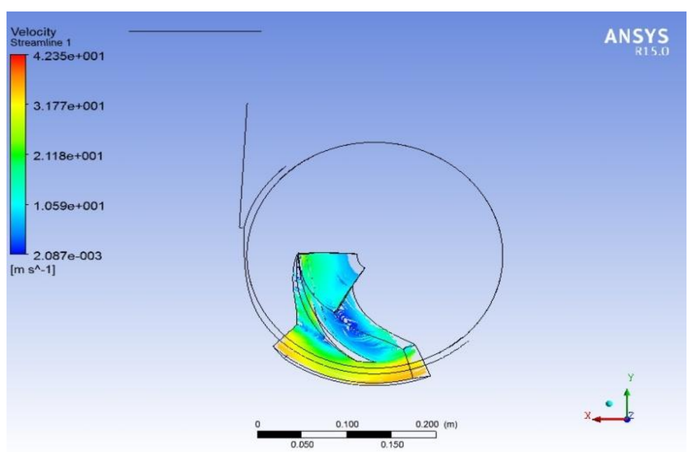


Figure 6

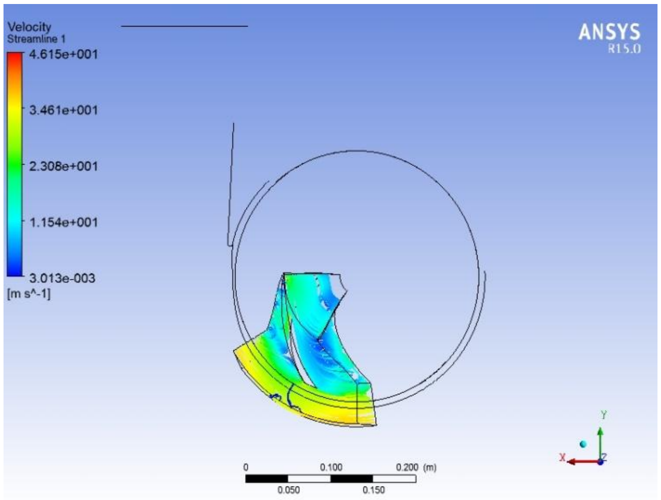


Figure 7

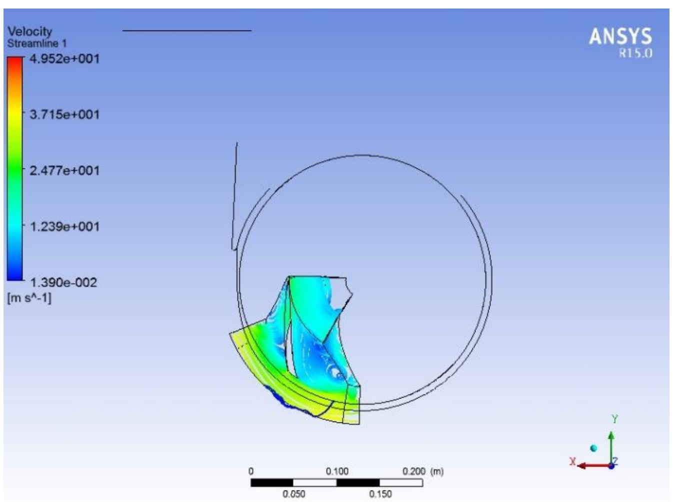


Figure 8

Result Table

Table 2

Inlet angle(◦)	Outlet angle(◦)	Velocity (m/s)
20	22.5	42.35
20	30	46.15
20	38	49.62

VI. CONCLUSION

From the results generated in the CFX-15 we can conclude that on increasing outlet vane angle the velocity of water at the outlet increases. Discharge of centrifugal pump is directly proportional to the flow velocity. Thus we can conclude that as vane outlet angle increases discharge of the centrifugal pump increases.

VII. REFERENCES

[1] S R Shaha et al. CFD for centrifugal pumps stae of the art, Chemical, Civil and Mechanical engineering tracks of 3rd Nirma University International conference journal

[2] Peter Hlbocana et al. Prime Geometry Solution of a Centrifugal Impeller Within a 3D Setting, XIIIth International Scientific and Engineering Conference ―HERVICON-2011‖

[3] Raghavendra S Muttalli et al. CFD Simulation of Centrifugal Pump Impeller Using ANSYS-CFX, International Journal of Innovative Research in Science, Engineering and technology Vol. 3, Issue 8, August 2014

[4] CFD analysis of centrifugal pump: A Review byNarayan P. Jaiswal Inl. Journal of engineering Research and Applications ISSN:2248-9622 Vol-4 Issue5 May 2014

[5] Design and analysis of centrifugal pump impeller using ANSYS Fluent by Ajit M. S. Dr. Jeoju M Issac Intl. Journal of Sccience, Engineering and

Technology(IJSETR), Vol4, Issue 10, October 2015

[6] Design and CFD analys of centrifugal pump by Thilun Nigussie, Edissa Drissba, International journal of Engineering Research and General science Vol3, Issue3,Mau-June-2015

Publish Research Article

Dear Sir/Mam,

We invite unpublished Research Paper,Summary of Research Project,Theses,Books and Book Review for publication.

Address:- North Asian International Research Journal Consortium (NAIRJC)
221, Gangoo Pulwama - 192301
Jammu & Kashmir, India
Cell: 09086405302, 09906662570,
Ph No: 01933212815
Email:- nairjc5@gmail.com, nairjc@nairjc.com , info@nairjc.com
Website: www.nairjc.com