"INVESTIGATION & IMPROVEMENT OF PERFORMANCE OF SPRINKLER NOZZLE BY USING FEM"

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Abstract - Irrigation is the method in which water is supplied to plants at regular intervals for agriculture. It is used to assist in the growing of agricultural crops, maintenance of landscapes, and soils in dry areas and during periods of inadequate rainfall. Sprinkler Irrigation very common method which is distributing similar to rainfall. Water is distributed through a system of pipes usually by pumping. It is then sprayed into the air and irrigated entire soil surface through nozzles and spray heads so that it breaks up into small water drops. Sprinklers provide efficient coverage for small to large areas and are suitable for use on all types of properties. It is also adaptable to nearly all irrigable soils since sprinklers are available in a wide range of discharge capacity. Nozzle is the heart of any sprinkler system. The design of nozzle is therefore of most important as it control the rate of flow, speed, direction, mass, and/or the pressure of water coming out. This project is basically focusing on the design, failures and improvements of sprinkler nozzle manufactured by Shree Industries, Murtizapur, Akola. (*Parent firm at Jaipur*)

There will be two major parts of this project. First, to survey the drip system used by farmer in the farms using nozzle and aligned details with the failures in existing sprinkler nozzle. Second, to suggest best possible alternatives for nozzle using advanced technologies like CAD CAE.

***Key Words*: Sprinkler, nozzle, Sprinkler Irrigation, CAD, FEM, etc.**

1. INTRODUCTION

Shree Industry mainly working in agriculture field. They are the manufacturer of rotating sprinklers used for irrigation system, also the accessories of the sprinkler irrigation system like HDPE pipes, foot batten, clamps, rubber rings etc.

They developed rugged, high pressure capable sprinkler and piping systems for plantations which have helped orange plantations in North Vidarbha and tea, coffee and cardamom plantations in South India iron out the vagaries of nature and produce higher returns.

As Indian agriculture field developed and particularly horticulture became more significant they introduced drip irrigation range. Again in the pioneering spirit which drives them they were the first to manufacture an inline product and for a time they were the only manufacturer of both cylindrical and flat emitter inline products.

Today they offer an extensive range of irrigation products and more importantly complete systems designed with our many years of experience and installed and serviced by experts. Since they manufacture both sprinkler and drip systems they are in a position to give unbiased advice on what would suit any particular circumstances

Their Technical Centre is at customer's disposal for advice.

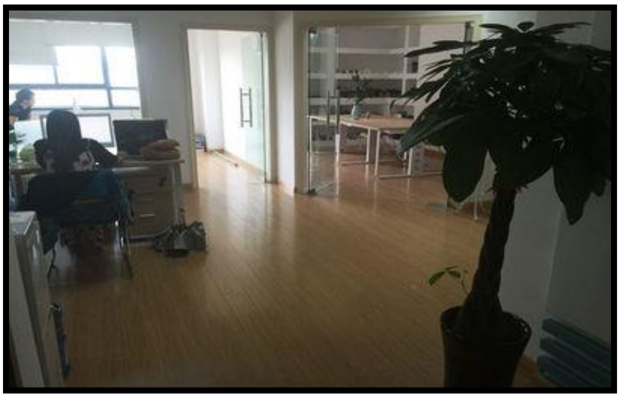

Figure 1: Company Layout Shree Industry

1.0 ENVIRONMENTAL CONSIDERATIONS & SCOPE OF PROJECT WORK

- We assume that natural precipitation is negligible for the purposes of our proposed watering schedules.
- Wind conditions are low, and temperatures are moderate so as to minimize the effects of evaporation.
- The field is assumed to be level, with no contours or irregularities.

- The project focus on the sprinkler with nozzle diameter of 5.5 mm. The pressure range is 2-4 kg/cm² and it is single directional operated sprinkler.
- The project does not include the flow parameters of the working fluid it only considers the structural impact.
- The pipe condition on which the sprinkler is attached is assume to be constant the vibration are not considered.

2.0 CAD CAE Methodology Used

Pro/ENGINEER is a parametric, feature based, solid modeling System. It is the only menu driven higher end software. Pro/ENGINEER provides mechanical engineers with an approach to mechanical design automation based on solid modeling.

The essential difference between Pro/ENGINEER and traditional CAD systems is that models created in Pro/ENGINEER exist as three-dimensional solids. Other 3-D modelers represent only the surface boundaries of the model. Pro/ENGINEER models the complete solid. This created CAD model is then directly transfer to FEM software like ANSYS workbench for further analysis.

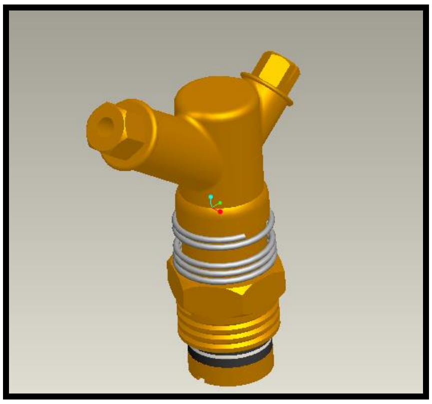

Figure 2: CAD Model

ANSYS Mechanical is a finite element analysis tool used for structural analysis. With the help of ANSYS we can solve various FEM related analysis problems. The ANSYS simulation platform delivers the broadest suite of best-in-class simulation technology and unifies it with your custom applications, CAD software and enterprise business process tools such as PLM. It's open and flexible framework connects engineering teams, tools and data.

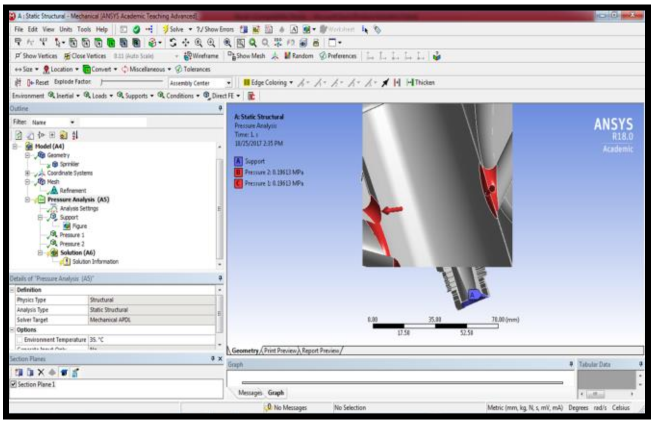

Figure3: Cut & full section view of application of input pressure at inside face

3.0 Result

After the analysis is done with supplied materials having fixed boundary conditions results obtained are as shown in table below

Table 01: Results obtained for all Material

Input Conditions	Sprinkler is Made up of Brass alloy	
	Fine size with **tetrahedron type of mesh is used**	
	Ambient Temperature = **350⁰C**	
	Pressure applied is **2Kg/cm² = 0.196133 MPa**	
	Brass	**Mn Alloy With Cu Contain**
Young's Modulus (MPa)	1.4 x 10^5	**4.5 x 104**
Poisson's Ratio	0.27	**0.35**
Density (g/cm³)	8.4	**1.8**
Results		
Total Deformation Value	2.0124 x 10^{-4} mm	6.2513 x 10^{-4} mm
Equivalent Stress	0.33678 MPa	0.32835 MPa
Shear Stress	0.10526 MPa	0.10514 MPa
Normal Stress	0.10573 MPa	0.10619 MPa
Maximum Principal Stress	0.29114 MPa	0.3135 MPa
Strain Energy Dissipated	2.1629 x 10^{-7} mJ	6.7778 x 10^{-7} mJ

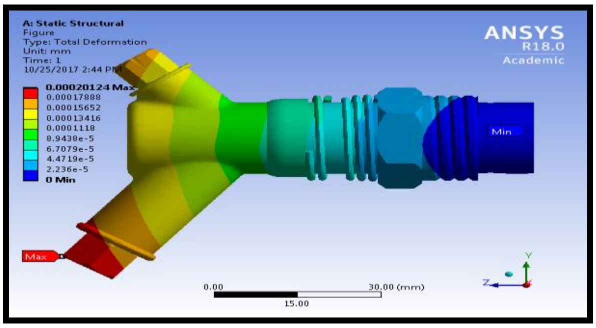

Figure 4: Total Deformation results of brass

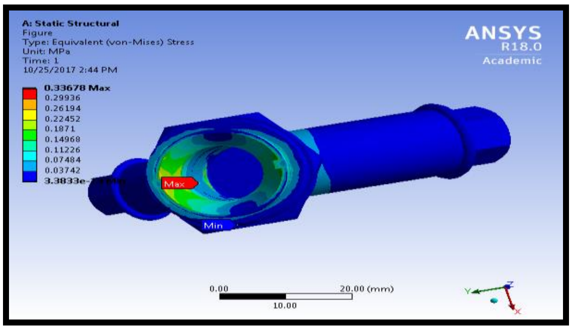

Figure 5: Equivalent Stress results of brass

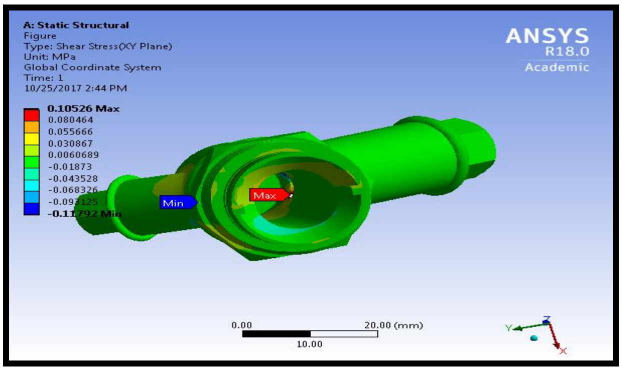

Figure 6: Shear Stress results of brass

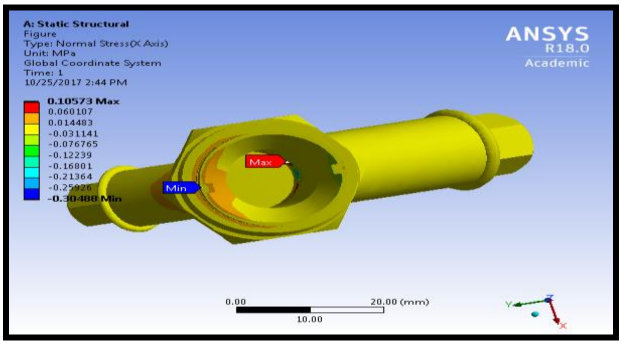

Figure 7:Normal Stress results of brass

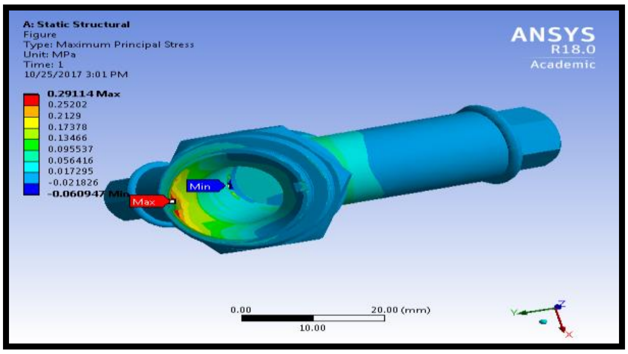

Figure 8: Maximum Principle Stress results of brass

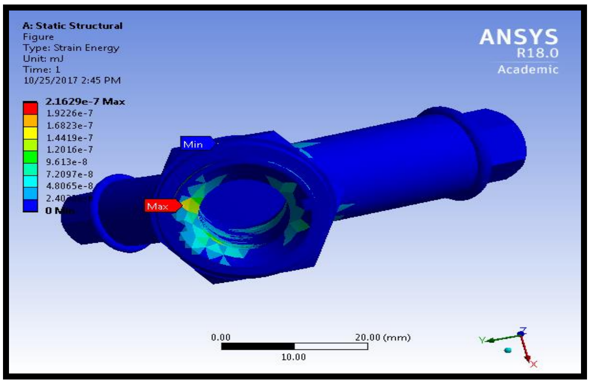

Figure 9: Strain Energy results of brass

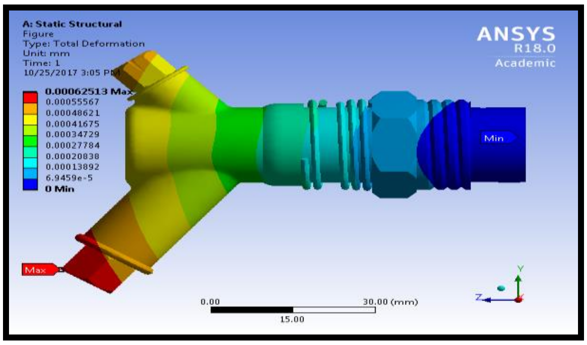

Figure 10: Total Deformation results of Mn Alloy with Cu

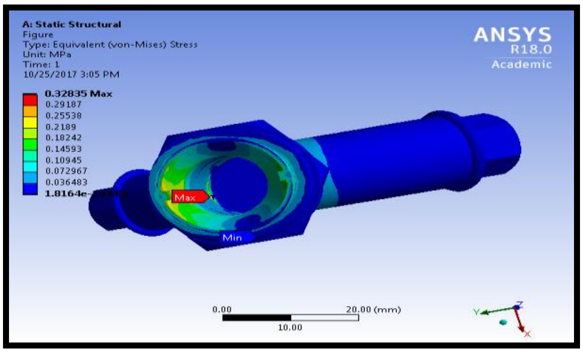

Figure 11: Equivalent Stress results of Mn Alloy with Cu

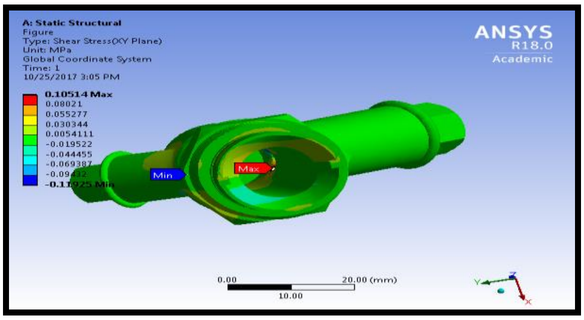

Figure 12: Shear Stress results of Mn Alloy with Cu

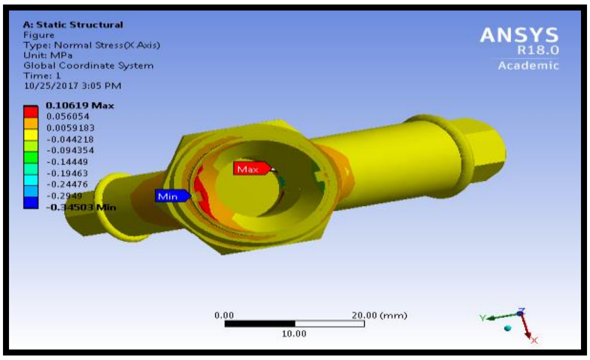

Figure 13: Normal Stress results of Mn Alloy with Cu

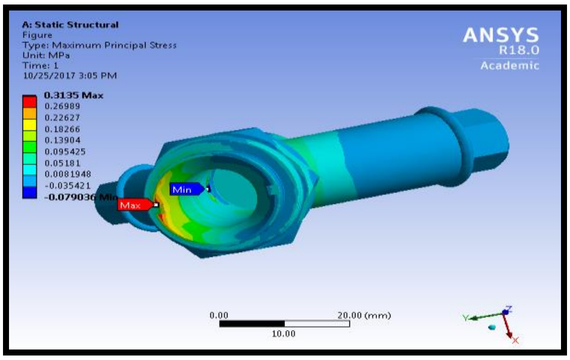

Figure 14: Maximum Principal Stress results of Mn Alloy with Cu

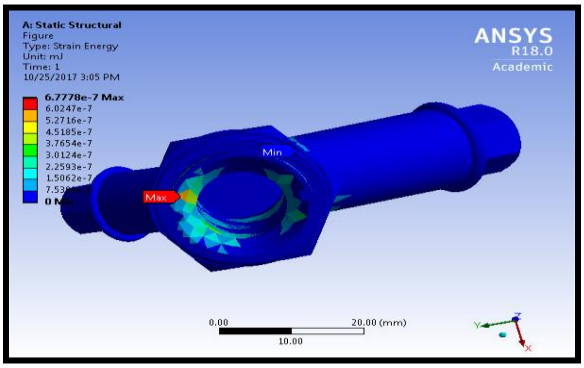

Figure 15: Strain Energy results of Mn Alloy with Cu

4.0 CONCLUSIONS

After FEM analysis using ANSYS workbench the result for total deformation, equivalent stress, shear stress, normal stress, maximum principle stress and strain energy it is clear that existing material is having less life and can work for less period for existing pressure condition of 2 kgf/cm^2 or 0.196133 MPa.

The compared materials having nearly same cost per kg that of the brass are used i.e. Mn Alloy with Cu.

The result for both the material shows that steel alloy with cu is better stable material than existing material brass and rest other. Result total deformation, equivalent stress, shear stress, maximum principle stress is least in steel ally which predicts that steel alloy is having more life than brass.

Total deformation of brass is 2.0124 x 10^{-4} mm which is lower when compared to Mn alloy with Cu presence. Equivalent Von mises which is used to predict yielding of materials under various multiaxial loading conditions using results from simple uniaxial tensile tests is found less in Mn alloy i.e. 0.32835 MPa than the existing material brass 0.33678 MPa. All the FEA results of each materials shows that for present boundary conditions Brass is more suitable than Mn alloys having Young's modulus of 4.5 x 10^4 MPa is better suitable.

The optimization of the sprinkler for its material is carried out by means of FEM analysis using ANSYS workbench which is explained in this thesis.

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