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# BI-DIRECTIONAL MULTI-SPINDLE LIQUID MIXING MACHINE

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**Abstract:- Now a – days, there are various fields where there is a need to have the mixing of liquids and semi-solids. Taking an example of ionic paint mixing, the conventional method of mixing the paint is quite tedious, time consuming. The conventional method for mixing the ionic paints is by bifurcating the paint into two halves and then mixing it by repeated transferring of paint between the two buckets and thereby achieving the required mixture. This project presents an idea to develop a system to overcome the older method likewise also in the other fields like the chemical industries, mixing of metallic powers, some dairy applications and in pharmaceutical industries. The Bi-Directional Multi-Spindle Liquid Mixer is a novel device which uses the principle of planetary gear mechanism for mechanical motion of the spindles. As the turbulence of any liquid increases, its flow lines get disturbed. It would be advantageous to change pattern of flow, which avoids vortex formation, i.e. motion of particles in a spiral path which ultimately results in cross flows and uniform viscosity distribution which plays a major role in mixing the liquid, by using this principle the machine is generated. The machine consists of four spindles containing different types of blades which revolve as well as rotate around itself and circumference of the container. Also, the blades of the machine can be rotated in both directions to get the required cross flows as well as to avoid vortex formation. The main shaft spindle (connected to sun gear) which is rotated by an external source via A.C. drive has a circular ring at its bottom rotating in a both direction, and the other three spindles (connected to planet gears) consists of a blade (plate) of sheet metal having number of holes, a helical screw feeder and a whisk type blender blade. When the main shaft rotated it also rotates the others by gear mechanism thereby rotating the spindles connected to the planetary shafts which will start creating a turbulence in the paint mixture thereby mixing the paint forming a homogeneous mixture. This method will be the most satisfying for the older one by reducing the tediousness and be the comfortable one for the paint workers.**

**Key Words:planetary gear mechanism, turbulence, pattern of flow lines, vortex formation, viscosity, A.C. drive, helical screw feeder.**

## I. INTRODUCTION

During the visit at a painting site, we found that the method used for mixing the paint was very tedious and time consuming for the workers. We first studied the conventional method of mixing the paint and then decided to modify the older one by adding the automation and design the mixing machine which could be used movable, compact in size, smoother in operation and relatively cheaper which should mix the paint thoroughly, without any manual help. We decided to use the planetary gear box mechanism for the main primary principle motion by connecting the stirrer containing spindles which would revolve around itself and also rotate around the circumference of the container containing the paint mixture. We also designed and analysed the partial system in PRO-E and ANSYS respectively.

### *1.1 CONVETIONAL METHOD*

In conventional method of mixing the paint, firstly the paint mixture was manually stirred by using a metal rod by rotating it in the container and then the mixture was separated in two containers and it is then repeatedly transferred from one container to the other to agitate the mixture.

### *I.II. THE PROBLEM*

In the conventional method, the required flow pattern in the fluids for proper and best quality of mixing the paints is not obtained hence the particles resists to cope up and mix with the other particles for the base colour rather than mixing thoroughly in mixture of paint, ultimately results into poor quality mixture of paints there by poor quality output of paint.

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*I.III. THE SOLUTION*

In order to have a through mixing of paint it would be appropriate to have stirrers that would have a motion such that rotates about own axis as well revolves about another fixed centre axis which helps it reach all parts of the container. This ensures that turbulence required for thorough mixing is provided all over the container.

It would be advantageous to change pattern of flow, which avoids vortex formation, i.e. motion of particles in a spiral path. Also, if a sheet metal plate is added that brings the particles

adhering to walls of container back into main flow or mixing area, good quality mixture will be ensured.

The planetary mixer with four different stirrers is an ideal solution that has all the above-mentioned features. This machine involves rotating stirrers that revolves about the fixed container axis as well as incorporates changes the flow pattern with the help of a circular ring at the base, whisk type blender blade, sheet metal plate having number of small holes and a helical screw feeder blade. Machine has variable mixing speed feature at the same time delivers heavy torque to the stirrers for proper mixing.

## I. EXPERIMENTAL SET-UP

Fig 2: Experimental Set-up.

## II. CONSTRUCTION

The Multi-Spindle Bi-Directional Liquid Mixer consists of the following parts:

*1. Motor –*

The motor usedis a three phase AC motor, meaning that the speed is infinitely variable from 0-1440 rpm. The motor is mounted on the frame and is connected to the planetary gear mechanism by means of open belt drive.

*2. Variable – Frequency Drive (A.C. Drive) –*

The function of A. C. drive is to convert the single-phase supply into three phase supply which has a feature of varying the rpm output of the motor shaft. The other feature of this drive is that it can rotate the motor in both directions. The A.C. drive used is of TOSHIBA make.

*3. Motor Shaft Pulley–*

A double slot V-belt pulley is mounted on the shaft of motor by means of socket head grub screw.

*4. Main Pulley –*

The main pulley is V-belt pulley mounted on the input shaft of the main gear (sun gear) of the planetary gear mechanism and connected to the upper slot of the motor pulley by open belt drive. This pulley is used to rotate the main gear thereby rotating the other three planetary gears which are in mesh with it.

*5. Assembly Rotating pulley –*

A V-belt pulley of larger diameter (12") mounted on the assembly is connected to the lower slot of the motor pulley by open belt drive. This pulley is used to rotate the whole assembly by rotating the circular plate to obtain the revolution or the rotation of the stirrers around the circumference of container.

*6. Input shaft –*

The input shaft is held by double ball bearing mounted in the square plate bearing housing which holds the main sun gear used for planetary motion of stirrers.

*7. Spur Gears –*

A sun gear (main gear) of 78 teeth is mounted on the input shaft and three planetary gear of 50 teeth in mesh with the main sun gear are mounted in the assembly.

*8. Circular plates –*

The assembly of the gears are mounted between the two circular plates in which the shafts on which gears are mounted are supported with the bearings at the top and bottom on the plates for a very smooth motion of the assembly. The whole assembly of the planetary gears rotates between these two circular plates.

An assembly rotating pulley is fixed on the top circular plate with the help of bolts.

*9. Whisk type blender stirrer –*

The stirrer arrangement comprises of blade carriers mounted on stirrer shaft (planetary gear shaft) that hold blades for stirring purpose on their periphery.

*10. Sheet metal plate strainer –*

The strainer arrangement comprises of a perforated sheet mounted on the strainer shaft (planetary gear shaft) having a number of holes drilled on it.

*11. Helical screw feeder type blade –*

The helical screw feeder type arrangement is mounted on the planetary gear shaft.

*12. Circular ring –*

A circular ring having number of blades in its shaft periphery connected to the end ring is attached to the sun gear shaft with the help of muff coupling.

*12. Muff coupling –*

The three muff couplings are used to connect the three shafts coming from the assembly to the different blades, stirrer, and strainer for easy removing of the blades after the mixing for the cleaning purpose.

*13. Square plate –*

The square plate is the main supporting member that supports the bearing housing.

*14. Container –*

The container is in the form of a cylindrical drum mounted below the stirrers.

*15. Frame –*

Frame is a fabricated structure that supports the entire mixer assembly**.**

The above all the components are shown in *Fig. 3.1* and *Fig. 3.2*.

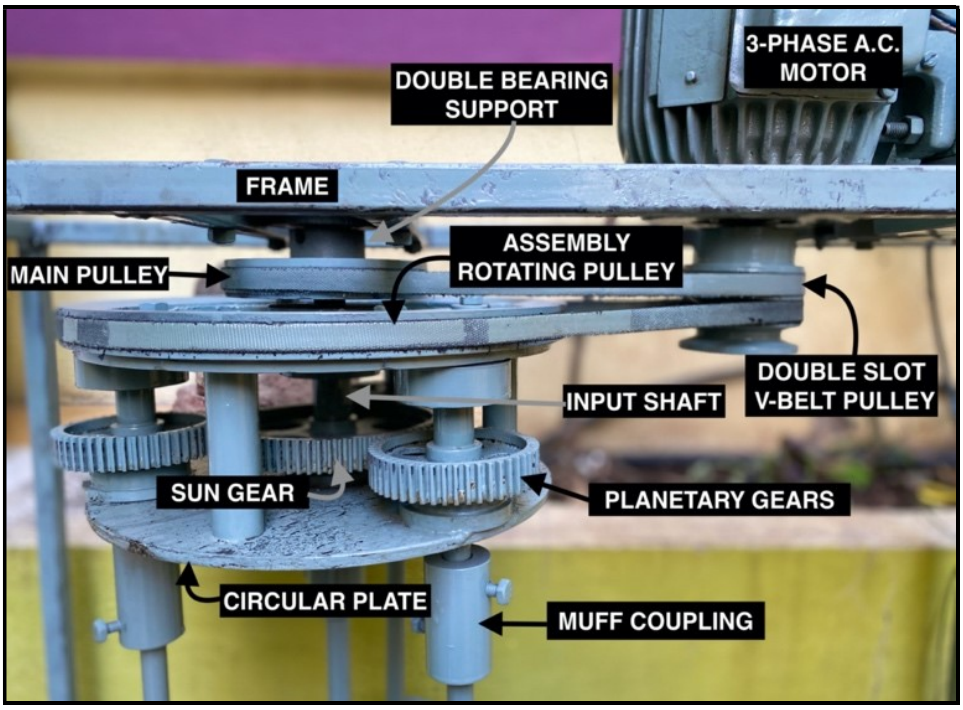


Fig. 3.1: Components.

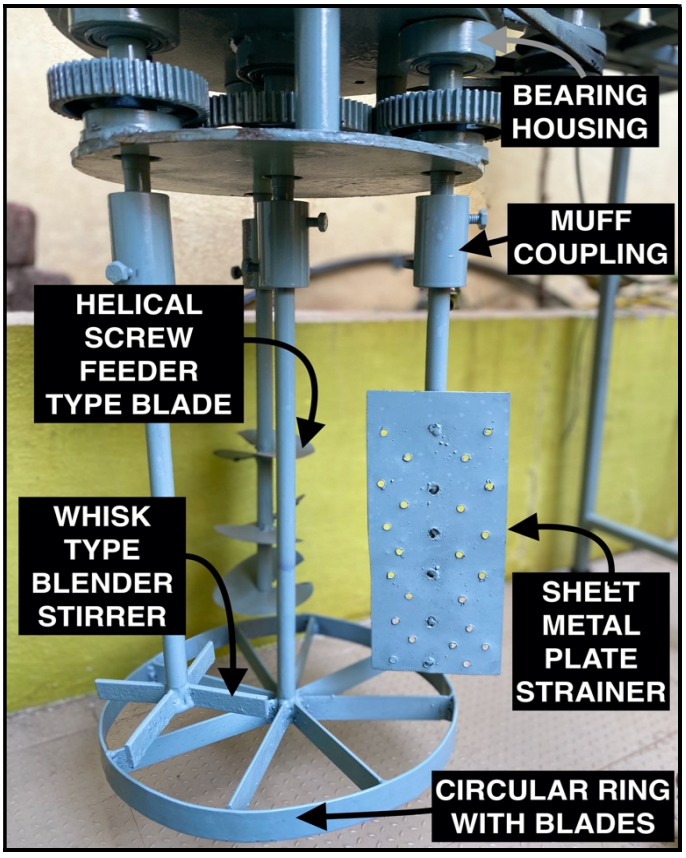


Fig. 3.2: Components.

## III. WORKING

The motor is started via A.C. drive, which converts single-phase A.C. current into three-phase A.C. current through which the motor is rotated at required speed with the help of regulator attached to it. When motor is started the double slot motor shaft pulley rotates the main pulley (connected to upper slot) and the assembly rotating pulley (connected to lower slot) via the V-belt. The speed of the motor shaft is so adjusted that which should create turbulence but should not come the paint outside the container. The main pulley rotates the input shaft which carries sun gear. The input shaft (sun gear), which has a circular ring connected at its bottom rotates the other three planet gears by the meshing action. The other three gears meshed with the sun gear also rotates in the opposite direction as that of the direction of sun gear. All these gears are assembled between the two flat circular plates and the main input shaft is supported by the double bearing support connected to the frame. The shafts carried by the planet gears are connected with the sheet metal plate strainer, whisk type blender stirrer and helical screw feeder type blade respectively. The sheet metal plate strainer having number of holes drilled on it makes the particles of paint to pass through the holes which mixes the paint at micro level. The whisk type blender stirrer creates the churning effect thereby increasing the atomization of the particles. The helical screw feeder type blade cuts the flow lines of the paint resulting in the increase of turbulence. These strainer, stirrer and blades are connected to the main gear shafts of the planet gears with the help of muff coupling, to have easy removal for the cleaning purpose. This makes the system to rotate this strainer, stirrer and the blade around itself.

But at the same time the assembly rotating pulley with the reduction of speed, also rotates the whole assembly which causes the blades not only to rotate around itself but also to revolve around the circumference of the container. This rotation and revolutions of all the three different blades (anti-clockwise direction) and the circular ring (clockwise direction) creates the turbulence in the paint (since it can be run in both directions for example only one direction is preffered) thereby creating the irregular flow pattern which causes the proper and perfect mixing of the paint mixture which creates homogeneous mixture.

## IV. ANSYS ANALYSIS OF SPUR GEAR FOR VALIDATION OF DESIGN

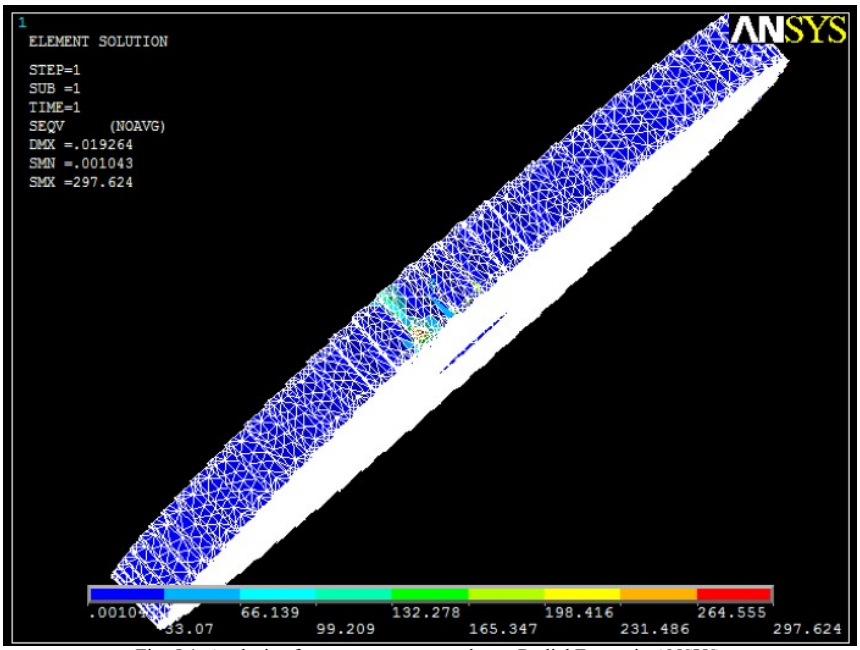


Fig. 5.1: Analysis of a spur gear stresses due to Radial Forces in ANSYS.

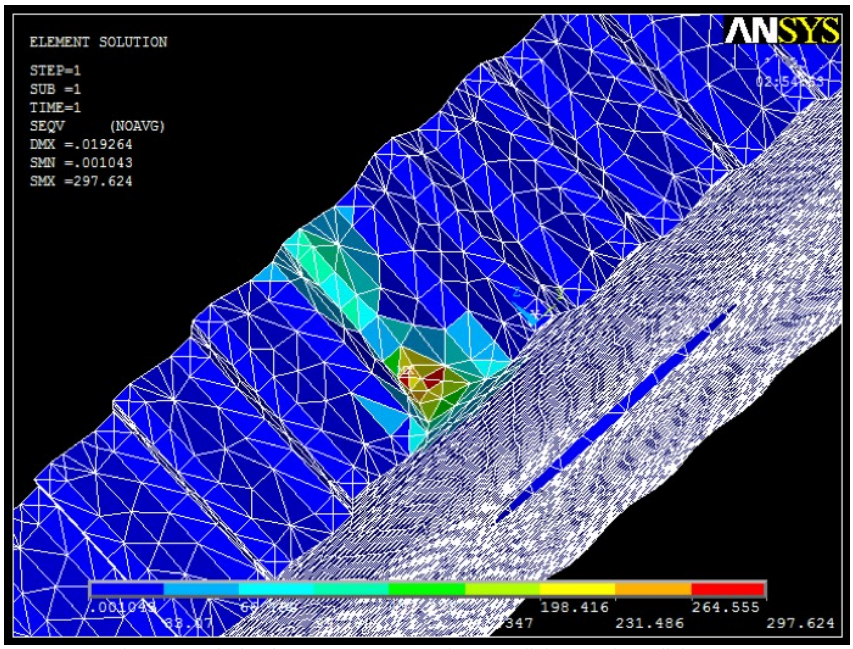


Fig. 5.2: Analysis of a Spur gear stresses due to Radial Forces in Radial Zoom.

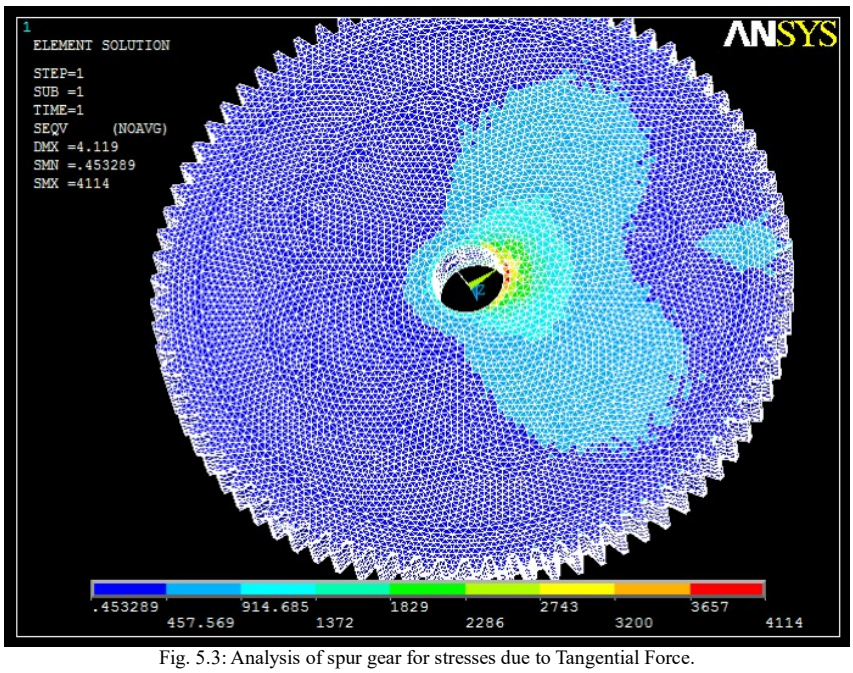


Fig. 5.3: Analysis of spur gear for stresses due to Tangential Force.

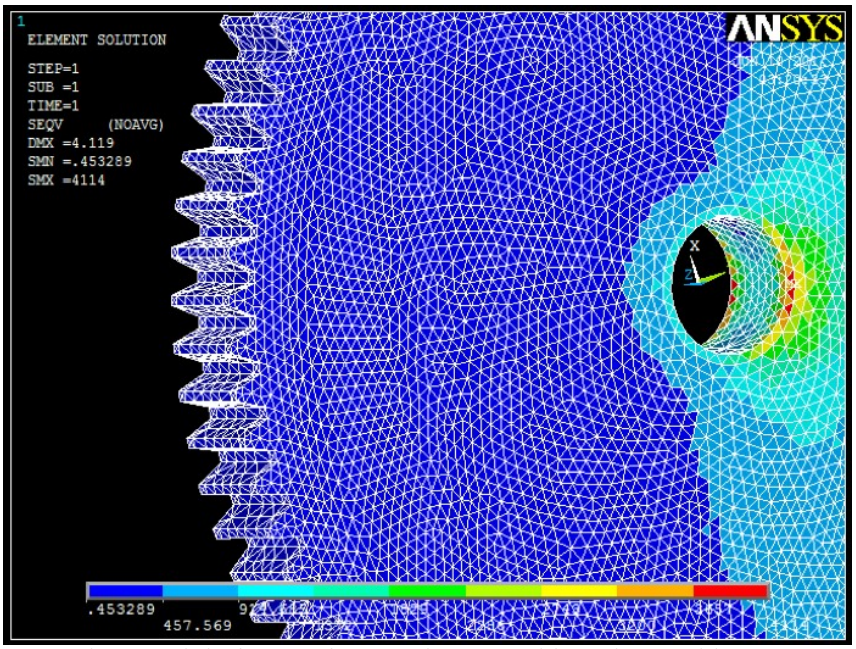


Fig. 5.4: Analysis of spur gear for stresses due to Tangential Force in Tangential Zoom.

## V. FUTURE SCOPE

1. Increasing the area of application, its use in ionic and metallic paint mixing, by the use of alternator it's motion can be changed to make its used in mixing of semi-solids.
2. In future, with the help of mechatronics, viscosity sensors and color detection sensor, can be connected to the 4 spindles of the machine, during the working the values detected by these sensors can be sent to microprocessor, which will have programmed in such a way that till all the values of different spindles match it shall be ON and the point at which the values provided by the sensors to the microprocessor match (with certain tolerances) the microprocessor will automatically OFF the machine.
3. According its comfortability, its capacity can be increased to 150 to 200 liters for bulk mixing.

## VI. CONCLUSIONS

The objective of this project was to develop a machine whose purpose is to thoroughly and properly mix the paint such and the machine can be movable, less time consuming, non-tedious and worker friendly. We tried our best to overcome the drawbacks of the conventional method and to have a novel solution on them. We have selected the design whose objective is to improve the quality of the mixture of paints with variable speed. After careful consideration of the possible alternatives, we successfully designed a machine with required specifications. With calculations and software analysis we have concluded our design is safe.

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