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Water Purification by Indigenous Reverse Osmosis Techniques

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ABSTRACT
The objective of the research was to provide clean drinking water to each house and at a cheap rate. For that the basic physical water treating methods were used like filtration (through gravels and charcoal) and the main process used in reverse osmosis (RO). Desired results were achieved after the process. Sewage water, sea water and also solutions with different dyes were tested by the apparatus and all the results were positive. Successful RO purification was conducted for different solutions and then TDS was measured for all of them. UV-Visible Spectroscopy Test of these samples was also conducted and the results were positive and directly showing the successful functioning of the research.

Keywords: reverse osmosis, activated charcoal, filtration, semi-permeable membrane, UV-spectroscopy.

INTRODUCTION

The objective of water cleaning process is to make the water free from impurities, suspended solids and other dissolved and un-dissolved elements which are harmful for health of living beings. Impurities can cause various diseases like polio, malaria, dengue, cholera, scabies, anaemia, typhoid, fluorosis, hepatitis, diarrhea and malnutrition [1-4]. All these diseases result due to presence of one or more specific kind of impurities. The impurities can be living organisms or non-living particulates [5-7]. For example, the disease fluorosis occurs from the presence of fluoride ion which can be found in water due to industrial discharge or other effluents. The conventional water purification techniques involve the basic steps of coagulation and filtration. The coagulation process involves the addition of some coagulation agent in water which is able to group the particulates and impurities together [8-12]. In this way the size of the agglomerate formed is large enough to enable filtration and cleaning of water. Other techniques include the boiling of water which is one of the most efficient ways to get rid of all the living organisms found in water. Especially in India, we can find numerous techniques of cleaning water by indigenous techniques. The filtration part is done by clay pot of suitable pore-size. The water filters through passing by pores in clay-pot (matka). Very fine cloth and winnowing sieve is also used sometimes for filtration process.
With modernization of technologies reverse osmosis became very popular technique to clean water. It uses semi-permeable membrane to achieve high quality of water. Other than these there are other techniques also like ultra-filtration, gravity based filtration, hydrophilic membrane filtration etc. In this research we have combined the traditional and modern techniques in order to come up with a more economic and safe cleaning techniques which are easy to replenish and the major benefit is that it does not strip the drinking water of essential elements [13-15].
The whole assembly was made of very easily available materials like the conventional RO module and the gravel, small pebbles and charcoal for cleansing and de-odorizing column, semi-permeable membranes, high pressure pump, filter paper, brine seal camer, adhesives, pipes, polyester base, polysulfide layer, necessary chemicals, activated charcoal (carbon). The basic process of water-cleansing thus was achieved by using low-cost materials and further several tests were conducted for the cleaned samples [16-19].

EXPERIMENTAL METHODOLOGY

Activated Carbon has a unique ability to remove all the pesticides, heavy metals and toxic organic compounds from water. It also removes odor from water [20-22]. This is the reason that activated charcoal is now being used in face-washes and creams. Gravel acts as natural filtration technique for water as when water trickles down the pebbles the impurities are not allowed to pass through them. As a result only clean water is obtained after this layer.
Apart from these there are RO-modules which have semi-permeable membranes which are made of cellulose-based compound [23]. They have a perforated central tube, brine seal, and permeate collection material all of which makes it best suitable for water purification [24-27]. The major emphasis was to find an alternative to find a cheaper and efficient material set to filter water with the same efficiency either directly or with combination of the two techniques.
Various samples including organic dyes, inorganic salt solutions and sea/sewage water were tested. Detailed Implementation in the designing and development of the project is described. The different components of the project are the motor,

the RO module assembly and the indigenous cleansing column.
The electric motor: The electric motor is used to provide pressure to transport the water from various components of the project. The operating pressure of the motor is around 60 psi. Conventional RO modules were used in order to enhance the cleansing action.
The Indigenous cleansing column: This was the most innovative component in this research. This was a low-cost, plastic column filled with different layers of materials such as pebbles, activated carbon to clean the passing water organically. This proved to be very effective from the TDS tests and UV tests done on the samples. The experimental work was divided in different parts for the sake of proper implementation and development.

RESULTS AND DISSCUSSION

To check the purification of our RO filter, the following observations were noticed.

ORGANIC DYES

Two different organic dyes, methylene blue and phenol red were taken in solution form and the solutions were passed through the RO filter. Both these dyes have a strong characteristic color which can be used as a preliminary test for the working of indigenous RO-assembly. After passing it through the filter colorless and clear solution (water) was obtained from the other side. The indigenous RO-assembly was able to remove the color of the solution. Then the UV-Spectroscopy test was conducted to ensure the efficiency of design.
After passing them through the RO filter the input and output solutions for each dye were collected and Ultra-Violet-Visible Spectroscopy(UV-Vis) was conducted on them in the range of 200-800nm.
A- Methylene blue soln.
B- Output soln. after passing soln. A
C- Phenol red soln.
D- Output soln. after passing soln. C

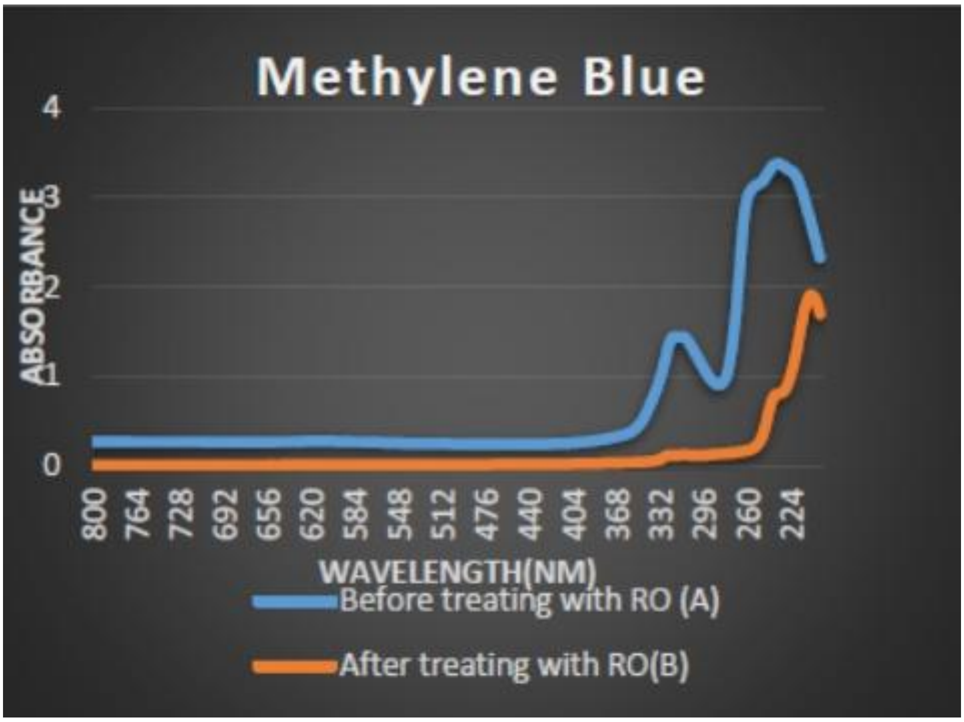

Fig. 1: UV- Spectroscopy test results for Methylene Blue solutions.

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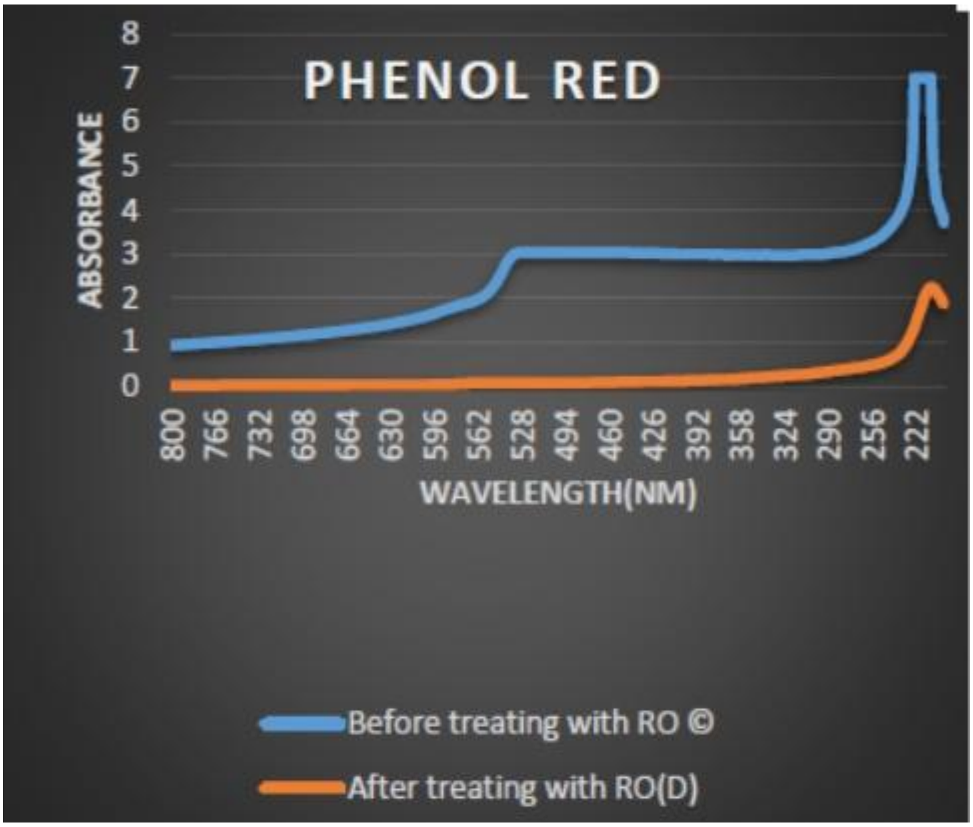

Fig. 2: UV-Spectroscopy test results for Phenol Red solutions.

In both the cases we can clearly say that the absorbance value for a particular wavelength as drastically reduced from the input to output solutions. This indicated that the impurities have reduced in the resultant solutions when passed through the filter. This clearly indicates that the RO filter is purifying water efficiently.

SEWAGE WATER/SEA WATER

Sea-water is one of the major polluted waters as it contains a wide-variety of effluents and contaminants. These include effluents from industries, oil-spills, landfills, agricultural chemicals and wastes and raw sewage material [28]. Thus for testing the efficiency of the indigenous RO-assembly, sea water forms a principal testing sample.

Sea water was collected from the Marina Beach, Chennai. Some of it was passed through the conventional RO filter. The remaining sample was passed through the indigenous RO-assembly. The outputs were colorless and clear. We took both these sample and measured their TDS using TDS/Conductivity meter. The results were satisfactory for the indigenous RO-assembly. The cleaning efficiency and TDS values obtained were at par with the commercial RO- Filters available in market.

SIMPLE SALT SOLUTIONS

Simple salt solutions can contain various elements which can cause severe harm to health of living-beings [29]. In-fact most of the elements when present in larger quantities can cause harmful effects and can give rise to phenomenon like eutrophication and bio-magnification in human body as well as water bodies. Thus there is a need of cleaning water from all the harmful chemicals and elements from drinking water [30].

We made some solutions of coloured salts like $KMnO_4$ and passed them through RO filter. The output was colourless and clear. We took the TDS of input and output solutions using TDS/Conductivity meter.

TDS of $KMnO_4$ before RO -174ppm

TDS of output – 49ppm

The decrease in TDS values indicated that the indigenous RO-assembly is able to remove the suspended and dissolved solids from solution. The results were satisfactory and proved the efficiency of indigenous RO-assembly in cleaning the water and stripping it off the harmful chemicals. Further combining the results of all three categories of samples, the important conclusions were formulated.

CONCLUSION

In addition to RO-module, we have made an indigenous filtration tube consisting of gravel and charcoal which helps in removing taste and odour of the impure water. It also helps in maintaining the water pressure. The major emphasis was to find an alternative to find a cheaper and efficient material set to filter water with the same efficiency either directly or with combination of the two techniques. This is an innovative method which can be used with RO to increase the efficiency. The whole assembly comprised of very in-expensive and easily available materials like the conventional RO module and the gravel, small pebbles and charcoal for cleansing and de-odorizing column, semi-permeable membranes, high pressure pump, filter paper, brine seal camer, adhesives, pipes, polyester base, polysulfide layer, necessary chemicals, activated charcoal (carbon). All of these were having specific-purpose in the water cleaning process. The UV-Spectroscopy tests prove that the absorbance value for a particular wavelength has drastically reduced from the input to output solutions. This clearly indicates that the RO filter is purifying water efficiently. Thus the design of indigenous water-purifier is efficient in cleaning the water and making it free from suspended solids, organic and in-organic chemicals and other impurities.

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