



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 4, April 2022

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.118

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

Review on Design and Prototyping of Kaplan Turbine Runner Blade

A.Vijay Kumar¹, Rachuri Lokesh², Sangani Rohith², Pallakonda Sravan², R Krishna Chaithanya²

Assistant Professor, Department of Mechanical Engineering, Guru Nanak Institute of Technology, Khanapur,
Hyderabad, India¹

U.G. Student, Department of Mechanical Engineering, Guru Nanak Institute of Technology, Khanapur,
Hyderabad, India²

ABSTRACT: This work aims at studying the Kaplan turbine mainly the Kaplan runner wheel which is a reaction type turbine. And printing the prototype using rapid prototyping method which is 3D Printing, utilizing FDM machine we need to get out the prototype of kaplan turbine. So by this end of the project we let me know the how the 3D printing works efficiently than other manufacturing approaches. In this project we're utilizing Solid works software for both design and simulation of a kaplan turbine runner blades.

KEYWORDS :Hydropower; Kaplan Turbine; Power output; Blade angle; Modelling; 3D Printing; Prototyping, CFD

I. INTRODUCTION

A turbine is a rotary mechanical device that develops energy from a fluid flow and converts it into useful work. A turbine is a turbo machine with at least one moving part called a rotor assembly, which is a shaft or barrel with blades attached. Moving fluid acts on the blades so that they move and transfer rotational energy to the rotor. Gas, steam and turbines have a casing around the blades that contains and controls the working fluid. The Kaplan turbine is an exterior or inward flow reaction turbine. since working fluid changes pressure as it moves through the turbine. Power is gained from both the hydrostatic head and from the kinetic energy of flowing water. The Kaplan turbine is an outward flow reaction turbine, which means that the working fluid changes pressure as it moves through the turbine and gives up its energy. Power is recovered from both the hydrostatic head and from the kinetic energy of the flowing water. The design combines features of radial and axial turbines.

Kaplan turbine, a variation of the Francis Turbine. The Kaplan turbine is a propeller- type water turbine that has flexible blades. It was developed in 1913 by Austrian professor Viktor Kaplan, who combined automatically fitted propeller blades with automatically fitted door gates to achieve efficiency over a wide range of flow and water positions. The Kaplan turbine was an development of the Francis turbine. Its invention allowed effective power produce in low- head operations which weren't possible with Francis turbines. The head ranges from 10 to 70 m and the output ranges from 5 to 200 MW. Runner circumferences are between 2 and 11 m. Turbines rotate at a constant rate, which varies from installation to installation. That rate ranges from as low as 54.5 rpm (Albeni Falls Dam) to 450 rpm. Kaplan turbines are now extensively used throughout the world in high- flow, low- head power production.

II. LITERATURE SURVEY

1. Tarun Singh Tanwar, et al. Fluid flow conditions and parameters within a Radial Turbine with compliment to each part of the turbine in contact with the working fluid and all working region of the Radial turbine Plant that The maximum efficiency regime indicated by both approaches is nearly same. Reason for slight difference of efficiency calculated by theoretically and CFD technique can be because of natural misdoings and due to discretisation of areas and result of differential equations in computational approaches [21].

2. Ketczeu-Ngakam J, et al. Studied the Characterization of Hydrodynamics Parameters of a Kaplan Turbine by using Numerical analysis. Plant that the static pressure is too high near the volute walls and inside the distributors [20].

3. Mohamed Adel, et al. Studied the Numerical study of performance of kaplan turbine with draft tube. studied Kaplan turbine has a rotor with four blades mounted on a conical boss. The blade angle of the rotor is flexible from 60 ° to 80 °. A computational liquid unique code was used (CFDRC, 2008) to demonstrate the temperamental two- stage sluice field around the sharp edges of the Kaplan turbine [23].

4.K. Rama Chandra Manohar, KT is a propeller- type water turbine which has mobile edges. It was created in 1913 by Austrian educator Viktor Kaplan, who joined automatically acclimated propeller bleeding edges with typically acclimated gate ways to achieve profitability over a broad multifariousness of sluice and water position [18].

5.Ajaz bashir janjua, Given that the turbine sharp edges in a water turbine are constantly presented to water and dynamic powers, they need high consumption obstruction and quality. The chromium content in these steel amalgams surpass the base of 12 chromium needed to show some atmospheric corrosion inhibition. Further noteworthy weld-capacity takes into consideration easier form of the turbine sharp edges. This likewise considers advanced weld quality which brings about a superior form. Choosing a material with low consistence is critical to negotiate advanced proficiency claiming the lighter cut edges turn more effectively. The most extensively honored material employed as a part of Kaplan Turbine sharp edges are treated steel amalgams (SS) [15].

6. Tanjina Bintay Azad, Hydropower is one of the largest renewable energy sources for electricity generation. A good portion of the energy is commonly produced a era from using this hydropower as it's most economizing than using the other sources like coal burning or natural gas burning and left the lower injurious effect on the atmosphere [16].

7. Gordon, in 2001, proposed a approach of estimating and analysing the performance arc for several types of turbines. He developed a set of empirical equations for the calculation of turbine runner efficiency [14].

8.Ms.M. Ujwala etal. conducted a study on the design and analysis of low head, underweight Kaplan turbine blades. They substantially worked for enhancing the hydrodynamic efficiency of the Kaplan turbine by reducing weight, shape differences, blade angle with a combination of materials Aluminium amalgamation, Structural sword, Titanium mixture Stainless sword [26].

9. Chamil Abeykoon and Tobi Hantsch, showed that the theoretical design is low in accuracy particularly due to the numerous simplifying hypotheticals attached with the calculus process [26].

10.K. Menny, stated that the top efficiency can be achieved with 4 blades of this kind of turbine [26].

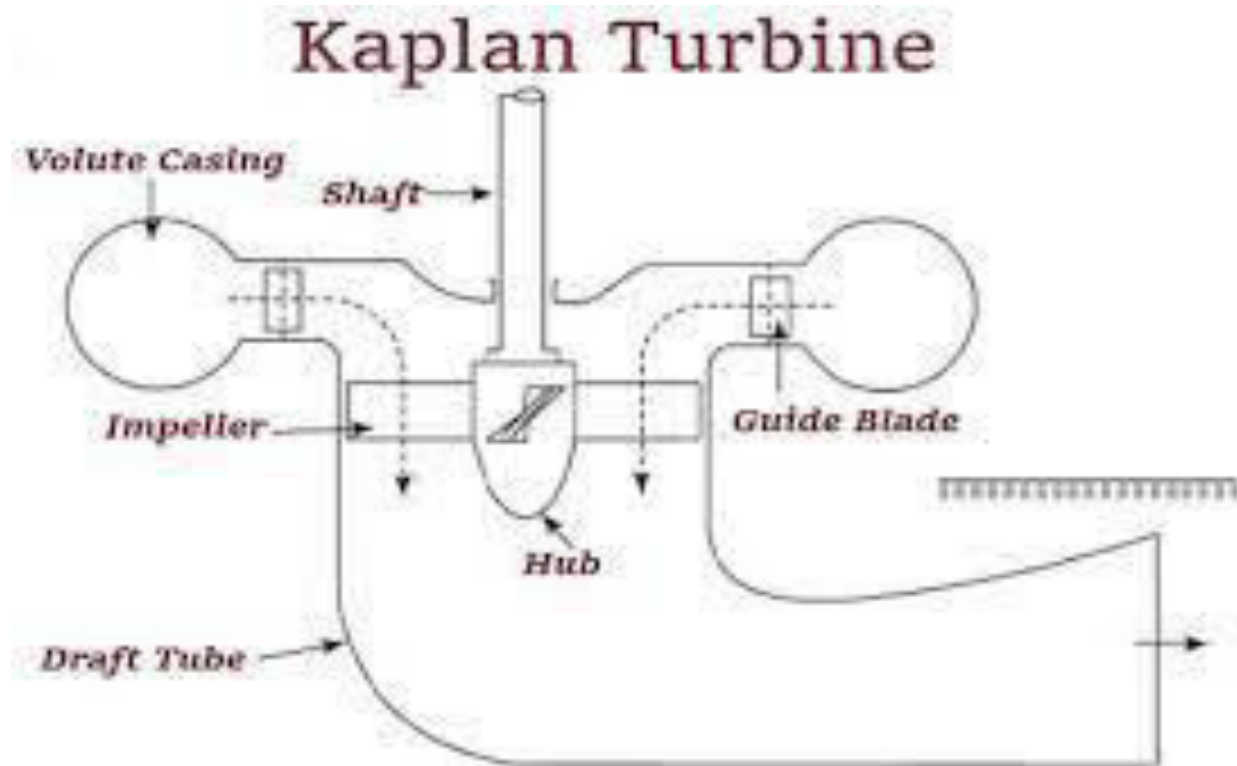


Figure 12d diagram of kaplan turbine

Kaplan turbine is a complete reaction turbine that works grounded on the lift force generated on the impeller blades due to its aerofoil shape. The working process of the Kaplan turbine is suchlike to the propeller- type turbine along with modifiable runner blades so that it can work easily at vortices and shocks during partial loading conditions. Kaplan turbine creates excellent progress to the small-scale hydropower workshops by generating high speed of the shaft at a

truly low head. A double- regulated Kaplan turbine offers a full discharge at 15 – 100 efficiency, whereas single-regulated Kaplan turbine shows maximum discharge at 30 – 100 efficiency. [23]

What's kaplan turbine

The Kaplan turbine is an axial flow turbine. In the Kaplan turbine, the water enters and exits the turbine through the runner's axis of revolution (axial flow). In simple words, the water enters and exits the turbine in an axial direction but this water flows in a direction parallel to the runner's axis of gyration. [1]

The Kaplan turbines work at the high flow rate of water and low head with maximum efficiency that isn't possible in Francis turbine. A unique point of Kaplan turbines is that their blades change their position as demanded to maintain the topmost efficiency under different water flow conditions. The water flowing through these turbines loses its pressure.

The area that water requires to enter into the Kaplan turbine is large, which corresponds to the total area of the blades. Because of the large area of the turbine, these turbines are also most useful in areas having a head with high water flow rates. This was especially important before the development of the Kaplan turbine. [2]

Before the development of Kaplan turbines, the maximum number of turbines was only suitable for a large head. Viktor Kaplan constructed 1st Kaplan turbine in 1913. Viktor Kaplan designed the Kaplan turbine grounded on the turboprop design and thus it works on the reverse principle of the propeller.

his was the 1st hydroelectric turbine that could operate at high water flow as well as a low head. The Kaplan turbine is also called a propeller turbine because its blades resemble propellers and work in the opposite direction with the same phenomenon. This makes it suitable for use in the lake and low head areas [4].

Kaplan turbine working principle

The Kaplan turbine working principle is actually simple. These turbines design for a low water head so that a high inflow rate of water is permitted. The Kaplan turbine scheme for hydropower is the same as for the Francis turbine. [1]

Kaplan turbine works on the principle of the axial flow reaction. In an axial flow turbine, the fluid moves by the impeller in a direction parallel to the impeller's axis of revolution. A Kaplan turbine works in the following way

- First of all, the water introduces into the volute/ scroll casing from the pen- stock.
- As water flows inside the volute jacket, companion blades direct the water from the covering toward the impeller blades. These blades are flexible and may change their position grounded on flow conditions.
- As the water enters into the impeller area, it takes a turn of 90o so that it can strike the impeller blades in an axial direction.
- When the water strikes the impeller blades, these blades start revolving because of the water reaction force.
- These blades converts K.E of the water into speed and increase the speed of the water.
- After passing through the impeller blades, the water reaches the draft tube, where the kinetic and pressure powers of the water reduce.
- This draft tube converts the kinetic energy or speed into pressure energy and increases the pressure of water.
- When the water pressure increases according to the requisites, the water delivers into the tailrace.
- The increased pressure of the water rotates the turbine. A generator is coupled with the turbine shaft. The revolution of the turbine further rotates the generator coil. According to Faraday's 1st law, " when a conductor rotates in a magnetic field furthermore electricity produces," and in hydroelectric powerplants, electricity produces by using the same phenomena. [7]

elements of kaplan turbine

he elements of the Kaplan turbine are given below in detail. [10]

1. Runner or Impeller
2. boss
3. Draft Tube
4. Runner Blades
5. Shaft

6. Guide Blades

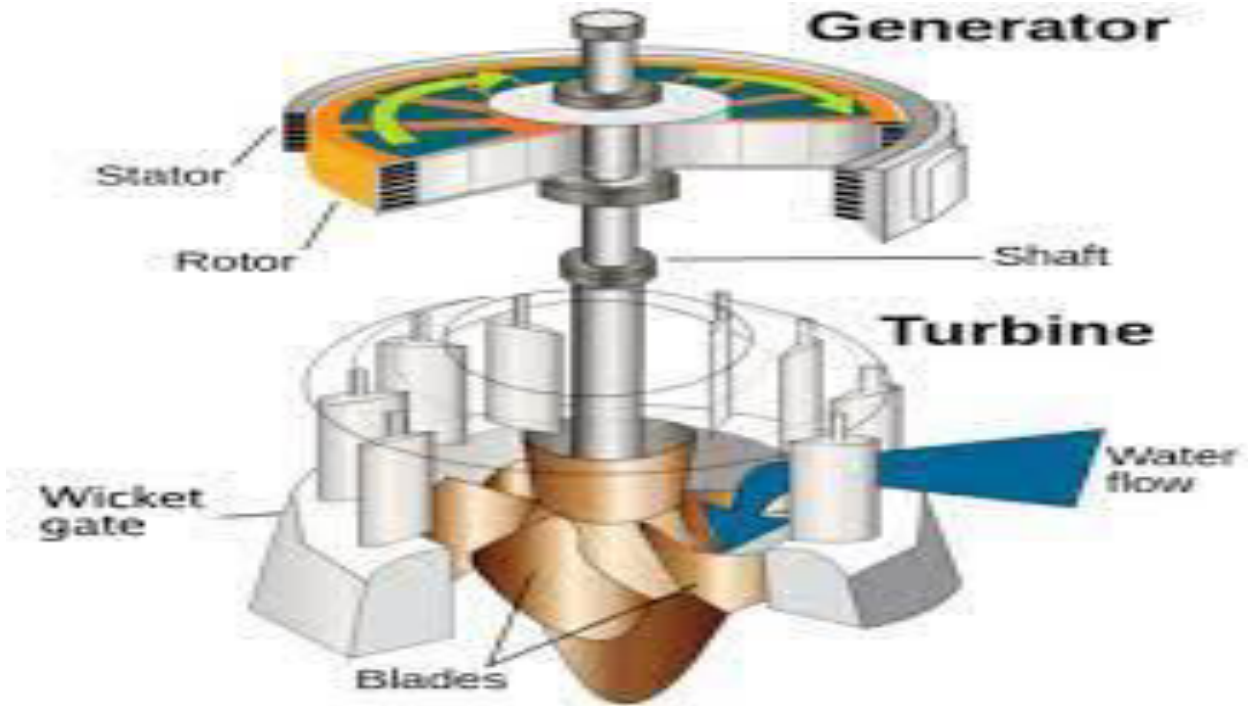


Figure 2 Runner of the Kaplan turbine

1) Runner Blades

The blades are the crucial elements of the turbine. The Kaplan turbine blade looks like a propeller. Other axial flow turbines have plane blades, while Kaplan blades haven't plane blades but are of twist shape lengthways so that the water swirls at the inlet- outlet. When the water strikes these blades, they start rotatory movement, which further rotates the shaft.

2) boss

boss includes in the essential elements of the Kaplan turbine. The blades mountain on the boss of the turbine. It controls the revolution of blades. And blades follow it for their movement. It connects with the central turbine shaft.

3) Shaft

The one end of the turbine shaft is linked with the turbine runner, while the other end is linked with the generator coil. As the runner rotates due to the revolution of the blades, the shaft also rotates, which further transmits its revolution to the generator coil. As the generator coil rotates, it produces electricity.

4) Guide Vane

The guide vane is a regulating element of the entire turbine. It switches on and off according to the necessities of power. Guide vanes rotate at a specific angle to regulatethewaterflow.However, it opens more so that a large volume of water can strike the rotor blades, If the power necessity is more. As the power necessities reduce, it opens lower so that a low quantity of water can strike the blades. The guide vanes increase the efficiency of the turbine. Without the guide vanes, the turbine ca n't operate efficiently, and the turbine efficiency will reduce.

5) Runner

The runner has a really vital task in the Kaplan turbine working. The runner or impeller is a rotating element of the turbine. It provides help for electricity produce. The axial water flow acting on the blades causes the revolution of the impeller, which further rotates the shaft.

6) Mechanism of Blade

The blade has a portable axis at the connection point. The blade control mechanism controls the attack angle as the water hits the blade, caused by the mobile blade connection. It includes in essential elements of the Kaplan turbine.

7) Volute casing

The entire turbine mechanism is enclosed by a casing called a scroll casing. The scroll casing reduces thecross-sectional area. First of all, the water flows from the pipe into the volute housing; after that, it flows into the guide vane area.

The water rotates upto 90° from the guide blade and moves axially by the impeller. The turbine casing prevents the guide vanes, impeller blades, runner, and other inner essential elements from damage due to any external weight.

8) Draft Tube

In the case of a Kaplan turbine, the atmospheric pressure is high than the pressure at the runner outlet area. Therefore, the fluid from the turbine outlet can't discharge directly into the tailrace. Due to this reason, a tube having a gradationally rising area uses to discharge the fluid from the outlet into the tailrace. This raising area tube is known as a Draft Tube.

The draft pipe attaches the outlet of the runner to the tailrace and drains the water from the turbine. The primary function of the draft tube is to reduce the flow rate and minimize the loss of K.E. at the exit. They reduce the water speed by raising the water shell.

Applications of Kaplan Turbine

1. These turbines use for the produce of electricity.
2. Microturbines are cheap that design for single power produce that can work for at least 24 inch head
3. Large Kaplan turbines are designed independently for each spot to achieve maximum efficiencies of up to 90.
4. really valuable to install, manufacture, and design, but they work for most years.
5. These turbines work more effectively at a high flow rate and low head.

Currently, the demand for the Kaplan turbine is raising each over the world. These turbines are extensively used for electricity product in different hydropower shops. So, the main reason for the fashionability of these turbines is their easy construction and small size. These turbines bear a low head that's a big of these turbines over other reaction turbines. So, the Kaplan turbine has high efficiency as compared to the Francis turbine. That's a significant advantage of these turbines over Francis turbines.

Characteristics of Kaplan turbine

Except for the runner, other elements of axial turbine are suchlike to the mixed- flow turbine.

Characteristics of axial turbine High speed which is 2 times of mixed- flow turbine when H and N is the same, small size. The runner blades can turn (double adaption); the turbine has high efficiency when H and N change.

b. Structure of runner axial portable- blade turbine is generally used in large hydropower station with low head and large discharge. Main Parts Blades, boss, main shaft, runner cone, rotating mechanism.

Blade Curved face, airfoil section, thick root, thin edge to bear the torque of water flow. quantity of blades Related to H, generally 4 -8 pieces.

Blade rotating angle $F F = 0^\circ$; when optimum operating condition, the blades begin to turn when $F > 0$, the blades turn to close when FF

Materials used in 3D Printing; To guide developers and architects, listed below are the Top 10 materials used for mechanical 3D printing.

ABS

ABS (Acrylonitrile Butadiene Styrene) is a thermoplastic that's generally used as a 3D printer filament. It's also a material generally used in private or home 3D printing and is a go-to material for top 3D printers.

Distinct Characteristics

- It's one of the most accessible and cheap materials for 3D printing.
- ABS is largely available and has a wide variety of colours.
- This material has a longer lifetime compared to Nylon.
- It's also mechanically strong.
- This material isn't suitable for potterers. It's only used for manufacturers and masterminds who are looking for high-quality prototype product.

Disadvantages

- It requires heated bed when printing.
- Since ABS accoutrements have high melting point, it has a tendency to witness warping if cooled while printing.
- This type of filament is anon-biodegradable poisonous material that releases poisonous smothers with awful smell at high temperature.



Resin

Resin is one of the most used material in 3D printing. It's mostly used in technologies similar as SLA, DLP, Multijet or CLIP technologies. There are colorful types of resins that can be used in 3D printing similar as castable resins, tough resins, flexible resins, etc.

Distinct characteristics

- It can be used in multiple operations.
- It has low shrinkage.
- Resin materials have high chemical resistance.
- This material is rigid and delicate.

Disadvantages

- It's costly.
- This type of filament also expires.
- It needs to be stored securely due to its high photo-reactivity.
- When exposed to heat, it can effect unseasonable polymerization.

PLA (Polylactic Acid)

PLA or Polylactic Acid are made from renewable coffers similar as sugarcane or cornstarch. It's also called "green plastic". It's mainly used in primary and secondary academies since it's safe to use and easy to print with. It's also used in FDM desktop printing.

Distinct characteristics

- PLA is easy to print since it has low screwing.
- It can also be printed on a cold face.
- It can print with sharper corners and features compared to ABS material.
- This material is available in different colours.

Disadvantages

- PLA materials aren't actually sturdy and can screw when exposed to extreme heat.
- This type of material is less sturdy.

Gold and silver

present, it's possible to 3D print using gold and silver. These filaments are sturdy materials and are processed in powder form. These materials are generally used in the jewellery sector. These metal use the DMLS (Direct Metal Laser Sintering) or SLM process for printing.

Distinct Characteristics

- It has high electrical conductance.
- It's heat evidence.

Disadvantages

- Printing with gold and silver are costly.
- It takes a lot of effort and time to get it right.
- Both gold and silver are tricky to work with spotlights because of its high reflectivity and high thermal conductivity.
- Since extremely high temperature is needed to print these materials, a regular FDM 3D printer isn't suitable to use.

Stainless steel

Stainless steel is printed by fusion or beam sintering. There are two possible technologies that can be used for this material. It can be DMLS or SLM technologies. Since stainless steel is all about strength and detail, it's perfect to use for miniatures, bolts and crucial chains

Distinct Characteristics

- Stainless steel can be heat treated in order to enhance strength and hardness.
- It performs well in high strength operations.



It provides strong resistance against corrosion.
It has high rigidity.

Disadvantages

Structure time for 3D printing using these metals are much longer.
Printing with stainless steel is costly.
Printing size is limited.

Titanium

Titanium is the strongest and the lightest material for 3D printing. It's used in the process called Direct Metal Laser Sintering. This metal is mostly used in high-tech fields like as space disquisition, aviation and medical field.

Distinct Characteristics

It provides major complexity and resolution in design.
It offers mechanical inventors precision in design.
It has an average face roughness.
Titanium is also biocompatible and resists corrosion.

Disadvantages

Titanium 3D printing is precious.

Ceramics

Ceramics is one of the newest material that's used in 3D printing. It's farther durable than metal and plastic since it can repel extreme heat and pressure without verily breaking or warping it. Also, this type of material isn't prone to corrosion like other metals or wear away like plastics do.

This material is generally used in Binder Jetting technology, SLA (Stereolithography) and DLP (Digital Light Processing).

Distinct characteristics

It has high- precision elements with a smooth and glossy face.
It has also resistance to acid, heat and lye.
It has a wide range of colour

Disadvantages

Ceramic requires great quantity of temperature to melt.
It isn't suitable for glazing and kilning processes.
Since it's fragile, it has limitations in printing objects with enclosed and interlocking parts.
It isn't ideal for piece assembly process.

HIPS or High Impact Polystyrene are plastic filaments that are used for support structures in FDM printers. It similar to ABS when it comes to ease of use. The only difference is its capability to dissolve. HIPS is fully answerable to a liquid hydrocarbon called limonene.

Distinct Characteristics

It has good machinability. It can also be used to make complex structures.
It's very smooth and underweight.
It's water resistant and impact resistant.
It's cheap.

Disadvantages

It produces strong fumes. Therefore, it's recommended to be used in a ventilated area.
Without constant heat flow, this material can clog up nozzle and delivery tubes of the printer.

III.METHODOLOGY

This below methodology we are going to follow in our project.

A . Design : In the Solidworks software the model of physical prototype to be fabricated is designed. Solid model is automatically generated as the enclosed volume . therefore prototyping the cross sections in direction must be closed curves for generating a solid object.

B. Conversion to stl file : After creating the model it is required to convert the model into a file format compatible with the 3D printing. Small triangular sections are used to approximate more curved surface in stl file format.

C. Checking and preparing : This stage involves or examining the design model stl file format followed by model preparation of physical model fabrication in next stage. Different softwares are available to check and repair the files. Idea maker is one of the software . Its main objective is to obtain optimization and guiding of work flow in 2d printing by enabling editing of stl file and data preparation. The stl file is imported to the slicer software. After importing files into software initially files are viewed to check errors which may lead to undesirable cracks, gaps, holes in physical model. Then error are repaired using tools available for repair in the software. After ensuring that stl files free from errors, data preparation is carried out . data preparation involves model slice data calculation and determine other build parameters the model is sliced into cross sections.Thickness of each slice and other build parameters such as build orientation ,assortments of special movement are evaluated using ,analysis data

D. 3D printing : In this stage fabrication of physical model is carried out in 3d printing machine. Once the 3D digital data is ready, printing machine is loaded with required material and machine is started for printing of the model. This stage is completely automated. Based on the size of the part and number of parts to be fabricated, building process may extend up to hours. After completion of part printing ,operator alert system gets activated. Thereby operator can stop the machine and the part for post processing .

E. Post processing : post processing is the final stage of 3d printing process. In this stage prototype obtained in printing is allowed to undergo different post processing operations such as cleaning, finishing, and post curing, based on the requirements. Mostly post processing are carried out manually, therefore operator has to deal carefully, without causing damage to the part. It may not be necessary to perform all post processing operations on parts built.

IV. CONCLUSION

In this project, the Kaplan turbine was designed using theoretical calculations and analyzed by varying blade angles to improve efficiency.The kaplan turbine was printed by using rapid prototyping method called fused deposition modelling.And done simulation using CFD analysis using solidworks software

REFERENCES

- [1] Liddell, Henry George; Scott, Robert; A Greek–English Lexicon at the Perseus Project.
- [2]. Munson, Bruce Roy, T. H. Okiishi, and Wade W. Huebsch. "Turbomachines." Fundamentals of Fluid Mechanics. 6th ed. Hoboken, NJ: J. Wiley & Sons, 2009. Print.
- [3]."Sir Charles Algernon Parsons". Encyclopædia Britannica. n.d. Retrieved 19 September 2010.
- [4].Adrian Osler (October 1981). "Turbinia" (PDF). (ASME-sponsored booklet to mark the designation of Turbinia as an international engineering landmark). Tyne And Wear County Council Museums. Archived from the original (PDF) on 28 September 2011. Retrieved 13 April 2011.
- [5].Sonntag, Richard E.; Borgnakke, Claus (2006). Introduction to engineering thermodynamics (Second ed.). John Wiley. ISBN 9780471737599.
- [6]. Anderson, John D., Jr. (2017). Fundamentals of aerodynamics (Sixth ed.). New York, NY. pp. 756–758. ISBN 978-1-259-12991-9. OCLC 927104254
- [7]. Miller, G. E.; Sidhu, A; Fink, R.; Etter, B. D. (1993). "July). Evaluation of a multiple disk centrifugal pump as an artificial ventricle". Artificial Organs. 17 (7): 590–592. doi:10.1111/j.1525-1594.1993.tb00599.x. PMID 8338431
- [8]. Miller, G. E.; Fink, R. (1999). "June). Analysis of optimal design configurations for a multiple disk centrifugal blood pump". Artificial Organs. 23 (6): 559–565. doi:10.1046/j.1525-1594.1999.06403.x. PMID 10392285



- [9]. "COW THAT ASSISTED SCIENCE". The South Eastern Times (1661). South Australia. 24 November 1922. p. 6. Retrieved 10 March 2017 – via National Library of Australia.
- [10]. "MINING INTELLIGENCE". Launceston Examiner. XLV (210). Tasmania, Australia. 22 August 1885. p. 3. Retrieved 10 March 2017 – via National Library of Australia.
- [11]. Lewis, B J; Cimbala, J M; Wouden, A M (2014-03-01). "Major historical developments in the design of water wheels and Francis hydroturbines". IOP Conference Series: Earth and Environmental Science. 22 (1): 012020. Bibcode:2014E&ES...22a2020L. doi:10.1088/1755-1315/22/1/012020. ISSN 1755-1315
- [12]. Paul Breeze, Power Generation Technologies (Third Edition), 2019
- [13]. "New Austrian Stamps". The Sun (1765). Sydney. 24 January 1937. p. 13. Retrieved 10 March 2017 – via National Library of Australia
- [14]. Hydropower project Tocomo (PDF). IMPSA (Report).
- [15]. Jonker Klunne, Wim. "Turgo turbine". hydropower.net. hydropower.net. Retrieved 7 March 2016.
- [16]. Robinson; Scott (2018). "Development of the Turgo turbine" (PDF). Hydropower & Dams
- [17]. E.F. Lindsley, Water power for your home, Popular Science, May 1977, Vol. 210, No. 5, 87-93.
- [18]. "World wind capacity at 650,8 GW, Corona crisis will slow down markets in 2020, renewables to be core of economic stimulus programmes" (Press release). WWEA. 16 April 2020. Retrieved 1 September 2021. Wind power capacity worldwide reaches 650,8 GW, 59,7 GW added in 2019
- [19]. YoosefDoost, Arash; Lubitz, William David (2020). "Archimedes Screw Turbines: A Sustainable Development Solution for Green and Renewable Energy Generation—A Review of Potential and Design Procedures".
- [20]. YoosefDoost, Arash; Lubitz, William David (December 2021). "Design Guideline for Hydropower Plants Using One or Multiple Archimedes Screws".
- [21]. K. Rama Chandra Manohar, "Modeling and Analysis of Kaplan Turbine Blade Using CFD," *ijet*, vol. 5, no. 7, p. 6, 2018.
- [22]. "Design & CFD Analysis of Blade Geometry of Kaplan Turbine," *ICMIEE*, vol. 2, no. 2021, p. 16, 2021
- [23]. Pobitra Halder, ... M.M.K. Khan, in *Advances in Clean Energy Technologies*, 2021
- [24]. https://mechanicalboost.com/kaplan-turbine-a-completeoverview/#Applications_of_Kaplan_Turbines



INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 8.118



ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 **9940 572 462**  **6381 907 438**  **ijirset@gmail.com**



www.ijirset.com

Scan to save the contact details