International Journal of Innovative Technologies
WWW.IJITECH.ORG
ISSN 2321-8665
Volume.06, Issue.02,
July-December, 2018,
Pages:0511-0520

Design and Pressure Analysis of Multi-Stage Pressure Boosting Movitec Pump

A. SURENDRA MOHAN[1], J. PRADEEP KUMAR[2]
[1]PG Scholar, Dept of Mechanical Engineering, SVITS, Mahbubnagar, TS, India.
[2]Assistant Professor, Dept of Mechanical Engineering, SVITS, Mahbubnagar, TS, India.

Abstract: A multi- stage vacuum pumping system utilizing a first stage positive displacement pump and a second stage liquid ring pump, and wherein at pressure differential predetermined values is maintained across the stage pump due to the provision of a slip producing constant torque coupling means. In order to study the inner flow field of multi-stage centrifugal pump, the model named Movitec was selected. Steady turbulence characteristics of impellers, diffusers and return channel were calculated by software, the turbulence model with sliding mesh technology. Then, the distributions of pressure, velocity and Turbulence kinetic energy was obtained and the distributions of velocity field of a channel were analyzed. The results show that the static pressure in impeller is increasing with the increasing of radius. The circumferential component of relative velocity is in the opposite direction of impeller rotating. At the same radius, the component value of pressure surface is larger than suction surface. With the increasing of flow rate, absolute velocity and relative velocity flow angle are becoming small, in opposite of the relative velocity and absolute velocity flow angle. The high turbulent zone of impeller is located in the gap of impellers and diffusers. Flow similarity and structure similarity of the multi-stage pump are confirmed. For this project, there are two basic requirements. The first requirement is to design and analysis of a physical model. The second requirement is to control the motion by the method, such as following a track, which consists of straight lines and curves. These systems are done by modeling software's like CatiaV5, and analysis is done by Ansys software. By utilizing the high air pressure, the presence enables it to move the impellers with much less force. Specifications of a product are detailed in terms of the product size, speed range, weight and power consumption.

Keywords: LDV and PIV, HVAC.

I. INTRODUCTION

A sponsor pump is a machine which will expand the weight of a liquid, for the most part a fluid. It is like a gas blower, however for the most part a less complex component which frequently has just a solitary phase of pressure, and is utilized to expand weight of an as of now pressurized gas. Two-organize promoters are additionally made. Supporters might be utilized for expanding gas weight, exchanging high weight gas, charging gas barrels and searching.'

A. Development And Function

Supporter pumps are generally cylinder or plunger compose blowers. A solitary acting, single-organize supporter is the least difficult arrangement, and contains a barrel, intended to withstand the working weights, with a cylinder which is driven forward and backward inside the chamber. The barrel head is fitted with supply and release ports, to which the supply and release hoses or pipes are associated, with a non-return valve on each, obliging stream in one course from supply to release. At the point when the supporter is latent, and the cylinder is stationary, gas will spill out of the bay hose, through the channel valve into the space between the chamber head and the cylinder. On the off chance that the weight in the outlet hose is lower, it will then stream out and to whatever the outlet hose is associated with. This stream will stop when the weight is adjusted, considering valve opening weights. Once the stream has ceased, the supporter is begun, and as the cylinder pulls back along the barrel, expanding the volume between the chamber head and the cylinder crown, the weight in the barrel will drop, and gas will stream in from the bay port. On the arrival cycle, the cylinder pushes toward the barrel head, diminishing the volume of the space and packing the gas until the point that the weight is adequate to defeat the weight in the outlet line and the opening weight of the outlet valve. By then, the gas will stream out of the barrel by means of the outlet valve and port. Sponsors to be utilized with oxygen must be produced using oxygen-good materials, and utilize oxygen-perfect greases to stay away from flame.

Fig.1.

B. Power Sources

Promoters might be driven by an electric engine, water power, and low or high weight air or physically by a lever framework. Those controlled by packed air are typically straight impelled frameworks, where a pneumatic barrel

specifically drives the pressure cylinder, frequently in a typical lodging, isolated by a seal. A high weight pneumatic drive course of action may utilize an indistinguishable weight from the yield strain to drive the cylinder, and a low weight drive will utilize a bigger distance across cylinder to increase the connected power. It did three-dimensional numerical recreation investigation of turbulent stream for demonstrate SXB with multistage fire pump. Movitec deliberately considered the appropriateness of turbulence models by the LDV and PIV. Mimicked the unfaltering turbulent stream field for the multi-organize twofold suction radial pumps and acquired speed vector graph of stream field under various working states of the pump. Ascertained three-dimensional numerical recreation investigation of turbulent stream for show D450-60×7 with vitality sparing advancement and broke down the genuine task information procurement. In light of the Reynolds Average Navier-Stokes condition and adjustment utilizing the Ansys programming, this paper reenacts inside stream in multi-arrange divergent pump under three sorts of various stream rates, and examines weight dissemination and speed vector of impeller and sharp edge. The outcomes could give hypothesis to enhancement plan of the multi-arrange diffusive pump.

II. LITERATURE REVIEW

Pump choice is an indispensable outline segment in any water and wastewater venture. During the time spent choice, engineers need to assess a wide range of parameters, including wanted stream rate(s), pumping head, control prerequisite and productivity. The specialist at that point gets maker data on pumps, and upon determination and afterward establishment of a pump, runs tests intermittently to guarantee the pump works as promoted. In many cases, the data gave by the maker can vary from the aftereffects of a field test, particularly after some time. This can be credited to consumption, fouling and additionally disintegration. This report examines a few working parameters and the impact they have on the execution of a level split-case diffusive draw utilized at Madison Water Utility's Unit Well 30. It will then be contrasted with maker information. Moreover, this report additionally investigates other direct composes keeping in mind the end goal to acclimate the specialists with accessible options. To better comprehend pumping frameworks an inside and out writing audit was led. Pump composes, which included, radial pumps, vertical turbine pumps, and positive removal pumps were examined. This examination gave a strong premise of comprehension of pump choices and advanced general comprehension of how each pump is planned and what it is most helpful for. By looking at the pumps based on how they function, their execution assessment, and what they are utilized for, a general base of learning was created.

A. Outward Pump

Spiral radiating pumps work by exchanging vitality from the impeller to the liquid as the liquid passes. An engine first drives the pump shaft that applies torque to the impellers. As the liquid enters the impeller focus, the impeller exchanges its rakish energy to the liquid, expanding the weight and speed of the liquid. The liquid at that point leaves through the impeller cutting edge. Fig.2 shows this procedure. The liquid is gathered by the volute and after that leaves the pump through the ring diffuser. The volute packaging bit by bit increments in cross-sectional zone to back off the liquid as it leaves the pump. The execution of outward pumps is assessed through its pump bend and productivity. The pump bend measures how the release stream rate shifts with the head it needs to pump against. Pump effectiveness is a proportion of intensity yield by to control contribution to the pump shaft. There are numerous utilizations of diffusive pumps, among them: HVAC, weight boosting, water extraction from wells, wastewater pumping and mechanical pumping. Pumps differ in channel outline, outlet plan, impeller measure, heading of turn, nooks, materials, and significantly more, contingent upon its application. This area of the survey will center around even split-case outward pumps, regularly utilized for weight boosting in various ventures, including civil, synthetic compounds, vitality and mining.

B. Level Split-Case Pumps

These pumps are regularly utilized as supporter draws in water and wastewater applications. Figure 3 is a photograph of an even split-case direct taken at a supporter pumping station. They add weight to the water conveyance framework, where at least 35 psi exists under Wisconsin DNR code. The split-case trademark takes into account less demanding support, as one can get to the pivoting parts by opening the packaging, not at all like different pumps that would require disassembling. The choice of a diffusive pump relies upon a few variables. Initial, a framework head bend and configuration guide require toward be resolved. An outline point is the stream rate and head the framework needs to work at. Next, this point as well as pump bend ought to be overlaid on the pump bends, gave by the makers. The chose pump ought to have a bend that experiences the plan point at a high proficiency (in any event higher than its companions). Most extreme weight, liquid temperature, material and simplicity of support ought to likewise be considered in the choice of pumps.

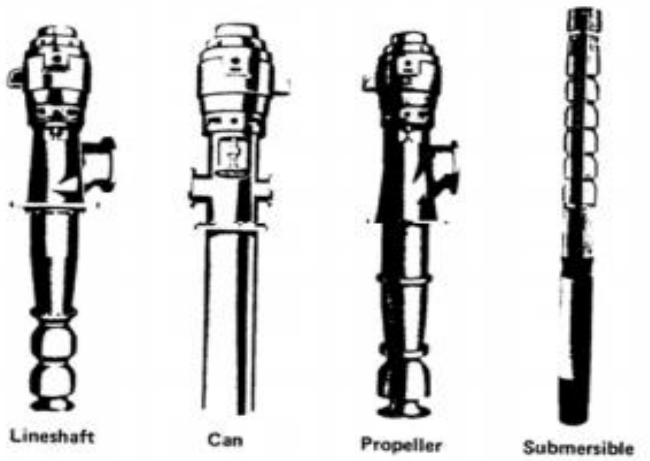

Fig.2.

C. Vertical Turbine Pump

Vertical turbine pumps are utilized as a part of a wide assortment of enterprises. They can be utilized as a part of the geotechnical field aiding borehole application or the stimulation segment helping in Water Park pumping (Gould's Water Technology, 2012). There are three fundamental classifications, submersible pumps (profound well and short setting), line shaft pumps (profound well, short setting and barrel), and evenly mounted hub stream pumps (Jones et al., 2008; See Fig. 4 for cases). Vertical pumps have distinctive attributes that set them apart from radial pumps and positive dislodging pumps.

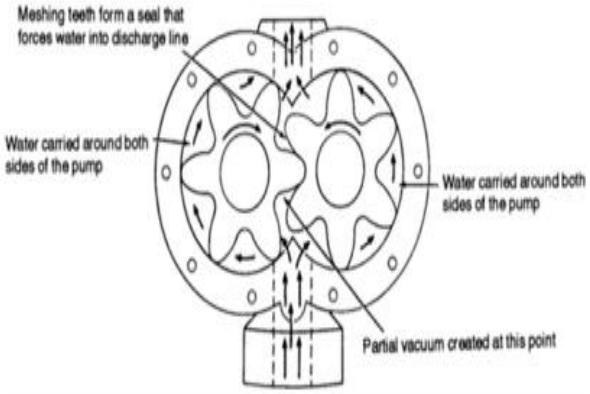

Fig.3.

The procedure to choosing a pump is key. Essential outline lattice assessments of cost (O and M), introductory cost, space, and so forth are altogether included. Some critical different elements are stream and head, impeller size, vibration and pump measure. These fundamentally impact pump efficiencies, which would be spoken to in pump bends. Edmondson (2014) additionally expresses that brake drive and required net positive suction head are other fundamental parts of direct choice because of their impact on pump execution. Overlaying framework head bends on head-capacity bends finish the determination procedure as talked about in the outward pump segment.

III. PRINCIPLE OF MULTI-STAGE PRESSURE BOOSTING PUMP

A. The Multi-Stage Pressure Boosting Pump Principle

Promoter pumps are generally cylinder or plunger write blowers. A solitary acting, single-organize promoter is the easiest setup, and involves a chamber, intended to withstand the working weights, with a cylinder which is driven forward and backward inside the barrel. The chamber head is fitted with supply and release ports, to which the supply and release hoses or pipes are associated, with a non-return valve on each, obliging stream in one bearing from supply to release. At the point when the sponsor is latent, and the cylinder is stationary, gas will spill out of the channel hose, through the gulf valve into the space between the chamber head and the cylinder. On the off chance that the weight in the outlet hose is lower, it will then stream out and to whatever the outlet hose is associated with. This stream will stop when the weight is evenedout, considering valve opening weights. Conveyance rate begins at near cleared volume when there is no weight distinction, and drops relentlessly until there is no powerful exchange when the weight proportion achieves the most extreme lift proportion.

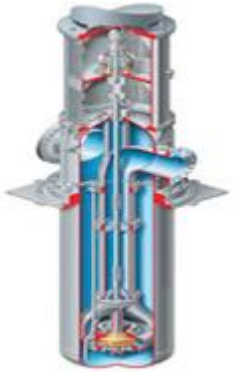

Fig.4.

Pressure of gas will cause an ascent in temperature. The warmth is generally completed by the packed gas, yet the sponsor parts will likewise be warmed by contact with the hot gas. A few sponsors are cooled by water coats or outside balances to increment convectional cooling by the surrounding air, however littler models may have no extraordinary cooling offices by any stretch of the imagination. Cooling game plans will enhance productivity, however will cost more to make. Sponsors to be utilized with oxygen must be produced using oxygen-good materials, and utilize oxygen-perfect greases to maintain a strategic distance from flame.

IV. DESIGN METHODLOGY OF MULTI-STAGE PRESSURE BOOSTING MOVITEC

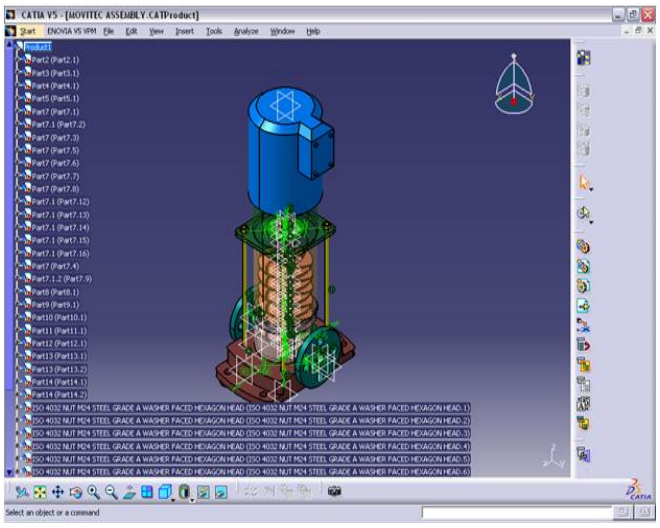

Fig.5. Model plan of Multi-Stage Pressure Boosting Movitec in CATIA-V5.

A. Introduction to CATIA

CATIA (Computer Aided Three-dimensional Interactive Application) is a multi-stage CAD/CAM/CAE business programming suite created by the French organization Dassault Systems as shown in Fig.5. Written in the C++

programming dialect, CATIA is the foundation of the Dassault Systems item lifecycle administration programming suite. CATIA contends in the top of the line CAD/CAM/CAE showcase with Cero Elements/Pro and NX (Unigraphics).

B. Modeling of Multi-Stage Pressure Boosting Movitec Model in CATIA V5

This Multi-Stage Pressure Boosting Movitec is outlined utilizing CATIA V5 programming as shown in Fig.6 and 7. This product utilized as a part of vehicle, aviation, shopper merchandise, substantial building and so forth it is intense programming for planning confounded 3d models, utilizations of CATIA Version 5 like part configuration, get together outline.

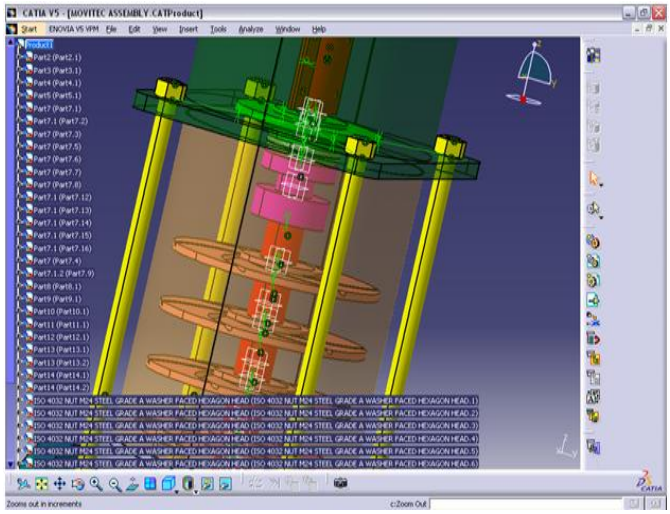

Fig.6. Model course of action of Multi-Stage Pressure Boosting Movitec system in CATIA-V5.

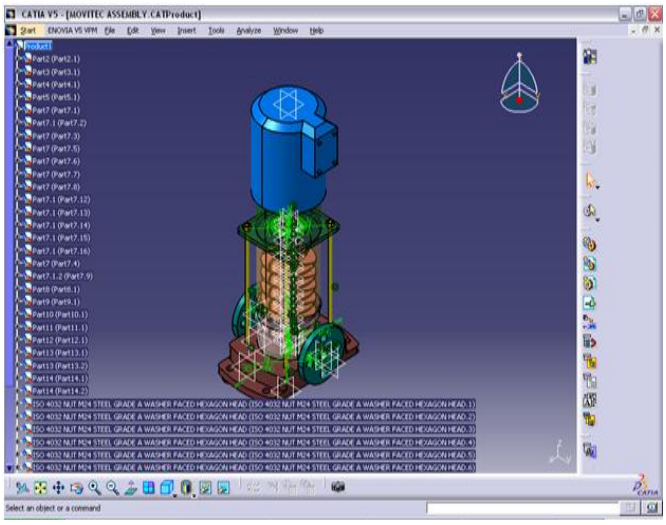

Fig.7. Using Manipulate Command.

C. Assembly Modeling of Multi-Stage Pressure Boosting Movitec

In this displaying every last segment get gathered together with the methods for limitations, happenstance, contact, counterbalance, point, settle segment, adaptable, control, and so on.

Control: This order is utilized to control/turn/pivot the segment in any requried heading according to the need/appropriate requirements are to be connected on the segment.

Multi View: This is the charge in which every one of the perspectives of the segment/model can be shown on the screen at a same time, they can be altered under the workbench as shown in Fig.8.

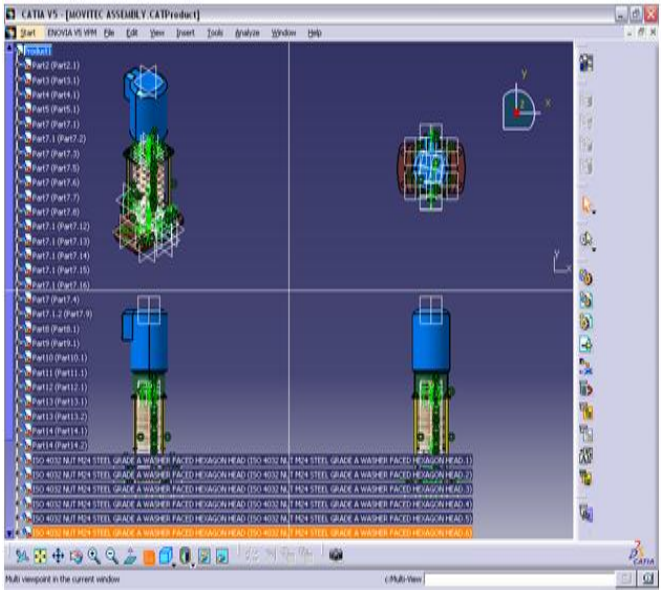

Fig.8. Using Multi View Command.

V. ANALYSIS OF MULTI-STAGE PRESSURE BOOSTING MOVITEC

A. Procedure for FE Analysis Using ANSYS

The examination of the Multi-Stage Pressure Boosting Movitec is finished utilizing ANSYS. For contend get together isn't required, engine and joined framework is to completed by applying minutes at the pivot area along which hub we have to specify as shown in Fig.9. Settling area at the impellers of the pump of get together.

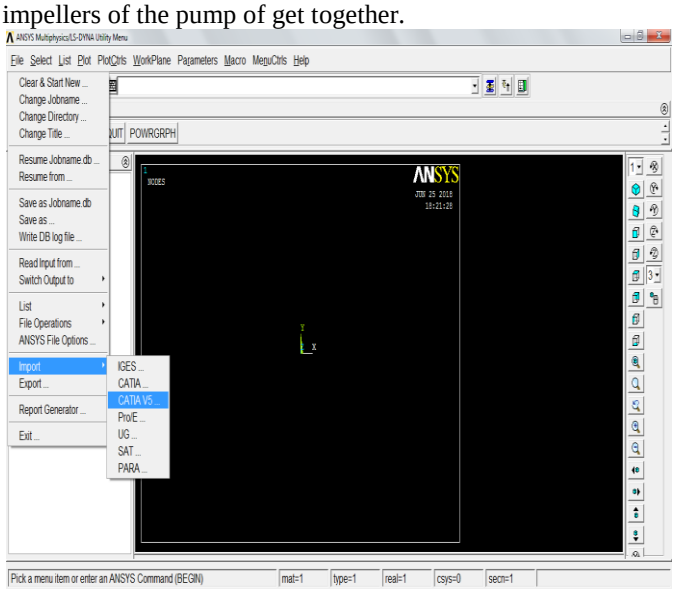

Fig.9. Import board in Ansys.

B. Preprocessor

In this stage the accompanying advances were executed:

Import Record in ANSYS Window:

Record Menu > Import> STEP > Click alright for the flew up discourse box > Click.

Peruse" and pick the record spared from CATIAV5R20 > Click alright to import the document.

VI. CONTROL EQUATION

The relentless stream is figured continuously arrange verifiable time venturing technique, and the turbulence display is supplemented with a Movitec model and standard divider capacities for the close divider, predictable with the non-slip divider condition. The stream of the pump is computed by the limited volume technique to comprehend the Reynolds found the middle value of energy condition for 3D enduring turbulence stream. What's more, utilizing condition show makes Reynolds-found the middle value of condition shut.

A. Models And Boundary Conditions

Pump Geometry Mode: The mimicked question is a multi-arrange submersible radiating pump named Movitec. The pump is a low-particular speed radial pump with a particular speed. Principle outline parameters of recreated pump are as per the following: Q=3m3/h, H=60m, n=2860 r/min, impeller distance across = 118mm, impeller width at outlet = 2.5mm, cutting edge outlet edge =20º, the quantity of impeller edges Z= 5, the quantity of spiral vanes = 6 and the quantity of back vanes =6. As indicated by water driven chart of the impeller and guide vanes, three-dimensional stream model of four-arrange impellers is set up, as appeared in fig.10.

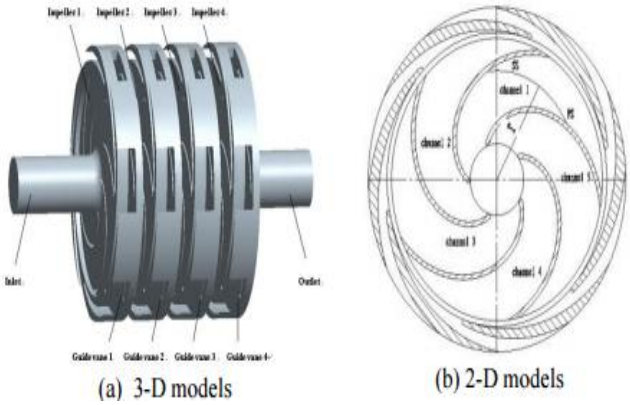

Fig.10. Count models.

Work Age And Limit Condition: Called attention to execution expectation mistake will be bit by bit decreased with the change of the quantity of the frameworks. Hence, the framework autonomy is checked to give an important correlation between the forecast and trial. What's more, keeping in mind the end goal to limit the impacts of limit conditions and guarantee numerical strength, gulf and outlet funnels ought to be proper expanded. Organized hexahedral cells were utilized to characterize the channel and outlet area, and unstructured tetrahedral cells with solid adaptability were utilized for control vanes and impellers as shown in Figs.11 and 12.

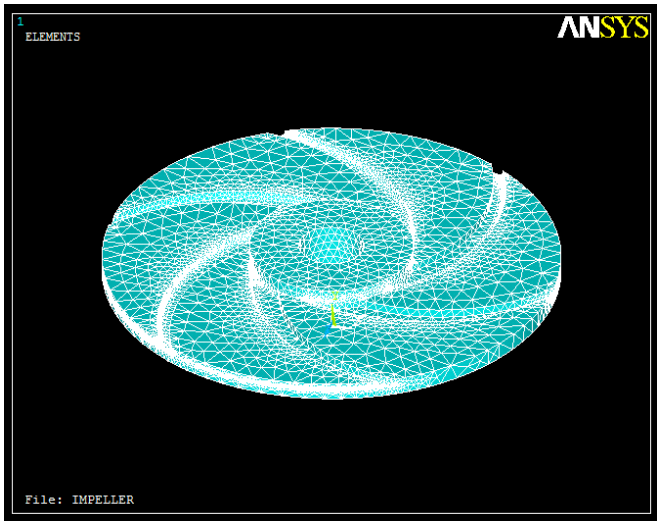

Fig.11. Computation work.

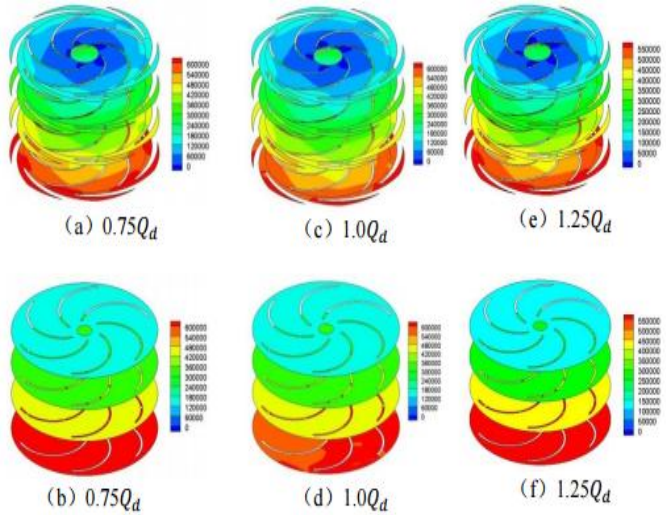

Fig.12. The dissemination of static weight of each impeller and diffuser under various conditions.

B. Examination Results of Impeller

Weight Distribution And Velocity Vector Of The Flow Field:

Weight Field Examination: The static weight circulation of center segment for single stage impeller, manage vane and return direct vane under multi-conditions. As can be seen from the figure, static weight appropriation equitably increments along the outspread heading of the impeller. At a similar range of the impeller, weight surface of the edge is more noteworthy than suction surface about the static weight. Under each working condition, the base weight inside the impellers is found suction surface of the main stage edge gulf and the low weight of suction surface zone is developing with the expansion of the stream. It is a place that the primary stage impeller is inclined to cavitations. At the point when the liquid enters the auxiliary impeller, the delta weight is around

equivalent to the static weight of the main stage impeller. The delta of the second stage does not happen cavitations, in light of the fact that the gulf weight is significantly bigger than the vaporizing weight. The rotor-stator cooperation created by the relative development between the guide vanes and the impellers, bringing about static weight uneven dispersion of the impeller outlet, and the motor vitality is bit by bit changed into the potential vitality when fluid streams from the impeller into the guide vane. To the following stage impeller, the potential vitality stayed steady, and the weight is uniformly disseminated, as demonstrated as follows

Speed Field Examination: The total speed and circumferential segment of the relative speed for impellers and vanes under multi-conditions. The low speed locale close to the channel of the sixth International Conference on Pumps and Fans with Compressors and Wind Turbines, impeller is appeared in fig.13. Circumferential part of the outright speed in the little stream condition is more noteworthy than that the vast stream condition. There is a lower speed some portion of the high speed zone. This is on the grounds that at the bigger span, the impeller section step by step extended, the coupling limit of the stream is diminished and the fluid stream happen counterbalance the circumferential way. This marvel has likewise been affirmed in the writing of the PIV tests. As can be seen from figure, circumferential part of the relative speed is inverse to the bearing of the Impeller turn. Its esteem is negative at a similar span and the outright estimation of the weight surface is more prominent than the suction surface. Notwithstanding what sort of working conditions, the speed dissemination and the stream design in each phase of the impeller are nearly the same.

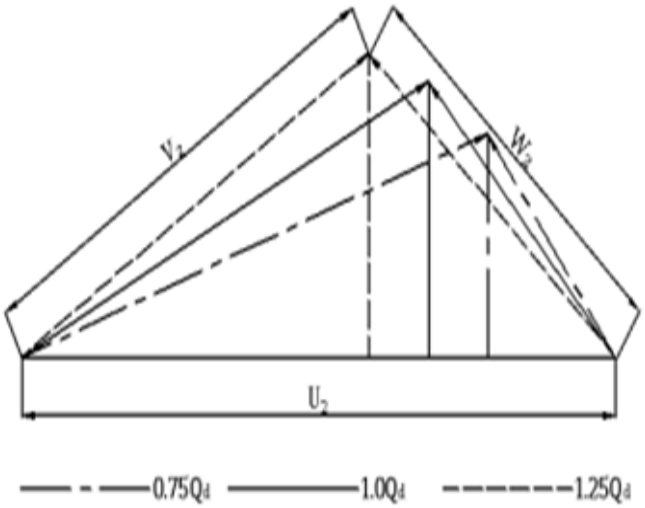

Fig.13. Speed triangle of PS at impeller outlet under various conditions.

An augmented perspective of the relative speed vector of the stream channel under 0.75Qd. As can be seen from the, the wonder of slow down can be clearly seen in the stream channel. The marvel of isolation can be seen in the stream channel. The standard produces a solid unsettling influence; because of the stream channel have a substantial whirlpool territory and more extreme reflux as shown in Fig.14. This is the reason the pump execution is low under the little stream conditions.

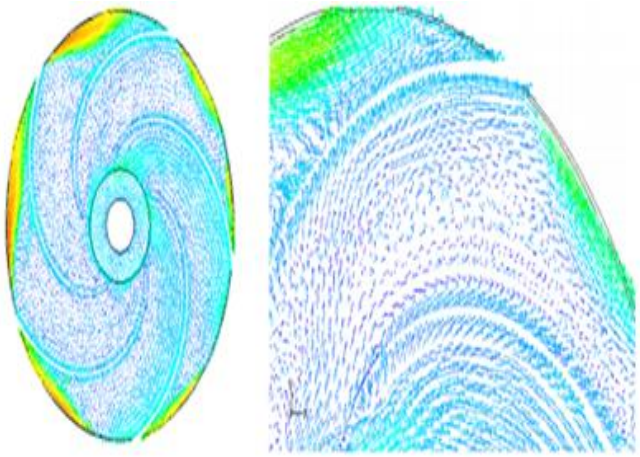

Fig.14. Relative speed extent of first impeller and develop.

VII. DISCUSSION ON ANALYSYS RESULT

Results of this paper is as shown in bellow Figs.15 to 38.

A. Results of Displacement Analysis

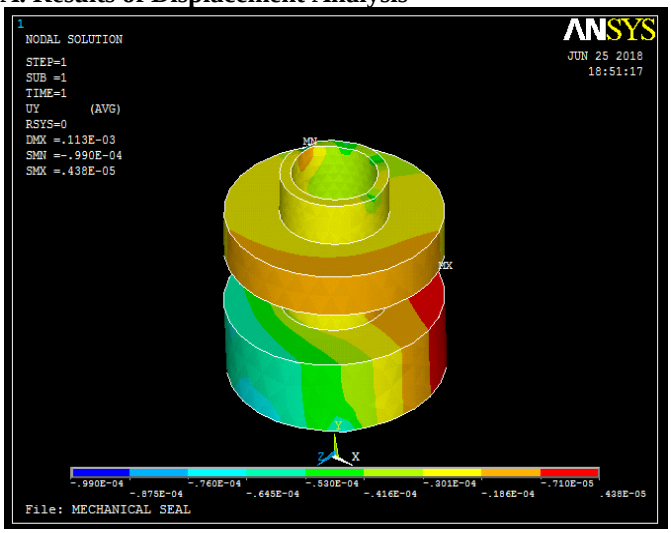

Fig.15. Displacement of Mechanical Seal.

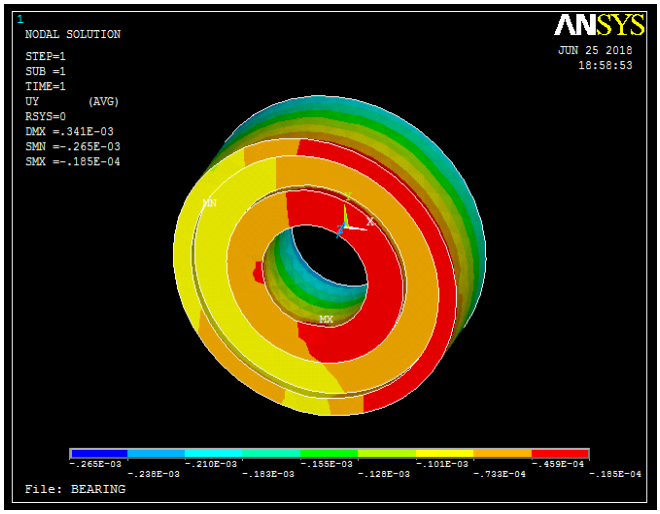

Fig.16. Displacement of Bearing.

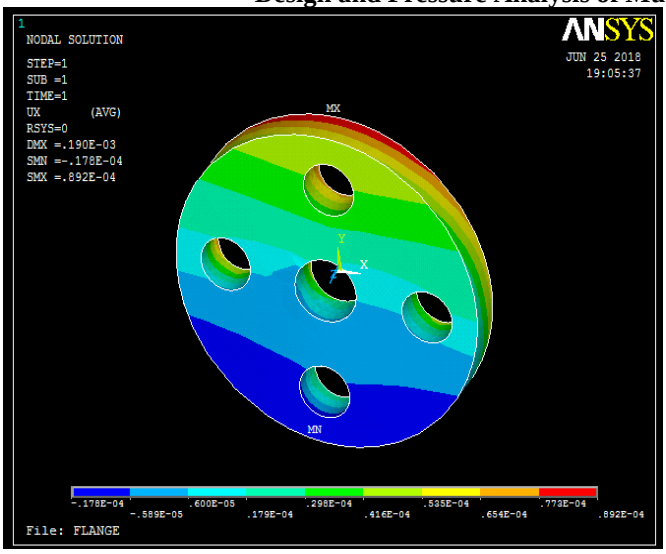

Fig.17. Displacement of Flange.

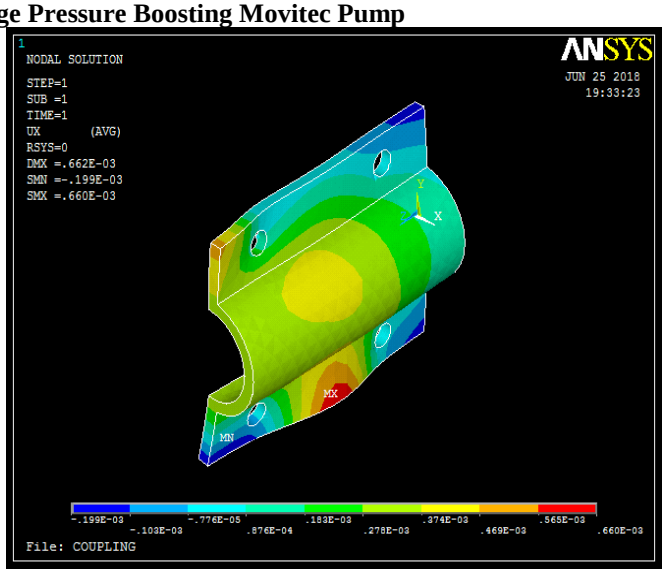

Fig.20. Displacement of Coupling.

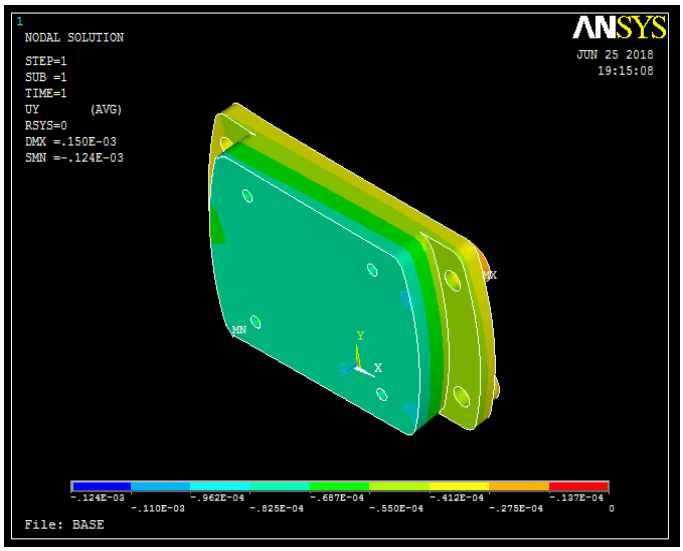

Fig.18. Displacement of Base.

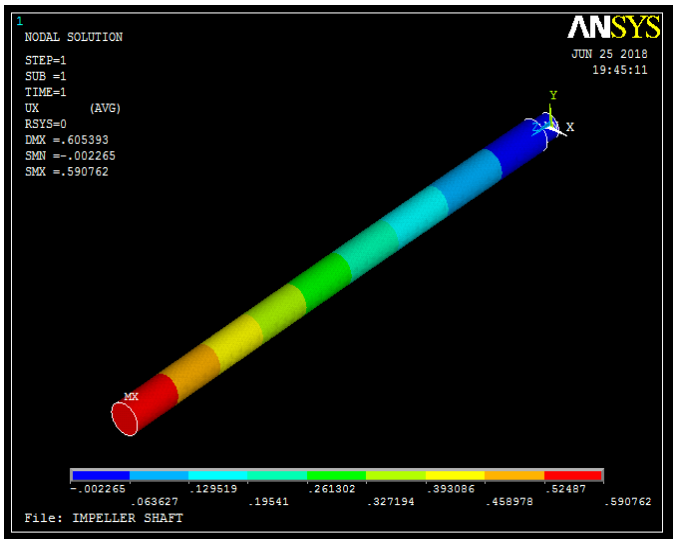

Fig.21. Displacement of Impeller Shaft.

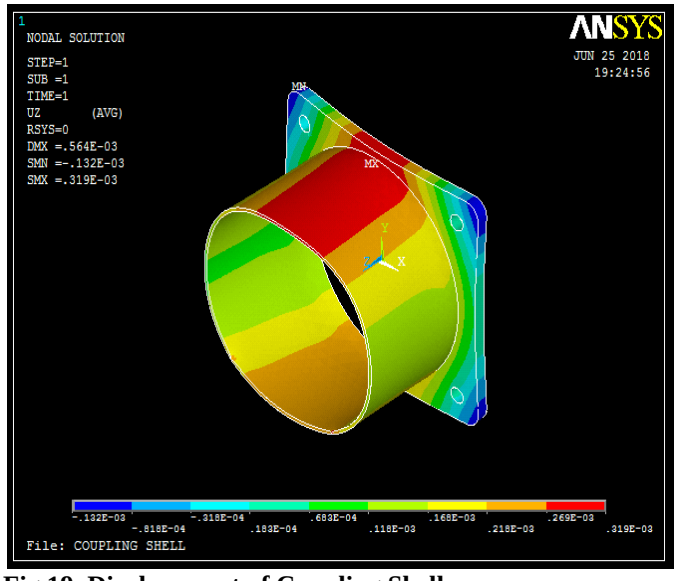

Fig.19. Displacement of Coupling Shell.

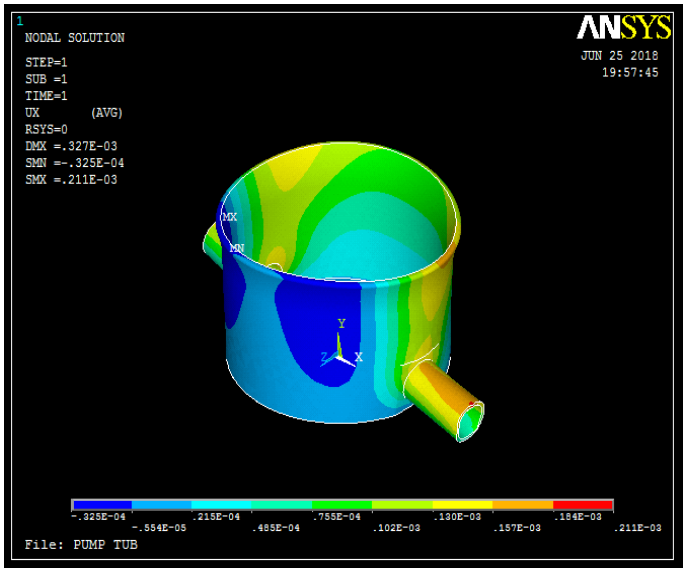

Fig.22. Displacement of Pump Tub.

B. Results of Stress Analysis

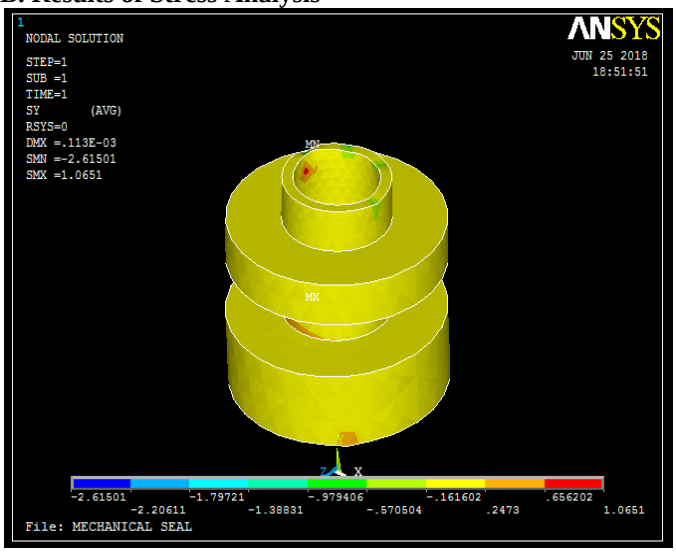

Fig.23. Stress of Mechanical Seal.

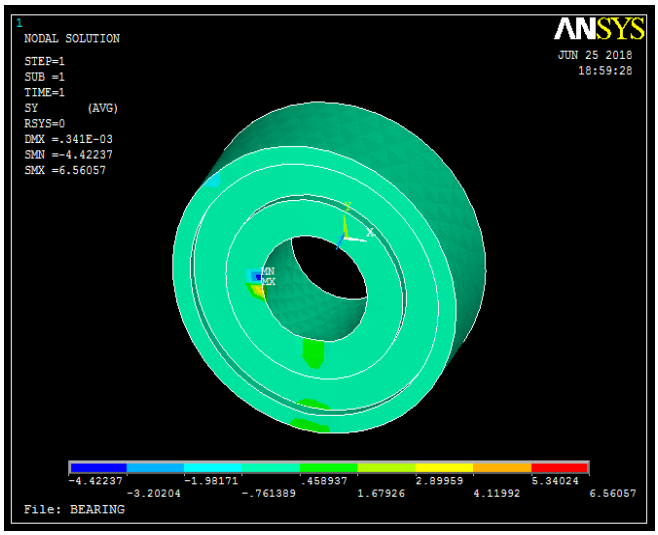

Fig.24. Stress of Bearing.

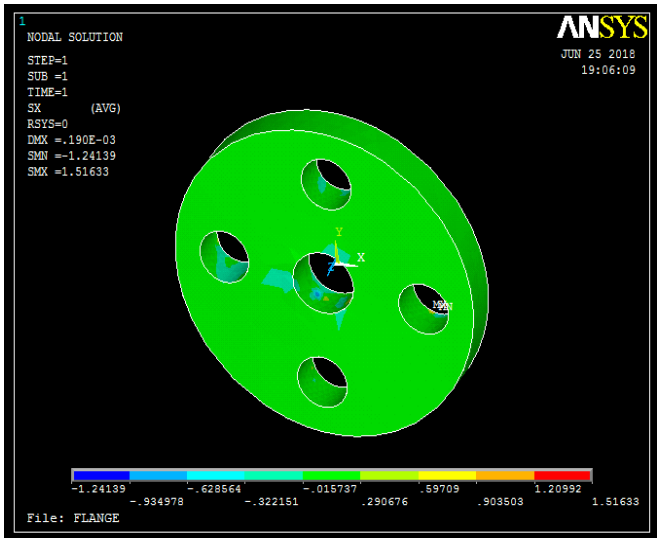

Fig.25. Stress of Flange.

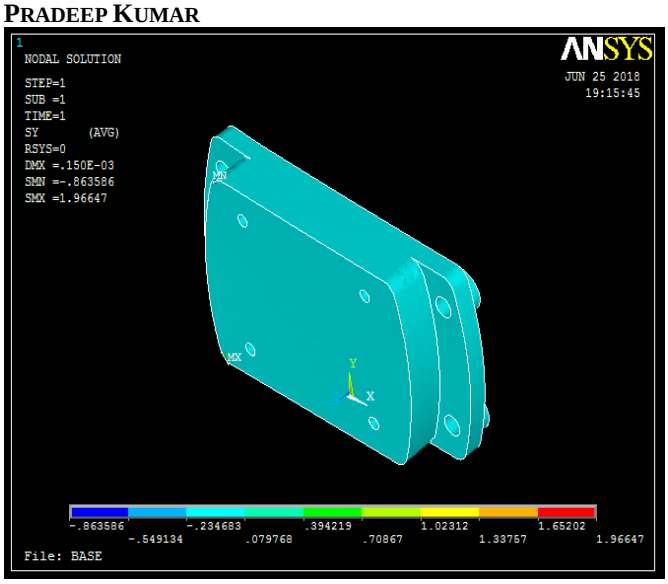

Fig.26. Stress of Base.

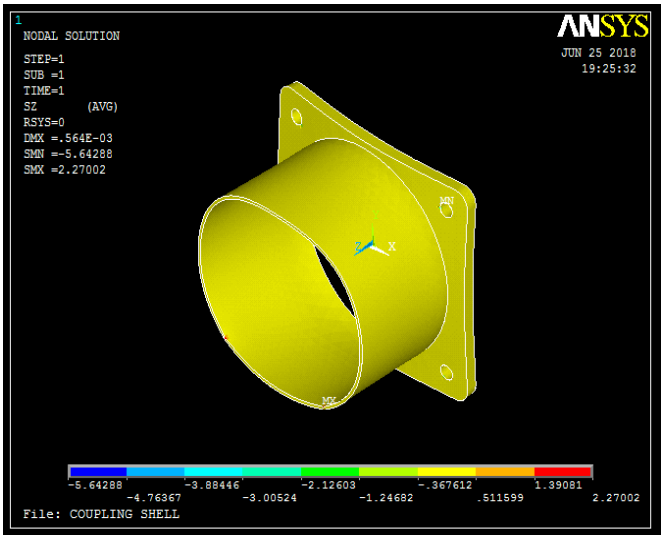

Fig.27.Stress of Coupling Shell.

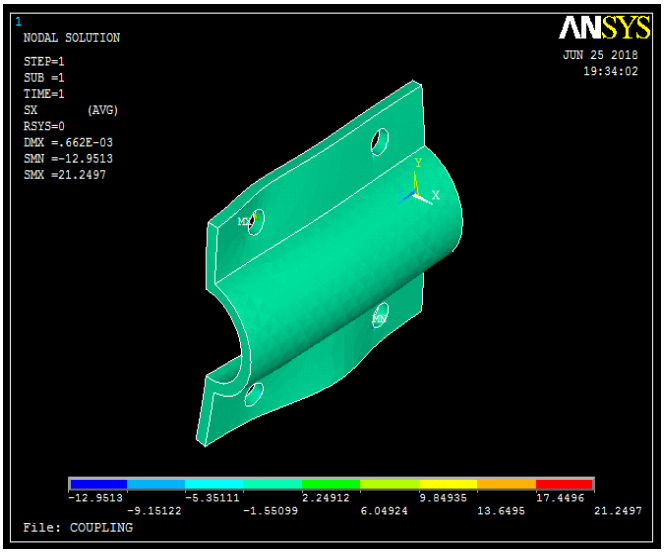

Fig.28. Stress of Coupling.

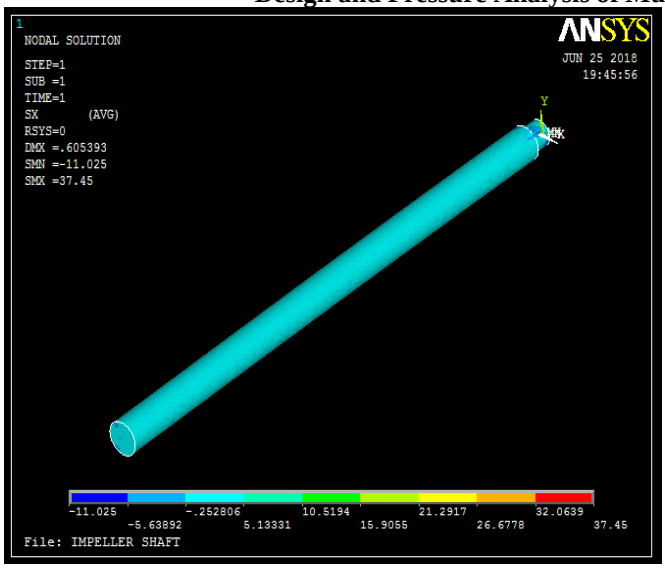

Fig.29. Stress of Impeller Shaft.

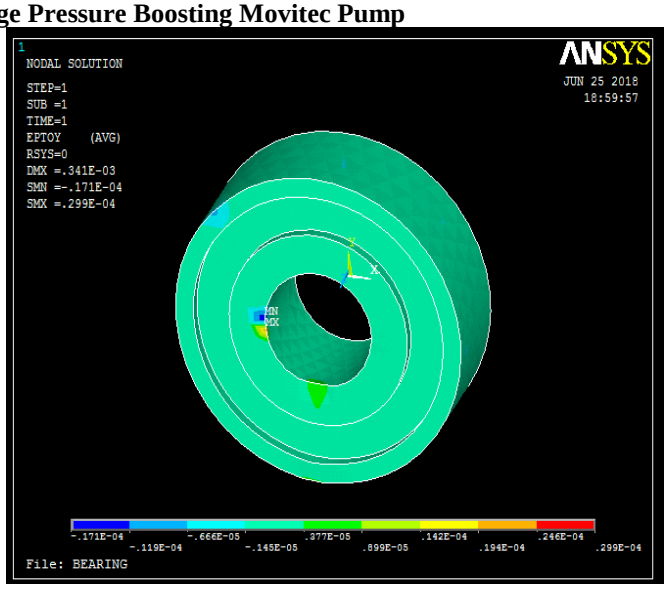

Fig.32. Strain of Bearing.

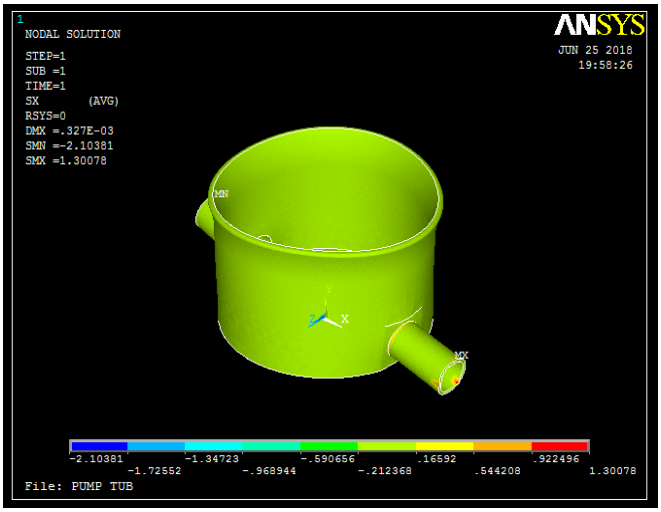

Fig.30. Stress of Pump Tub.

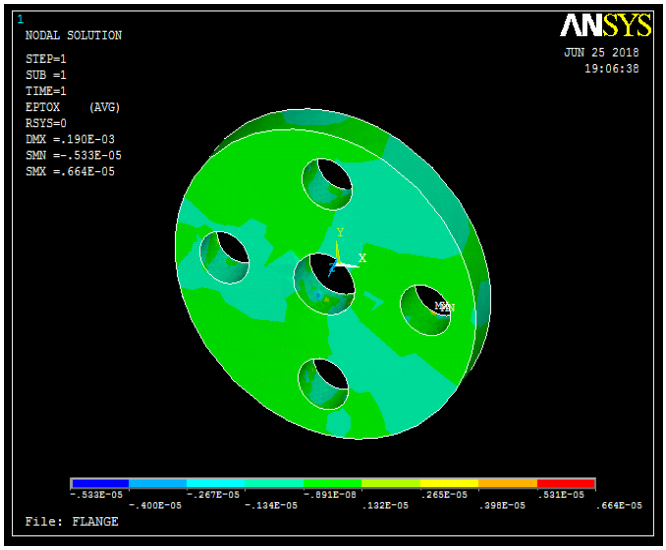

Fig.33. Strain of Flange.

C. Results of Strain Analysis

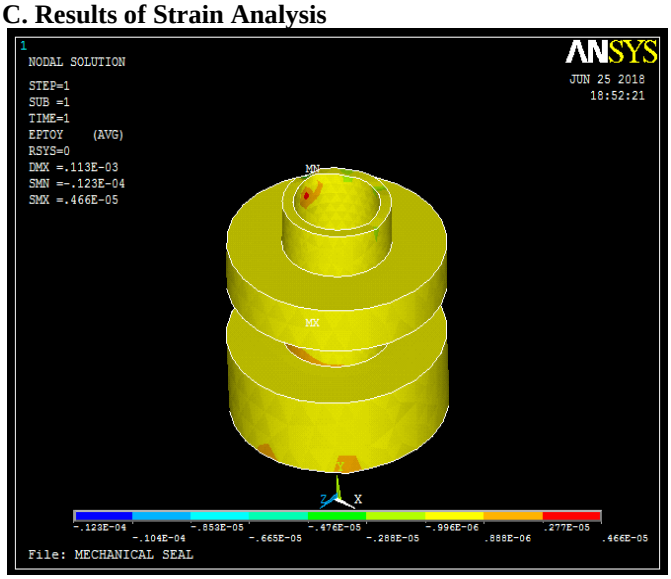

Fig.31. Strain of Mechanical Seal.

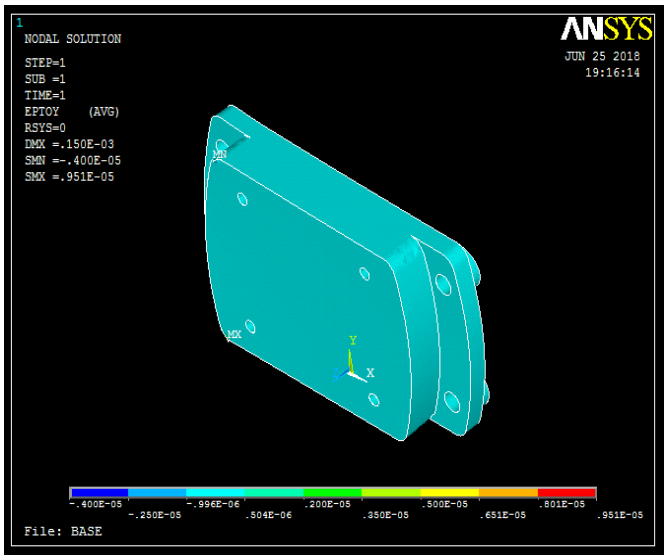

Fig.34. Strain of Base.

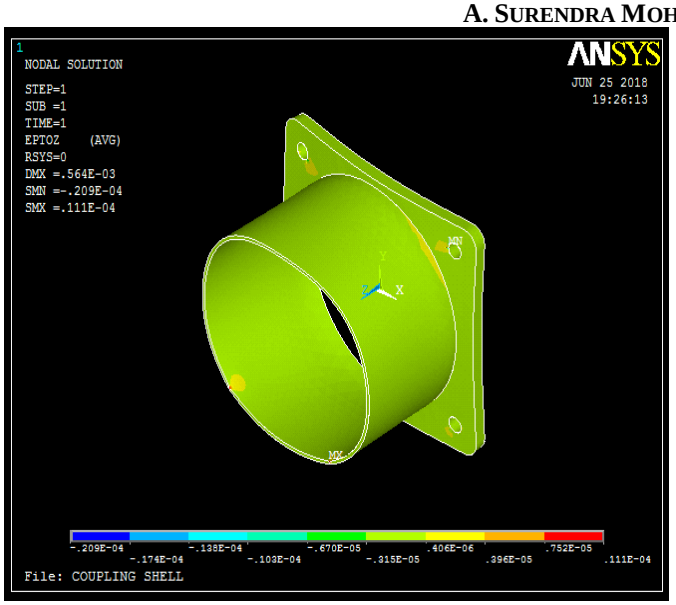

Fig.35. Strain of Coupling Shell.

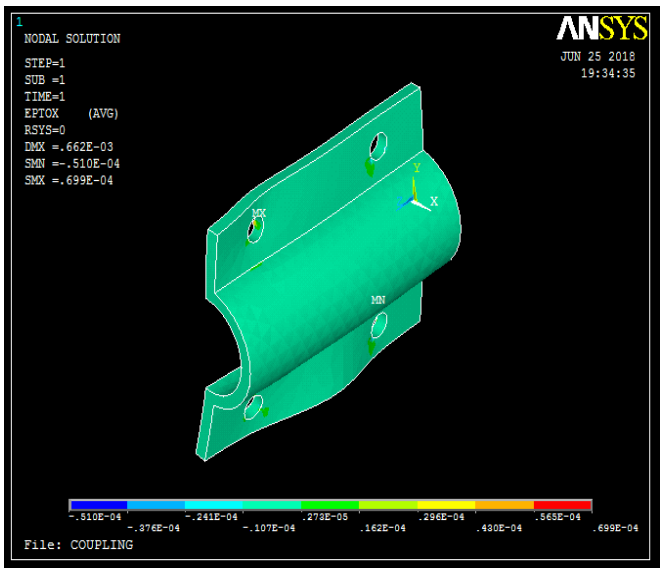

Fig.36. Strain of Coupling.

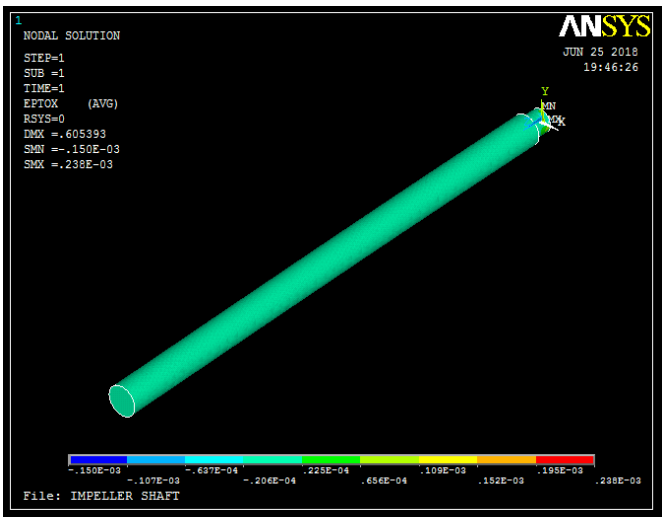

Fig.37. Strain of Impeller Shaft.

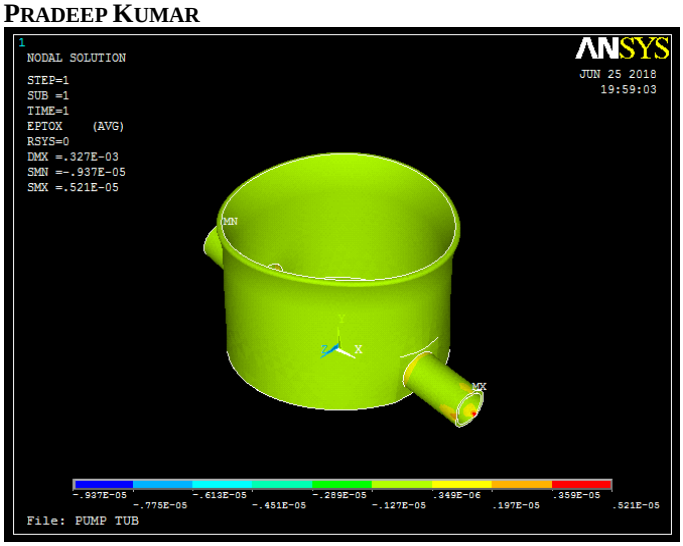

Fig.38. Strain of Pump Tub.

IX. CONCLUSION

An exceptionally nonlinear model for the dynamic conduct of the promoter pump is considered. A parametric report to examine the impact of the control parameters on the dynamic reaction is led. The control parameters that impact the transient reaction are observed to be dimensionless condition is produced to foresee the settling time of the reaction. In light of the created condition, the Optimum estimations of the control parameters are gotten. As appeared in above figures the Impeller is coincided and fathomed utilizing Ansys and dislodging at the rib is 0.892E-04 mm, which is less. This is demonstrating to us that obviously every segment in get together is having minor uprooting, and the plan is effectively done. Worry at the spine is 1.518 MPa is at the settling area (Minimum Stress which is adequate); and the strain an incentive at the rib is 0.664E-05 MPa, additionally the liquid stream rate is between 0.75Qd to 1.25Qd. The esteem which is less contrasted with yield estimation of given materials; this is underneath the yield point. The last outcome positive way .There is no issue while in Final get together plan; without disappointment. For demonstrating that above investigation is done for applying removals and rotational power examination.

X. REFERENCES

[1]Alfred Steele, 1984 "Propelled Plumbing Technology", Steele Press, 299 pages

[2]Robert H. Thompson, "Outline Considerations for Fire Pumps in High Rise Buildings, Part 2", October 5, 2006

[3]JIM BEVERIDGE, P. ENG, "Residential Water System Design for High-ascent Buildings", 2007,Vol. 6: No. 3 (PSD)

[4]High rise water conveyance, Peter A. Kraut, P.E Dennis M. Connelly, "Skyscraper Plumbing Design", 2007, PSD

[5]Hot Water Recirculation in High-Rise Buildings, February 2010, Plumbing Engineer Wolfgang Osada, "Reclamation of household water pipes in elevated structures", March 2008

[6]Jonathan S. Ladd, 2005, "An Evaluation and Pressure-Driven Design of Potable Water Plumbing Systems"

[7]Paul Larson, July 10, 2007 "How to Properly Size a Domestic Water Pressure Booster System, pme.