

DESIGN OF FISH DESCALING MACHINE

A THESIS SUBMITTED IN THE PARTIAL
FULFILLMENT OF THE REQUIREMENTS OF THE
DEGREE OF

**Bachelor of Technology
In
Mechanical Engineering**

By

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Department of Mechanical Engineering
National Institute of Technology
Rourkela
2014-2015

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Under The Supervision of
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Department of Mechanical Engineering
National Institute of Technology
Rourkela
2014-2015



National Institute of Technology Rourkela

CERTIFICATE

This is to certify that the work in this thesis entitled “Design Of Fish Descaling Machine” by Nibedit Nahak, has been carried out under my supervision in partial fulfillment of the requirements for the degree of Bachelor of Technology in Mechanical Engineering during session 2014-2015 in the Department of Mechanical Engineering, National Institute of Technology Rourkela.

To the best of my knowledge, this work has not been submitted to any other University/Institute for the award of any degree or diploma.

Place: Rourkela

Professor (Dr.) Susant Kumar Sahoo

Date:

(Supervisor)

Department of Mechanical Engineering

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ABSTRACT

In the past, various products have been found to descale the fish but till not much importance has been given to the idea of developing an efficient product with reasonable cost for a targeted section of customers in the society. After the need analysis and identification of the to-be-developed product, the search of the idea leads to an innovative concept of scaling fishes succeeding the need of it. Now there are various machines available in the market to scale but a system that ascertaining both cost and quality has not been produced on a mass scale yet.

In this report, we first study the existing market and level of usage on the machine by various category of customers. Then the various mechanisms and cost analysis depending on the nature of the job performed by the accessories are discussed which is followed by the project design and analysis. Some designs that could provide a solution for the problem are found. Out of this, the best design is found out considering factors like the effort required, cost, efficiency, time and quality over performance. The various possible subsystems of the device are listed. The morphological analysis is then done. The most efficient and cost effective combination of subsystems is selected. This is the solution for the problem. The specification and size of the parts of the device are also given.

LIST OF FIGURES

<u>Fig. No.</u>	<u>Name</u>	<u>Page</u>
5.1	Organizational Structure in device for descaling fish	13
8.1	Projections of Drum	17
8.2	Projections of Left Plate	18
8.3	Projections of Right Plate	18
8.4	Projections of Drive Shaft	19
8.5	Projections of Pin	20
8.6	Projections of Rod support ring	20
8.7	Projections of Motor	21
8.8	Side Views of Tub	22
8.9	Isometric View of Tub	23
9.1	Drum Fish Scaling Machine	24
9.2	Assembled Drum	25
9.3	Front and Top View of the Assembly	26

LIST OF TABLES

<u>Table No.</u>	<u>Name</u>	<u>Page</u>
5.1	Morphological Analysis	13
5.2	Evaluation Table for final product choice	14
6.1	Schedule of Work	15

CONTENTS

Acknowledgements	i
Abstract	ii
List of Figures	iii
List of Tables	iv
1. Introduction	1
2.1 Motivation for the Project	
2.2 Objective of the Project	
2. Problem Definition	2
1.1 Project Statement	
1.2 Project Identification	
3. Aim of the Present Work	3
4. Literature Survey	5
5. Methodology	11
6. Schedule of Work	15
7. Observations and Calculations	16
8. Design of Components	17
9. Results and Discussions	24
10. Conclusion	27
References	28

Chapter: 1 INTRODUCTION

1.1 Motivation:

Fish provides a good source of high-quality protein and contains many vitamins and minerals. Research over the past few decades has shown that the nutrients and minerals in fish, and particularly the omega 3 fatty acids found in several fishes, are heart-friendly and can make improvements in brain development and reproduction [1]. This has highlighted the role for fish in the functionality of the human body [2]. According to a recent statistical data, the estimation shows a global per capita fish supply to about 16.7 kg per year [3]. Due to the ease in the source of fishery considering marine, lake or pond, and rivers, it can be availed cheaply on comparing with other animal foods. So, it can be easily understood that fish has been one of the foods of preference. Hence in the preparation of processing fish as a food requires some precautions as it is being handled by several machine setups.

A fresh, hygienically cleaned, well-scaled fish with minimum distortion get preferred for the further operations in making delicious food or packaging. Hence, the project finds great application in the real life by producing such machine for scaling operation of fish. As the machine is light in weight with ease in handling and less maintenance enables the targeted customers for making their work more efficient within a very short span of time.

1.2 Objective:

- Understanding the basic principle of a machine having a motor
- Understanding the typical classification of machines meant for mass production and for domestic/small scale use
- Understanding the basic applications of rolling mechanism without slipping
- Understanding the execution of DC/AC device with electrically recharging system
- Understanding the deflection in simply supported shafts with bearing

Chapter: 2 PROBLEM DEFINITION

2.1 Problem Statement

To design a Fish Descaling Machine, a portable set up which is to be developed for the purpose of the household type domestic customers and hotel, restaurant type business people.

2.2 Problem Identification

This product will relate to improvements in fish scaling apparatus and has an object to provide a simple, efficient and economical way of the descaling task. The machine has to perform the job very neatly with the required speed and as less time as possible. The machine will have definitely a rotating part having teeth/blades for peeling the scales off the skin and which, in turn, will be regulated by a DC/AC motor with the help of the current.

The model has to find its applications in cottage and small scale industries like hotels, restaurants, fish sellers and also for personal use in domestic environment, which would have to be portable and as light as possible.

Chapter: 3 AIM OF THE PRESENT WORK

We intend to design a fish descaling setup that automates the manual work done by people. For the fisherman after fishing, or maybe a fish seller during his sale we try to develop such a machine which will make that unpleasant chore of scaling fish, easy and clean. The usage of the product is much wide in day-to-day life of common people, hence we want this to be so light-weight, simple and compact in nature for which it will be very portable, easy to operate and will super clean the skin of the fish with absolutely no mess.

We also seek that if any enhancement in some auxiliary operations is possible. So, out of some auxiliary operations there may be a proper cleaning of the fish thereby making it hygienic and hence suitable for further processing. This leaves the fish free of scales, dirt or slime. Then, simply empty the contents of scales and water, and rinse the drum and tank. Another sub-operation in eliminating the chances of polluting the workspace would be to lessen the exposure of the scales after the end of the whole descaling process. We should look forward to such a machine that can minimize the work of turning the fish upside down for descaling. Hence, we should build such a machine which won't be needing any manual change of fish surface for each attempt of descaling. Hence, a confined space should be facilitated to lessen this job. As the product will be more viable for the domestic or micro commercial usage we make it sure to build a simple yet efficient machine. This ensures that the machine is made keeping in view of an unskilled labour i.e. anyone should easily operate the machine without any prior knowledge of a bit of anything. But with that the work should ensure better quality and optimum time consumption over the existing products.

For the job, we need to pour some fishes (around 5) into the drum and some water into the tub up to a certain marked level, as input. Each fish will be taken out from the drum after the completion of the operation, as output. We have partitioned the complete functioning of the system into subunits:-

1) **Design of a confined space for the fish motion:**

A confined space for the fish is intended to lessen the exposure of the descaled scales and along with it won't require any intervention of the customer once the fishes are kept inside. This will aid the customer in multitasking by automatically turning the fishes upside down

and that also so safely that a customer can move away by turning the machine ON without a second thought for the fear of the kids or any creature from outside. It will shield the whole environment thereby avoiding any chances of risks nearby.

2) Design of a roughening surface for descaling:

A blade or a perforated surface can be used to attain the main purpose of descaling of fishes. The surface or the blade should remove scales away so cautiously that any cut on the skin of the fish is readily avoided. This should be designed and handled so carefully such that there any interference in descaling a fish should not happen within the system or even any injury to the operator.

3) Design of a cleaning assistance along with descaling:

In addition to descaling operation any mean of water flushing is necessary for an average production else it would hamper the operation if the scales get stuck to the body of the fish even after the scale removal. As we look forward to a small scale production but quickly within a short span, there would be more than one fish for the work. So, either water stock within a volume can be proposed or even a water flushing may also be taken into account. But as we repeatedly recite that this is supposed to be a small scale production, so it would be wise to minimize flush of water is as much as possible, which in turn will reduce complexity and economical aspect of the product.

Chapter: 4 LITERATURE SURVEY

The design of various machine elements is a complex part of mechanical engineering and is much essential in developing mechanical systems. V B Bhandari has jotted down several rules, standards and roadmaps for the design of various machine elements. Here, the book Design of Machine Elements by V B Bhandari of 3rd Edition published by Mc Graw Hill 2012 has been helpful in making the project.

Companies like Trifisk Manufacturing, Uftokuyi, Jiaozuo Zhoufeng Machinery Co. Ltd, ZZ Alliance Manufacturing Co. Ltd, Food Machinery of America, Northrock, Haskin Strand, Zhengzhou Azeus Machinery Co. Ltd, Bear-Paw Fishing Tackle, KT-S, Wedge Outdoors, Open Country Camp Ware, Trio FTC have been some of the innovators in the field of manufacturing of seafood processing equipment and setups. Some of them has been cited in this section.

Also, there are enormous patents those have been filed to serve the operation of descaling a fish. There are several types of products that these patents claim. Depending on the type of usage of the product whether for large food processing industries or for cottage/ small enterprises or even just for household and restaurants purpose. The earlier categorized products take much space and need much maintenance for a mass production. For the medium level customers, the patents have suggested following a portable but a moderate rate of production. But for the last category customers, a manual, one at a time handling with almost no maintenance models have been proposed by patents. Some of those has been referred in this section.

1. **Trifisk Manufacturing:** The scaling machine, the industry provides, is a full station set up with automation. It can handle 125 small size fishes around a minute. But this needs some maintenance as it's been built for food processing. The setup consists of commercial grade stainless steel housing and feeding table. It's completely automated and descales fish as they get fed at the feeding table. At first the upper skin gets descaled and then the lower scale gets descaled as the fish moves on the transmission line. This has a constraint of limited usage. It is meant only for mass production like in some fish food processing industries. Hence, it needs much amount of inputs like power, water, and fish as well [4].
2. **Uftokuyi:** The fish scaler unit from this company removes the scales of any size without any damage occurring to the skin of the fish. It comes with two variants viz. 110V and 220V. It

has a rotor that's connected to a motor and having 8 small blades over the rotor body. It is portable and rechargeable. Hence, it comes under the demand of the domestic customers [5].

3. **Jiaozuo Zhoufeng Machinery Co. Ltd:** This Company makes two different models serving the purpose of descaling a fish. One is having a normal horizontal axis motor, rotor shaft, and four blades. It has a protective cover for not letting the scales reflected from the rotating blades. In addition to that the cover also prevents any cut to the operator. The measure limitation of the machine is it has blades of too much thickness. But this has a distinct feature of the blade by having hollow areas for better heat transfer. This enables for long time operation and hence handling of more fishes along with. And only right handed or left handed people can operate this due to its fixed directional rotation. The other machine looks like a polisher on the body of the fish. This removes the scale by having a handle and a vertical axis motor and a circular surface with 4 curves on the face of the circle. Both of the machines is only preferable to use as the household purpose or domestic usage like cottage industries [6].
4. **ZZ Allance Manufacturing Co. Ltd:** The industry makes a vertical axis drum fish scaler setup. With designed brush of stainless steel inside the machine. This can operate an amount of 8kg of fish at a time. It can descale fishes at 20 sec per time. It has a broken rate of 1%. It is also constrained to a group of customers with mass production [7].
5. **Food Machinery of America:** This industry is a heavy duty performer for descaling of fish as commercial use. It has two variants viz. Standard model and Heavy Duty model. And each of these come with 110V and 220V specification. The power comes from a 1/3hp motor with a 3/4'' thick cable connected to a 3'' metal descaling head. A rotating ceramic handle which performs the main descaling operation, is around 3 3/4'' long in length. The scaling head has diamond tooth tool. It is designed such a way that it can be hung from a hook. It is turned on by removing the head from the hook and pushing the hook-up. When finished, placing the head back into the hook turns it off. This machine is designed for continuous use in commercial fish processing operations. This makes faster descaling than any other domestic product category. But it's not so fast to be taken for the processing industries for seafood [8].
6. **Northrock:** This Company makes an exact product as built by the Food Machinery of America. But it differs to the earlier by having a different handpiece, drive cables and their connections to the motor [9] [10].

7. **Haskin Strand:** It makes the exact product as of the Food Machinery of America. It makes the fish descaling set up under a different brand. But unlike the Northrock, it has a different handle and drive cables (Standard and Heavy Duty). Also, the connection to the motor handle and hand piece also differs in Standard models than Northrock [11] [12].
8. **Zhengzhou Azeus Machinery Co. Ltd.:** The machine from this industry is an automated machine and has the capacity to scale all kinds of fish and there is no any restriction for the size of the fish to be fed. The fish scale and body of the fish gets separated automatically and the fish body can expel from the discharge hole. It has a long service life as the teeth on the body of the machine is integrated with the teeth and built from stainless steel. But this can serve only to processing industries due to its large range of operation and mass production with stable running and of hygiene standard [13].
9. **Bear-Paw Fishing Tackle:** The Company makes a certain type of fish scaler that comes with a model name of Economical Fish Scaler. It produces 3 variants for scaling fishes. One is Electrical Fish Scaler (EFS) [14]. All the variants have a feature of cleaning the scale by an extra-hard Teflon material impregnated coating for fast and easy cleanup. Another variant have the capacity to scale larger fish, hence it has the model name as Heavy Duty Electric Fish Scaler (HDEFS) [15]. The third variant is Power Drive Fish Scaler (GFS) [16]. It is designed for use with any electric drilling machine. By simply inserting the drive tip into the drill chuck, the aim is attained. It is good for handling and any person having a drilling machine can use it conveniently and hence, in turn, it is the limitation of having a limited group of users. But other two models are for the usage of domestic/ household customers [17].
10. **KT-S:** This fish scaler is a hand-held setup. It has two variants in voltage viz. 110V and 220V. To descale a fish, we need to manually slide the rotor arm over the fish. The motor is housed in an internally grounded metal box with an ON/OFF switch, securely insulated and protected from spray. Unlike other setup, it doesn't need any external grounding. It is capable of continuous use in fishing operations. But, it doesn't have any protective cover for any accident prevention or gathering the scales at a place thereby polluting the workspace. The metal scaling head is protected by a metal splashguard, and spins on ball bearings. All external parts are waterproof. There 4 layers, two of steel, one of insulation and outer plastic cover. The cord is thinner, lighter and more flexible. However, it is usable for domestic / cottage industry customers [18].

- 11. Wedge Outdoors:** It is a horizontal drum type fish scaler. A tub houses the setup by allowing a driven shaft of in the drum, rest on the bearing block one side. The other side of the shaft certainly doesn't need any rest because of the coupling between the motor and the shaft itself. Water is kept at a certain level of the tub and then allowed to start the operation. The dimension this model has is 18'' long and 14.5'' diameter. On removing the plate of the cylindrical drum, we put fish into it and then as the motor drive coupling shaft rotates the whole drum incorporated to it also rotates. The descaling operation of fish will be done in fewer minutes but it has a limitation of certain weight of fish intake and hence it is best for the medium level usages like household or small enterprises like a fish seller like customer. The main job is performed by the edges of the perforated holes inside the drum. It has several larger holes to clean out the removed scales off the fish [19].
- 12. Open Country Camp Ware:** It is also a drum fish scaler. It comes with an exact specification as of the previous one, but the length exists as two variants of 18'' and 26''. It has the capacity of scaling fish up to a dimension of 22'' in length. It can be used either indoor or outdoor. But it has an intake capacity of around 5 fishes at a time which cites it a limitation of usage in larger firms [20].
- 13. Trio FTC:** It is a heavy duty descaling machine for commercial use but has an advantage of being light of only 700gm. Hence, a person doesn't need to push it hard against the body of the fish. Just by nudging on the fish can finish the job so swiftly and that also for a longtime run of a handle of around 8hrs continuous use. This all makes the job easy and comfortable. It is different from all existing machines in terms of mechanism. There is a provision of in and out of the compressed air for running the air motor. There's a safety lever of ON/OFF with a safety cover with water-plug and water flush. Because of the powerful motor, this needs well air connection with a pressure of 6bar with 210 litre per min intake. And hence, there's no need of any necessary electrical power. The flushing water also needed at a pressure of 3 bar and 2 litre per min. This setup can't run for household purpose, because of the distinction becomes the limitation for a certain group of users [21].
- 14. Power Operated Fish Scaling Apparatus:** It's a patent suggested by *Carlos Hernandez (US 7,618,308 B1)* in year 2009. The apparatus has a rotary motor encased in a cylindrical housing. This motor rotates the rotor and ultimately the blades rotate at a speed of 1500-2000 RPMs. He has given the plurality of planar blades with different types of blade profiles. The thickness

of the blades is less than the blade width, which allows the blade to flex. The patent is meant for the household type aforesaid third category customers [22].

- 15. Portable And Rechargeable Fish Scaler Devices:** A similar model suggested by *James Barlow (US 2003/0143939 A1)* in 2003. This device consists of 3 or 4 blunt-edged radial arms are provided with a shaft. These edges prevent any accidental contact with the user. The invention provides a reasonably cheap cost and safe method to the aforesaid third type of customers [23].
- 16. Fish Scaler:** Suggested by inventor *Morris C. Till (4,667,372)* in 1987. The fish scaler has an elongated support shaft having a first free inner end adapted to be received in an electric drill chuck. A larger diameter hub disk is mounted on the support shaft near an end received in the drill chuck and a Second hub disk is mounted on the Support Shaft at a location spaced inwardly from the outer end of the shaft A plurality of scale flicker rods are mounted in a conical array on the hub disks and have one end connected in the end of the shaft [24].
- 17. Fish Scaling Assembly:** This has been patented by *John E. Byrd (US 2012/0190283 A1)* in the year of 2012. This assembly consists of a knife handle and operates with reciprocation of the knife handle and usually a wedge-shaped scale removing member carried by at least one blade [25].
- 18. Fish Scaler:** From a patent *DE 102011100067 B4*, the device aims for small production. Fish scaler having a central body having a rotational axis which is aligned in the axial direction of the body having the body optionally, a pin which is arranged coaxially to the rotation axis and the body has a radially outer wall portion as the connection area, which for the connection of a plurality of working elements is provided with the body, characterized in that a working member having at least one working edge, which are aligned parallel or at an angle inclined or bent to the rotation axis of the body is the body in a section plane perpendicular to the axis of rotation considered a form of an equilateral hexagon and the connecting portion having a hexahedral shape in which the individual areas are divided from one another by edges, which correspond to the corners considered in cross-section and the working elements of the connecting portion also again be detachably connected [26].
- 19. Brophy:** The patent has been given by *Neil Brophy (5,221,229)* in the year of 1993. A tool for scaling fish includes a handle with a shaft rotatable mounted to the handle and projecting therefrom. A generally cylindrical scaling head is engaged on the shaft and rotated at a high speed.

The scaling head has a circular array of relatively wide ribs spaced around its periphery and extending the length of the head. When the tool head is brought into contact with a fish, the moving ribs strip away the fish scales efficiently and effectively without damaging the underlying flesh of the fish [27].

- 20. Fish Scaler Apparatus:** This patent was given by *Richard C. Bruckert (5,129,855)* in 1992. It's a fish scaler that includes an exterior cylindrical container in which, there's interior cylindrical insert positioned radially within the exterior container by an arrangement of setting blocks facing to the exterior surface there about. A central axle is directed coaxially of the container and exterior bucket projecting through a lid for accommodating a drill to permit its rotation [28].
- 21. Opanasenko:** A fish descaling proposal by *Walter W. Opansenko (4,485,526)* in the year 1984 was one type of drum apparatus with a horizontal axis. This fish scaling apparatus comprises a frame, a hollow elongate fish scaling drum mounted on the frame. Mechanism behind the rotating of the fish-scaling drum, with axially spaced abrasive portions is separated by relatively non-abrasive portions, where the scales of the fish will get intermittently abraded by the rough-abrasive portions as the fish move axially downstream to remove the scales. The setup is too large, so it's been considered only for a mass production in big processing industries [29].
- 22. Bucket fish scaler:** This is a bucket scaling setup with rotating impeller around a vertical axis and was proposed as patent no. *US 4726095 A*. A simple and easily used and cleaned portable fish scaling device which includes a water-tight bucket with an abrasive like rough continuous surface within the bucket, and an agitator for agitating water in the bucket. As the water is agitated, fish suspended within the water gently tumble against the abrasive surface and are thereby scaled. The abrasive surface is an inwardly dimpled bucket liner where the agitator is a rotatable impeller [30].

Chapter: 5 METHODOLOGY

5.1 Need Analysis & Market Study:

This is really most important and difficult part of the whole project, we can't lead blindly by producing our product, but we have to study the need of the production. So, we need to study the relevant market and observe what the challenges are based on customers' reviews. [31]

Methods to follow:

1. Observations

For the project, many observations have been made from a several manufacturer of the concerned product. Among them some of them are:

- *Autofishscalers.com*: Bear- Paw, EFS Electric Fish Scaler (Heavy Duty, Standard Duty)
- *KT-S*: Commercial Fish Scaler (110V, 220V)
- *Wedge outdoor*: Slick Skin Drum Fish Scaler
- *Food machinery of America, Northrock, Haskin Strand*
- *Open Country Camp Ware*: Tumble Drumm Fish Scaler

2. Customers reviews, complaints

3. Users experience

4. Present need of a particular section of customers

5.2 Need Statement [32]:

Clearly defining the problem with its domain of a solution we want. It should contain:

1. Problem: Design of a fish descaling machine.
2. Standard of performance (quality/usability level)
 - Household customers
 - Restaurants / Hotels
 - Fish sellers
 - Small enterprise for fish food processing

3. Constraints (limitations): It'll find a specified market of customers i.e. only cottage and small scale industries.

5.3 Search for alternative ideas/Process [33]:

Methods to follow:

1. Patents
2. Journals: No such journals have been published yet because it comes under a category of product
3. Observing the nature around
4. Biological process
5. Adaptation of an existing solution
6. Imitation of other solutions
7. Brainstorming

5.4 Evaluation of ideas or processes:

With respect to some parameters, these can be evaluated. Those variants of the product may be as follows:

1. Automated fish scaler setup
2. Handheld- power operated fish scaler
3. Manual scrubbing fish scaler
4. Drum fish scaler
5. Cylindrical scaler with horizontal axis
6. Stainless steel fish scaling machine
7. Fish scaling by water jet removal technique
8. By 3rd Inversion in 4-bar mechanism

5.5 Morphological Analysis to Generate Alternate Devices from Selected Idea [34]:

Break the idea/process to different function/component combining which the final product can be made. Some of the functions are:

Rotation function: Alternative will, gear, rope, belt drive etc.

Transport of mass function: Alternative will, by gravity, by screws, by conveyor etc.

Supply control function: Alternative will, pneumatic, position sensors etc.

By making a matrix, we'll write all the possible sub-functions in the Row and the respective alternatives in the Columns.

Table 5.1 Morphological Analysis

Functions	Alt-1	Alt-2	Alt-n
Type of motor	DC	DC permanent magnet motor	AC
Transport of mass	Conveyer	Power Screws	Fixed
Supply Control	Electrical	Manual	Manual
Body/ Frame	Cylindrical	Rectangular	Cylindrical
Translational motion of the machine	Fixed	Fixed	Manual

Combining alt-1 of function-1, alt-3 of function-2, we can make a device, so, total alternative devices = $l \times m \times n = 3 \times 3 \times 3 = 9$, where, l, m, n are no. of alternatives for function 1, 2, 3 respective

Out of which some may be infeasible, very costly, non-compatible etc. will be rejected.

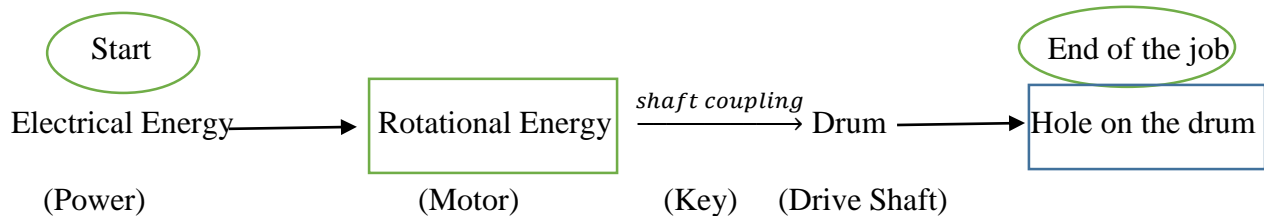


Fig. 5.1 Organizational Structure in device for descaling fish

5.6 Evaluation of devices/final product for development [35]:

Parameters to be taken for evaluation (It depend on device) i.e.

1. Cost
2. Response Time (Quick to act)
3. Safety
4. Life Period etc.

Table 5.2: Evaluation Table for final product choice

Factors	Idea 1	Idea 2	Idea 3	Idea 4	Idea 5	Idea 6	Idea 7	Idea 8
Cost	6	8	10	9	2	5	2	2
Time to develop	3	8	10	9	2	5	2	2
Degree of space occupancy	5	8	10	9	0	9	1	0
Satisfied customer	3	7	2	8	4	8	4	4
Price	10	8	10	9	1	8	1	1
Time Period	4	8	2	7	9	8	9	9
Load Range	9	5	5	4	10	5	10	10
Skill necessary	8	8	10	10	1	0	1	1
Warranty	8	8	10	7	10	8	10	10
Portability	7	8	10	9	1	9	1	1
Total	6.3	7.6	7.4	8.1	4	7.3	4.1	4

Now this device no.4 i.e. drum fish scaler is selected for further development (fixing specification, simplification, standardization, drawing, modeling etc.)

5.7 Design and simulation model of the apparatus:

With the help of CAD modeling software, the design and simulation of the components and subsequently of the assembled product shall be done at each stage.

Table 6.1: Schedule of Work

Activity	Aug	Sep	Oct	Nov	Jan	Feb	Mar	Apr	May
1	■	■							
2		■							
3		■	■	■					
4			■						
5			■	■	■	■	■		
6						■	■		
7						■	■		
8							■	■	■
9									■

Where the activities are mentioned under

1. Observations
2. Reviews
3. Need Analysis & Market Study
4. Constraints
5. Search for Alt. Idea/ Process
6. Morphological Analysis to Generate Alternate Devices from Selected Idea
7. Evaluation of devices/final product for development
8. Design and simulation model of the apparatus
9. Analyze via analytical and experimental processes

Chapter: 7 Observations and Calculations

Observations:

From the simulation and analysis of the model, we got to know that as the load increases with the rotational speed remaining constant, the performance of the device reduces. This is because of a standard load capacity only can be lifted by the drum. It's been seen around 4-5 fish of medium length can be descaled properly. Similarly, as the load remains constant, but the speed of the motor is increased, then also the device becomes unable to scale perfectly and effectively to all the portions of the body of each fish.

Calculations:

For driving shaft,

Here, indicated torque on the motor: $T = 2\text{kg-cm} = 0.196133\text{ Nm} = 196.133\text{ N-mm}$

Rpm of the motor: $N = 60\text{ rpm}$

The material of the shaft being 316 stainless steel,

Ultimate Tensile Strength = $75,000\text{ PSI} = 517.10625\text{ MPa}$

Ultimate Yield Strength = $30,000\text{ PSI} = 172.36875\text{ MPa}$. [36]

As shear strength = $.577 \times$ Yield Strength, so the shear stress $\tau = 0.577 * 172.36875 = 99.456\text{ MPa}$

Then, the diameter of the shaft would be, $T = (\pi/16) \tau \cdot d^3$

So, $d = [T / (\pi/16) \tau]^{1/3}$

$\Rightarrow d = 2.15\text{ cm}$;

So, $d = 2.54\text{ cm}$ (1'' standard) [37]

Chapter: 8 Design of Components

1. Design of Perforated Cylindrical Drum:

The drum is the main part of the whole fish descaling machine setup. For better result from the operation, stainless steel has been taken for the building of the drum.

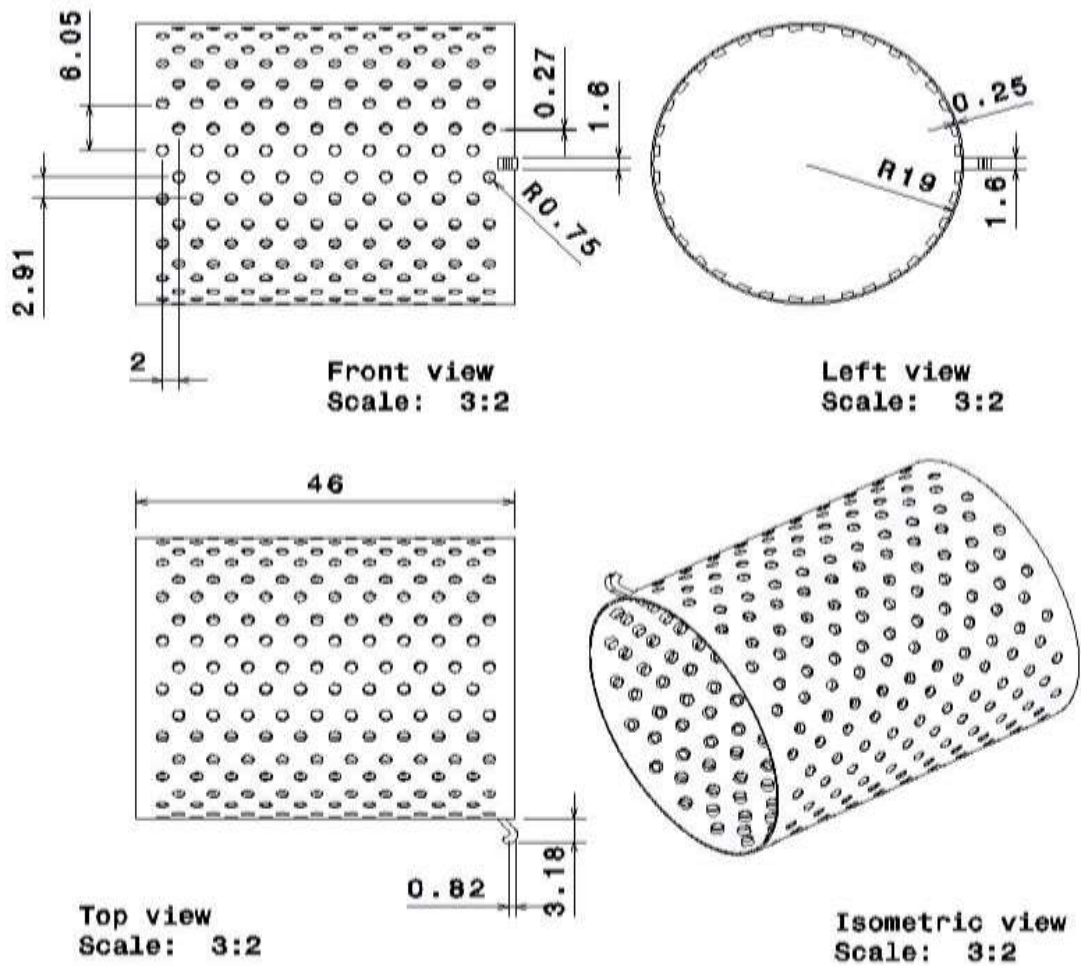


Fig. 8.1: Projections of Drum

The drum is a cylindrical one which has a diameter of 38 cm and 46 cm length. For the removal of the scale from the body of the fish, the surface of the cylinder has been perforated with hole of diameter 15 mm. There are two cylindrical surfaces which have been made into the shape of a drum by a shearing action and they have an internal gap of 2.5 mm. The surface of the cylinder has been punched in order to make significant burr. The height of one burr is approx. around 2.7

mm. By the combination of those surfaces, all the burrs with respective hole become strong enough to remove the scales of the fish. There is a pattern of holes that repeats circularly over the body of the cylinder to fill all the space as possible. This pattern is like A-B-A-B. If we measure across the circumferential surface of the drum, then the gap between each adjacent pattern A-A or B-B is around 6.05 cm and the distance between A-B is around 2.91 cm.

There also is a fixed hook which facilitates the opening–cum–closing of the plate to pour fishes into the cylinder before the starting of the process by tightly holding a locking latch against the plate. It is detachable and hence can be reused if gets damaged or weaken.

The drum assembly is so done that the total assembly can be taken out for cleaning its base i.e. the tub.

2. Design of Side Plate:

A side plate to the end of the cylindrical drum is attached to the both sides of the drum. A plate has locking latch on its outside while other has a motor to its outside. Any plastic material or aluminium material can be used for the building of this plate. The added features like locking latch can be of aluminum material.

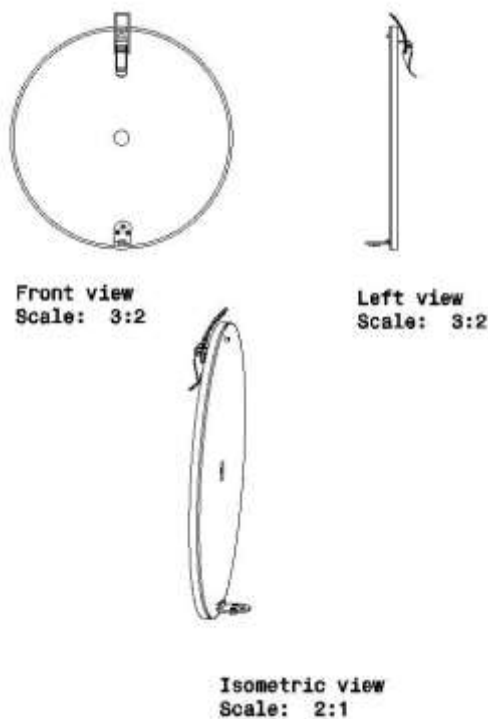


Fig. 8.2: Projections of Left Plate

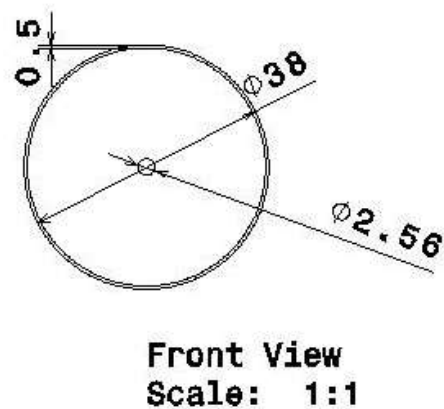


Fig8.3: Projections of Right Plate

Both the plates has the same dimension as alone the plate is being considered. They have a diameter of as same as the cylinder i.e. 38 cm. both the plate gets fitted to the cylinder up to 5 mm. they each have a provision for passing the drive shaft through them. And for that a hole of diameter 2.56 cm supports the drive shaft along with a support for rod concentric to it.

Plate 1 mainly serves as a gate to the cylinder. So, to serve this purpose a hinge is attached to the end of it which is consequently attached to the cylinder. When the fish is put into the drum, then at first this plate is opened to an extent which is facilitated by a locking latch attached just down to the circumference of the plate. As mentioned earlier the hook on the drum cylinder sets the locking latch into a perfect position.

Plate 2 is attached to the drum cylinder to the opposite to the side of plate 1. This plate is never made opened and hence acts like a closed wall in the confined space of the drum. The drive line by the shaft passes through this plate and ends with Plate 1.

3. Design of Drive Shaft:

The drive shaft is essentially the brain of the machine as by this shaft, the transmission of power takes place and in turn it governs all the rotation involving in the machine. A stainless steel material can be taken for building the drive shaft.

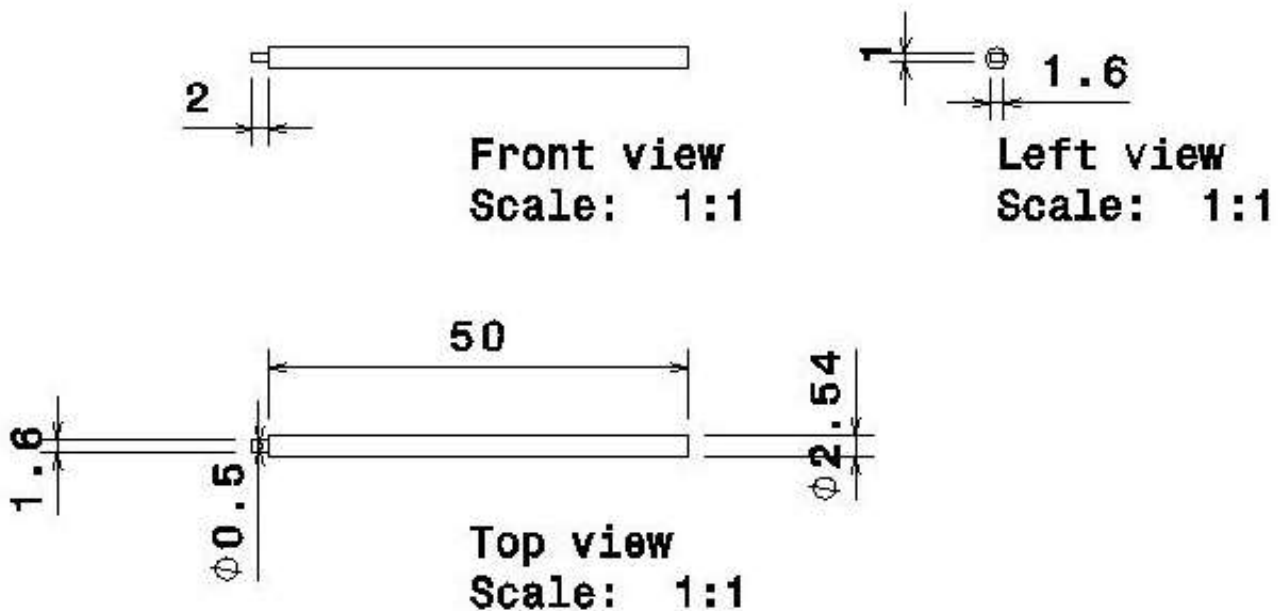


Fig. 8.4: Projections of Drive Shaft

The shaft responds all vibrating, fluctuating loads (if any) through the supports on Plate 1 and Plate 2. It has a length of 50 cm and of the diameter of 1" i.e. 2.54 cm (Standard Size). To one end of the shaft, there is a rest on which the shaft will rotate and to the other side the shaft gets engaged with the driving motor shaft. That engagement is achieved by a pin of diameter 5 mm. it combines both of the shafts there by transferring an equal amount of rotation, torsion and hence alignment.

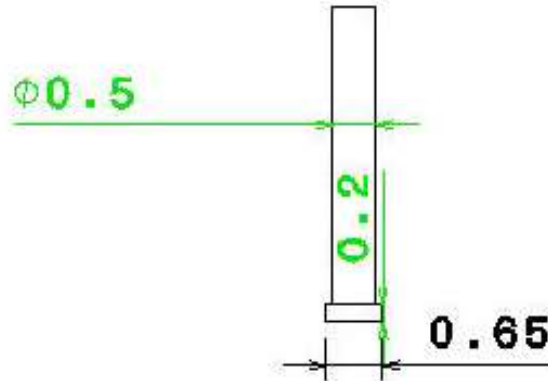


Fig. 8.5: Projections of Pin

4. Design of Rod Support Ring on The Plate And Tub:

To reduce the friction generated from the rotation of the drive shaft, a support is provided to the rod. This component can be made out of any plastic ring or even any carbon slip ring.

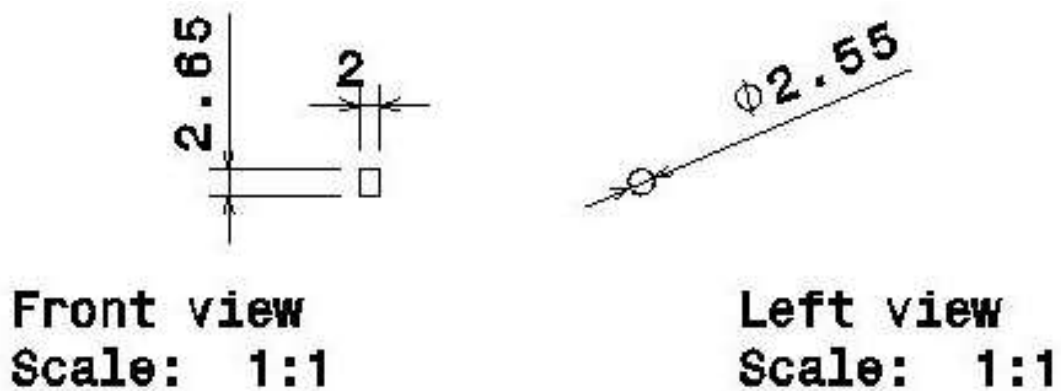


Fig. 8.6: Projections of Rod support ring

The ring is concentric to the hole through which the drive shaft passes. Hence, it made little larger than the rod, hence its diameter is 2.55 cm and 20 mm long in length. It supports all

the reaction forces exerted by the plate on the shaft due to the rotation. It also reduces any wear in those plates. Each plate i.e. Plate 1 and Plate 2 has one ring like this. Apart from that this also helps the motor shaft drive coupling to rotate freely in the tub.

5. Design of Driving Motor:

An AC motor is the heart of a machine. It continuously feeds a certain amount of power along with a certain RPM. We intended an AC motor for the sake of larger load handling. The motor has an extruded shaft, which connects to the driven shaft through its drive coupling. There's a switch mounted on it for the sake of ON/ OFF operation. This facilitates a controlled handling of the machine.

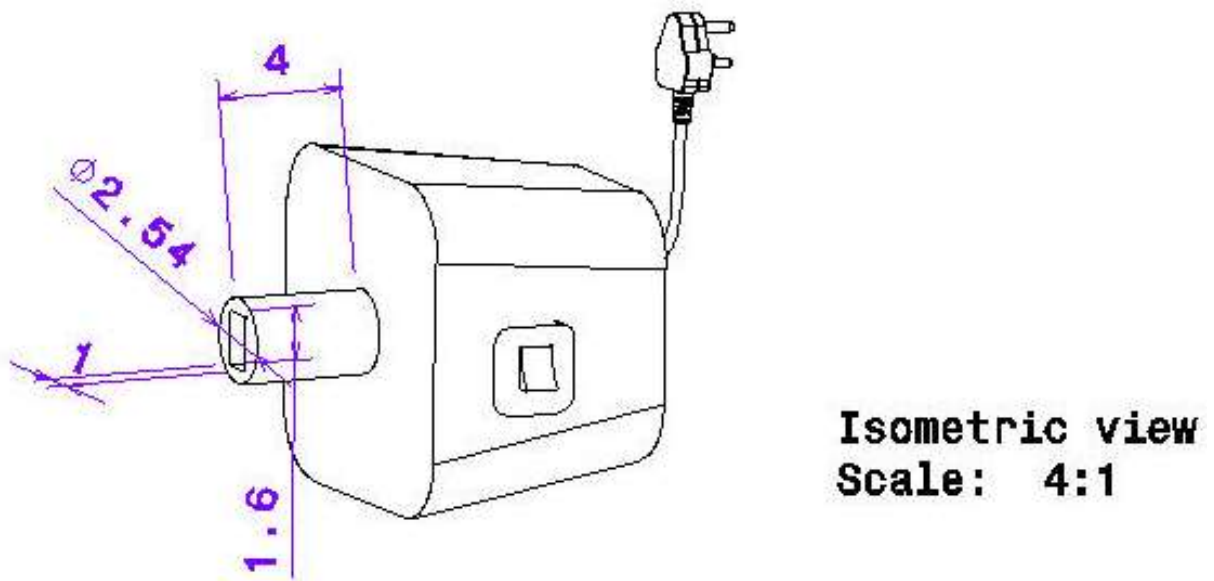


Fig. 8.7: Projections of Motor

The motor has been chosen accordingly its output power. It is commercially available and hence it can be well understood what is the power and RPM output of the motor driving shaft. A standard motor of 0.5 kW with 500 RPM will serve better in this case. The motor has a standard output extended portion of a shaft of length 4 cm of diameter 1" i.e. 2.54 cm. This is placed in the tub with the aid of bearing support ring through the hole in the tub. For the better arrangement, the shaft is slotted at 1x 1.6 rectangular hole to facilitate the driven shaft. There is a hole of 5 mm diameter to keep the engagement firmly in a fixed kind position. A pin, as discussed earlier, is attached to both of the shafts.

6. Design of Tub:

The whole assembly of components is placed compact in a tub of plastic material. The material of sturdy propylene can be used as it resists odor and mildew. It serves a rigid base for all the parts mounted on to it. The tub holds water up to a certain indicated level.

There is a bearing block to the opening side of the drum. For the motor shaft, there is a provision for a hole of the shaft diameter. The tub has a dimension of 53 cm x 40 cm x 32 cm. the tub is 15 mm in thickness. The bearing block has a dimension of 3cm x 4 cm to 5cm x 4cm multi-section. It has the provision of keeping the shaft in position with perfect alignment. At a level of 4cm from the base there is an indicator which notifies the water level to contain in it.

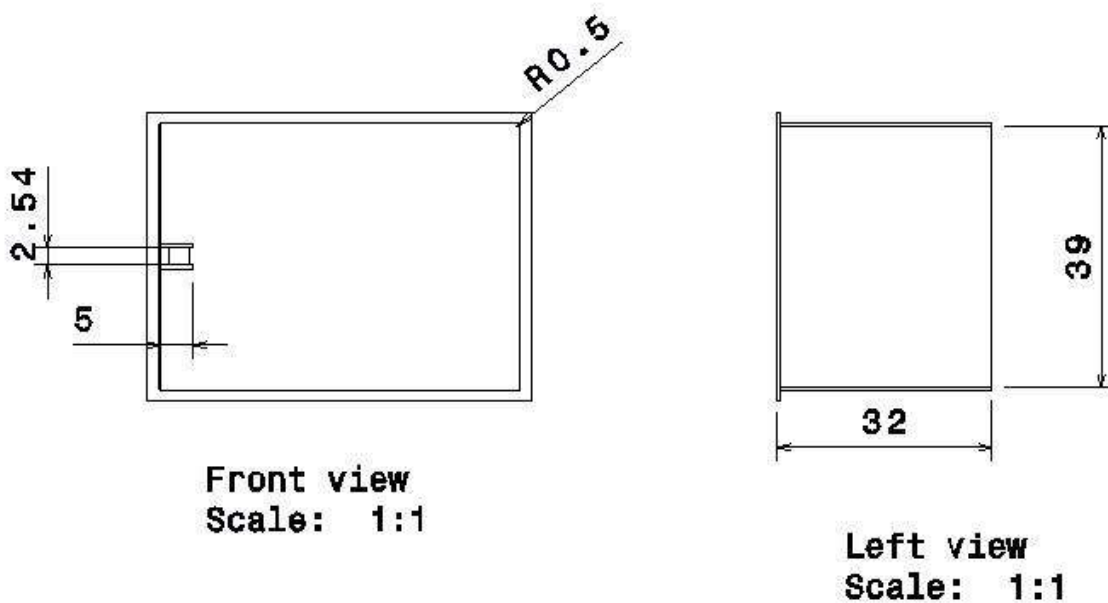
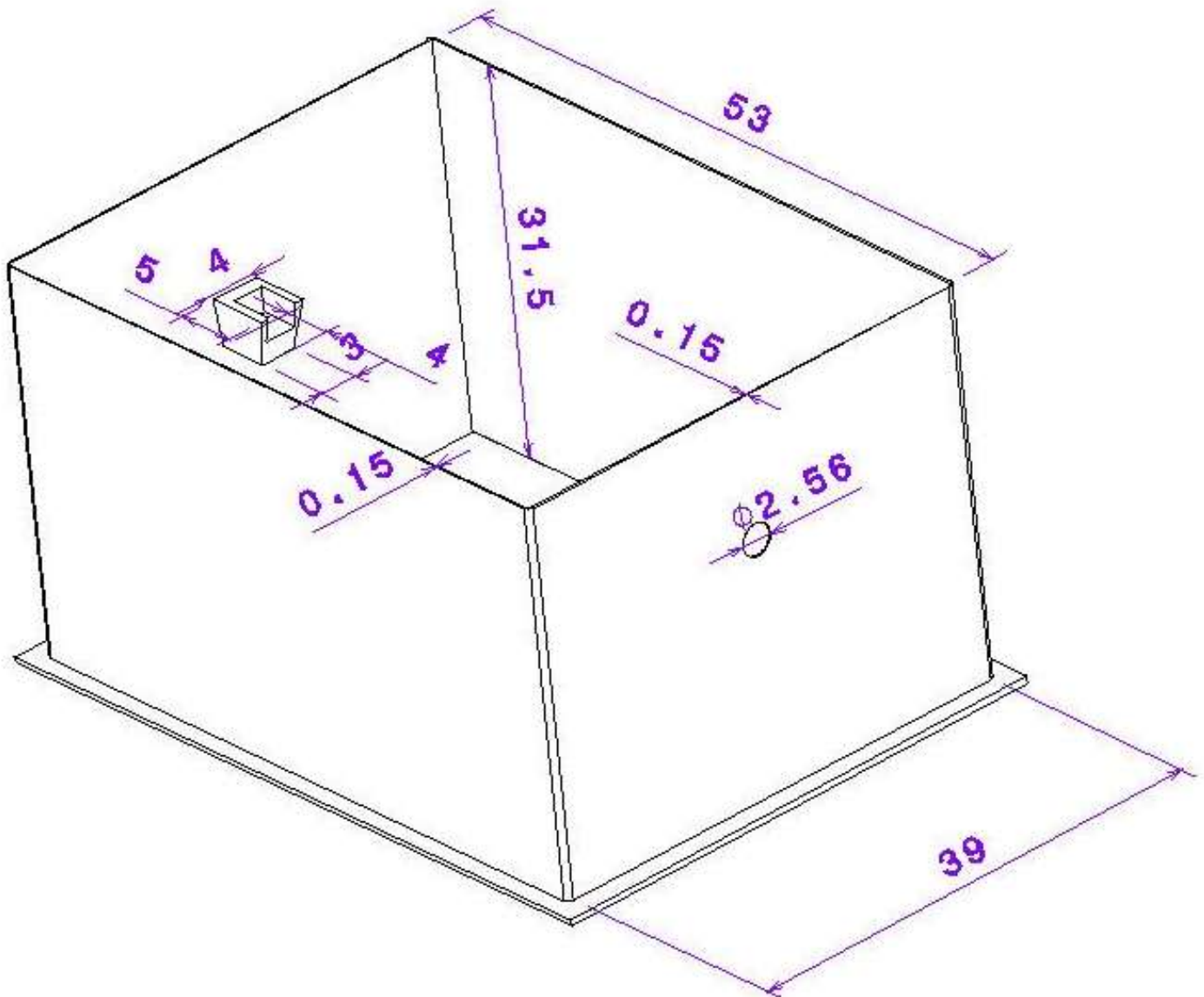


Fig. 8.8: Side Views of Tub



Isometric view
Scale: 2:1

Fig 8.9: Isometric View of Tub

The basic aim of the project was to design a descaling machine for fish. Here, the model is an adaptation of an existing model of Open Country Campware's Tumble Drumm Fish Scaler. An assembly of the whole parts was made and it was simulated in CATIA V5R21. The model worked properly as given input. The assembly model is shown in the figure. The whole model needs an 110V regulation for the motor.

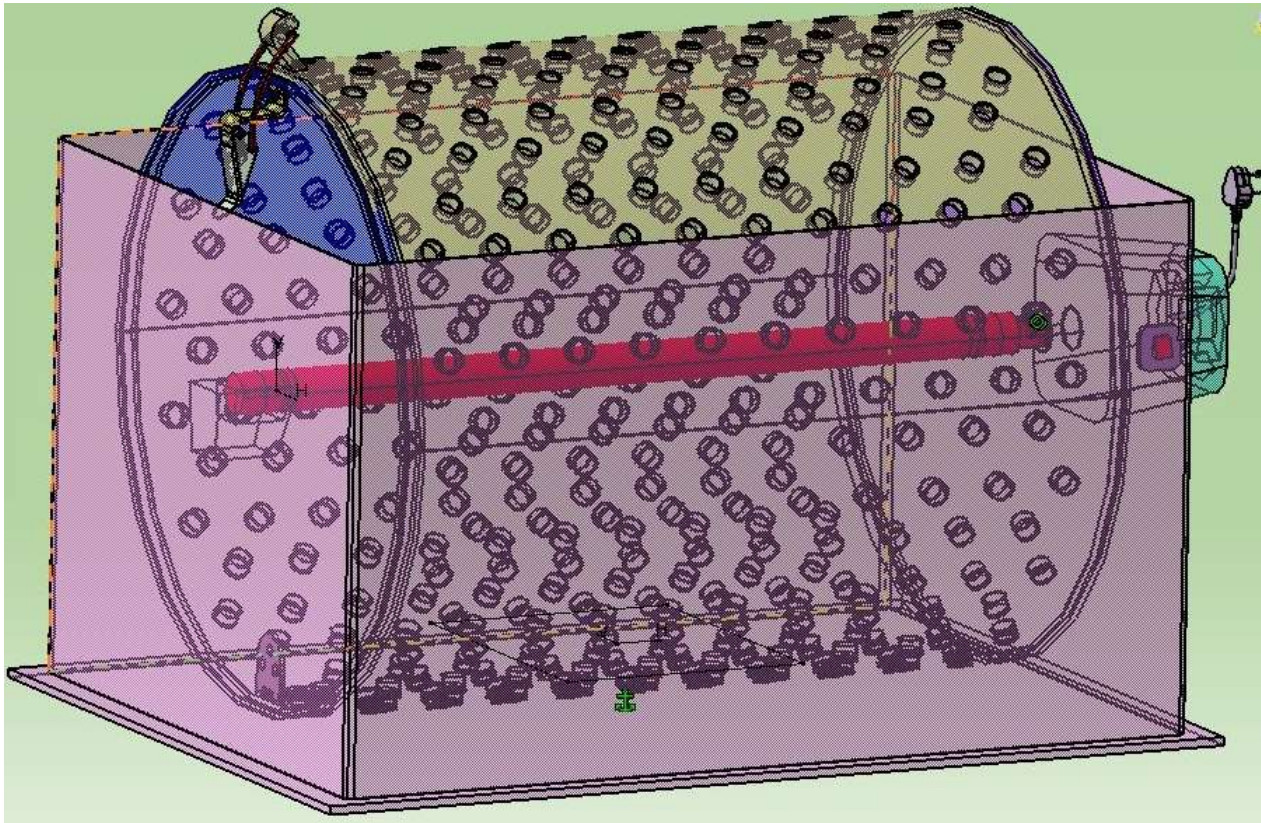


Fig.9.1: Drum Fish Scaling Machine

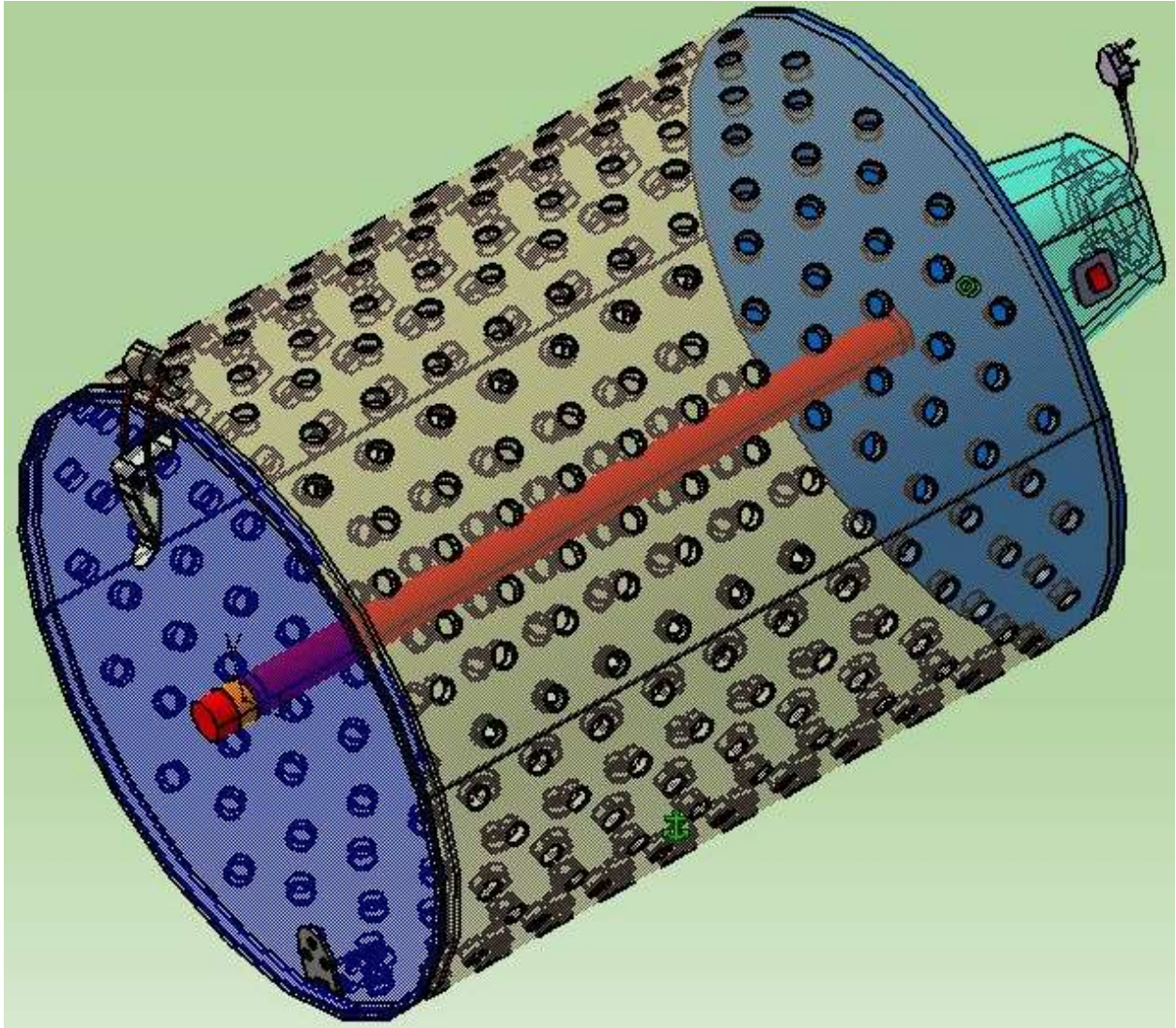
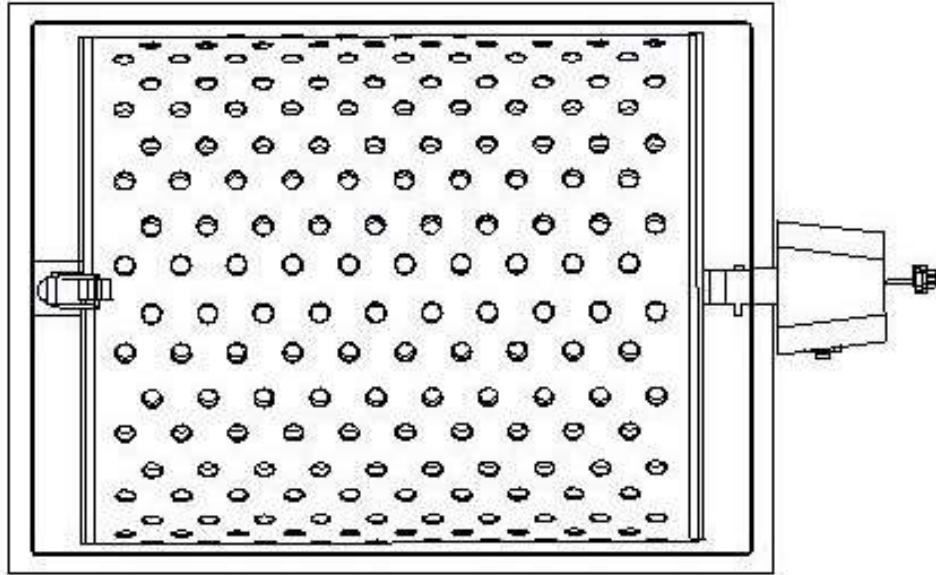
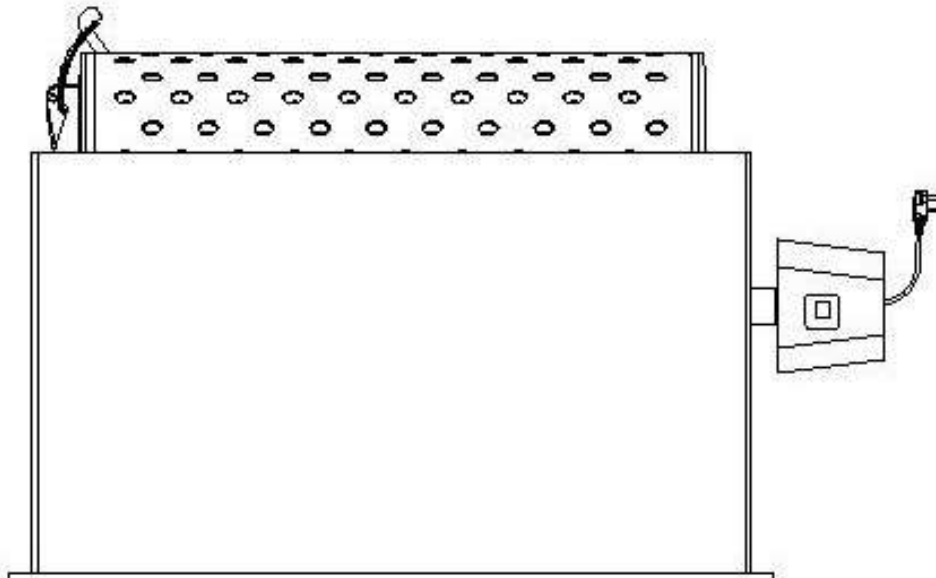


Fig. 9.2: Assembled Drum



Top View
Scale: 3:2



Front View
Scale: 3:2

Fig. 9.3: Front and Top View of the Assembly

Conclusion

In this work, the design of a fish descaling machine has been done. We believe that in this work, the automation of the first phase of the processing of a popular food has been attained. We believe that the work is an adaptation of an existing model aforesaid. There have been some parameters and design non-constraints those have been left out to allow more and more research work on this particular device which shall yield cheaper, more hygienic and better technology in the future. The fabrication of the device could be made with the above set of data and information described. We believe that this product has a vast industrial application as the food processing industry has been booming since the past few years. The overwhelming popularity of an ever existing cheaper non-veg dish i.e. fish recipe in the country and even in several places abroad leads the foundation of an entrepreneurial venture.

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