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Design & Analysis of Nozzle for the Improvement of Cooling In Grinding Machine

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***Abstract*— Grinding is one of the most versatile machining processes having many different applications in the machine tool industry: abrade hard materials, improve surface finish, tighten the tolerance on cylindrical or flat surfaces by removing a small amount of material, surface grinding of mould sections, internal diameter and outer diameter grinding of valve bodies and many other useful applications. The grinding processes can be tailored to produce surfaces with the required geometrical features such as roughness and tolerance, the mechanical property such as hardness, and the correct metallurgical requirements such as no white layer. To achieve these goals, it needs to put the appropriate amount of thermal and mechanical energy into the work piece by the grinding action. As a consequence, large amounts of the heat generated must be evacuated to avoid thermal damage of the work piece and accelerated wheel wear.**

1 INTRODUCTION

Lubricating techniques are having some drawbacks such as manual lubrication is carried out by a worker when a tool work piece contact region is get heated due to friction thus at the same time the lubricant is introduced in this high friction region manually**.** So any delay during lubrication in the region by the worker will harm the work piece and grinding wheel (tool). Similarly flood lubrication required the continuous supply of fluid i.e. lubricant in friction zone. That will required the control over the flow of fluid, fluid disposal and the heavy filtering system. The mist lubrication is also used for low speed grinding as in this case the lubricant in terms of aerosol form is sprayed in the high friction region thus reduce the temperature of tool & work piece but it have some restriction that it can't be used in high speed grinding operation as the heat involved is very high. Thus to achieve the necessary lubrication & cooling in high speed grinding to reduce the heat generated in the contact region & to provide the necessary cooling by reducing the amount of fluid used for the lubrication without using heavy disposal & filtering system this study is carried out.

The nozzle which will provide the require quantity of fluid in the contact zone with velocity required to break the air barrier without disperse jet is very efficient in cooling & lubrication. In this work the comparison is made between a conventional nozzle i.e. Webster Nozzle & newly designed nozzle on account of improved velocity at the exit of nozzle and with reduced pressure distribution throughout the nozzle. In this work the material and dimension of the both the nozzle is kept constant and only the internal geometry is varied to achieve the required improvement at exit.

II LITERATURE SURVEY

Dry grinding still presents important limitations to be applied in industrial practice. Total elimination of the cutting fluid results in higher temperatures during the process, affecting surface integrity and geometrical precision of the ground part in addition to increasing grinding wheel wear. This excess temperature due to absence of lubrication may damage the wheel & work piece also.

The capabilities of dry grinding are shows that under special conditions heat generation can be largely reduced. They also analyzed the possibility of soft steel grinding with ultrasonic vibrations.

III COMPARISON BETWEEN WEBSTER NOZZLE & NEWLY DESIGNED NOZZLE

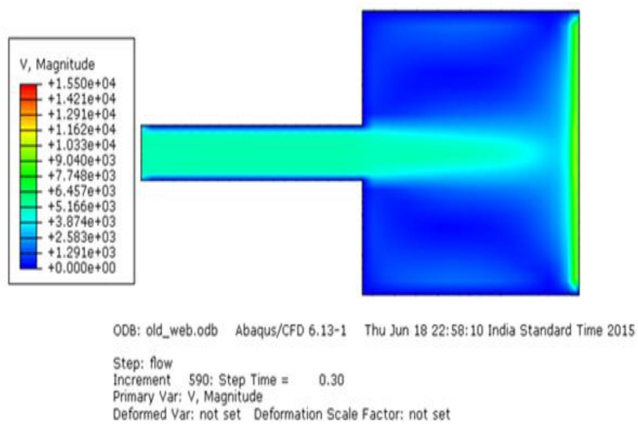

Figure 1 Velocity Distribution in Webster Nozzle

Here we compare the Webster nozzle & Newly Designed Nozzle according to CFD analysis simulation. The parameters on which the comparison is done are stated below.

a) VELOCITY DISTRIBUTION:

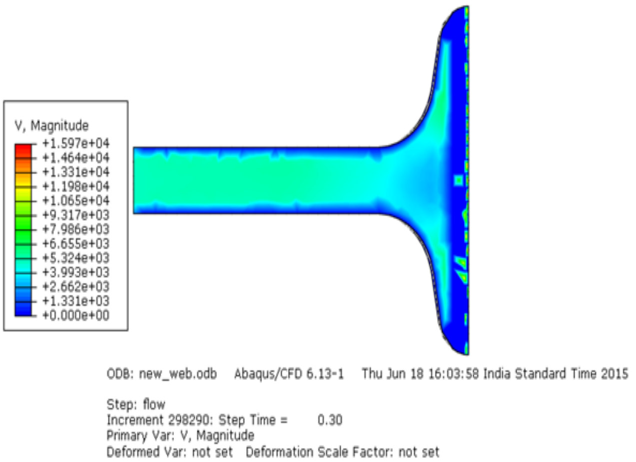

Figure 2 Velocity Distributions in Newly Designed Nozzle

b) PRESSURE DISTRIBUTION:

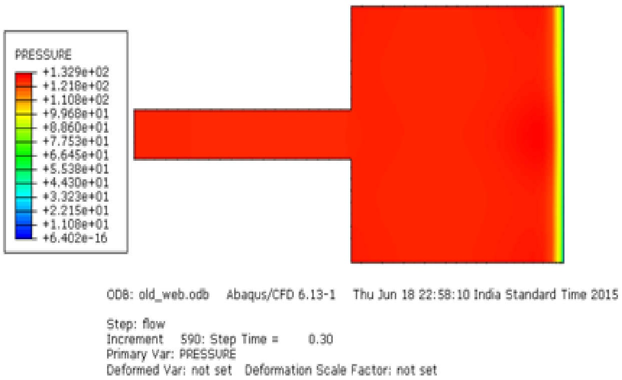

Figure 3 Pressure Distribution in Webster Nozzle

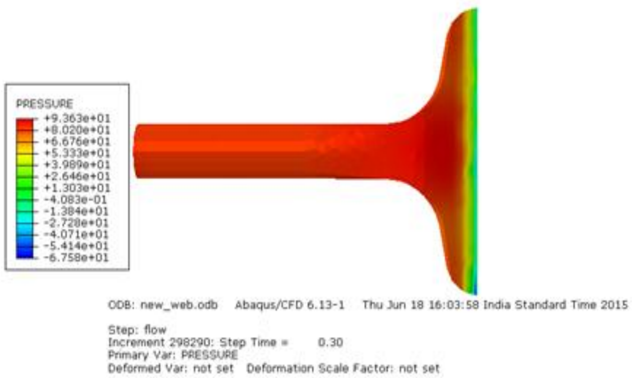

Figure 4 Pressure Distribution in Newly Designed Nozzle

c) VORTICITY:

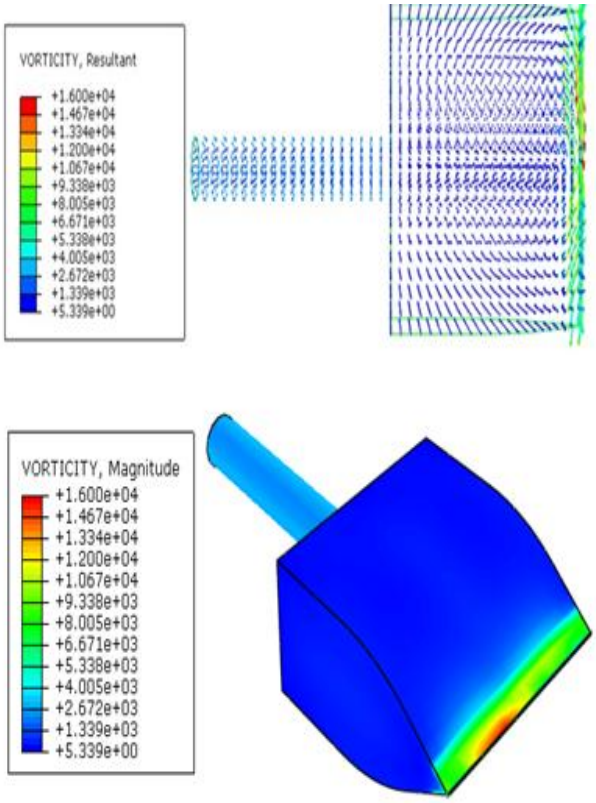

Figure 5 Vorticity in Webster nozzle

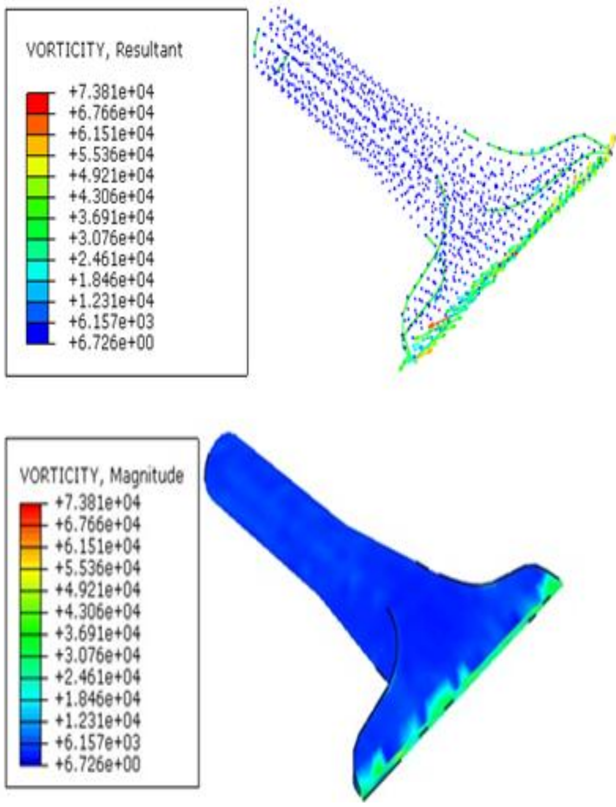

Figure 6 Vorticity in Newly Designed Nozzle.

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III. CFD ANALYSIS

A) Model of Webster nozzle:

a. The drawing of Webster nozzle is given, from that drawing the model of the nozzle is prepared in PROE 5.0. From the drawing it is clear that the area of the Webster nozzle is (9.53 * 50 * 0.5).

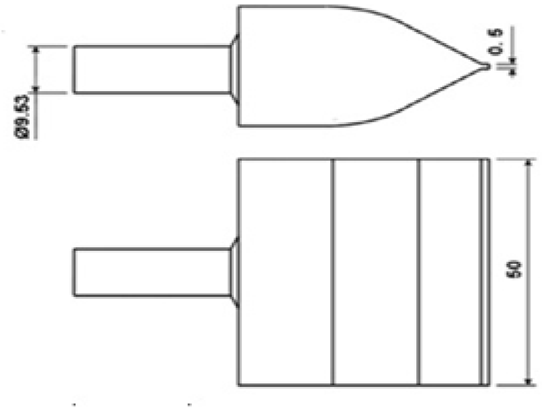

Figure 7 Drawing of Webster nozzle.

b. Model of Webster nozzle modelled in PROE 5.0 is given below.

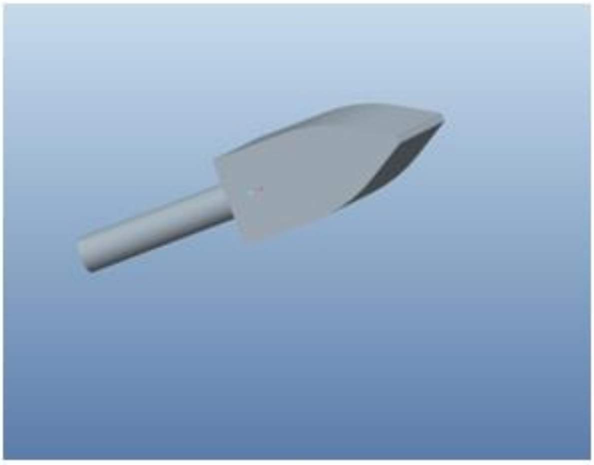

Figure 8 Webster nozzle model

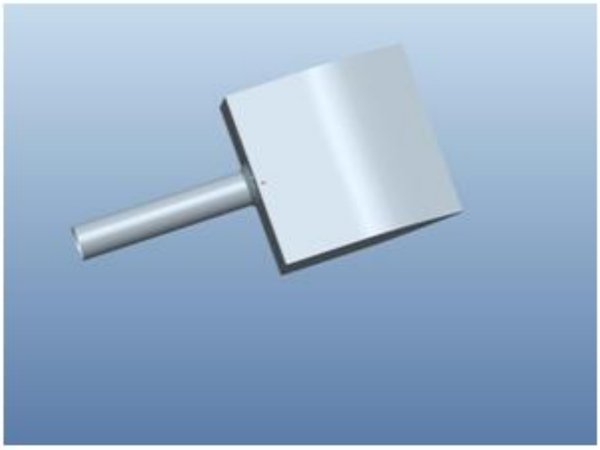

Figure 9 Webster nozzle model

B) Model of Newly designed nozzle:

a. From the design of Webster Nozzle a new one has been proposed. The inlet diameter and the outlet exit have been fixed to the same values of the Webster ones (9.53 mm *0.5 mm* 50 mm respectively). In this case the variation of velocity at the exit of the nozzle may vary & it is expected. Pressure & velocity distribution in the jet is expected to improve according to drawing, resulting in a more uniform pressure at the nozzle inlet with increase in flow velocity at exit of the nozzle.

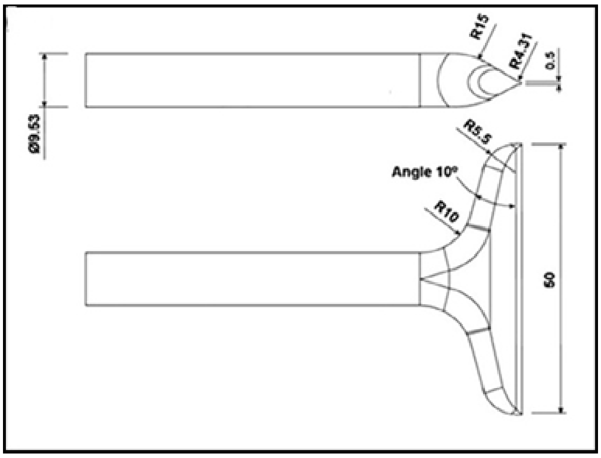

Figure 10 Drawing of the Newly Designed Nozzle.

b. Model of NEWLY DESIGNED NOZZLE modeled in ProE 5.0 is given below.

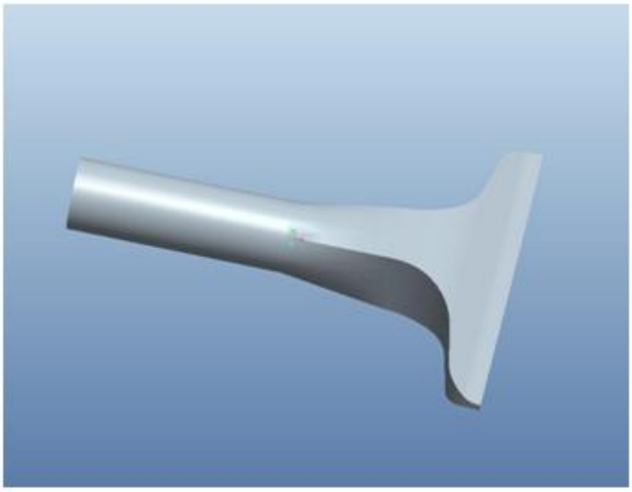

Figure 11 Model of Newly Designed Nozzle

IV MESH MODEL

Mesh generation is the most important and time consuming part of any numerical analysis. Though we have very powerful numerical tools, a very long time still spent in mesh generation steps. A high quality mesh model is one of the most important factors that determine the successful prediction of the behavior of an objective. In present case, we have used surface mesh with linear triangular element with medium size for fluid domain. This surface mesh requires particular conditioning before being used in numerical application. The unstructured meshes with tetrahedron elements are generated in the internal volume using tetrahedron filler mesh. Again boundary layer meshing of appropriate layers done at inlet and outlet in order to achieve behavior of fluid in the Webster & newly designed nozzle.

The mesh model of Webster nozzle with hexahedral mesh.

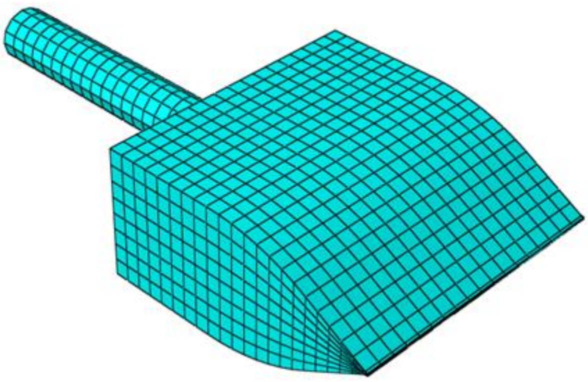

Figure 12 Hexahedron Meshing of Webster nozzle.

Mesh model of Newly Designed Nozzle with tetrahedron mesh.

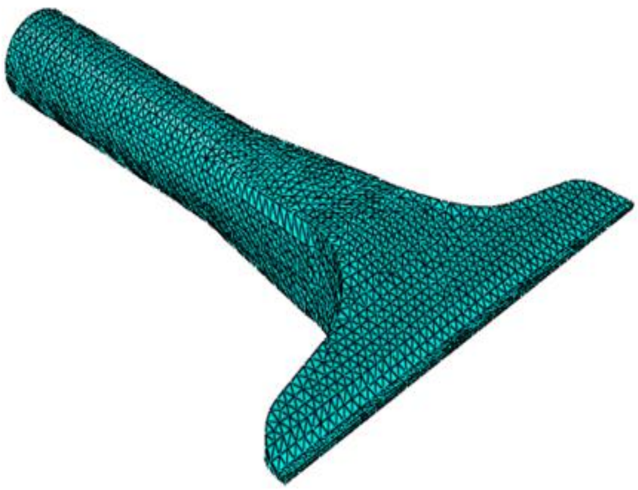

Figure 13 Tetrahedron Meshing of Newly Designed Nozzle.

V RESULT & DISCUSSION

1. From above velocity distribution it is cleared that after providing the inlet velocity of 5 m/s the Webster nozzle will give the exit velocity 15.4 m/s while Newly Designed Nozzle will give the velocity of 15.97 m/s.
2. From the above CFD analysis of pressure distribution it is cleared that the pressure at the inlet of Webster nozzle is 132.9 N/mm^2 where pressure at inlet of the Newly Designed Nozzle is 93.6 N/mm^2.
3. According to above CFD analysis for vorticity will give the results as shown above. From above results no conclusion has been made but if we observe the flow pattern in the newly designed nozzle it is uniform than the Webster nozzle.

Thus the amount of energy losses in the Newly designed nozzle is reduced due to uniform flow pattern rather than Webster nozzle.

4. According to theoretical calculation it is cleared that after replacing the Webster nozzle by Newly Designed Nozzle there is 28 % reduction in pump power. Simultaneously provide improved fluid velocity at the exit at reduced pressure distribution from inlet to outlet.

VI CONCLUSIONS

Hence from the above results of Webster & Newly Designed Nozzle the following conclusion has been made.

1) From velocity distribution it is concluded that after providing the inlet velocity of 5 m/s the Webster nozzle will give the exit velocity 15.5 m/s while Newly Designed Nozzle will give the velocity of 15.97 m/s. Thus by using the Newly Designed Nozzle the velocity at exit of nozzle is increased.
2) From the above analysis of pressure distribution it is concluded that the pressure at the inlet of Webster nozzle is 132.9 N/mm^2 where pressure at inlet of the Newly Designed Nozzle is 93.6 N/mm^2. Thus the uniform pressure distribution is seen in Newly Designed Nozzle.
3) The major requirement of this study is to improve the velocity at exit of nozzle to break the air layer surrounding the grinding wheel which will break at velocity more than 15m/s & thus it is achieved but From above analysis of vorticity no conclusion has been made due to the random values but if we observe the flow pattern in the newly designed nozzle it is uniform than the Webster nozzle.
4) Thus the amount of energy losses in the Newly designed nozzle is reduced due to uniform flow pattern rather than Webster nozzle.
5) According to theoretical calculation it is concluded that by replacing the Webster nozzle by Newly Designed Nozzle there is 28 % pump power reduction takes place.

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