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STEAM HAMMER REDUCTION BY USING SHOCK ABSORBER

Mr. Gopiaravind R*1, Ms. Anugeetha Shine*2

*1Student, Department Of Industrial Safety Engineering, Bannari Amman Institute Of Technology, Erode, Tamil Nadu, India.

*2Assistant Professor, Department Of Mechanical Engineering, Bannari Amman Institute Of Technology, Erode, Tamil Nadu, India.

ABSTRACT

The pressure vessel or any pressure holding equipment has a possibility to produce a forced stream in the condition of excess pressure than its limitations through the pressure relief valve area, it has a risk of the steam hammer or hydraulic shock, which is a major issue that the engineers need to take under consideration. Steam hammer is a phenomenon that leads to the sudden increase of pressure due to an increase of temperature in equipment or pressure storage vessels, which can affect pipes, valves, and gauges in any water, gas, or oil applications due to the sudden transient event which may cause a catastrophic disaster. The installation of a steam hammer reduction, a shock absorber with a rupture disk will decrease the impact of the steam hammer on pipes, valves, and gauges.

Keywords: Steam Hammer, Rupture Disk, Pressure Relief Valve, Pressure Vessels, Steam Hammer Reduction By Using Shock Absorber.

I. INTRODUCTION

The aim of this project is to design steam hammer reduction shock absorber, using appropriate components to observe and reduce the steam pressure. It will be a prototype to make optimization of how the pressure plays a role in the system. The main idea of the project is to add Al6061 spiral Coil and rupture disk to help to reduce the steam pressure impact. The project is significant to many industrial applications through understanding the main features of designing, manufacturing, and economic aspects. This is very important from a safety perspective as this project will lead to increased safety and enhance the performance of pipes, valves, flanges, etc., as well as save the environment and humans from any sudden damage that can be caused by the steam hammer phenomenon.

II. METHODOLOGY

The setup of the system is depends on temperature, pressure and humidity of the steam. In this project, we have used non-return valve that make the flow of steam in one direction and avoid the back flow of steam. Rupture disk that is used to reduce the sudden impact in the shock absorber and pipes. That the rupture disk open when the equipment attain its lowest pressure. Another device is a shock absorber that helps to prevent the sudden impact in pressure relief valve. Then shock absorber also reduce the vibration and noise in the pipes and valves caused by steam hammer. And then make flow of steam in a minimal pressure so when the steam is released through the pressure relief valve severity rate will be less. Pressure relief valve release the excess steam from the equipment with less pressure. And the set pressure in pressure relief valve is more than the rupture disk to reduce steam flow from the equipment to maintain the optimum pressure.

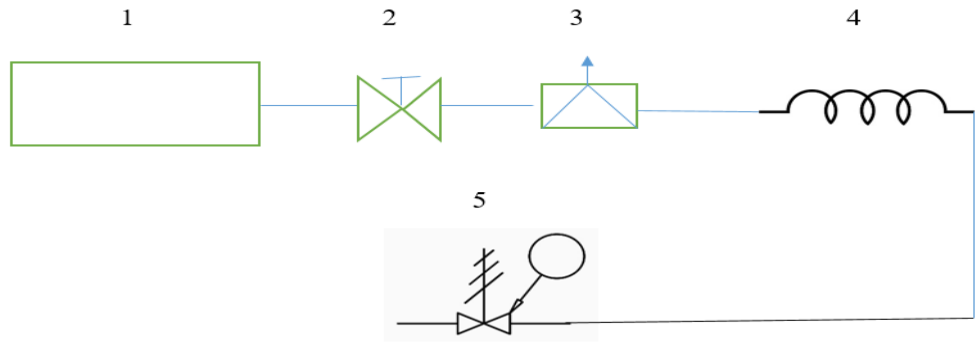
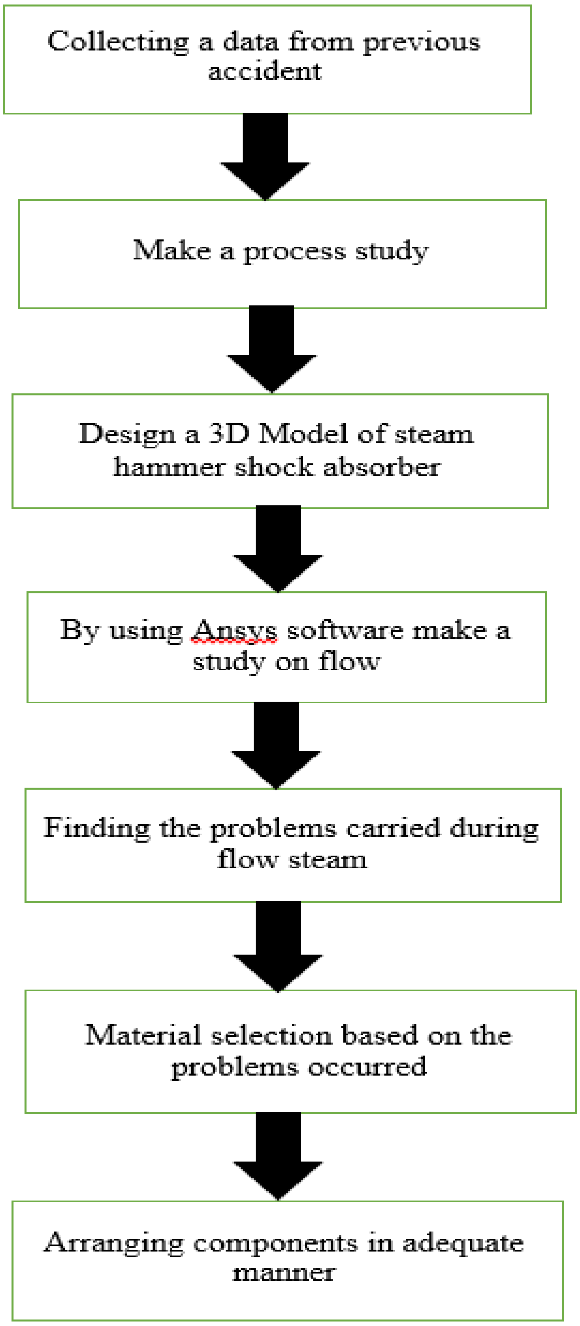


Figure 1: Process chart

1. **Boiler**
2. **Non Return Valve**
3. **Rupture disk**
4. **Steam hammer reduction by using shock absorber**
5. **Pressure relief valve**



MATERIAL USAGE

Here we use the material that is Aluminium 6061. The material have high impact strength, tensile strength, corrosion and erosion resistance and also provide good surface finish. That are to by the reference of American Society of Mechanical Engineering (ASME).

Aluminium 6061

Aluminium 6061 was one of the first metal to be developed in 1935, and is one of the most commonly available heat-treatable aluminum alloys for commercial use. The 6061 alloy is primarily composed of aluminum, magnesium and silicon. Its other metallic elements include iron, copper, chromium, zinc,

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manganese and titanium, in descending order of quantity. Alloy 6061 set the standard for a medium-to-high strength, lightweight, economical material. Earlier alloys had been susceptible to stress-corrosion cracking, but the addition of a small amount of Chromium made this alloy highly resistant to corrosion.

6061 aluminum properties include its structural strength and toughness, its good surface finish, its good corrosion resistance to atmosphere and sea water, its machinability, and its ability to be easily welded and joined. Most other aluminum alloys are difficult to weld due to their chemical composition and lack of conductivity. While welded 6061 aluminum alloy materials may lose some strength, they can be re-heat-treated and artificially aged again to restore strength, making this one of the superior alloys.

The temper designations mainly have 6061-T4, T451, Al 6061-T6, 6061-T651, etc. It is one of the most widely used alloys. The main alloying elements are magnesium (Mg) and silicon (Si). The content of silicon and magnesium in this alloy is close to form magnesium silicide (Mg2Si), so it is a heat-treated wrought alloy.

Aluminum 6061-T6 has a minimum yield strength of 35 ksi (240 MPa), which is almost equal to that of A36 steel. This strength, combined with its light weight (about 1/3 that of steel), makes it particularly suitable for structural applications where static loads are a concern. Compared to 7000 (e.g. alloy 7075) and 2000 series (e.g. alloy 2024) aluminum, AA6061, although lower in strength, is less sensitive to solution heat treatment and quench variation. Because 6061 aluminium alloy is easy to extrude, it can provide a variety of product forms such as sheet, strip, plate, rod, forgings, tubes, pipes, wires, extruded parts and structural shapes.

Aluminum 6061 has good corrosion resistance, mechanical properties, formability, weldability, and machinability. Generally suitable for medium to high strength requirements, and has good toughness. Applications range from food and beverage packaging, electronic products and home appliances, architectural decoration, transportation to aerospace components. Alloy 6082, popular in Europe, is slightly stronger than AA6061 and has similar uses.

III. MODELING AND ANALYSIS

DESIGN CONSTRAINT

This designing system is analyzed by a numerous number of constraints corresponding to the main target of designing criteria. The system responses such as pipe size, pipe flow velocity, pressures, and temperature have been considered and implicated in the project

FACTOR CONSIDERED DURING DESIGN

While designing a steam hammer shock absorber we need to consider several factor to increase its efficiency and safety. They are

- Operating temperature
- Operating pressure
- Humidity of the equipment
- Parameters of the equipment
- Release pressure of pressure relief valve

DESIGN METHODOLOGY

The design of this project is concentrating on the piping system and boiler principles. The project has been implemented in four stages; first, collecting the information from the research papers and industry while attending internship. According to that, from calculating the information needed, we studied the issues and problems in the pressure vessel system and piping system, then came up with the idea of developing the shock absorber using coil to reduce steam hammer effect. The second stage was designing of the system and specified the parts and components of the system, including pipes, coil manufacturing, and rupture disk. Furthermore, the third stage was categorized and subcategorized specifying the design components and formulas needed for calculations. Finally, we predict the theoretical data from using pressure vessel system and piping system with main consideration of Bernoulli's equation.

One of the main elements in the system is the steam producing or steam storage equipment i.e it could be any device such as boiler, pressure vessel, super heater, etc. Another important element in the system is the pressure relief valve. In this system, it could be protect the equipment by releasing the steam. Also, we have a

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rupture disk that functions protect the steam hammer shock absorber and make a steam flow in constant rate. The Aluminium spiral pipe is used as a shock absorber to reduce the pressure.

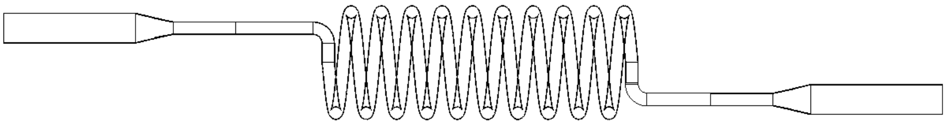

Figure 2: Drafting of Steam hammer reduction shock absorber

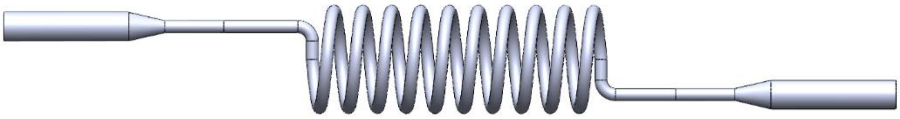

Figure 3: Front view Steam hammer reduction shock absorber

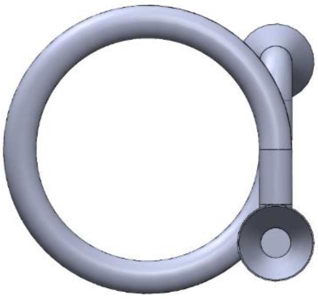

Figure 4: Top view Steam hammer reduction shock absorber

THEORY AND THEORETICAL CALCULATIONS

The main idea of the theoretical calculation are to be differ from is to predict the total head loss and flow rate velocity to measure the number of coil turns and length in order to study the efficiency of using the coil as a shock absorber of a water hammer.

1) Find the velocity of boiler
2) Find the regular maintaining temperature
3) Find the regular maintaining pressure
4) Find the humidity
5) Find the initial opening pressure release of pressure relief valve
6) Find the parameter of pipes
7) Find the number of turns of coil

BERNOULLI EQUATION

The Bernoulli effect is a state of conservation or of energy for flowing fluid where the reduction in pressure occurs when the fluid speed increases.

$$P1 + \frac{1}{2}\rho V1^2 + \rho gh1 = P1 + \frac{1}{2}\rho V2^2 + \rho gh2$$

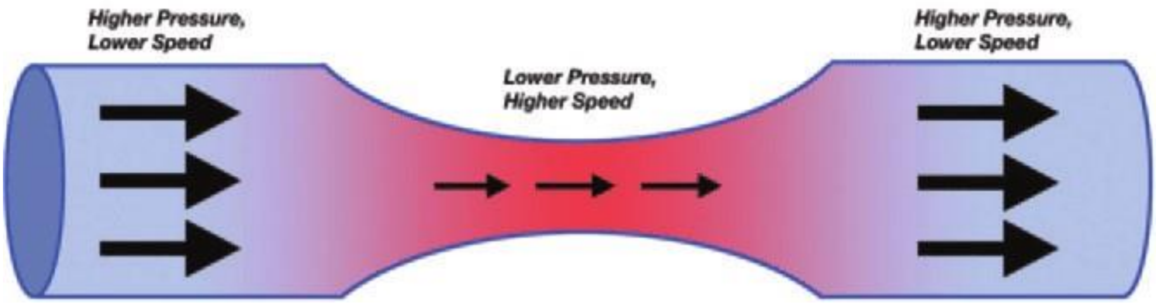

Figure 5: Diagram of bernoulli principle

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Reynolds Number

To determine the behavior of flowing steam in the pipe, here we use Reynolds number, as it is the ratio of inertial forces to the viscous forces. This ratio helps to determine the flow type, i.e. laminar, transitional, and turbulent.

$$Re = \frac{\rho u L}{\mu}$$

Re ≤ 2300	**Laminar flow**
2300 ≤Re ≤ 4000	**Transitional flow**
Above 4000	**Turbulent flow**

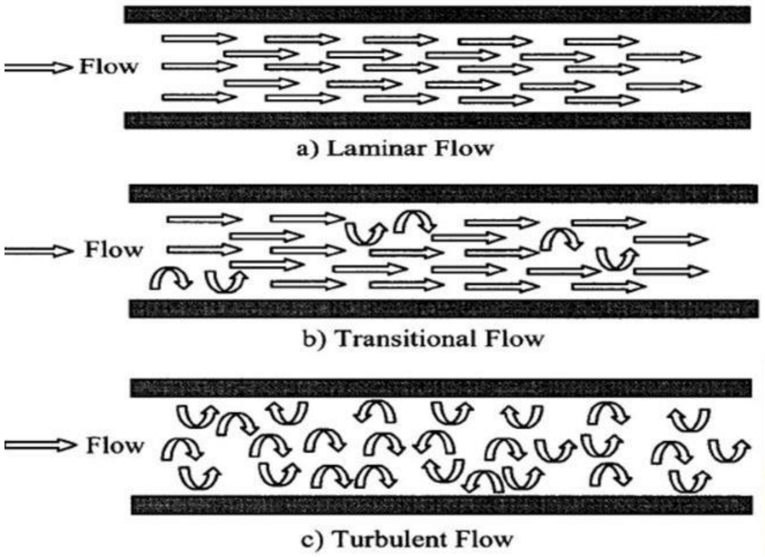

Figure 6: Flow profile types

Pressure drop in coil

$$\Delta p = \frac{2 f_c L_c u^2}{d_c}$$

Friction loss in pipe

$$f_s = 0.04(Re)^{-0.2}$$

Friction loss in coil

$$f_c = f_s[Re(d_c/D_c)]^{1/20}$$

Number of turns of coil

$$L_c = N\sqrt{(2\pi R_c)^2 + P^2}$$

Thickness of the coil

tp = (PD/2Se – P) + C

IV. RESULTS AND DISCUSSION

Hence the steam hammer effect in the pressure relief valve station from steam boiler, steam storage containers, steam pipeline. Hence these excess pressure which can cause some catastrophic disaster i.e bleve, noise, vibration, explosion, burn injuries, flying object these kind of impact are reduced by installing the rupture disk and steam hammer shock absorber with the dimensions for their respective application. When this steam hammer shock absorber is installed the severity and equipment damage also to be reduces so that safety standards of the pressure relief valve station has been developed. The outcome of this project is a general design it varies for the different application based on the dimensions, pressure, temperature etc,

V. CONCLUSION

The steam hammer shock absorber safe installation to be provided, and it is presented in this report fulfil the criteria specified in the project. This design has many advantages regarding safety and economy as it is economical to manufacture and maintenance. And that the Steam Hammer shock Absorber material can withstand upto temperature of 160 °C and pressure of 12 bar. That has been done by the reference of American Society of Mechanical Engineering (ASME).

Overall, the objective of the system was achieved successfully. In this project, we were to do a mathematical calculation to measure the friction losses in pipes, elbow, tee sections to estimate the length and number of turns in the coil. However, the findings were obtained by a comparison of coil pressure reduction (ΔP) between theoretical and experimental values.

In this project, we were able to apply our knowledge and skills taken during our study in both communication and ME courses. According to that, the design of the project helps us to search and conduct studies related to steam hammer effect, use different software programs which helped us to organize, draw, calculate the information needed such as Soildworks. Last but not least, the project developed our mindset on engineering problems and helped us to think logically and search for a solution for any problem.

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