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DESIGN AND DEVELOPMENT OF WATER PURIFIER FOR RURAL POPULATION

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Abstract: *In rural India, people are not much aware of the purity of drinking water. In present status available water sources are getting polluted through different chemical mixtures and water treatment. So the importance for purification of water becomes a necessity for life. A water purification device which neither consumes electricity nor requires any pipeline connection fulfils the requirements of people in rural areas. So there is lot of scope to introduce a storage type water purifier for this segment.*

This project deals with the design and development of water purifier for the rural population. The project was carried out in the Isometric solutions Bangalore. A water purifier is designed and developed which meets the customer requirements and manufacturing requirements. Multiple concepts are generated and concept selection based on Pugh matrix is employed to select the best concept for future design and development.

A low cost water purifier is designed and developed which satisfies the customers of the rural areas which helps them to achieve healthy lifestyle. This is highly benefits the Indian rural population.

Keywords: *Design and development of water purifier*

1. INTRODUCTION

One of the most pervasive problems afflicting people throughout the world is inadequate access to clean water. Problems with water are expected to grow worse in the coming decades, with water scarcity occurring globally, even in regions currently considered water-rich. Addressing these problems calls out for a tremendous amount of research to be conducted to identify robust new methods of purifying water at lower cost and with less energy, while at the same time minimizing the use of chemicals and impact on the environment.

It is but an irony that though 70% of the earth's surface is covered by water yet it cannot be consumed without purification. Less than 1% of the water available on earth can be used for drinking purposes and that too is increasingly getting polluted. Pure water once naturally available is a long gone affair now in many parts of the country. According to World Health Organization 80% of diseases are water borne. The water that we get in our tap may be

contaminated with physical, chemical and microbiological impurities and may also have a high TDS (Total Dissolved Solids) Level. [1]

Although freshwater as a water resource might be plentiful and fully accessible to some populations, for others this is not the case. Natural disasters and atmospheric and climate conditions can cause drought, which can be problematic for many who rely on a steady supply of water. Arid areas around the world are most vulnerable to drought due to high annual variations in rainfall. In other cases water overconsumption can lead to problems that affect entire regions both environmentally and economically. [2]

In this context, this project deals with design and development of a water purifier for rural population.

2. NEED FOR WATER PURIFIER

India faces an enormous challenge in providing its citizens with clean potable water free from pathogenic bacteria, viruses, and cysts which cause diseases such as diarrhea, cholera, typhoid, and amoebiasis. It is estimated that about 10 million illnesses and 700,000 deaths in India could be attributed to diarrhea of which 400,000 are children under the age of five. [2]

Due to climatic changes, draughts, industrial wastes and alarming levels of salinity sources like rivers, catchments and reservoir systems are under dire stress resulting in the deteriorating water quality day by day. Due to the increased pollutants, river water is getting contaminated with dissolved impurities, bacteria and viruses.

The present day water has different types of deadly contaminants unheard in the past. Total dissolved solids in excess, heavy metals like lead, copper, iron, mercury and arsenic and other pollutants like insecticides and pesticides in the water can wreak havoc on the human body.

Mental retardation, cancer, kidney stones, digestive disorders, cardiac problems, intestinal catarrh, fluorosis are some of the long term effects caused as a result of these water contamination. 85% of all human diseases are due to water contamination. The rural population is the major sector suffering from this issue. Hence there is a real demand for the pure drinking water. [2]

All these needs collectively focus on the need for low cost, flexible and portable water purifiers which keeps the in line with healthier environment. In this context, this project deals with design and development of a water purifier for rural population.

3. OBJECTIVES OF THE STUDY

a) To review the available literature and collect data to understand the user aspirations, market and the competitors of water purifiers.

b) To analyze the collected data to arrive at Product Design Specification (PDS), after Quality Function Deployment preparation to overcome the usability issues, cost and aspects of appealing aesthetics of water purifier.

c) To generate concepts of storage type water purifier based on arrived PDS and to select final concept for development.

d) To fabricate a 1:1 scale mock-up of the final concept to end up with a low cost water purifier.

4. METHODOLOGY

With the above objectives in mind following methodology is adopted.

a) Literature review for water purification is carried out by referring reviewed journals, books, manuals and related documents.

b) Data collection is done by user study and market study through questionnaires, interviews, images, videos etc. to study and understand the water purifier, its market and users.

c) QFD generation based on the customer requirements and corresponding technical requirements, and PDS is generated prioritizing the features in the QFD.

d) Concepts are generated by sketching, adopting various concept generating technique like brain storming.

e) Few concepts are selected and the selected model will be created with the detailed features using CATIA-V5R17.

f) Concept evaluation for selecting the final concept is carried out by Pugh's method.

g) 1:1 scaled physical model will be made with good aesthetics and detailed features.

5. DESIGN AND DEVELOPMENT OF WATER PURIFIER

In this study deals with the detail design of the concept selected on the basis of Pugh matrix. From the Pugh matrix concept selection process, there are ten basic parts which are assembled to arrive at the final design of the product. The part drawings and their respective drawings are shown below.

1) lid

The lid is the upper most part of the purifier which covers the pre-filter from any damages. The lid is designed so that it is easily lifted while pouring or filling water to the purifier. Three dimensional view and part drawing are shown in the figures 5.1 and 5.1a respectively.

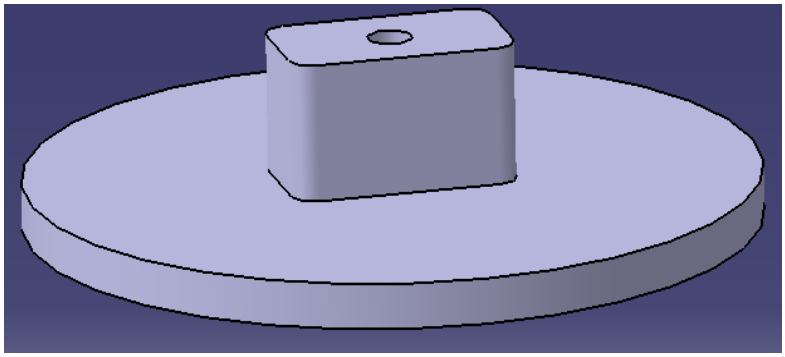

Figure 5.1: lid

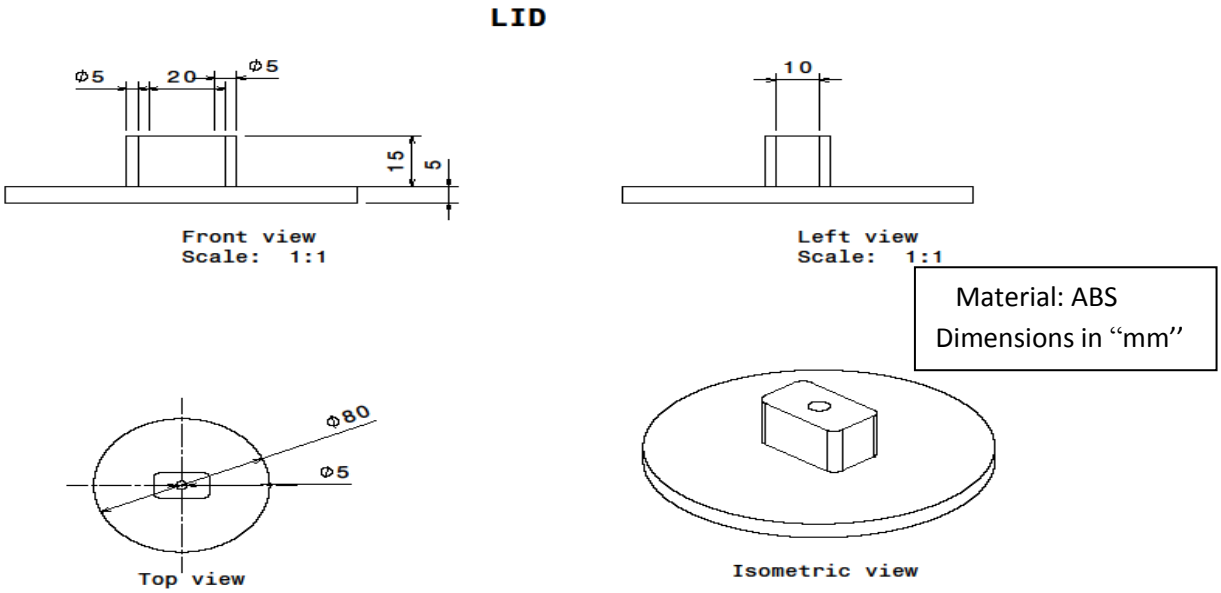

Figure 5.1a: Drawing of lid

2) Cover

The second part of the water purifier is the cover. This is attached to the top chamber to protect it from any external damages and also supports the pre filter when it is placed in the top chamber. Three dimensional view and part drawing are shown in the figures 5.2 and 5.2a respectively.

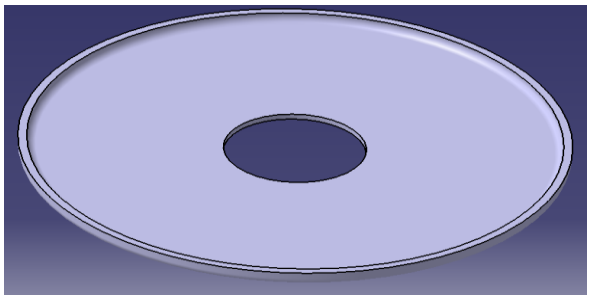

Figure 5.2: Cover

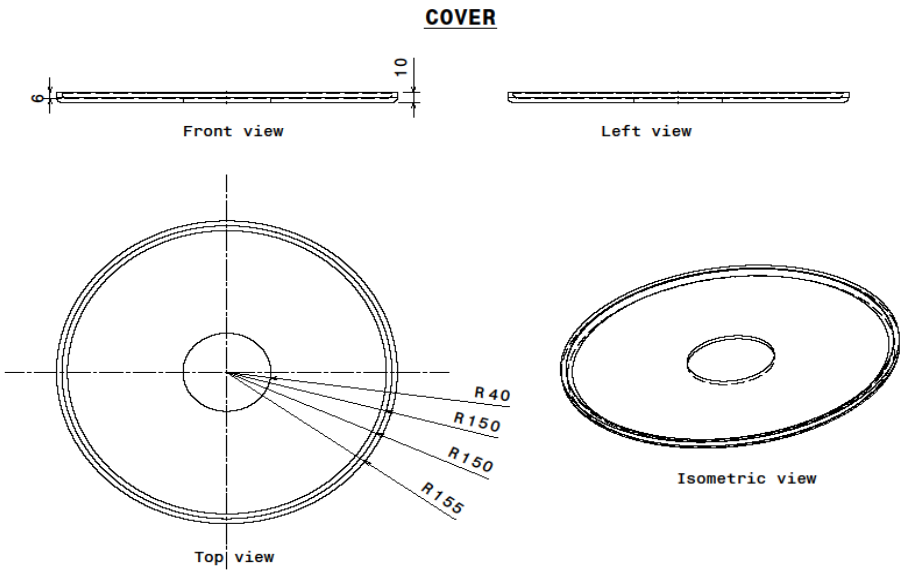

Figure 5.2a: Drawing of Cover

3) Part 3: Top Chamber

The top chamber is the main part of the water purifier which generally decides the capacity of the purifier. The top chamber is designed with less sharp inside edges and complications. A counter bore hole is provided at the top of the top chamber where pre-filter is placed. The base of the top chamber is opened which provides for the easy assembly and disassembly of the purifier. Three dimensional view and part drawing are shown in the figures 5.3 and 5.3a respectively.

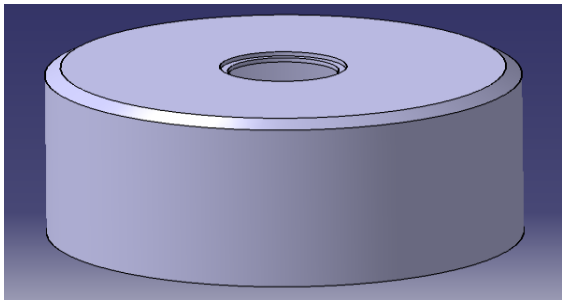

Figure 5.3: Top Chamber

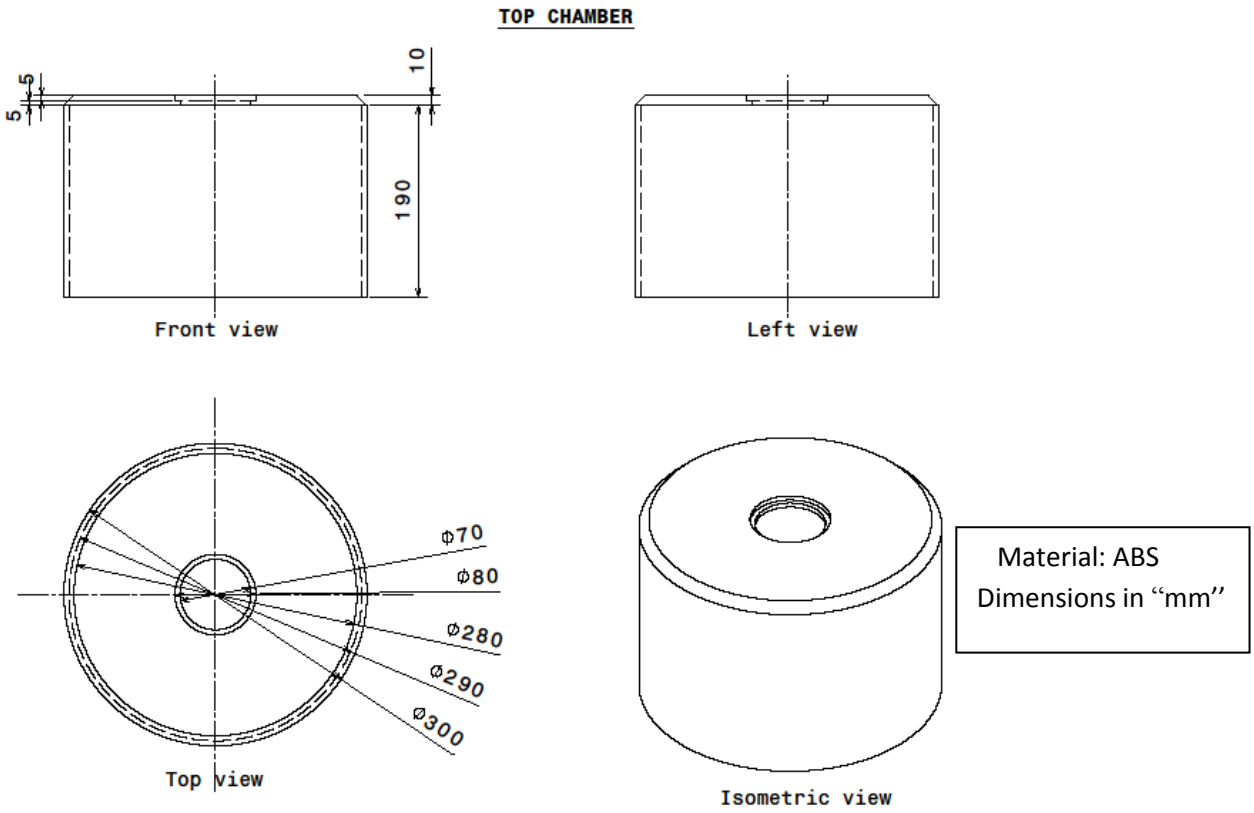

Figure 5.3a: Drawing of Top Chamber

4) Pre Filter

The pre filter is placed in the top chamber which acts as the barrier and removes lager size contaminants initially while filling water itself. Hence supports the purifying cartridge to survive for longer period. Three dimensional view and part drawing are shown in the figures 5.4 and 5.4a respectively.

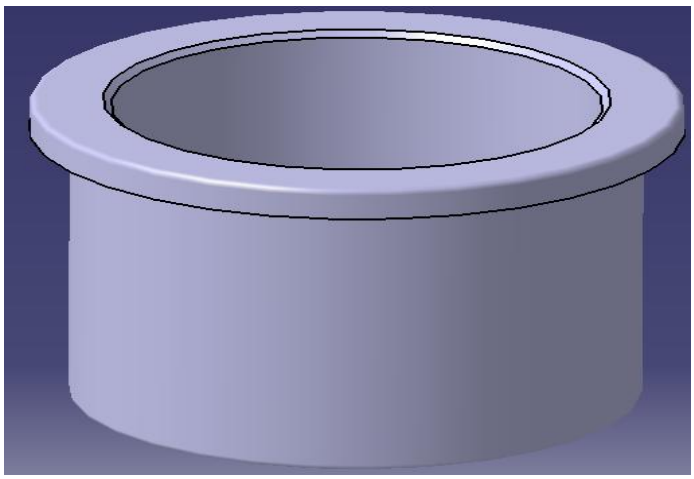

Figure 5.4: Pre Filter

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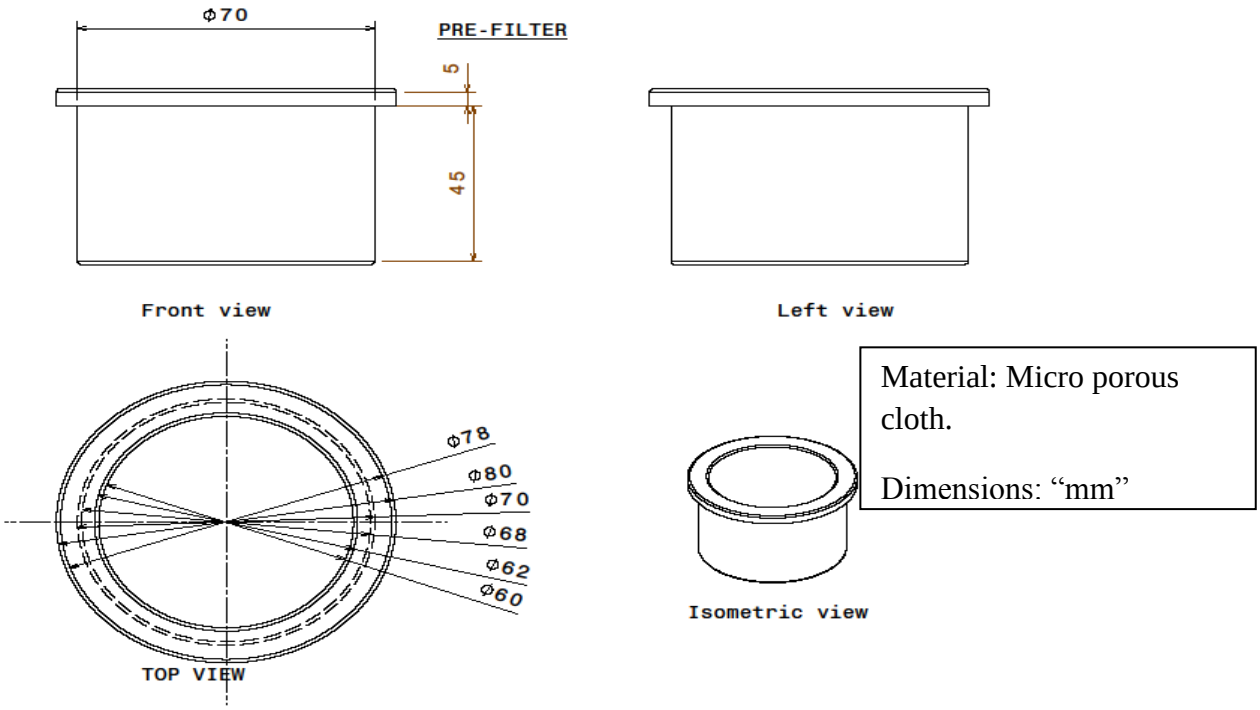

Figure 5.4a: Drawing of Pre filter

5) Carbon filter

The carbon filter is the next part which is assembled to the middle support of the water purifier. This filter contains pores through which water flows. During the flow, the filter adsorbs the chlorine leaving the clean water for next purification. Three dimensional view and part drawing are shown in the figures 5.5 and 5.5a respectively.

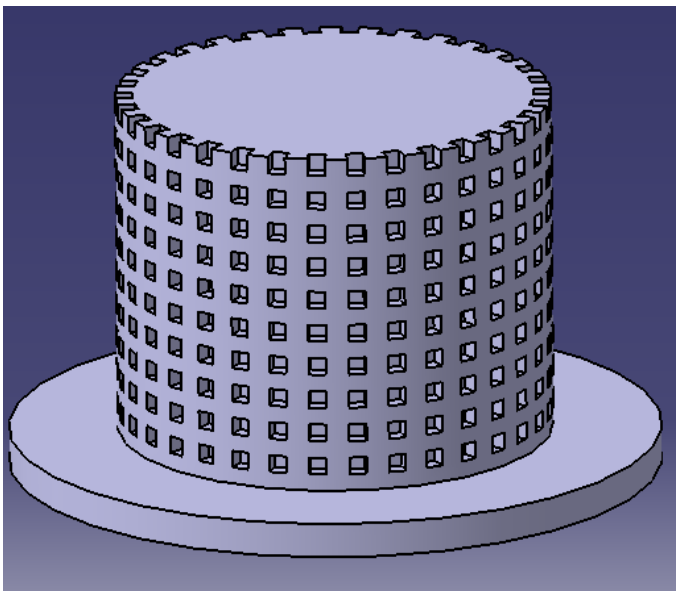

Figure 5.5: Carbon Filter

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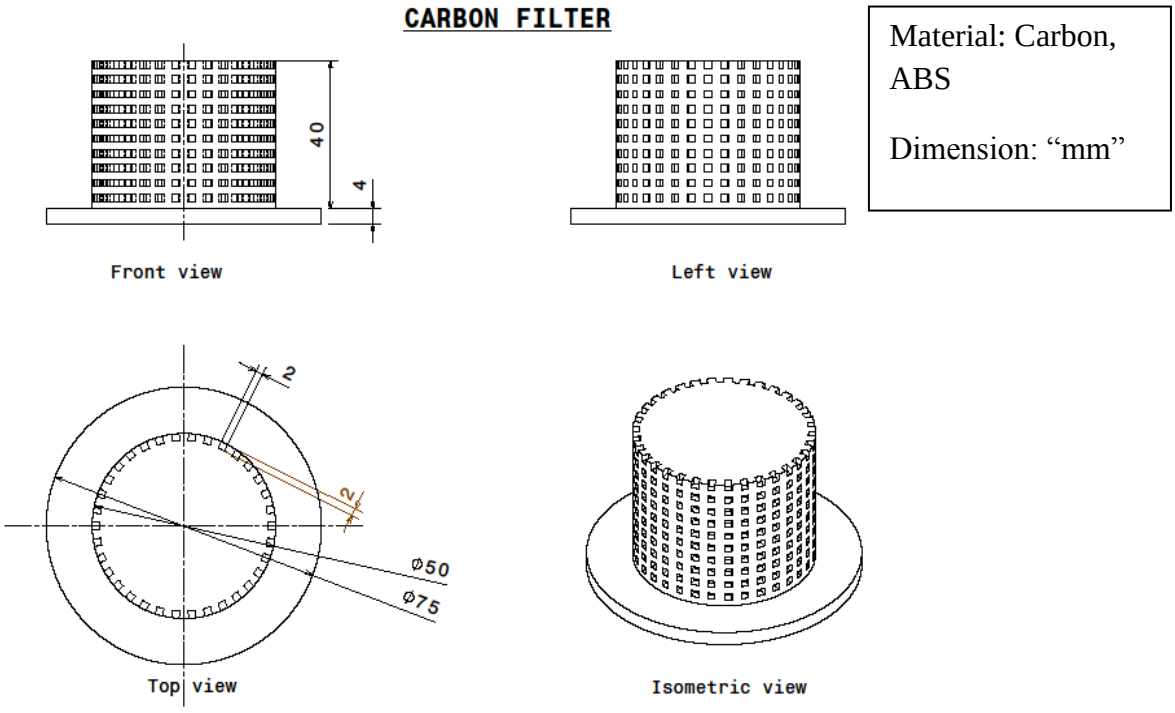

Figure 5.5a: Drawing of Carbon Filter

6. Middle Support

The middle support acts as the intermediate to the top and the bottom chamber. The water flows from the connectivity of middle support to the bottom chamber. The diameter of the support is made lager so that it gives necessary rigidity to the top chamber when place on it. Three dimensional view and part drawing are shown in the figures 5.6 and 5.6a respectively.

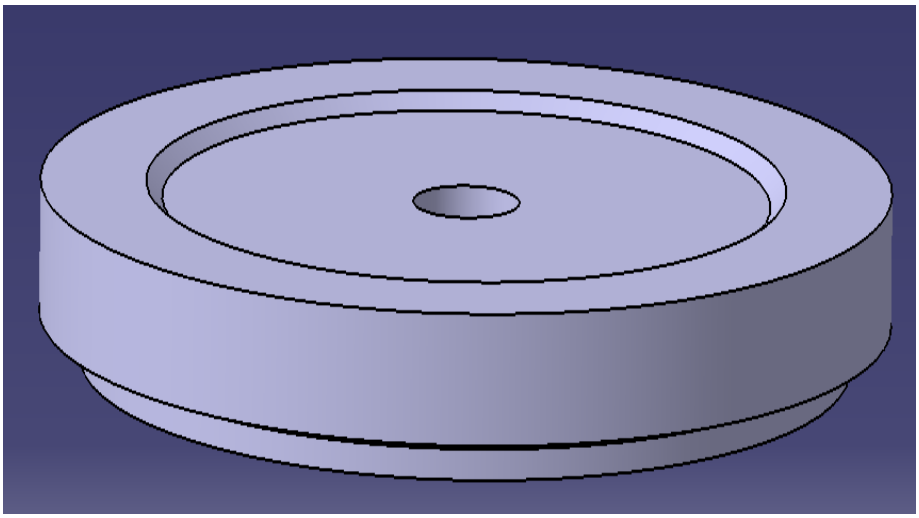

Figure 5.6: Middle Support

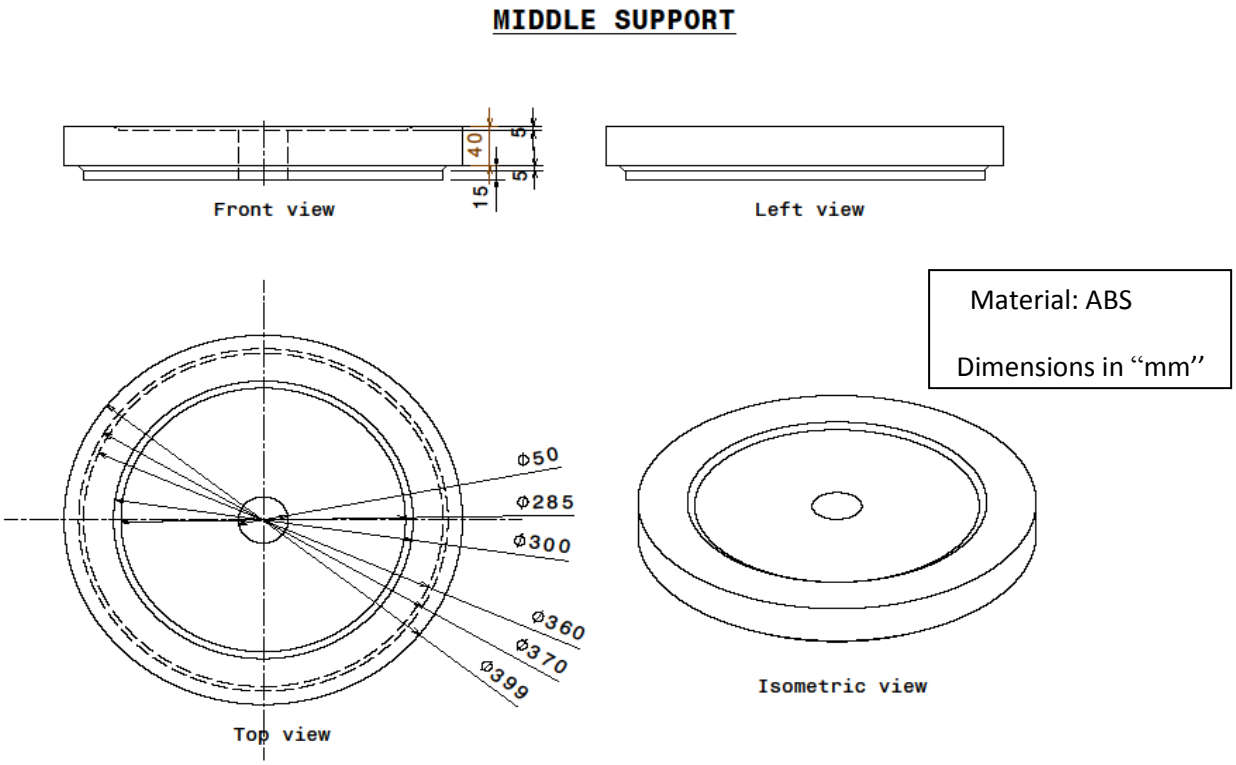

Figure 5.6a: Drawing of Middle Support

7. Purifying Cartridge

The purifying cartridge is designed to remove contaminants in the water. This is placed in connection to the middle support and the bottom chamber. Three dimensional view and part drawing are shown in the figures 5.7 and 5.7a respectively.

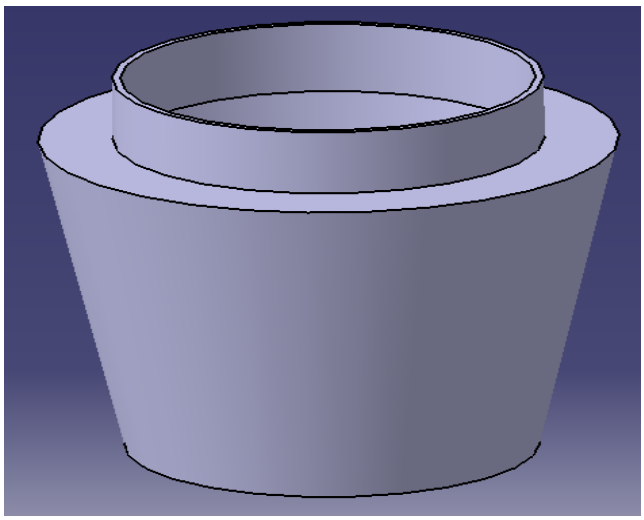

Figure 5.7: Purifying Cartridge

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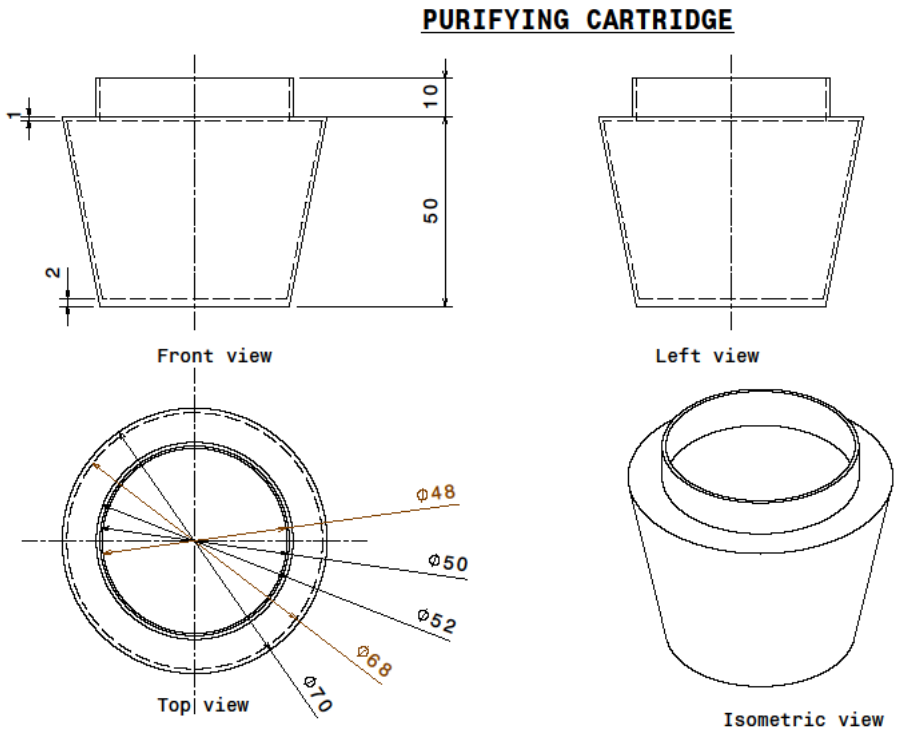

Figure 5.7a: Drawing of the Purifying Cartridge

8. Bottom Chamber

The purified water from the purifying cartridge gets collected in the bottom chamber. The diameter of the bottom chamber is 400mm so that it collects more water for the use. The chamber is provided with two taps which may serve the people on the rural better during the functions. The base of the chamber is concave so that the flow of water is directed to either taps with no wastage of water at the bottom of the chamber. 'D' shaped cut is provided at the tap so as to place a tumbler without any adjustments. Three dimensional view and part drawing are shown in the figures 5.8 and 5.8a respectively.

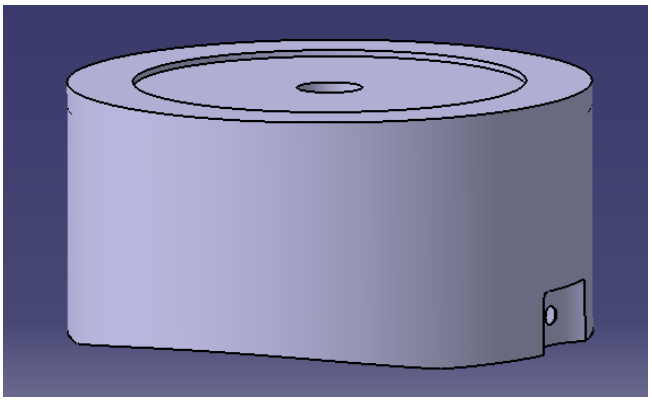

Figure 5.8: Bottom Chamber

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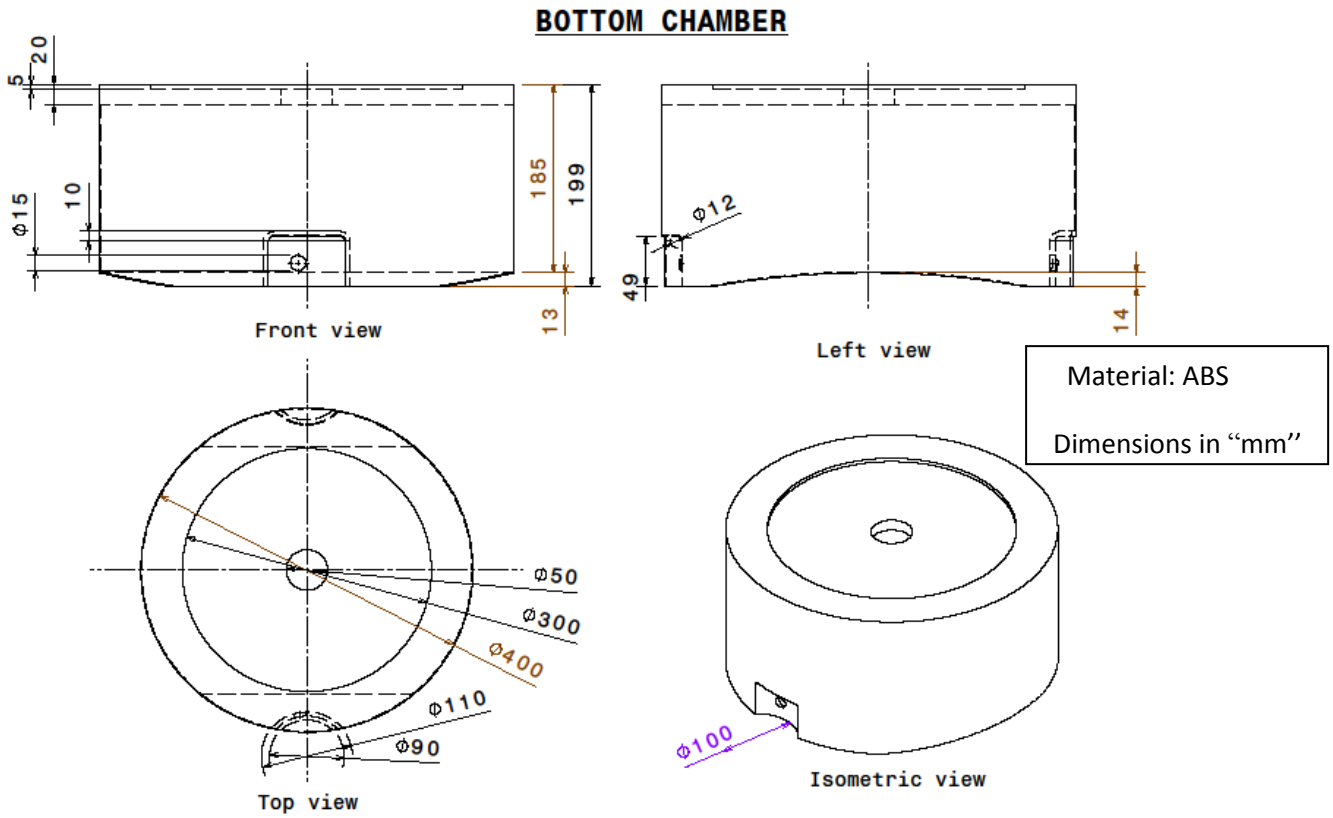

Figure 5.8a: Drawing of Bottom Chamber

9. Tap

The tap is positioned at the base of the bottom chamber so that the flow rate is even. The D shaped cut also at the tap reduces the damages to the tip of the tap. Three dimensional view and part drawing are shown in the figures 5.9 and 5.9a respectively.

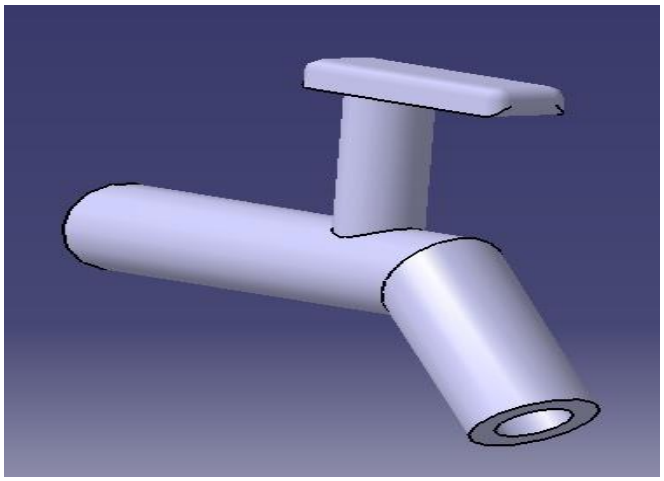

Figure 5.9: Tap

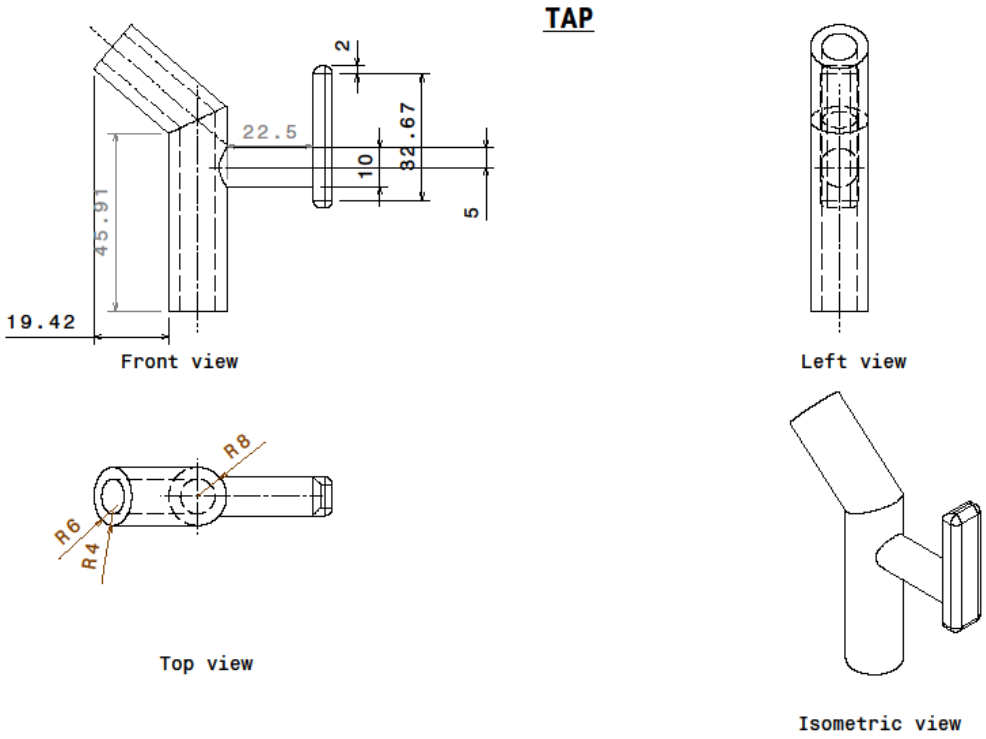

Figure 5.9a: Drawing of Tap

10. Base

The final part of the water purifier is the base. The height of the base should be nominal to all the other design parameters. The position of the tap has an adverse effect if the base is either too high or too small. The diameter of the base should be such that it should be stable when all components are placed on it. Three dimensional view and part drawing are shown in the figures 5.10 and 5.10a respectively.

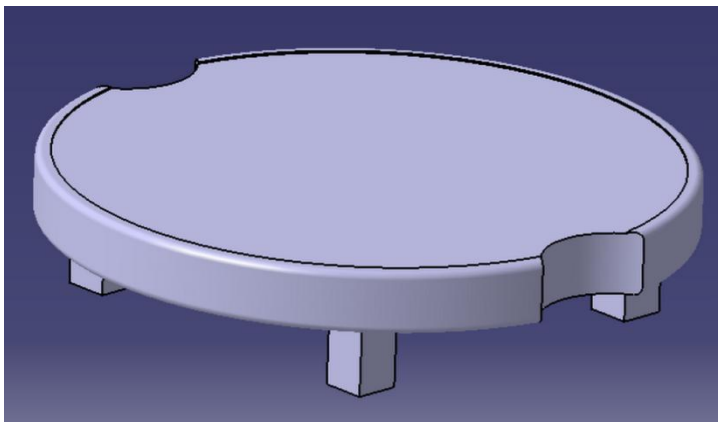

Figure 5.10: Base

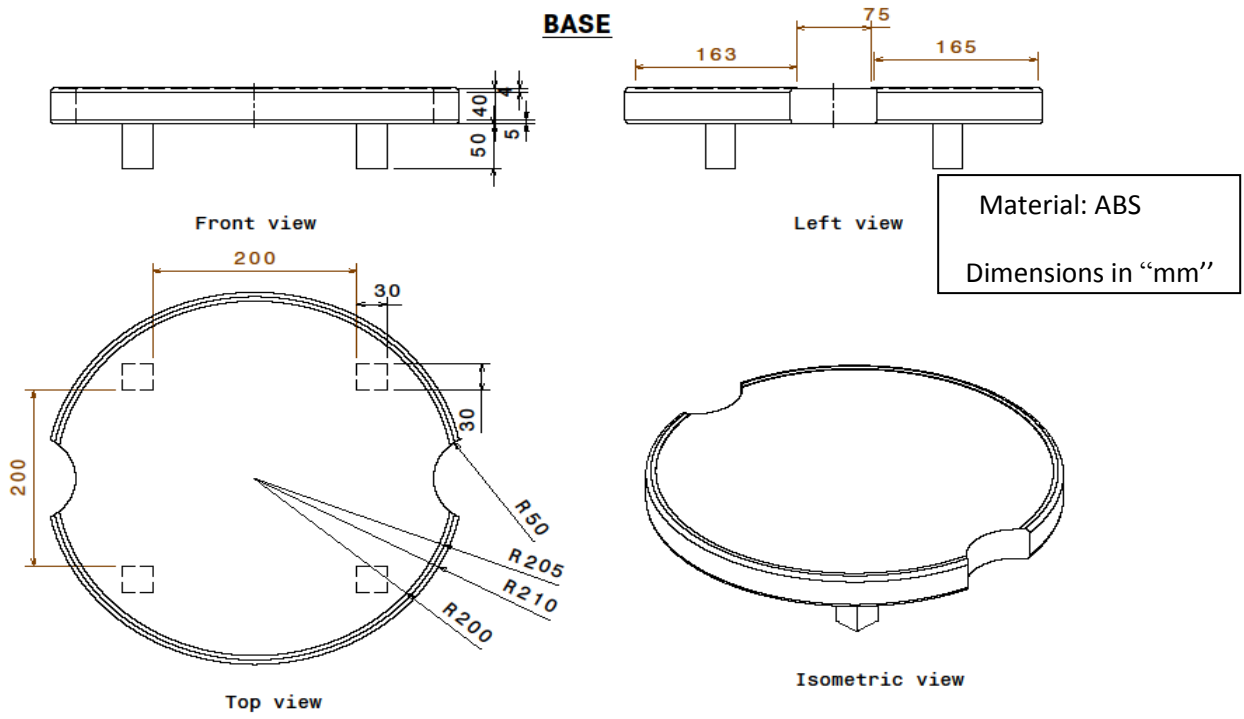

Figure 5.10 a: Drawing of the Base

11. Assembly

The figure 5.11 shows the assembly of the water purifier. The figure 5.11a shows its drawing of the water purifier.

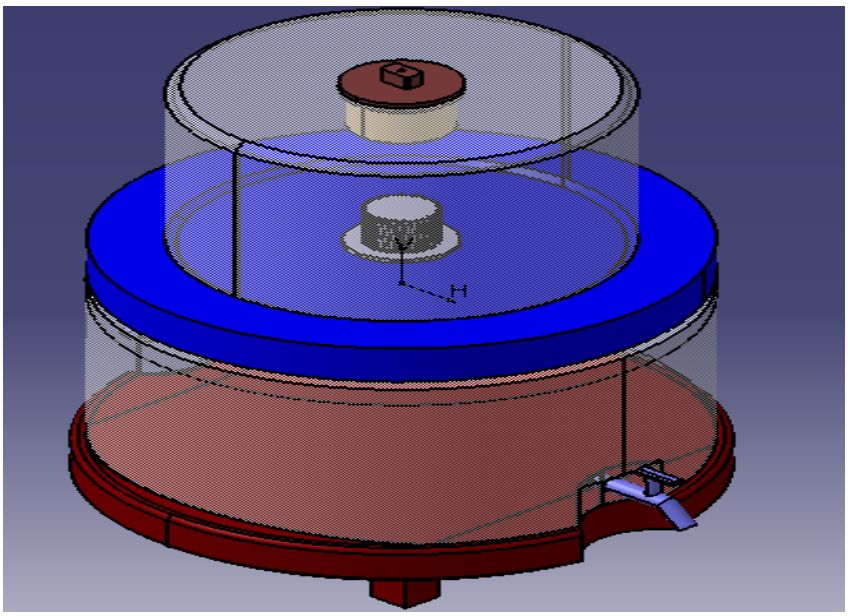

Figure 5.11: Assembled View of the Purifier

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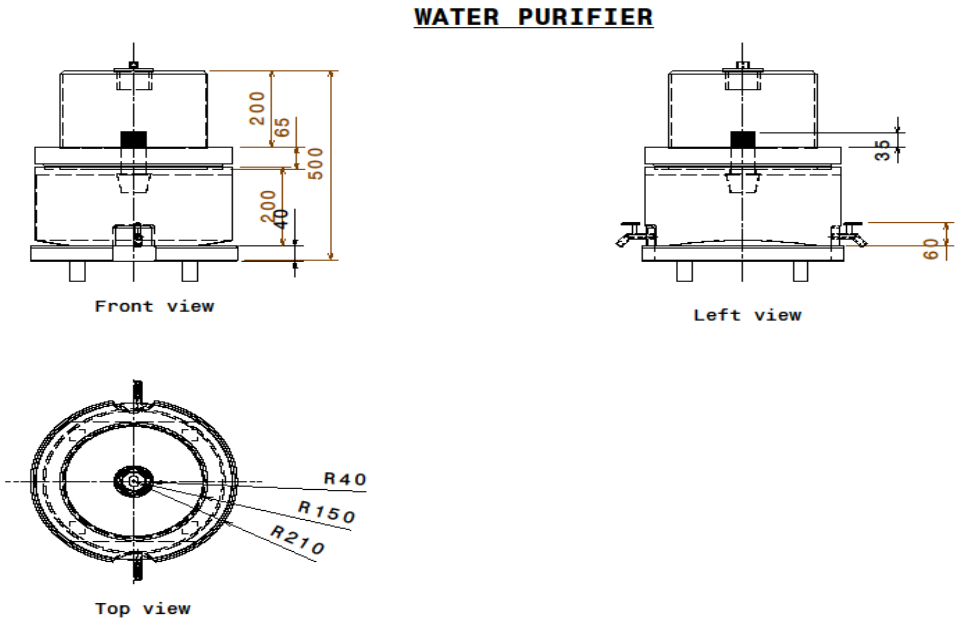

Figure 5.11a: Drawing of the Water Purifier

12. Exploded view

The figure 5.12 shows the explode view of the water purifier with all its components named at their respective positions.

The above figure 5.12 shows exploded view of the water purifier. The purifier consists of ten main parts of which the top and the bottom chambers decide the storage capacity of the purifier. The prefilter is of 160*100 diameters so that contaminants are retained in it. Both the top and bottom chambers are almost of the same capacity which is the basic customer requirement in the rural areas. The chambers are also transparent so that anyone could replenish the water when the water level is less in the purifier. A middle support acts as the connectivity between the top and bottom chamber. The purifying cartridge is assembled inside the middle support through which the water flows down to the bottom chamber. The base of the bottom chamber is curved upwards so that the water is not collected at the base below the level of tap. The water flows equally to the two taps provided. At the tap position, 'D' cut is provided which helps to place the tumbler without any adjustments. The total height of the purifier is around 500mm so that it is not too risky to fill the water especially for the women when purifier is placed on the table. The spherical shape of the purifier provides the necessary stability. The parts are all assembled as snap fit so that regular cleaning of the inner surface can be done with ease.

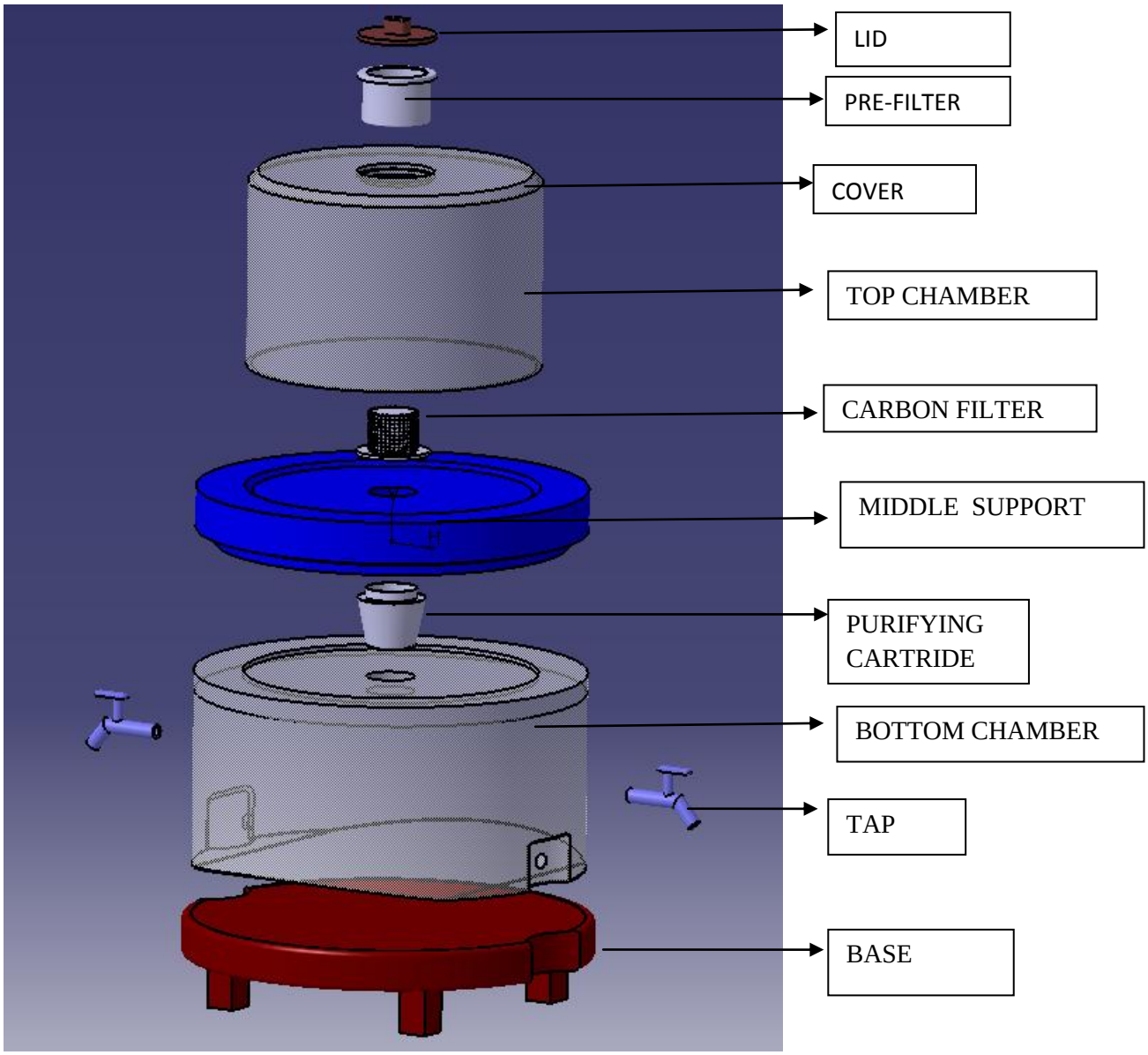

Figure 5.12: Exploded View of the Water Purifier

The above design of water purifier meets most of the requirements of the people in the rural areas where power is the major issue. Hence the development of this purifier may serve many people across.

6. BILL OF MATERIAL

The table 6.1 shows s the bill of material of the water purifier which is designed and developed.

Table 6.1 Bill of Material of Purifier

Sl. No	Name	Numbers	Material
1	Lid	1	Acrylonitrile Butadiene Styrene
2	Pre-filter	1	Micro porous cloth
3	Cover	1	Acrylonitrile Butadiene Styrene
4	Top chamber	1	Acrylonitrile butadiene styrene
5	Carbon filter	1	Carbon
6	Middle Support	1	Acrylonitrile Butadiene Styrene
7	Purifying Cartridge	1	Plastic and Carbon
8	Bottom Chamber	1	Acrylonitrile Butadiene Styrene
9	Tap	2	Poly Vinyl Chloride
10	Base	1	Acrylonitrile Butadiene Styrene

7. PROTOTYPE

Considering all the design parameters, a final prototype is generated. The figure 5.13 shows the prototype of the water purifier which will fulfill the customer requirement by is less complicated design and operating parameter.

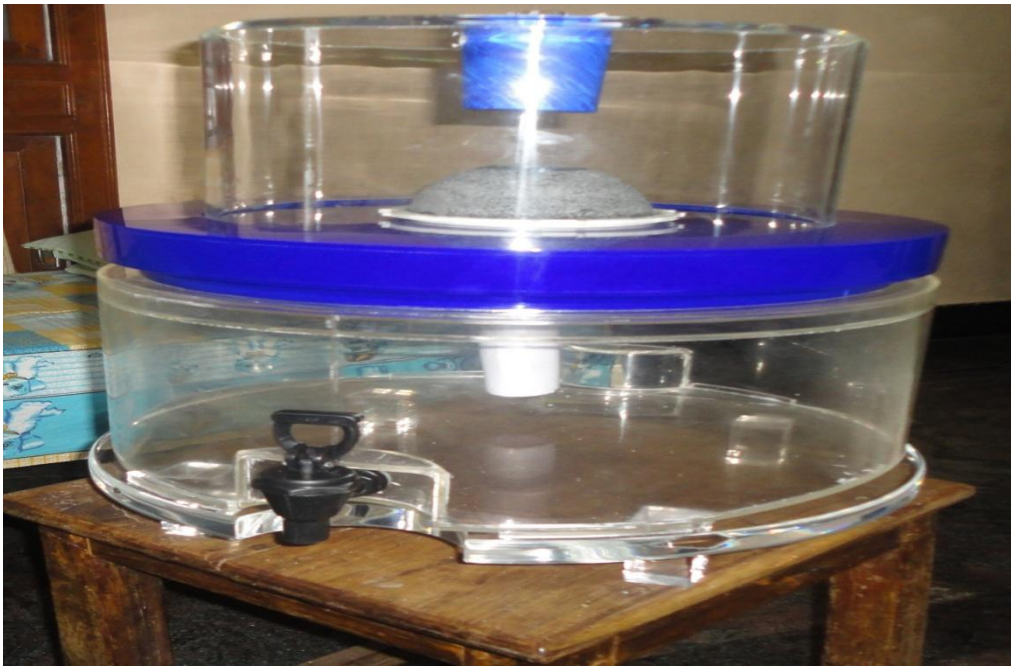

Figure 7: Prototype

8. CONCLUSION

In rural India, people are not much aware of the purity of drinking water. In present status available water sources are getting polluted through different chemical mixtures and water treatment. So the importance for purification of water becomes a necessity for life. A water

purification device which neither consumes electricity nor requires any pipeline connection fulfils the requirements of people in rural areas.

Hence the design and development of the water purifier may be beneficial in several ways for the peoples in the rural areas. The design must consider the cost, storage capacity, portability, easily disassembled for cleaning purpose etc. Considering all these criteria, a well designed storage type water purifier may be developed.

Customer's needs are the basement for the design purpose. In this project the designed water purifier has the advantage of two taps which may be used to provide clean water with minimum delay during functions etc. The bottom of the base is provided with a bulge so that no water stays in the purifier and 100% flow rate can be achieved.

There is a 'D' shaped cut which is provided at the taps to ensure the placement of the tumbler without any harm to the taps. Both the chambers are almost of the same bigger capacity which may help for the families with more members providing each person pure water. The chambers are made transparent which may help in the replenishment of the water.

Hence this project of design and development of water purifier may be very beneficial especially for the rural population.

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