DESIGN AND FABRICATION OF MANUALLY OPERATED OVERHEAD WATER TANK CLEANING MACHINE

A PROJECT REPORT

Submitted by

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in

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M.KUMARASAMY COLLEGE OF ENGINEERING, KARUR

BONAFIDE CERTIFICATE

Certified that this project report **"DESIGN AND FABRICATION OF MANUALLY OPERATED OVERHEAD WATER TANK CLEANING SYSTEM"** is the bonafide work of **"MATHAN BALAJI.G (927622BME050), MIDHUN.K (927622BME051), MOHAMEDRIAZ.S (927622BME310)"** who carried out the project work during the academic year 2023 – 2024 under my supervision. Certified further, that to the best of my knowledge the work reported herein does not form part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

DECLARATION

We affirm that the Project titled **"DESIGN AND FABRICATION OF MANUALLY OPERATED OVERHEAD WATER TANK CLEANING SYSTEM"** being submitted in partial fulfillment of for the award of Bachelor of Engineering in Mechanical Engineering, is the original work carried out by us. It has not formed the part of any other project or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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2) MIDHUN .K	----------
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I certify that the declaration made by the above candidates is true to the best of my knowledge.

Name and signature of the supervisor with date

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Words are boundless to thank **Our Parents and Friends** for their constant encouragementto complete this project successfully.

INSTITUTION VISION & MISSION

Vision

- To emerge as a leader among the top institutions in the field of technical education.

Mission

- Produce smart technocrats with empirical knowledge who can surmount the global challenges.
- Create a diverse, fully-engaged, learner-centric campus environment to provide quality education to the students.
- Maintain mutually beneficial partnerships with our alumni, industry and professional associations.

DEPARTMENT VISION, MISSION, PEO, PO & PSO

Vision

- To create globally recognized competent Mechanical engineers to work in multicultural environment.

Mission

- To impart quality education in the field of mechanical engineering and to enhance their skills, to pursue careers or enter into higher education in their area of interest.
- To establish a learner-centric atmosphere along with state-of-the-art research facility.
- To make collaboration with industries, distinguished research institution and to become a centre of excellence.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

The graduates of Mechanical Engineering will be able to

- PEO1: Graduates of the program will accommodate insightful information of engineering principles necessary for the applications of engineering.
- PEO2: Graduates of the program will acquire knowledge of recent trends in technology and solve problem in industry.
- PEO3: Graduates of the program will have practical experience and interpersonal skills to work both in local and international environments.
- PEO4: Graduates of the program will possess creative professionalism, understand their ethical responsibility and committed towards society.

PROGRAM OUTCOMES

The following are the Program Outcomes of Engineering Graduates:Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability:** Understand the impact of the professionalengineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

The following are the Program Specific Outcomes of Engineering Graduates:

The students will demonstrate the abilities

1. **Real world application:** To comprehend, analyze, design and develop innovative products and provide solutions for the real-life problems.
2. **Multi-disciplinary areas:** To work collaboratively on multi-disciplinary areas andmake quality projects.
3. **Research oriented innovative ideas and methods:** To adopt modern tools,mathematical, scientific and engineering fundamentals required to solveindustrial and societal problems.

MAPPING OF PO & PSO WITH THE PROJECT OUTCOME

Cos	COURSESTATEMEN T	BLOOMS LEV EL	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	P0 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
1	Formulate a real world problem, identify the requirement and develop the design solutions.	K3	3	3	3			3	3	3	3	3			3	3	3
2	Identify technical ideas, strategies and methodologies	K3	3	3	3			3	3	3	3	3			3	3	3
3	Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project	K4	3	3	3	3	3	3	3	3	3	3		3	3	3	3
4	Test and validate through conformance of the developed prototype and analysis the cost-effectiveness.	K4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
5	Prepare report and present oral demonstration	K4	3							3	3	3		3	3		3
Average			3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

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CHAPTER 1

ABSTRACT

This project presents the design and fabrication of a manually operated overhead water tank cleaning machine, utilizing a mechanical system of bevel gears and a rack and pinion mechanism, eliminating the need for electric motors. Traditional cleaning methods for overhead water tanks are not only labor-intensive but also pose significant health and safety risks. The proposed machine aims to address these issues by providing an efficient, safe, and user-friendly solution. The cleaning device is designed to incorporate a rotating brush system powered by a manual crank that drives a set of bevel gears. These gears translate the rotational motion of the crank into the brush's rotational movement, ensuring thorough cleaning of the tank's interior surfaces. Additionally, the machine features a rack and pinion mechanism to adjust the vertical position of the cleaning head, allowing it to reach different depths and areas within the tank. Constructed from corrosion-resistant materials, such as stainless steel for the frame and durable, non-abrasive materials for the brushes, the machine is built to withstand the harsh environment inside water tanks. Through this innovative approach, the project aims to enhance the effectiveness and safety of water tank maintenance without relying on electrical components. The prototype has undergone testing in different scenarios, demonstrating its capability to reduce cleaning time significantly while maintaining high standards of hygiene. This manual overhead water tank cleaning machine offers a sustainable and practical solution for maintaining clean water storage systems in residential, commercial, and industrial settings

CHAPTER 2

INDRODUCTION

In the pursuit of maintaining clean and safe water storage, the Overhead Water Tank Cleaning Machine emerges as a cutting-edge solution. This innovative technology is designed to revolutionize the traditional methods of water tank cleaning, providing a more efficient, thorough, and time-saving approach. Water tanks, whether for residential, commercial, or industrial use, are prone to accumulating sediments, algae, and contaminants over time. Conventional cleaning methods often involve draining the tank, manual scrubbing, and the use of chemicals, which can be labor-intensive, time-consuming, and environmentally unfriendly. The Water Tank Cleaner Machine addresses these challenges by employing advanced cleaning mechanisms called “DESIGN AND FABRICATION OF MANUALLY OPERATED OVERHEAD WATER TANK CLEANING MACHINE”. This project focuses on the design and fabrication of a manually operated overhead water tank cleaning machine that leverages mechanical systems, specifically bevel gears and a rack and pinion mechanism, to perform cleaning tasks without the need for electric motors. By eliminating reliance on electrical power, the proposed device aims to provide a cost-effective, reliable, and user-friendly alternative that can be used in a variety of settings, including areas with limited access to electricity. The machine's design centers around a manually driven rotating brush system, facilitated by bevel gears, to scrub the interior surfaces of the tank. A rack and pinion mechanism allows for precise vertical adjustment of the cleaning head, ensuring thorough cleaning coverage. Constructed with durable, corrosion-resistant materials, the machine is designed to withstand the demanding environment within water tanks, ensuring longevity and minimal maintenance. The

introduction of this manual cleaning device addresses the critical need for a safe, efficient, and sustainable method to maintain water tank hygiene, reducing downtime and ensuring a consistent supply of clean water. This project represents a significant advancement in water tank maintenance technology, providing a practical solution that enhances operational safety and effectiveness.

2.1 LITERATURE REVIEW

ThongeSuraj D., Shelke Prasad K. , WakteVaibhav B., ThongeSharad A.4 Prof. Shinde R.S.

"Automatic Water Tank Cleaning Machine"

Aim of this project is to develop a mechanical system for cleaning domestic cylindrical water tank. The mechanical system includes two main mechanisms which are rack and pinion gear mechanism and reciprocating four bar linkage mechanism. The rack and pinion arrangement is used to move whole mechanical system up and down for cleaning the cylindrical tank. The rack is fixed on the motor and the four-bar mechanism is attached to the motor shaft. PVC brushes are attached to the ends of the four-bar linkage. Four bar linkage is made in such a way that it can be adjusted according to inside diameter of the tank. When the motor is started the linkage rotates and with the help of brushes, cleaning of wall and base of tank takes place. The purpose of this project is to reduce the human efforts and to avoid the chemical influence on health of person entering the tank for cleaning.

Mr. ShubhamSamrit , Mr.DivyarajsinghMandale ,Mr. AnkitRokade, Mr.PareshChoudhary , Mr.Faisal Khan , Mr.AbhijeetKongre , Mr.Harshaldalvi , MrSaurabhZade Prof. M.S.Giripunje

"Fabrication of Water Tank Cleaning Machine"

Aim of this project is to develop a mechanical system for cleaning domestic cylindrical water tank. The mechanical system includes two main mechanisms which are rack and pinion gear mechanism and motion reversal mechanism. The rack and pinion arrangement is used to move whole mechanical system up and down for cleaning the cylindrical tank. The rack is fixed on the motor and the rotational mechanism is attached to the motor shaft. PVC brushes are attached to the ends of the four-bar linkage. Four bar linkage is made in such a way that it can be adjusted according to inside diameter of the tank.

Mr. MayurKhaparde , Mr. Shubhamkalmegh, Mr. Mayank Lund

"WATER TANK CLEANING MECHANISM"

A water tank cleaning mechanism is basically one of the cleaning medium. Generally we are all not aware of the crisis for water that is why we need to resolve it. Saving water for future will indulge in getting over the scarcity of water. This mechanism will help in overcoming the issues related to water tank used for the storing of water, by only cleaning the walls without disturbing the flow lines and cleaning it. As for sure until and unless it hasn't been discovered a full proof cleaning for tanks. By over viewing the total scenario of water usage, it has been seen that villages are still dry there is no water for the farms, farmers and their families hope for the best but still some areas are covered and some are still not influenced. The government protocols for saving water are acting now effectively, they have started cleaning rivers, stated with new enforcements to tackle the irrigation projects, using water only that much that it will do, etc. WATER TANK CLEANING MECHANISM [WTCF] has a powerful motor mounted over the top so as that will rotate the blades on which

the string/threads of cotton are attached with the help of plate. A shaft coupled with motor is the power transmission entity. It has a base over the back as the motor weighs heavy so to counter balance the weight of motor an the angles of steel 2 more balancing angles are provided in the front.a gear mechanism with sprocket of a bicycle having chain over it is used for the vertical and downward motion of the shaft. The angles have been set such that it perfectly fits in and help balancing. The cleaning plated can be changed according to the diameter of the tank.

S. Abhishekh, D. Kiran, P. Praveen and Dr. K. L. Senthilkumar

"Design and Fabrication of Automatic System Overhead Tank Cleaning"

-In this modern world, cleaning of overhead tanks manually is a tedious job. To overcome this we have aimed at tackling the disadvantages of cleaning overhead tanks, so an automatic system overhead tank cleaning is designed to provide high safety, high efficiency, and to avoid environmental pollution problems. Purpose of this project is to clean domestic cylindrical water tank with the help of mechatronics system. The mechatronics system consists of a grooved gear rod attached to two arms with brushes at ends. The two arms are connected to the gear rod by nut. By rotating the gear rod, the up and down motion of the two arms is achieved. The gear rod is rotated with the help of a D.C gear motor. The motor and the shaft are connected by a rubber belt. The clockwise rotation of the main shaft will make the arms move. The whole operation is controlled by of relay switches, buttons, and PIC microcontroller. The number of times for the operation to repeat can be fed into the circuit. The achievement of this project is reduction of cost and manual labour because there will be harmful diseases for the person who will go inside and it will affect the health as well as the other human being who consumes water from the tank.

CHAPTER 3

WORKING PRINCIPLE

The manually operated overhead water tank cleaning machine functions through a combination of mechanical systems, specifically bevel gears and a rack and pinion mechanism, to achieve efficient cleaning without the need for electric motors. The machine's operation can be understood through the following key components and their interactions:

Bevel Gears:

The cleaning process begins with the user turning a manual crank handle located outside the water tank. This crank is connected to a primary shaft that extends into the tank. Attached to the end of this primary shaft is a bevel gear, which meshes with another bevel gear oriented at a right angle. This secondary bevel gear is connected to the cleaning brush's shaft. As the user rotates the crank, the primary bevel gear transmits rotational motion to the secondary bevel gear, causing the brush shaft to rotate. This rotation enables the brush to scrub the interior surfaces of the tank effectively.

Rack and Pinion Mechanism:

To allow vertical movement and reach different areas within the tank, the machine is equipped with a rack and pinion system. The rack, a linear gear, is fixed along the vertical axis of the cleaning machine’s frame. The pinion, a small gear, is mounted on the shaft connected to the cleaning head. By turning a secondary handle, the user can rotate the pinion, which engages with the rack and moves the cleaning head up or down. This mechanism allows precise positioning of the brush to ensure comprehensive coverage of the tank’s interior surfaces.

Brush Assembly:

The cleaning brush is made from durable, non-abrasive materials that are gentle on the tank surfaces but effective in removing dirt, sediment, and biofilm.

As the brush rotates, driven by the bevel gears, it scrubs the interior walls of the tank, dislodging and cleaning off contaminants.

By manually operating the crank and adjusting the rack and pinion system, the user can control the rotation and vertical movement of the cleaning brush, ensuring thorough and efficient cleaning of the tank's interior. This mechanical approach offers a reliable, cost-effective, and user-friendly solution for maintaining water tank hygiene without the need for electrical power.

CHAPTER 4

MAJOR COMPONENTS

Materials Used:

4.1 FRAME
4.2 BRUSH
4.3 HANDLE
4.4 SHAFT
4.5 METAL STRIP
4.6 BEARING
4.7 BEVEL GEARS
4.8 RACK AND PINION

4.1 METAL FRAME

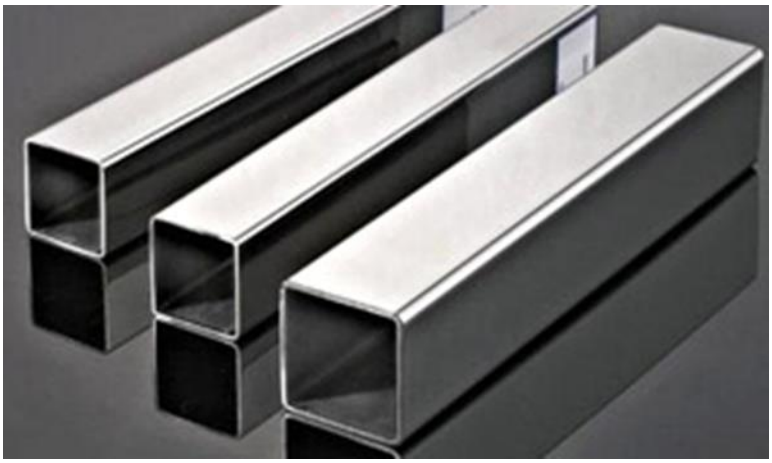

Fig.4.1 Metal frame

The metal frame is generally made of **mild steel** bars for machining, suitable for lightly stressed components including studs, bolts, gears and shafts. It can be case-hardened to improve wear resistance. They are available in bright rounds, squares and flats, and hot rolled rounds Suitable machining allowances should therefore be added when ordering. It does not contain any additions for

enhancing mechanical or machining properties. Bright drawn mild steel is an improved quality material, free of scale, and has been cold worked (drawn or rolled) to size. It is produced to close dimensional tolerances. Straightness and flatness are better than black steel. It is more suitable for repetition precision machining. Bright drawn steel has more consistent hardness, and increased tensile strength. Bright steel can also be obtained in precision turned or ground form if desired.

4.2 CLEANING BRUSH

Fig. 4.2 Brush

The scrubber brush that is used is same as that used in the present rider scrubber (electrically powered). This brush is also easily available in the market on demand. The scrubber brush is circular in shape that when rotat

The front brush used in this machine is the simple spring loaded brush ensuring the brushing up of the big dirt particle coming on the way of cleaning floor. This brush is fixed at the very first portion of the machine. es cleans the floor effectively

4.3 HANDLE

Fig. 4.3 Handle

Handle Material used: Mild Steel

The machine is designed with two handle to adapt to various tank sizes and shapes. This adjustable handle allows the user to extend or retract the reach of the cleaning device, ensuring it can be effectively used in different overhead water tanks

4.4 SHAFT

Fig. 4.4 Shaft

Specifications

Shaft diameter: 12mm

Material: mild steel

Length:26 inch

Shaft

Shaft is a common and important machine element. It is a rotating member, in general, has a circular cross-section and is used to transmit power. The shaft may be hollow or solid. The shaft is supported on bearings and it rotates a set of gears or pulleys for the purpose of power transmission. The shaft is generally acted upon by bending moment, torsion and axial force. Design of shaft primarily involves in determining stresses at critical point in the shaft that is arising due to aforementioned loading. Other two similar forms of a shaft are axle and spindle. Axle is a non-rotating member used for supporting rotating wheels etc. and do not transmit any torque. Spindle is simply defined as a short shaft. However, design method remains the same for axle and spindle as that for a shaft. 8.1.2 Standard sizes of Shafts Typical sizes of solid shaft that are available in the market are, Up to 25 mm 0.5 mm increments 25 to 50 mm 1.0 mm increments 50 to 100 mm 2.0 mm increments 100 to 200 mm 5.0 mm increments 8.1.3 Material for Shafts The ferrous, non-ferrous materials and non metals are used as shaft material depending on the application. Some of the common ferrous materials used for shaft are discussed below. Hot-rolled plain carbon steel. These materials are least expensive. Since it is hot rolled, scaling is always present on the surface and machining is required to make the surface smooth.

Since it is cold drawn it has got its inherent characteristics of smooth bright finish. Amount of machining therefore is minimal. Better yield strength is also obtained. This is widely used for general purpose transmission shaft.

4.5 METAL STRIP

Fig. 4.5 Metal strip

Specifications

Length: 50cm

Width: 5cm

Thickness: 4mm

Metal strip is narrow, thin stock that is usually 3/16 in. (4.76 mm) or less in thickness and under 24 in. (609.6 mm) in width. Metal strips are formed to precise thicknesses and/or width requirements.

How Metal Strip is made?

Metal strip can be designed and manipulated through a large number of processes which are grouped into categories. They are joining and assembly processes, deformation processes, material removal processes, heat treating processes, and finishing processes.

Joining and assembly processes include welding, soldering, brazing, fastening, and other processes that connect parts permanently or semi-permanently to form a new entity.

4.6 BALL BEARING

Fig. 4.6 Ball Bearings

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races. The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least three races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly (e.g., a hub or shaft). As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were sliding against each other. Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races. However, they can tolerate some misalignment of the inner and outer.

SPECIFICATION

INNER DIA :12mm

OUTER DIA : 37mm

DESIGN

ANGULAR CONTACT

An angular contact ball bearing uses axially asymmetric races. An axial load passes in a straight line through the bearing, whereas a radial load takes an oblique path that acts to separate the races axially. So the angle of contact on the inner race is the same as that on the outer race. Angular contact bearings better support combined loads (loading in both the radial and axial directions) and the contact angle of the bearing should be matched to the relative proportions of each. The larger the contact angle (typically in the range 10 to 45 degrees), the higher the axial load supported, but the lower the radial load. In high speed applications, such as turbines, jet engines, and dentistry equipment, the centrifugal forces generated by the balls changes the contact angle at the inner and outer race. Ceramics such as silicon nitride are now regularly used in such applications due to their low density (40% of steel). These materials significantly reduce centrifugal force and function well in high temperature environments. Most bicycles use angular-contact bearings in the headsets because the forces on these bearings are in both the radial and axial direction.

PRELOADED PAIRS

The above basic types of bearings are typically applied in a method of preloaded pairs, where two individual bearings are rigidly fastened along a rotating shaft to face each other. This improves the axial runout by taking up (preloading) the necessary slight clearance between the bearing balls and races. Pairing also provides an advantage of evenly distributing the loads, nearly doubling the total load capacity compared to a single bearing. Angular contact

bearings are almost always used in opposing pairs: the asymmetric design of each bearing supports axial loads in only one direction, so an opposed pair is required if the application demands support both directions.

MAXIMUM LOAD

In general, maximum load on a ball bearing is proportional to outer diameter of the bearing times the width of the bearing (where width is measured in direction of axle). Bearings have static load ratings. These are based on not exceeding a certain amount of plastic deformation in the raceway. These ratings may be exceeded by a large amount for certain applications.

FIT

Bearings can withstand their maximum load only if the mating parts are properly sized. Bearing manufacturers supply tolerances for the fit of the shaft and the housing so that this can be achieved. The material and hardness may also be specified. Fittings that are not allowed to slip are made to diameters that prevent slipping and consequently the mating surfaces cannot be brought into position without force. For small bearings this is best done with a press because tapping with a hammer damages both bearing and shaft, while for large bearings the necessary forces are so great that there is no alternative to heating one part before fitting, so that thermal expansion allows a temporary sliding fit.

4.7 BEVEL GEARS

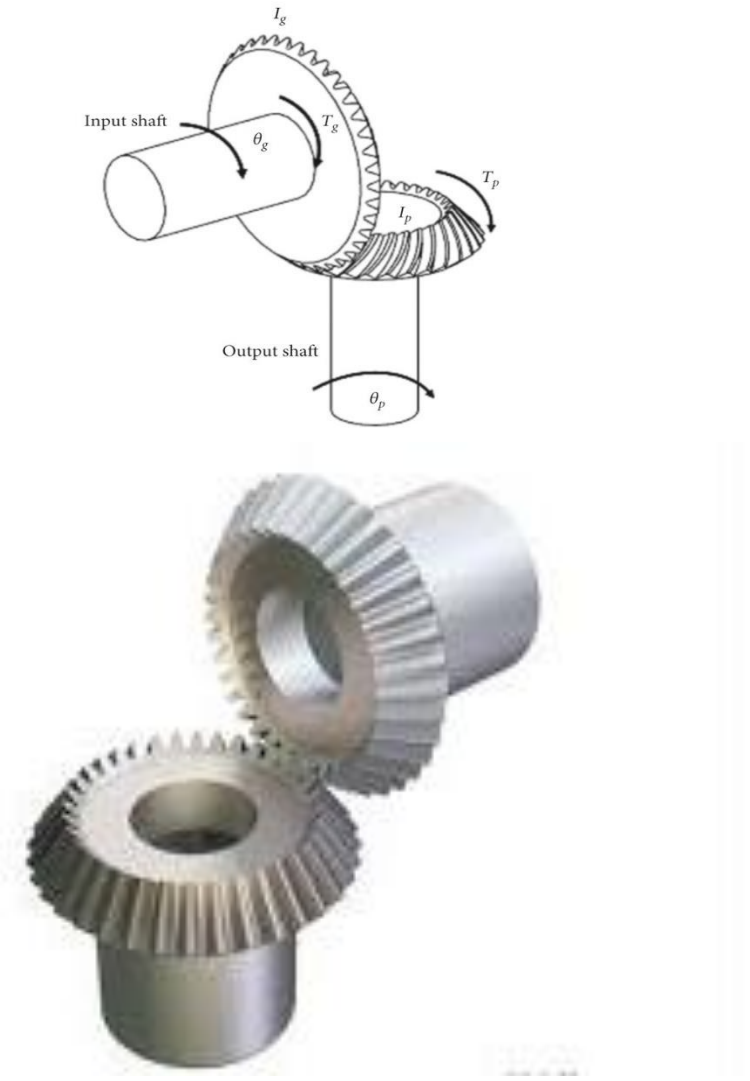

Fig. 3.7 Bevel Gear

Bevel gears are a type of gear where the axes of the two shafts intersect and the tooth-bearing faces of the gears themselves are conically shaped. They are typically mounted on shafts that are 90 degrees apart but can be designed to work at other angles as well. Understanding bevel gears requires knowledge of their geometry, types, and applications. Here's a detailed overview of the theory behind bevel gears:

Geometry of Bevel Gears

Pitch Cone: The fundamental concept in bevel gears is the pitch cone. The

pitch surface of a bevel gear is a cone.

Cone Angle: The angle formed by the pitch cone and the axis of the gear is called the cone angle.

Face Angle and Root Angle: The face angle is the angle of the gear tooth surface measured from the pitch cone, while the root angle is measured from the pitch cone to the bottom of the gear teeth

Back Cone: This is a theoretical cone that represents the back of the bevel gear

Key Equations and Concepts

Pitch Diameter: The diameter of the pitch circle, which is the imaginary circle that represents the point of contact between two gears. For bevel gears, the pitch diameter varies along the face width.

Module (m): A measure of the size of the gear teeth, defined as the ratio of the pitch diameter to the number of teeth. In bevel gears, the module is often specified along the pitch cone.

Pressure Angle (α): The angle between the line of action (which is the line along which the force is transmitted between the gears) and the tangent to the pitch surface. It affects the shape and strength of the gear teeth.

Gear Ratio: The ratio of the number of teeth on the driven gear to the number of teeth on the driving gear. For bevel gears, this also determines the relative sizes of the pitch cones.

Design and Manufacturing

Cutting Methods: Bevel gears can be manufactured using various methods, including hobbing, milling, and grinding. The choice of method affects the precision and finish of the gear teeth.

Load Distribution: The shape of the bevel gear teeth affects how the load is distributed across the gear face. Proper alignment and meshing are crucial for efficient load transfer and minimizing wear.

Material Selection: Materials for bevel gears must be chosen based on the application requirements, including load capacity, wear resistance, and manufacturing considerations. Common materials include steel, cast iron, and various alloys.

4.8 RACK AND PINION MECHANISM

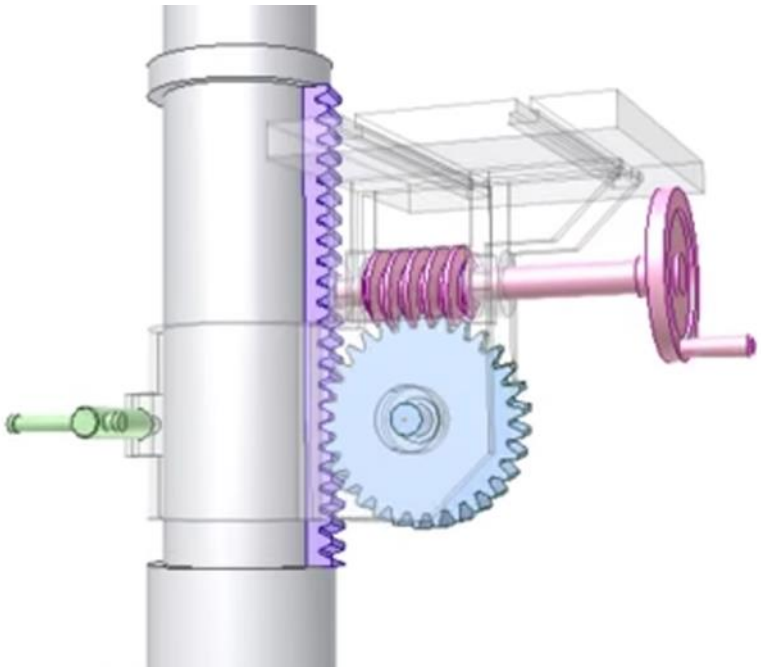

Fig. 4.8 Rack and Pinion

Rack and pinion mechanisms are used to convert rotational motion into linear motion or vice versa. This system consists of two main components: the rack, which is a flat, toothed bar, and the pinion, a small, cylindrical gear that engages with the teeth of the rack. Understanding rack and pinion systems involves examining their components, operation principles, types, and applications.

Components and Geometry

Rack: A straight or circular bar with teeth cut into one side, designed to mesh with the pinion. The pitch of the teeth (distance between corresponding points on adjacent teeth) on the rack must match that of the pinion.

Pinion: A circular gear that engages with the rack. The rotation of the pinion moves the rack in a linear direction. The size of the pinion, determined by its

pitch diameter, affects the speed and force of the linear motion.

Operational Principles

Conversion of Motion: The primary function of a rack and pinion system is to convert rotational motion into linear motion. When the pinion rotates, its teeth push against the teeth on the rack, causing the rack to move in a straight line. Conversely, linear movement of the rack will cause the pinion to rotate.

Speed and Force Relationship: The linear speed of the rack is proportional to the rotational speed of the pinion and its radius. The force exerted by the rack is inversely proportional to the pinion's radius, meaning a larger pinion reduces the force but increases the speed of the linear motion.

Advantages:

- Simple and robust design.
- Precise control over linear motion.
- High efficiency and reliability.
- Capable of handling high loads.

Disadvantages:

- Direct contact between teeth can lead to wear and tear.
- Requires regular maintenance and lubrication.
- Not suitable for high-speed applications due to potential for noise and vibration.

CHAPTER 5

HOW IT WORKS

Preparation and Setup:

Ensure the overhead water tank is empty or has minimal water to facilitate cleaning. Position the cleaning machine at the top of the tank, aligning the handle and cleaning head with the tank opening. Extend the handle to reach the bottom of the tank if necessary.

Initial Adjustment:

Adjust the rack and pinion mechanism by turning the secondary handle to lower or raise the cleaning head to the desired starting position, typically near the bottom of the tank.

Manual Crank Operation:

Begin rotating the manual crank handle located outside the tank. This action rotates the primary shaft connected to the bevel gear system. The primary bevel gear transfers the rotational motion to the secondary bevel gear, which is connected to the cleaning brush shaft inside the tank. As the bevel gears engage, the brush starts to rotate, scrubbing the tank's interior surfaces.

Vertical Cleaning Movement:

While the brush rotates, gradually move the cleaning head upwards by further adjusting the rack and pinion system using the secondary handle.

Continue to turn the crank handle to keep the brush rotating as it moves vertically. This ensures the brush cleans all areas of the tank from bottom to top. If needed, adjust the telescopic handle to maintain optimal brush contact with the tank walls.

Comprehensive Coverage:

To ensure thorough cleaning, move the cleaning head laterally within the tank by repositioning the telescopic handle, allowing the rotating brush to cover all areas. Repeat the vertical movement process, lowering and raising the cleaning head multiple times, to ensure all surfaces are scrubbed.

Final Cleaning and Rinsing:

After scrubbing the entire interior surface, flush the tank with clean water to remove any dislodged dirt and debris. Inspect the tank to ensure all areas have been thoroughly cleaned. If necessary, repeat the scrubbing process for any remaining dirty spots.

Disassembly and Storage:

Once cleaning is complete, retract the telescopic handle and remove the cleaning machine from the tank. Disassemble any parts as needed for storage and maintenance. Clean the brushes and other components to ensure they are free of debris and ready for the next use.

Maintenance:

Periodically check the condition of the bevel gears, rack and pinion system, and brushes. Lubricate the gears as needed to ensure smooth operation. Replace any worn or damaged parts to maintain the machine's effectiveness and longevity.

By following these steps, the manually operated overhead water tank cleaning machine can efficiently and thoroughly clean the interior surfaces of the tank, ensuring a hygienic water storage environment without the need for electrical power.

CHAPTER 6

MANUFACTURING PROCESS

Manufacturing processes are the steps through which raw materials are transformed into a final product. The manufacturing process begins with the creation of the materials from which the design is made. These materials are then modified through manufacturing processes to become the required part. Manufacturing processes can include treating (such as heat treating or coating), machining, or reshaping the material. The manufacturing process also includes tests and checks for quality assurance during or after the manufacturing, and planning the production process prior to manufacturing.

SAWING:

Cold saws are saws that make use of a circular saw blade to cut through various types of metal, including sheet metal. The name of the saw has to do with the action that takes place during the cutting process, which manages to keep both the metal and the blade from becoming too hot. A cold saw is powered with electricity and is usually a stationary type of saw machine rather than a portable type of saw.

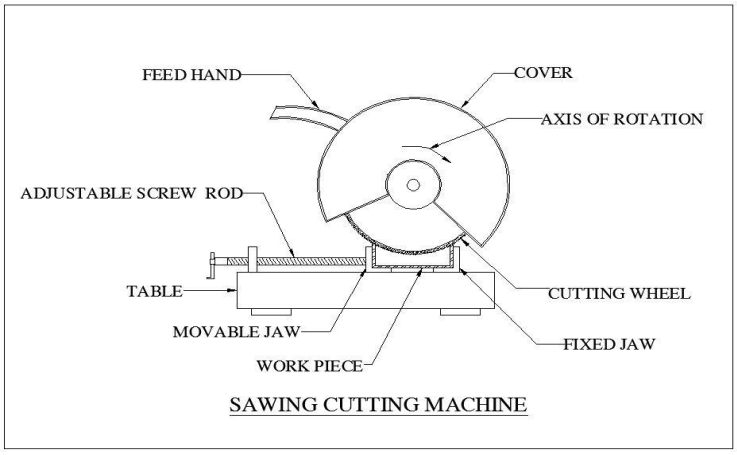

Fig. 6.1 Sawing Cutting Machine

Fig. 6.2 Cutting frames using sawing cutting machine

The circular saw blades used with a cold saw are often constructed of high speed steel. Steel blades of this type are resistant to wear even under daily usage. The end result is that it is possible to complete a number of cutting projects before there is a need to replace the blade. High speed steel blades are especially useful when the saws are used for cutting through thicker sections of metal.

WELDING:

Welding is a process for joining similar metals. Welding joins metals by melting and fusing **1,** the base metals being joined and **2,** the filler metal applied. Welding employs pinpointed, localized heat input. Most welding involves ferrous-based metals such as steel and stainless steel.Weld joints are usually stronger than or as strong as the base metals being joined.

Fig. 6.3 Welding frames using weld

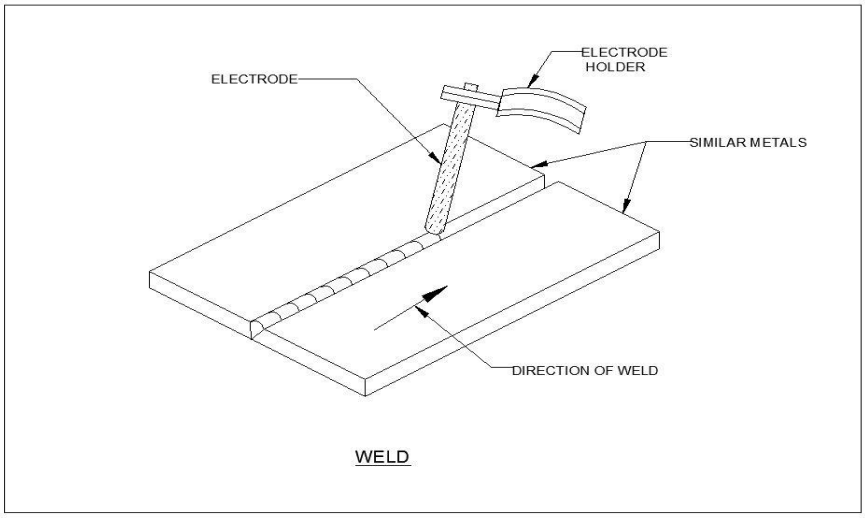

Fig. 6.4 Weld

Welding is used for making permanent joints. It is used in the manufacture of automobile bodies, aircraft frames, railway wagons, machine frames, structural works, tanks, furniture, boilers, general repair work and ship building.

OPERATION:

Several welding processes are based on heating with an electric arc, only a few are considered here, starting with the oldest, simple arc welding, also known as shielded metal arc welding (SMAW) or stick welding. In this process an electrical machine (which may be DC or AC, but nowadays is usually AC) supplies current to an electrode holder which carries an electrode which is normally coated with a mixture of chemicals or flux. An earth cable connects the work piece to the welding machine to provide a return path for the current. The weld is initiated by tapping ('striking') the tip of the electrode against the work piece which initiates an electric arc. The high temperature generated (about 6000^{o}C) almost instantly produces a molten pool and the end of the electrode continuously melts into this pool and forms the joint. The operator needs to control the gap between the electrode tip and the work piece while moving the electrode along the joint.

CHAPTER 7

MODEL DIAGRAM

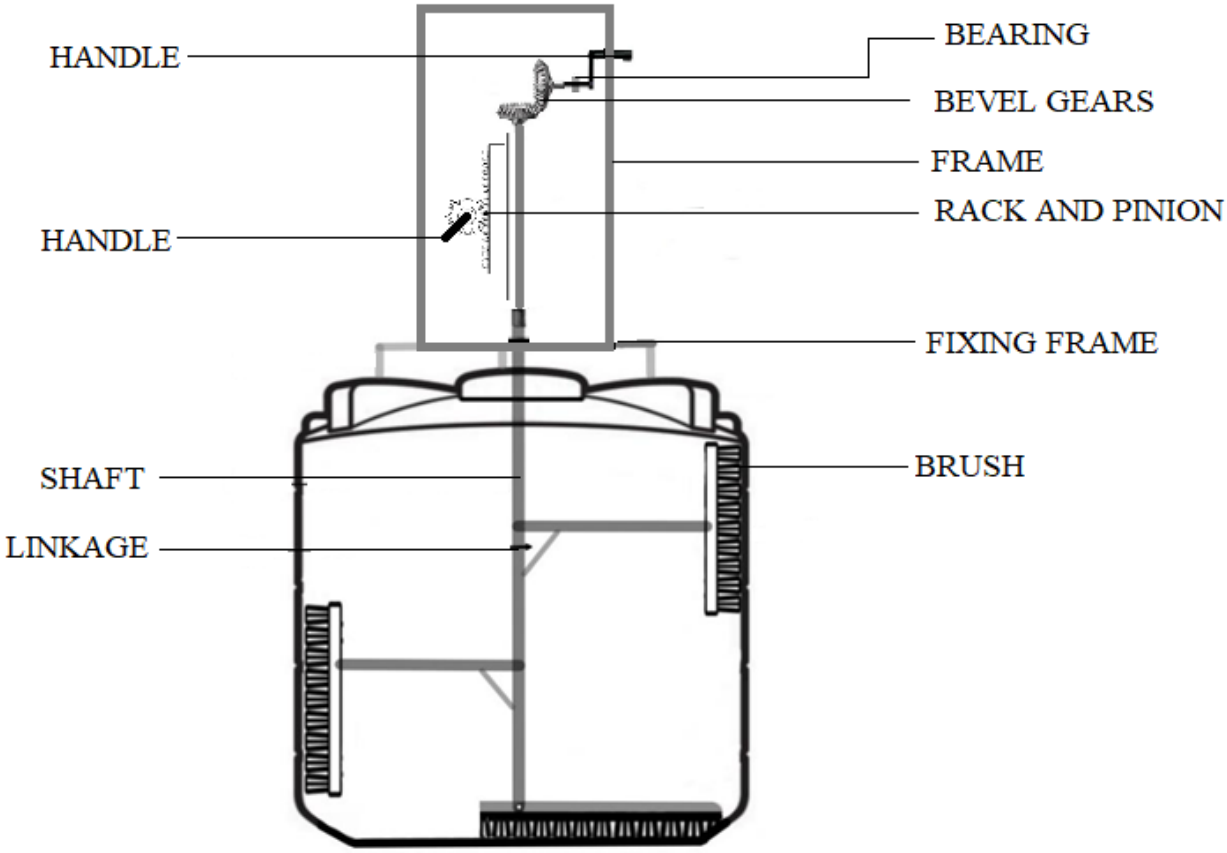

Fig. 7.1 Model diagram of Manually Operated Overhead Water Tank Cleaning Machine

CHAPTER 8

COST ESTIMATION

SL.NO	DISCRIPTION	COST Rs:
1	HAND LEVER	500
2	BRUSH	500
3	BEARING	400
4	FRAME	1800
5	SHAFT	500
6	METAL STRIP	300
7	BEVEL GEARS	500
8	RACK AND PINION	500
7	TOTAL (MATERIAL COST)	5000

Table. 8.1 Cost estimation

LABOUR COST

LATHE, DRILLING, WELDING, GRINDING, POWER HACKSAW, GAS CUTTING

Labour Cost = 1000/-

TOTAL COST

Total cost = Material Cost + Labour cost

= 5000 + 1000

Total cost for this project = Rs.6000/-

CHAPTER 9

RESULT

Fig. 9.1 Manually Operated Overhead Water Tank Cleaning Machine

ADVANTAGES

- Construction is simple and the components used are easily available in local markets.
- Cost effective construction and also maintenance free application.
- Direct contact of workers is reduced which helps in maintaining their hygiene level.
- User friendly operation.
- Labor charges are also reduced.
- Single machine is enough to different sized tanks

APPLICATION

This system can be used in ,

- Homes,
- Educational institutions,
- Corporate sectors.

CHAPTER 10

CONCLUSION

The water tank cleaner was used to clean the water tanks by using rotating brushes. This method was more effective and safe than the conventional methods. This method is capable to clean water tanks within less time and human efforts. In summary, the “DESIGN AND FABRICATION OF MANUALLY OPERATED OVERHEAD WATER TANK CLEANING MACHINE”, revolutionizes water storage maintenance. With advanced cleaning mechanisms, including manually drive rack and pinion system and three bar linkage system. It ensures thorough sanitation while conserving water. This innovative technology marks a crucial step towards efficiency, sustainability, and improved water quality in diverse applications.

CHAPTER 11

REFERENCE

1. ShubhamShrivastav, Hari Om Kumar, “Design and Development of Cylindrical Water tank cleaner”, vol. 6, 2016, pp. 262-264.
2. Dr. R. K. Bansal, “ Kinematics of machine”, Laxmi Publications (P) Ltd ., vol. 1, no. 4, pp. 23-287,Nov. 2011.
3. Vikramsingh R. Parihar, Improving Power Quality of Induction Motors using Capacitor Bank, International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering (IJIREEICE), Volume 6, Issue 9, pp 37-45, Sept 2018
4. Jay Graham,et.al, (2007) “The effectiveness of large household water storage tanks for protecting the quality of drinking water”, Journal of Water and Health, Vol 05, Issue 02, pp.307-313
5. W. S. N. Trimmer and K. J. Gabriel, “Design considerations for a practical electrostatic micro-motor,” Sens. Actuators, vol. 11, no. 2, pp. 189–206, 1987.
6. T. Schaub, "Spread frequency shift keying", IEEE Trans. Commun., vol. 42, no. 2/3/4, pp. 1056-1064, 1994.
7. Bruce T. Looper, “Apparatus for cleaning tanks or vessels”, US Patent 4244523, New York (1979).
8. Hubei Bureau of Quality and Technical Supervision. Oil Tank Cleaning Safety Technical specifications[S]: china, DB42/T 421-2007.2007-3-15.
9. Machine Mr. Yogesh K. Chaudhari1, Mr. Nitesh B. Patil2, Mr. Sachine A. Khangal3, Mr. Nisar S. Shakh4, Mr. Shrikant U.Nagare5 “Design & Fabrication of Water Tank Cleaning machine Design & Fabrication of Water Tank Cleaning “ (IJRASET) ISSN: 2321-9653; Volume 6 Issue V, May 2018.