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DESIGN AND DEVELOPMENT OF FIXTURE FOR INSULATION OF GEYSER

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Abstract : This research focuses on developing a fixture for geyser insulation in order to save production time and increase insulation quality. The device tackles fundamental challenges in geyser manufacturing, lowering lead times and labor costs. The study demonstrates that the fixture can improve overall geyser performance while also saving time during the insulating process by streamlining operations. The use of fixtures, templates, and new clamps has resulted in considerable efficiency savings in the insulation process, including reduced sheet marking time, total time, and average clamping time. This has enhanced productivity, with monthly outputs increasing from 78 to 130 geysers and annual outputs rising from 936 to 1560 geysers. Profitability grew by 60% due to lower labor expenses and increased productivity.

Introduction :

Company is India's largest manufacturer of Wood fired water geysers and solar water heating systems. Company is an ISO 9001 : 2008 certified by URS Certification Limited for Manufacture of Heat Transfer Equipment.

This project focuses on the insulation process for geysers, a critical component of their production cycle. The insulation process often presents challenges in terms of time consumption and resource utilization. The integration of fixtures, templates, and new clamps has led to significant reductions in sheet marking time and average clamping time, improving productivity and cost-effectiveness in the manufacturing workflow.

The project aims to uncover the transformative impact of these innovations by scrutinizing time consumption patterns and efficiency gains. By delving into the nuances of the insulation process and dissecting data at hand, it seeks to uncover actionable intelligence that can inform decision-making and drive continuous improvement initiatives. The primary objective of this study is to design and develop a fixture specifically tailored for geyser insulation, aiming to address critical issues in geyser production by reducing the production time required for the insulation process.

Thermal insulation is crucial to enhancing the performance of various systems when it comes to energy efficiency and sustainable living. Among these, geyser thermal insulation stands out as being particularly crucial for optimizing energy consumption and promoting eco-friendly practices. Heat loss is a common occurrence for geysers, which are used to heat water in homes and businesses.

Objectives :

1.To study and find out strategy to reduce lead time for 35 to 225 ltr geyser.
2.Design and development of sheet cutting template for geyser shell.
3.To design a fixture for reduction of lead time of insulation process for 35 to 225ltr geyser.
4.Development and validation of fixture for insulation of 35 to 225 ltr geyser.

Comparative analysis:

The company's present insulation system is inefficient, which causes high lead time. This insufficiency necessitates a reduction in production time in addition to impeding overall manufacturing efficiency. The goal is to streamline the insulating procedure so that it can saves and utilize other manufacturing operations. It is anticipated that this tactical upgrade “developing the fixture and process optimization” will shorten the production time for each unit and improve the quality of geysers.

The main objective is to reduce the time required for geyser insulation, particularly for 35 to 225 litre variants. To that end, we have scheduled the installation of fixtures and the use of various clamps.

Methodology:

The fixture development methodology that has been suggested involves a methodical process that includes multiple crucial steps. The first step in the process is to establish a precise problem statement that identifies the needs or problems that the fixture is meant to solve. Then, in order to obtain knowledge from previous studies, industry best practices, and technical developments pertinent to fixture design and implementation, a comprehensive literature review is carried out. Using this information, engineers and designers go on to develop and write plans for the structural and functional elements of the fixture during the fixture design process. After that, the right materials are chosen, taking into account aspects like robustness, affordability, and suitability for the production process. The fixture is developed, fabricated, and assembled when the design and material selections are completed, resulting in the creation of a working prototype.

Fixture :

Fixtures are workholding devices used to hold, locate, and support workpieces during manufacturing processes. Fixtures allow you to reference and position the cutting tool to the workpiece, but they do not guide the tool. A fixture is a tool or device used in manufacturing, assembly, or inspection that is designed to securely hold and support a workpiece. Fixtures provide a consistent and repeatable setup for the workpiece, helping to ensure accuracy and uniformity in a number of techniques. They are commonly used in welding, assembly, and machining to improve the precision and efficiency of production processes.

Design of fixture :

In order to comprehend the needs and limitations related to insulating containers with capacities ranging from 35 to 225 litres, our design process for the insulation fixture involved a great deal of research and analysis. We started by looking at current insulation methods, supplies, and fixture designs in order to find new and creative ways to improve the situation.

We carefully examined the dimensions of containers inside the given range after obtaining pertinent data in order to ascertain the ideal size and arrangement for the insulating fixture. To guarantee efficiency and compatibility, this required taking into account variables like diameter, height, and weight distribution.

To reach the required degree of insulation performance, we experimented with several materials, insulation techniques, and structural configurations during the iterative design process.

We also conducted internal assessments and asked for input from industry experts to improve and optimise the fixture's design based on real-world applications and industry best practices. We were able to solve any possible flaws or restrictions and improve the fixture's performance and dependability through the use of an iterative process.

figure 1 : design of fixture for insulation of geyser

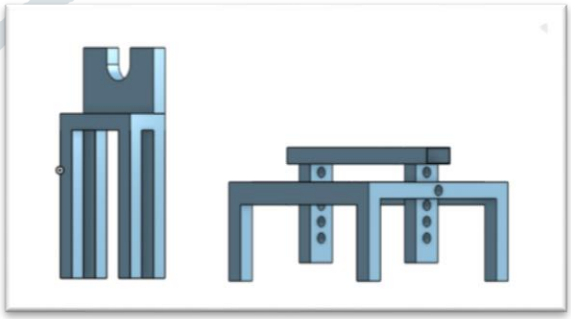


figure 2 : design of fixture for insulation of geyser

High-quality insulating materials, a sturdy structure, and intuitive features enable effortless loading and unloading of containers in the finished insulation fixture design. Its design guarantees dependable performance in a variety of applications and conditions by offering uniform and effective insulation throughout the whole spectrum of container sizes.

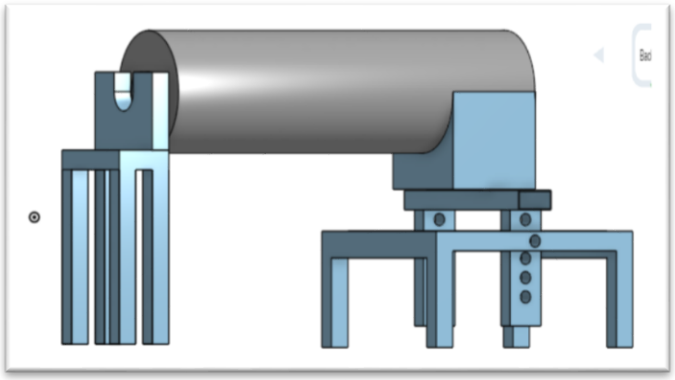


figure 3 : design of fixture with workpiece

The final fixture design figure 1 and 2 for the insulation process is Design 3.With an insulating range of 35 to 225 litres, the fixture type is configurable for geyser applications.This design was created using the 3-2-1 fixture-making technique.It can be modified based on the needs and geyser range, as depicted in the figure.Since this is the final design, it was created by studying the dimensions of different geysers and the previous two designs. It has an ergonomic design that allows workers to work comfortably, which reduces the amount of time needed to adequately insulate the workpiece.

Templates for sheet marking :

A template in engineering is usually a pre-made pattern or guide that is used as a model to duplicate or create identical parts, assemblies, or designs. Both digital and physical templates are available, such as CAD templates for part design and stencils for cutting out shapes. They support ensuring the engineering process is accurate, efficient, and consistent.

Templates are useful in engineering because they help to ensure accuracy, efficiency, and uniformity throughout the design, production, and construction phases. Engineers can accomplish their goals more successfully with the aid of these resources, which can be either digital or real. Examples of these include CAD models and design templates or stencils and jigs.

Figure 4 : Template Of 75 Liter For Sheet Marking

Figure 5: Template Of 100 Liter For Sheet Marking

Figure 6 : Template Of 150 Liter For Sheet Marking

Figure 7: Template Of 225 Liter For Sheet Marking

The above templates are created from waste and scrap of industry.

Setup Before Installation Of Fixture :

The below images shows the setup of industry before the installation of fixture :

Setup after Installation Of Fixture :

The below images shows the new setup placement for geyser with the use of fixture to insulate the geyser. This fixture will eliminate the supporter with the adjustable supporter for a specific range of 35 to 225 ltrs geyser. :

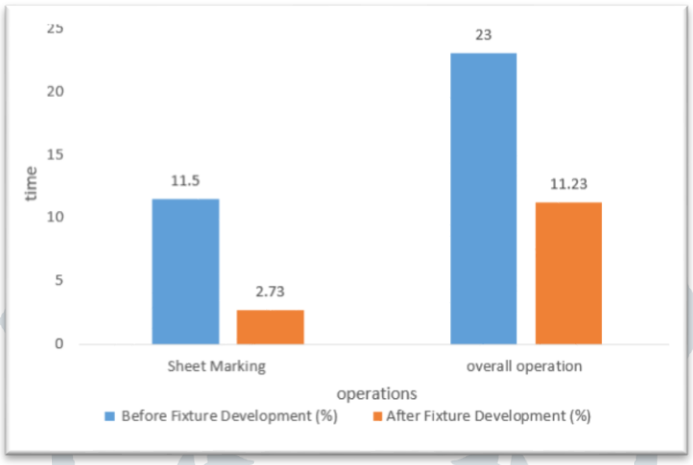
Time Calculated Before Fixture Developed:
•Average total time of insulation of geyser of 35 to 225 liters is 92.495 min
•The average sheet marking time is 10.695 min
In percentage,
10.695/92.495 = 11.5%

•Also, average workpiece setup time is 5.474 and 5.111 for glasswool cutting
Now by adding the average time of sheet marking, workpiece setup time and glasswool cutting time respectively,
Therefore, 10.695 + 5.474 + 5.111 = 21.28 mins
•In percentage,
21.28/92.495 = 23%
So, this operations consumes 23% of time in insulation .

Time Calculated After Fixture Developed:
Average total time of insulation of geyser of 35 to 225 liters is 92.495 min (data taken from fig no.:) (same time taken from 5.7 to reduce errors)
•The average sheet marking time is 2.53 min after using sheet marking templates.
In percentage,
2.53/92.495 = 2.73% (reduce by 8.77%)
•Also,average workpiece setup time is 4.667 and 3.19 for glasswool cutting
Now by adding the average time of sheet marking, workpiece setup time and glasswool cutting time respectively,
Therefore, 2.53 + 4.667 + 3.19 = 10.39 mins
In percentage,
10.39/92.495 = 11.23% (reduce by 11.767%)

So, this operations consumes 11.23 % of time in insulation, which is reduce by 11.767% after using fixture and templates of sheet marking.

Before fixture development, the overall time for insulation processes, excluding fixtures or templates, is calculated at 92.495 minutes, with sheet marking, workpiece setup, and glasswool cutting identified as major contributors. Sheet marking alone accounts for approximately 11.5% of total time, while workpiece setup and glasswool cutting together represent roughly 23%. After fixture development, while maintaining the same total insulation time, sheet marking time decreases to 2.53 minutes, and workpiece setup and glasswool cutting times decrease to 10.39 minutes each. Consequently, sheet marking now occupies only 2.73% of the overall time, marking an 8.77% reduction, while the combined setup and cutting time decreases to 11.23%, representing an 11.767% reduction. Thus, the use of fixtures and templates results in significant time savings, enhancing manufacturing efficiency across the insulation process.



The graph shows the reduction of time for insulating the geyser before and after the fixture is developed.

Calculation Of Clamping Time:

As per the data taken from industry.
•Average clamping time = 22.96 min
In percentage,
22.96/92.945(average total time)= 24.70%
So, 24.70% time consumes from total average time of 92.945 while using old clamps

- The average clamping time can be reduce by 50% by introducing new clamps shown in figure 8

Calculation :

Average clamping time using old clamps is 22.96 min
By using new clamps as shown in fig no. 5.10.2which reduce 50% time of 22.96 mins which is 11.48 mins.
In percentage,
11.48/92.945= 12.35%

figure 7: old clamps

figure 8: new hose clamps

The average clamping time with old clamps is calculated at 22.96 minutes, constituting 24.70% of the total average time of 92.945 minutes. With the implementation of new clamps, this average clamping time is halved to 11.48 minutes, representing a reduction of 12.35% in the overall average time. This reduction in clamping time contributes significantly to the enhanced efficiency of the process, resulting in notable time savings and improved productivity.

Calculation Of Labour Cost:
Average total time is 92.495 mins to insulate 1 geyser.
Average total time is reduce by 23.58% lets say 24% .
Means 92.495 mins of 24% = 22.10 mins
Therefore, 92.495 – 22.10 = 70.31 mins

For 92.495 mins total average time for insulating:
Labour cost is Rs. 380/day for one worker.
Workers required 2,
Therefore, 380*2 = Rs. 760/day

If workers work for 6 hours / day in 8 hour shift.
The total no. of geyer insulated is 3/day.

Therefore , cost of 1 geyser,
760/3 = Rs.253.33/geyser

•Total number of geyser insulate in month (26 days) is 78 geysers and yearly (312 days) is 936 geysers.

For 70.31 mins total average time for insulating (reduce time by 24%):

One geyser takes 70.31 mins,
Therefore in 6 hours 5.1 geyser is insulated, let's say 5 geyser/day

Therefore , cost of 1 geyser,
760/5 = Rs.152/geyser

•Total number of geyser insulate in month (26 days) is 130 geysers and yearly (312 days) is 1560 geysers.

So**, the industry saves Rs.101.33/geyser.**
In percentage,
(152/253.33)*100 = 60%

Therefore, 60% labour cost is reduce by developing the fixture and templates.
So, by the data obtained the reduction of 24% time will increase the production from 936 geysers to 1560 geysers yearly, 624 more geysers per year which means profit is increase by 60%.

Productivity :

(Current average total time / previous average total time) * 100
(70.31 / 92.495) * 100 =76.01%

The initial labor cost for insulating one geyser was calculated based on an average total time of 92.495 minutes per geyser, resulting in a cost of Rs. 253.33 per geyser for two workers per day. However, after reducing the average total time by 24% to 70.31 minutes per geyser, the labor cost decreased to Rs. 152 per geyser. This time reduction also led to increased productivity, allowing the workers to insulate 5 geysers in 6 hours, indicating a productivity increase of 76.01%. Consequently, monthly production surged from 78 to 130 geysers, and yearly production rose from 936 to 1560 geysers. With the increased production and reduced labor costs, profitability soared by 60%, showcasing the significant positive impact of time reduction on various aspects of the company's operations and finances.

Conclusion :

The provided data offers a detailed analysis of efficiency gains resulting from the implementation of fixtures, templates, and new clamps in the insulation process. Before fixture development, the insulation process required 92.495 minutes, with sheet marking, workpiece setup, and glasswool cutting as primary tasks. Fixture development dramatically reduced sheet marking time to 2.53 minutes and combined setup and cutting time to 10.39 minutes, resulting in an overall time reduction of 11.767%. The introduction of new clamps further reduced average clamping time, leading to a 12.35% reduction in total average time. Consequently, the average total time for insulating a geyser was reduced by 23.58%. Additionally, a 24% reduction in average total time translated into a significant decrease in labor costs and increased cost-effectiveness. Moreover, heightened productivity allowed workers to insulate 5 geysers in a 6-hour shift, leading to a substantial increase in production outputs and a 60% boost in profitability. This comprehensive analysis underscores the significant benefits of strategic process optimizations, positioning the company for sustained growth and success in the competitive market landscape.

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