

Value Analysis of Inward Curve Basin for a GVHT

Vrushabh Kadam¹, Aumkar Desai², Ashwini Joshi³, Vaishnavi Shinde⁴, Surekha Khetree⁵

^{1,2,3,4}Sudent, Department of Mechanical Engineering, Bharti Vidyapeeth's College of Engineering, Navi Mumbai, Maharashtra, India – 400 614

⁵Professor, Department of Mechanical Engineering, Bharti Vidyapeeth's College of Engineering, Navi Mumbai, Maharashtra, India – 400 614

Abstract – Value analysis is a method which helps improve a product either by reducing unnecessary costs or improving the product's performance. Costs may be reduced by using alternative manufacturing methods. Nowadays there is a very fast development in the rapid prototyping processes such as 3D Printing, which serve as a viable alternative to casting. 3D Printed components have up to 90% of the cast component strength and are up to 60% lighter in weight. 3D printing can be used to reduce the manufacturing cost of the product. In current paper authors have used the method of Value Analysis to reduce the cost of manufacturing of a new basin design for a Gravitational Vortex Hydro-Turbine (GVHT).

Key Words: Value Analysis, 3D Printing, Casting, GVHT

1. INTRODUCTION

Since Thomas Edison lighted the first bulb in human history in 1879, electricity has played a pivotal role in development & illumination of human resources. According to Ministry of Power (India) & Central Electricity Authority (India), between 31st March 2017 - 31st March 2018, Electricity production in India increased by around 6% from 1,066,268GWh to 1,130,244GWh.

Coal and fossil fuels are the prominent energy source in India. About 80% of electricity produced from coal and fossil fuels. Renewable energy sources generated about 16% of electricity produced in India.

Hydropower is the one of the most economical source of energy. Hydropower is also the most efficient source of electricity with an average efficiency around 86% - 95%, In comparison thermal power plants has an average efficiency of 33%. Solar energy has a average conversion efficiency of 15%.

The Industrial sector is the major consumer of electricity in India, Consuming about 42% of total electricity produced.

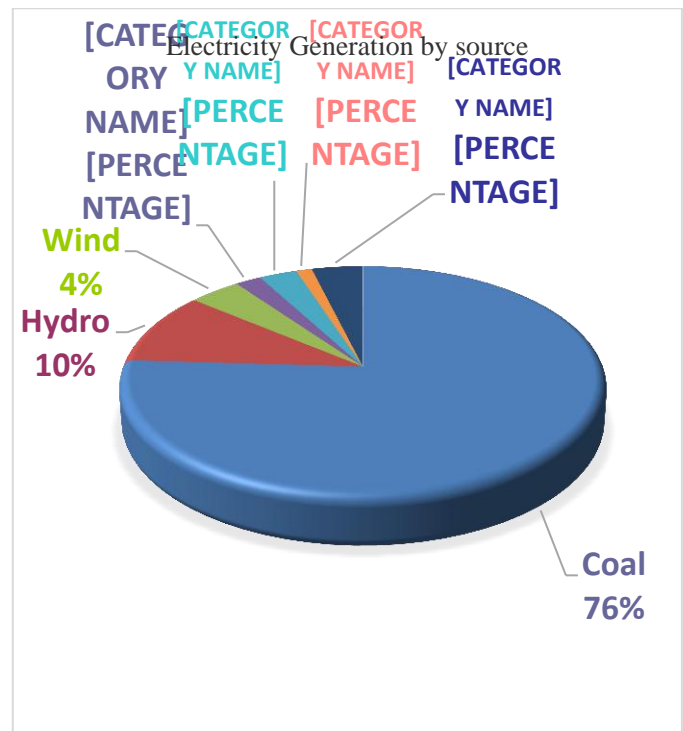


Fig- 1: Energy Generation by Source

1.1 VALUE ANALYSIS

Value Analysis is the systematic study between the relationship of design, cost and function of any product, material or service, so as to identify the unnecessary costs and eliminate those costs. It contributes in improving profitability to the firm by improving quality along with better customer satisfaction. It can be applied at any stage in the product's life cycle, but is generally applied when the value of the product decreases to a certain limit.

1.2 GRAVITATIONAL VORTEX HYDRO-TURBINE

A Gravitational vortex hydro-turbine (GVHT) work on the principle of free vortex. It converts rotational energy / centrifugal head into electrical energy. In a GVHT water enters a circular basin tangentially & energy is extracted from free vortex using a turbine.

The GVHT can operate under low heads 0.7m to 3m. It can generate about 12Kw to 15Kw of energy which is enough to power about 60 rural homes. As it is comprises of less moving parts, It's maintenance is easy. Due to lower specific speeds, the marine life in the channel is unaffected making the turbine environmentally friendly.

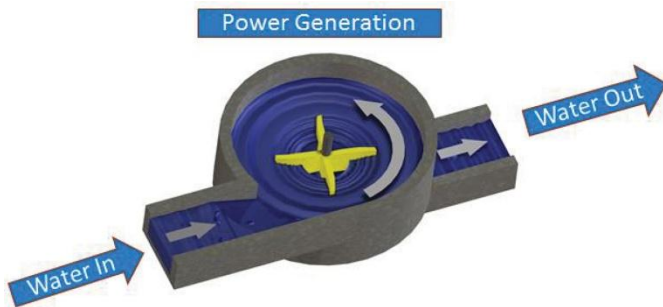


Fig- 2: GVHT Plant

The cost of small GVHT plant is approximately half that of thermal power plant of same capacity. Hence making it economically feasible. The GVHT is compact in design. It doesn't cause mass displacement of human resources hence it is socially viable.

2.1 PROBLEM STATEMENT

Various efforts are being made to improve the performance of GVHT all around the world. CFD of a new inward curve design has showed that it can give better performance than a conical design for same dimensional parameters. Problem arises when the inward curve is to be manufactured accurately. Inward curve is not like other designs of GVHT. This design is very difficult and may become highly inaccurate when manufactured from sheet metal. Hence a new, cheap, and fast method needs to be searched for manufacturing the inward curve design.

2.2 METHODOLOGY

For experimenting a new design of GVHT a small prototype is made. Generally the prototype is manufactured from sheet metal like stainless steel or aluminium. An inward curved design is very difficult, time consuming and highly inaccurate when manufactured from sheet metal. One of the solution is casting of the component. Casting is very costly operation and requires a lot of post processing. In this paper an value analysis is done to provide an alternative method to manufacture the inward curve design, which is cheaper and more accurate than casting. 3D printing is a rapid prototyping process which is suggested as an cheap alternative to casting of the component.

3.1 Inward Curve Design

A CAD model of a inward curve design is made using SOLIDWORKS having dimensions as follows:

Basin Top Diameter : 218 mm

Basin Bottom Diameter : 62 mm

Basin Height : 270 mm

Inward Curve Radius : $4 \times \text{Top Radius of Basin} = 436 \text{ mm}$

The model made & its cross-section is as shown in the figure

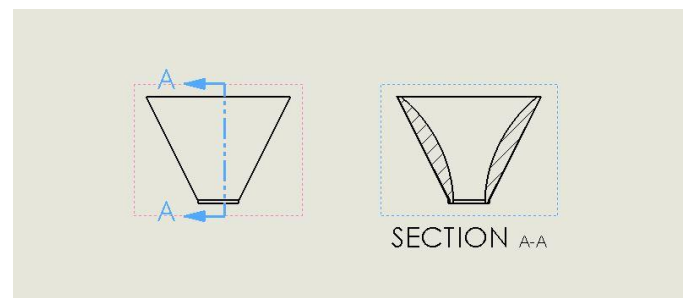


Fig- 3 : Basin Design & Cross-section

3.2 CASTING

Casting is a manufacturing process in which molten metal is poured into molds of required shape and size. The molten metal is the allowed to cool in the molds until it solidifies. The mold is then broken to take the required component out of it.



Fig -4 : Casting Iron in Sand Mold

Casting process requires a lot of post processing because of irregularities on the surface formed due to the mold -metal interface. The casting if not properly done can lead to uneven densities of components at various portions of the component. There are also a lot of surface & volumetric defects caused during casting, most of which can't be predicted. It also undergoes shrinking for which extra provisions have to be made in the pattern. The wastage of material is very high in this process.

3.3 3D PRINTING

3D Printing is a rapid prototyping process in which layers of semi-liquid material are printed one above the other. It is a new technology and is in developing stage. It produces parts with 90% of strength of a part of same dimensions which is cast, also the 3D printed part is up to 60% lighter in weight than the cast part.

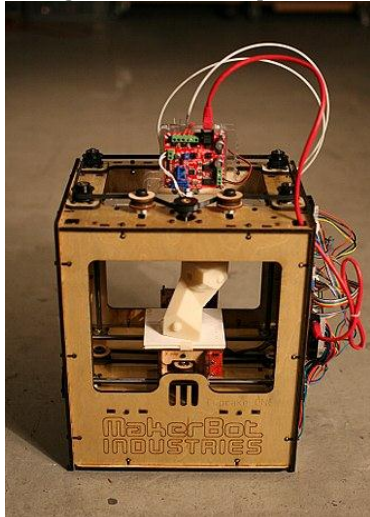


Fig- 5 : A 3D Printer

3D Printing is a cheaper and more accurate process than casting. The data of required part is fed to the 3D printed digitally by a computer or directly by a portable storage device such as SD cards, USB Drives, etc. The wastage of material in this process is minimum, which results in less requirement of material, which ultimately leads to reduction in manufacturing cost.

3.4 3D PRINTING VS CASTING FOR SPECIFIED BASIN DESIGN

After Doing market research it was found that the 3D Printing is more cheaper & more accurate process than Casting. The cost of manufacturing the basin by 3D printing is approx Rs. 10,000. The cost of manufacturing the same basin with same dimensions by casting is more than Rs. 25,000.

4 CONCLUSIONS

The research done states that 3D printing is cheaper than casting process. Value Analysis method study of the basin suggests that instead of manufacturing it traditionally by casting, it can be done by 3D printing for improve in the value of the product. It also significantly reduces the cost by almost 50% .

ACKNOWLEDGEMENT

We take this opportunity to express our profound gratitude & deep regards to Prof. Surekha Khetree for her

exemplary guidance, resources & constant encouragement throughout the course of this report. The blessing, help & guidance given by her from time to time shall carry us to long way in journey of life on which we are about to embark.

We also take this opportunity to express a deep sense of gratitude to our head of department Prof. Sandhya Jadhav for cordial support, valuable information, resources & guidance which helped us in completing the task through various stages.

We are grateful to our college for valuable resources provided by him. We are grateful for their co-operation during the period of our course.

REFERENCES

- [1] <https://ieeexplore.ieee.org/document/6563357>
- [2] <https://www.jameco.com/Jameco/workshop/productnews/casting-3d-printing-compare-contrast.html>
- [3] <https://en.wikipedia.org/wiki/Casting>
- [4] https://en.wikipedia.org/wiki/3D_printing