Department of Civil Engineering
Delhi Technological University
(Formerly Delhi College of Engineering)
Bawana Road, Delhi – 110042

CANDIDATE'S DECLARATION

I do hereby certify that the work presented is the report entitled "**Analysis of Cavitation in Centrifugal Pump using CFX**" in the partial fulfilment of the requirement for the award of the degree of "Master of Technology" in Hydraulic And Flood Control Engineering submitted in the Department of Civil Engineering, Delhi Technological University, is an authentic record of my own work carried out under the supervision of Prof. Rakesh Mehrotra , Department of Civil Engineering. I have not submitted the matter embodied in the report for the award of any other degree or diploma to any other institution.

ABHISHEK AGRAWAL

2K16/HFE/01

Department of Civil Engineering
Delhi Technological University
(Formerly Delhi College of Engineering)
Bawana Road, Delhi – 110042

CERTIFICATE

This is certified that the work contained in this minor project entitled "**Analysis of Cavitation in Centrifugal Pump using CFX**"by ABHISHEK AGRAWAL (2K16/HFE/01) is the requirement for the fulfilment of the degree of HYDRAULIC AND FLOOD CONTROL ENGINEERINGE at Delhi Technological University. This work was completed under my direct supervision and guidance. The student has completed his work with utmost sincerity and diligence.

Place Delhi
Date :

Signature

(Asso. Pro. Rakesh Mehrotra)
SUPERVISOR
Department of Civil Engineering
Delhi Technological University

ACKNOWLEDGEMENT

I would like to thank Vice Chancellor of Delhi Technological University, Prof. Yogesh Singh and Prof. Nirendra Dev (Head of Department, Civil Engineering, DTU) for providing all the facilities and equipments in the college to carry out this project work.

I would like to convey my thanks, great indebtedness and gratitude to my supervisor Asso. Prof. Rakesh Mehrotra, Department of Civil Engineering, Delhi Technological University, New Delhi, for his kind supervision, remarkable comments and constant encouragement.

Professors and faculties of the Department of Civil Engineering, DTU, have always extended their full co-operation and help. I would also like to thank my colleagues in the college.

I would like to address my seniors for their guidance.

(Abhishek Agrawal)

(2K16/HFE/01)

ABSTRACT

In our every day existence we use many things which use concept of vacuum like vacuum cleanser, exhauster and so on. The phenomenon of cavitation use in various industry like hydraulic lifts etc, It's has various advantages anf also disadvantages like in pumps. In centrifugal pump impeller rotates due to which suction creates (negative pressure), it suck the water from surrounding, due to decrease in these pressure boiling point of water decreases and water is now able to boil at low temperature, if in any instance if surrounding temp is more than boiling point (due to low temperature), water start boiling and form a bubble, now it not harmful till it burst, at outlet water have to flow at high pressure hence at this condition boiling point increases hence the present bubbles start bursting on the surface due to which deterioration of surface occurs. This deterioration cause unbalance condition during running result failure of machine. Cavitation also occurs due to air present in water, due to sucking of water at high pressure air coming out from the water and form bubble and leads to cavitation. In this project I am vary discharge at constant rpm to see variation of cavitation and observed that as discharge increases cavitation also increases. I also calculate efficiency at various discharge at constant R.P.M. and calculate change in $NPSH_A$ and $NPSH_R$ at various discharge and get the result that as discharge increases $NPSH_A$ decreases and $NPSH_R$ increase due to which cavitation occurs.

CONTENTS

List of Figures

List of Tables

Pump Terminology

Impeller—The moving element in a pump that drives the liquid.

Volute — The spiral-shaped casing surrounding a pump impeller that collects the liquid discharged by the impeller.

Head—A measure of the pressure or force exerted by water expressed in feet. Centrifugal pump curves show pressure as head, which is the equivalent height of water with specific gravity = 1.

Static Head—The vertical height difference from the surface of a water source to the centerline of the impeller. The vertical height difference from the centerline of the impeller to the discharge point is called discharge static head, while the vertical height difference from the surface of the water source to the discharge point is known as total static head.

Total Head / Total Dynamic Head—The total height difference (total static head) plus friction losses and demand pressure from nozzles etc. (total discharge head) = total dynamic head.

Capacity/Flow—The rate of liquid flow that can be carried, typically measured in gallons per minute (gpm).

Net Positive Suction Head—How much suction lift a pump can achieve by creating a partial vacuum. Atmospheric pressure then pushes liquid into pump. A method of calculating if the pump will work or not.

Cavitation—Cavities or voids in liquid. Bubbles take up space leading to a drop in pump capacity. Collapsing bubbles can damage the impeller and volute, making cavitation a problem for both the pump and the mechanical seal.

Specific Gravity—The weight of liquid in comparison to water at approximately 20° C (SG = 1).

Specific Speed—A measure of the function of pump flow, head, and efficiency.

Vapor Pressure—The force exerted by the gas released by a liquid in a closed space. If the vapor pressure of a liquid is greater than the surrounding air pressure, the liquid will boil.

Viscosity—A measure of a liquid's resistance to flow (i.e., how thick it is). The viscosity determines the type of pump used, how fast it can run, and with gear pumps, the internal clearances required.

Friction Loss—The amount of pressure / head required to force liquid through pipes and fittings.

Pump Efficiency—The ratio of energy delivered by the pump to the energy supplied to the pump shaft. Some pump curves will show you the percent of efficiency at the best efficiency point. The number varies with impeller design and numbers from 60 percent to 80 percent are normal.

Best Efficiency Point—The point of highest efficiency of the pump

Head and Capacity Relationship – Every pump will be capable of developing a specific pressure at a specific. The pump will pump any liquid to a given height or head depending upon the diameter and speed of the impeller. The amount of pressure you get depends upon the weight of the liquid. Head is a convenient term because when combined with capacity you come up with the conversion for horsepower.

Abbreviations

A	Volume fraction
β^*	Closure coefficient
C_μ	Closure coefficient
δ_{ij}	Kronecker delta
$\in$	Dissipation per unit mass
H	Head rise
I_{SP}	Specific impulse
K	Kinetic energy of turbulent fluctuations
P_c	Critical pressure
P_g	Gas pressure
P_0	Total pressure
L	Turbulence length scale
n_0	Number of bubbles per unit volume
P	Static pressure
P_V	Vapour pressure
P_∞	Pressure outside the bubble
Q	Flow rate
ρ	Density
R	Radius of microbubble
R_C	Critical bubble radius
σ	Cavitation number
S	Surface tension
S_{ij}	Mean strain rate tensor
$NPSH_R$	Net Positive suction head required
$NPSH_A$	Net Positive suction head available
CFD	Computational Fluid Dynamics
FVM	Finite Volume Method