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# Design and Development of Tuned Vibration Absorber to Control Vibrations of Stirrer Machine

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**Abstract:** ***Stirrer machines are found large applications in the chemical / paint industries for the homogeneous mixing of chemicals. The vertical spindle of the stirrer on which the cutter mounted is used to stirrer the highly viscous liquid. During such operations heavy vibrations are occurring. Here an attempt is made to design passive TVA (Tuned Vibration Absorber) for the reduction of vibrations of the stirrer machine and to increase the effectiveness of the stirrer machine. With the application of TVA, The disturbing frequency zone is shifted***
**Keywords:** ***Stirrer Machine, Tuned Vibration Absorber, Vibration Control, Idling Condition.***

## I. INTRODUCTION

The stirrer machines have wide range of application in chemical, food processing as well as paint manufacturing industries. Due to the involvement of rotary components, vibration will always be there. Stirrer machine as shown in Fig. contains a rotary blade located at the end of long steel rotary cylinder. The motion from motor to the blade is transmitted through belt drive. To mix a viscous fluid more torque is required. After a long use, pulleys were worn out as well as the channel which is used for the motion of the entire blade unit is also wearied out. These are the primary causes of vibration to occur in stirrer machine.
The idea of the vibration absorber [1, 2] is secondary system with mass-spring was considered as vibration absorber. Tuning of absorber i.e. adjusting either of the m,c,k parameters of the absorber such that natural frequency of the absorber becomes equal to the excitation force frequency. Theoretically, there are various methods for the vibration attenuation. They are detuning the system natural frequencies away from its excitation frequency. By increasing the level of damping in the system, i.e. using the Tuned vibration absorbers-TVA. By reducing the magnitude of excitation forces By Resilient supports-isolators. The function of the tuned vibration absorber is to absorb the vibration energy from the primary source and keep vibrating, thus it reduces vibration of the main system. The TVA consists of mass, stiffness, Damper as a primary elements to model a system. With the stiffness tuning and optimally tuned viscous damper [4], we are able to control vibrations of the system. With the increase of the stiffness ratio the optimal damping, required by the damping element of the elastically coupled viscous damper decreases considerably. All the responses are passing from the one common point irrespective of the damping factor. With optimally tuned damping we are getting almost flat response and minimum magnification factor. By proper tuning i.e. locating TVA at appropriate location we can reduce vibration up to 37% for hand blender [5]. For the case of hand blender dual mass TVA was used, a modification in the conventional design. The construction of stirrer machine is shown in Fig.1. The cantilever frame slides in a vertical "C" channel. The frame structure is hollow and it contains belt drive mechanism to transmit motion from motor pulley to the pulley on the shaft contains blade. Due to one of the above said reasons the entire cantilever frame structure vibrates in a plane perpendicular to the blade rotation axis.

Fig. 1 Stirrer Machine.

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For determining vibration frequency the FFT analyser magnetic probe was attached to the front side of the cantilever frame structure.

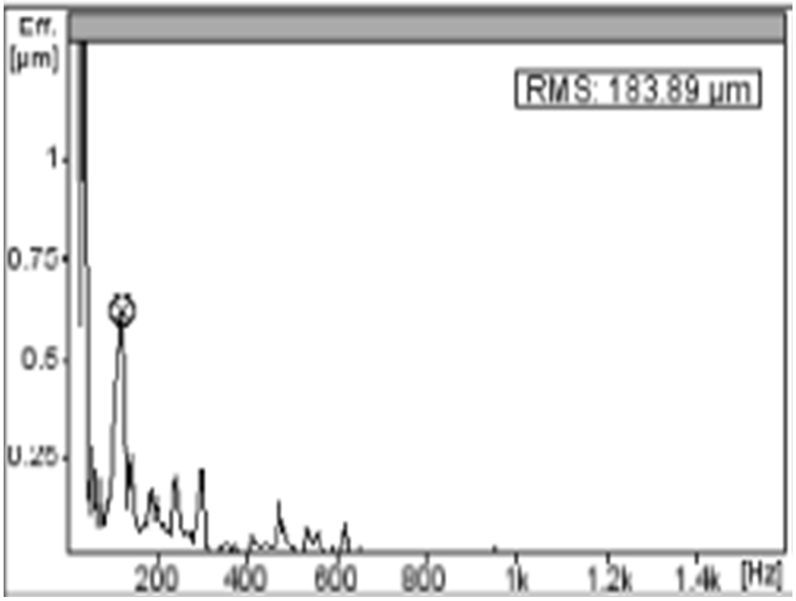


Fig. 2 Stirrer Machine vibration behaviour before attaching TVA.

From Fig. 2 it is seen that the cantilever frame structure is vibrating at amplitude more than 2 µm at the operating frequency and the other disturbing frequency found is around 90 Hz. Now to avoid this amplitude we have to design TVA such that this frequency range is avoided. Following is the proposed design of TVA

$$f_n = \frac{1}{2\pi}\sqrt{\frac{3\,X2X10^{11}X\pi X0.01^4}{0.4X64X0.15^3}} \approx 76\text{Hz}$$

The numerical analysis is carried out in ANSYS. The following figure shows modelling as well as modal analysis for determining natural frequencies for various modes. The numerical analysis results are giving nearby values of frequencies as by the analytical results.

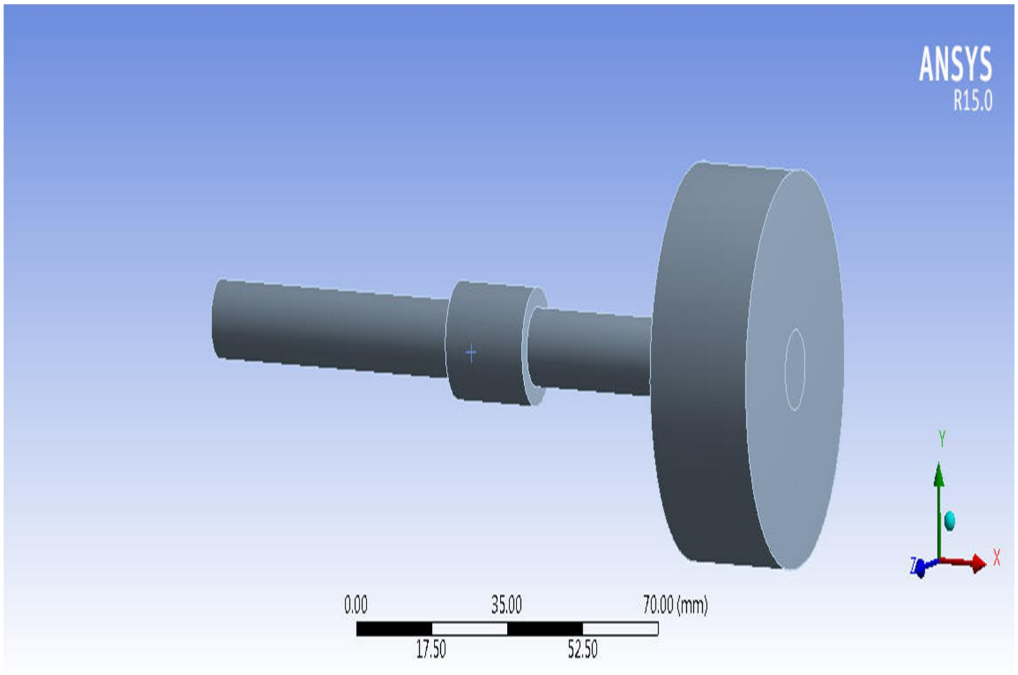


Fig. 3 TVA modelling in ANSYS.

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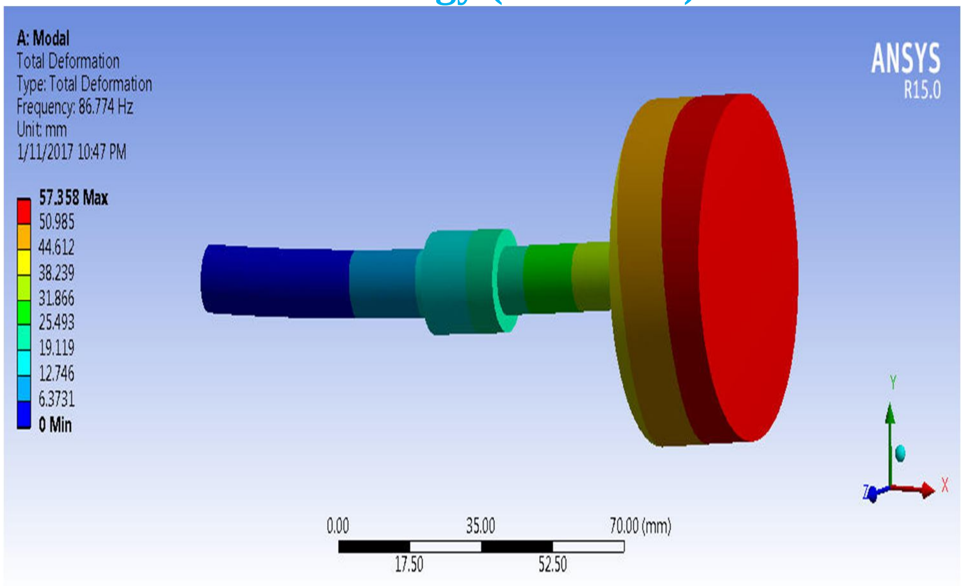


Fig. 4 Absorber modal analysis in ANSYS.

TABLE I
MODAL ANALYSIS RESULTS FOR TVA

| Sr.no | Mode | Frequency [Hz] |
|---|---|---|
| I | I | 86.774 |
| II | II | 86.782 |
| III | III | 376.28 |
| IV | IV | 952.15 |
| V | V | 952.53 |
| VI | VI | 2818.6 |

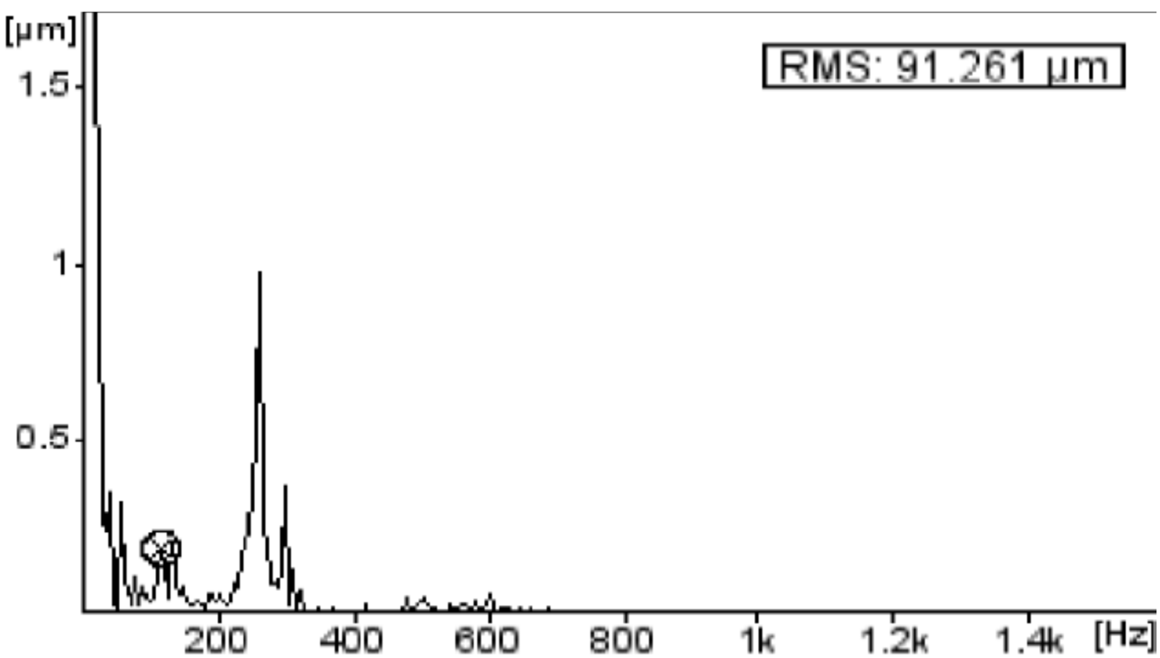


Fig. 5 Stirrer Machine vibration behaviour after attaching TVA.

## II. CONCLUSIONS

The Tuned Vibration Absorber has been designed for the stirrer machine. The frequency of TVA was calculated both analytically as well as numerically. The analytically determined frequency results differ marginally from the numerical results. By attaching TVA inside the frame opposite to each other, we get vibration reduction up to 50%. This result is for one type of liquid oil. With the change of viscous fluid, the frequency v/s amplitude results differ from the existing results so, in that case we should go for active TVA rather than passive one.

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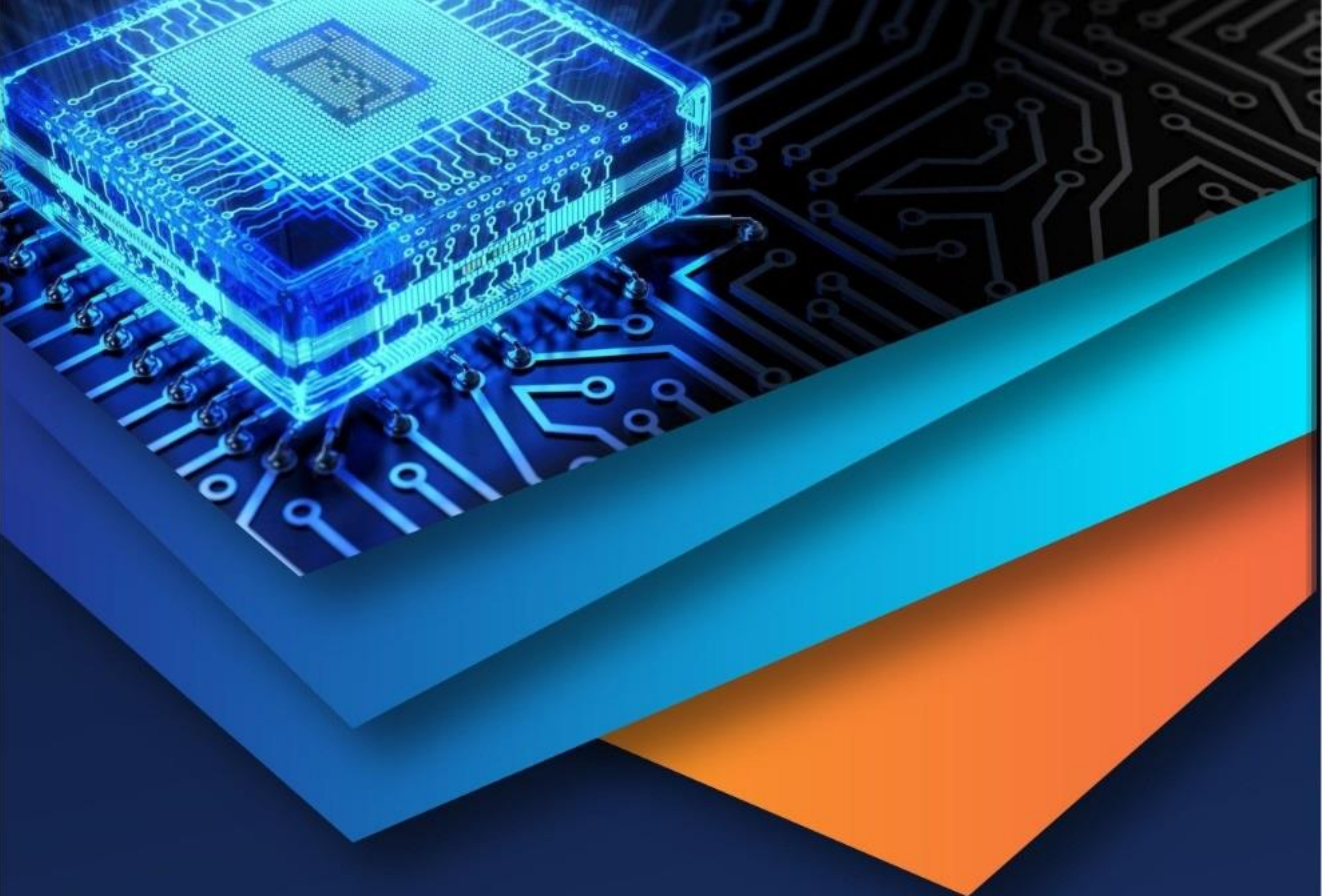

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