STUDY ON AN ECONOMICAL ALTERNATE FOR WATER TREATMENT IN RURAL AREAS

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CERTIFICATE

Certified that the research work presented in this Project entitled **"Study on an Economic Alternate for Water Treatment in Rural Areas"** has been carried out for the award of **Bachelor of Technology** from Babu Banarasi Das University, Lucknow under my supervision. The Project embodies results of original work, and studies are carried out by the students themselves and the contents of the Project do not form the basis for the award of any other degree to the candidate or to anybody else from this or any other University/Institution.

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DECLARATION

We hereby declare that this submission is our own work and that, to the best of our knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgement has been made in the text.

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ABSTRACT

The unavailability of safe and secure drinking water is a major problem of rural India. The poor water quality causes a number of health problems. It is estimated that 37.7 million Indians are affected by waterborne diseases annually, 1.5 million children are estimated to die of diarrhoea alone and 73 million working days are lost due to waterborne disease each year. The resulting economic burden is estimated at $600 million a year. The nature of contamination of drinking water in India varies from region to region - bacteriological contamination being more common in regions where open defecation is the norm. Chemical contamination being more common in regions where there has been high use of fertilizers and pesticides in agriculture over the past few decades. There is clearly an urgent need to take steps to protect our poorer populations from unnecessary health risks, medical expenditures and morbidity caused by consumption of unsafe water. It has been estimated for instance that improved quality of water supply reduces diarrhoeal morbidity by between 6% to 25%, if severe outcomes are included. Improvements in drinking water quality through household water treatment such as chlorination at a point of use, can lead to a reduction of diarrhoeal episodes by between 35% and 39%. As we know that poverty is one of the major issues of rural India, therefore, for providing good quality water in these areas it is necessary to provide some low-cost alternates for treatment of water using locally available materials. In this paper we have studied on economical alternate for water treatment in rural areas using Rice Husk Ash. Rice Husk Ash have adsorption properties which helps in removing toxic materials present in water. The content of silica present in RHA reduces the turbidity, or suspended particle count, and elongates the life of the filtration system-based filter can remove about 95% of bacteria from water. In this paper we have used cement and sand along with RHA so as to reduce the pores of RHA. Cement also helps in binding the filter material. As India is a major producer of rice, RHA is easily available at a very cheap price. So, filter based on RHA are very low cost. To study the efficiency of the filter based on RHA, we have performed various test such as turbidly test, pH test etc. This paper is mainly aimed at reducing Total Dissolved Solids, Total Suspended Solids, pH and turbidity of drinking water in rural areas which mainly depend of surface water and ground water sources for meeting their requirements of potable water.

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1.1 GENERAL

The rural population of India comprises more than 700 million people residing in about 1.42million habitations spread over 15 diverse ecological regions. It is true that providing drinking water to such a large population is an enormous challenge. Our country is also characterised by non-uniformity in level of awareness, socio-economic development, education, poverty, practices and rituals which add to the complexity of providing water.

According to the World Summit of Sustainable Development, the major reason for lack of safe water is either scarcity of water or contamination of water sources. Lack of safe drinking water is due to both lack of investment in water systems and inadequate maintenance of existing systems. About half of the water in drinking water supply systems in the developing world is lost to leakage, illegal hook-ups and vandalism. In some countries, drinking water is highly subsidized for those connected to the system, generally well-to-do people while poor must rely on either expensive private sellers or unsafe sources.

According to the UNICEF, lack of access to safe water is having a disastrous impact on children across the world. Reasons for this include shortage of water, poverty, and lack of education about the impact of drinking unpurified water. Nearly, 2.2 million children die annually from water borne diseases. The World Health Organization estimates that at any given moment, approximately one half of all peoples in the developing world are suffering from one or more of six primary diseases caused by poor water supply and suboptimal sanitation. These six diseases are diarrhoea, ascaris, dracunculiasis, hookworm, schistosomiasis and trachoma. The economic impact on developing countries of large proportions of people suffering from such diseases is understandably dreadful.

The health burden of poor water quality is enormous. It is estimated that around 37.7 million Indians are affected by waterborne diseases annually, 1.5 million children are estimated to die of diarrhoea alone and 73 million working days are lost due to waterborne disease each year. The resulting economic burden is estimated at $600 million a year. The problem of chemical contamination is also prevalent in India with 1,95,813 habitations in the country are affected by poor water quality. The major chemical parameters of concern are fluoride and arsenic. Iron is also emerging as a major problem with many habitations showing excess iron in the water sample. Table1.1 shows the permissible limits for various parameters and their undesirable effect they cause when they exceed the limit.

Table 1.1: Indian Standards for Drinking Water

S. no	Parameter	Desirable limit	Undesirable effect outside the desirable limit	Permissible limit in the absence of alternate
1	Turbidity	Max. 5 NTU	Above 5 consumer acceptance decreases	10NTU
2	pH value	6.5– 8.5	Beyond this range the water will affect mucous membrane and / or water supply system	No relaxation
3	Total Hardness (as CaCO3)	Max. 300mg/L	Encrustation in water supply structure and adverse effects on domestic use.	600mg/L
4	Iron (Fe)	Max. 0.3 mg/L	Beyond this limit taste / appearance are affected, has adverse effect on domestic uses and water supply structures and promotes iron bacteria	1mg/L
5	Chlorides (Cl)	Max. 250 mg/L	Beyond this limit, taste, corrosion and palatability are affected	1000mg/L
6	Fluoride (F)	Max. 1.0 mg/L	Fluoride may be kept as low as possible. High fluoride may cause fluorosis.	1.5 mg/L
7	Dissolved solids	Max. 500 mg/L	Beyond this palatability decreases and may cause gastro intestinal irritation	2000
8	Arsenic (As)	Max. 0.05 mg/L	Beyond this, the water becomes toxic	No relaxation

Providing safe drinking water to all in rural India is a challenging task. The user should be made aware of the importance of preventing contamination of water and user's accountability should also realize their individual responsibility in maintaining the quality of water.

As we know that poverty is one of the major issues of rural India, therefore, for providing good quality water in these areas it is necessary to provide some low-cost alternates for treatment of water using locally available material. Rice Husk Ash is such a material which is cheap and abundant in India.

1.2 PROBLEMS RELATED TO SURFACE WATER SOURCES

Surface water has different concerns than groundwater as groundwater is pulled out of the ground, which acts as a natural filter, but surface water is exposed to all elements and picks up something from anything it touches. Protozoan cysts, including both Cryptosporidium parvum and Giardia lamblia, are pathogenic microorganisms which can cause illness, specifically severe gastroenteritis.

1.2.1 Sources of Surface Water Pollution

The sources of surface water contamination are many. One of the most common sources of surface water pollution is human waste, especially in developing countries. Poorly maintained waste systems and adverse weather incidents such as flooding are also major sources of surface water pollution. Some of the major sources of surface water contamination are discussed below:

Sewage (Waste Water)

Sewage is another name for waste water from domestic and industrial processes. It is one of the major sources of polluting rivers.

Agricultural Pollution

Agricultural processes such as uncontrolled spreading of slurries and manure, disposal of sheep dip, tillage, ploughing of the land, use of pesticides and fertilisers can cause water pollution. Accidental spills from milk dairies can also affect the quality of water. Fertilizers can leak into rivers, and flooding leads to pollution of surface water as the volume spreads across areas that are normally not exposed to water.

Oil Pollution

Oil spillages affect water quality in a number of ways. Oil can make drinking water unsafe to drink. A substantial amount of oil released into oceans and seas will destroy wildlife and the ecosystems that sustain them. Oil spills also reduce oxygen supplies within the water environment. The main causes of oil related water pollution are:

- loss from storage facilities
- spillage during delivery and;
- deliberate disposal of waste oil to drainage systems

Radioactive Substances

Radioactive waste is another source of water pollution. Radioactive substances are used in nuclear power plants, industrial, medical and other scientific processes. They can be found in watches, luminous clocks, television sets and x-ray machinery. There are also naturally occurring radioisotopes from organisms and within the environment. If not properly disposed of, radioactive waste can result in serious water pollution incidents.

River dumping

Lots of people dump supermarket trolleys, bicycles, garden cuttings and electronic waste into rivers or river banks. River dumping not only causes water pollution; it also harms wildlife and increases the risk of flooding.

1.2.2 Colour and Turbidity in Surface Water

As surface water is exposed to all elements of nature, and water has a tendency to dissolve or take away a part of everything it touches, the main water quality issues for surface water tend to be colour and turbidity.

Colour in water can be attributed to tannins, which are fulvic and humic acids. Tannins derive from the decomposition of organic material. If the tannin level is very high you will be able to detect colour simply by filling a glass with the lake water. Lower levels are more difficult to detect and you may not see the colour unless you were to fill a white bath tub.

Turbidity is the amount of solid suspended matter present in the water supply. If you turn on a faucet and fill a glass of water and notice tiny white particulate matter floating down to the bottom of the glass, you have turbidity. Turbidity is considered an aesthetic compound, meaning it is not harmful to drink water with turbidity.

Surface water always has higher turbidity levels than groundwater as it does not have the natural filtration that occurs in groundwater applications.

1.2.3 Main Problems Related to Surface Water Sources in India

In India, river pollution has crossed the mark of crisis. Three important river systems of the north like Indus, Ganga and Brahmaputra suffer high levels of pollution. Maximum populated areas of the world are settled in all three basins.

The largest source of water pollution in India is untreated sewage. Other sources of pollution include agricultural runoff and unregulated small-scale industry. Most rivers, lakes and surface water in India are polluted due to industries, untreated sewage and solid wastes. Only 21.5 per cent of the solid waste generated in India is processed. This debris is one of the main sources of river water pollution.

A 2007 study found that discharge of untreated sewage is the single most important source of pollution of surface and ground water in India. There is a large gap between generation and treatment of domestic waste water in India. The problem is not only that India lacks sufficient treatment capacity but also that the sewage treatment plants that exist do not operate and are not maintained.

The majority of the government-owned sewage treatment plants remain closed most of the time due to improper design or poor maintenance or lack of reliable electricity supply to operate the plants, together with absentee employees and poor management. The waste water generated in these areas normally percolates into the soil or evaporates. The uncollected waste accumulates in the urban areas causing unhygienic conditions and releasing pollutants that leach into surface and groundwater.

Sewage discharged from cities, towns and some villages is the predominant cause of water pollution in India. Investment is needed to bridge the gap between the sewage India generates and its treatment capacity of sewage per day. Major cities of India produce 38,354 million litres per day (MLD) of sewage, but the urban sewage treatment capacity is only 11,786 MLD. A large number of Indian rivers are severely polluted as a result of discharge of domestic sewage.

The Central Pollution Control Board, a Ministry of Environment & Forests Government of India entity, has established a National Water Quality Monitoring Network comprising 1,429 monitoring stations in 28 states and 6 in Union Territories on various rivers and water bodies across the country. This effort monitors water quality year-round. The monitoring network covers 293 rivers, 94 lakes, 9 tanks, 41 ponds, 8 creeks, 23 canals, 18 drains and 411 wells distributed across India. Water samples are routinely analysed for 28 parameters including dissolved oxygen, bacteriological and other internationally established parameters for water quality. Additionally, 9 trace metals parameters and 28 pesticide residues are analysed. Biomonitoring is also carried out on specific locations.

The scientific analysis of water samples from 1995 to 2008 indicates that the organic and bacterial contamination is severe in water bodies of India. This is mainly due to discharge of domestic waste water in untreated form, mostly from the urban centres of India.

In 2010 the water quality monitoring found almost all rivers with high levels of BOD (a measure of pollution with organic matter). The worst pollution, in decreasing order, were found in river Markanda (490 mg/l BOD), followed by river Kali (364), river Amlakhadi (353), Yamuna canal (247), river Yamuna at Delhi (70) and river Betwa (58). For context, a water sample with a 5-day BOD between 1 and 2 mg O/L indicates a very clean water, 3 to 8 mg O/L indicates a moderately clean water, 8 to 20 indicates border line water, and greater than 20 mg O/L indicates ecologically-unsafe, polluted water.The levels of BOD are severe near the cities and major towns. In rural parts of India, the river BOD levels were sufficient to support aquatic life.

Rivers Yamuna, Ganga, Gomti, Ghaghara, Chambal, Mahi, Vardha and Godavari, are amongst the other most coliform polluted water bodies in India. For context, coliform must be below 104 MPN/100 ml, preferably absent from water for it to be considered safe for general human use, and for irrigation where coliform may cause disease outbreak from contaminated-water in agriculture.

In 2006, 47 percent of water quality monitoring reported coliform concentrations above 500 MPN/100 ml. During 2008, 33 percent of all water quality monitoring stations reported a total coliform levels exceeding those levels, suggesting recent effort to add pollution control infrastructure and upgrade treatment plants in India, may be reversing the water pollution trend.

A joint study by PGIMER and the Punjab Pollution Control Board in 2008, revealed that in villages along the Nullah, fluoride, mercury, beta-endosulphan and heptachlor pesticide were more than permissible limit (MPL) in ground and tap water. Plus, the water had high concentration of COD and BOD (chemical and biochemical oxygen demand), ammonia, phosphate, chloride, chromium, arsenic and chlorpyrifos pesticide. The ground water also contains nickel and selenium, while the tap water has high concentration of lead, nickel and cadmium.

Flooding during monsoons worsens India's water pollution problem, as it washes and moves solid waste and contaminated soils into its rivers and wetlands. The annual average precipitation in India is about 4000 billion cubic metres. From this, with the state of Indian infrastructure in 2005, the available water resource through the rivers is about 1869 billion cubic meters. Accounting to uneven distribution of rain over the country each year, water resources available for utilization, including ground water, is claimed to be about 1122 billion cubic meters. Much of this water is unsafe, because pollution degrades water quality. Water pollution severely limits the amount of water available to Indian consumers, its industry and its agriculture.

1.3 PROBLEMS RELATED TO GROUNDWATER

The ground water supplies have become highly contaminated by the addition of undesirable substances that makes it unfit and toxic for various purposes especially for drinking. The quality of groundwater is generally slower to change, especially when it comes from deeper aquifer. The groundwater is not directly exposed to wastewater discharge, air pollution, or contamination from run-off (if the well is properly constructed). Natural filtration can remove some contaminants as the water percolates through the soils and rock thus protecting the quality of ground water.

In general, greater part of the India, ground water is used for agricultural, drinking or industrial purpose. The ground water in shallow aquifers is generally suitable for use for 3 different purposes and is mainly containing calcium carbonates and bicarbonates. The quality in deeper aquifers also varies from place to place and is generally found suitable for common uses.

1.3.1 Source of Groundwater Contamination

Groundwater gets polluted when contaminants (from pesticides and fertilizers to waste leached from landfills and septic systems) make their way into an aquifer, rendering it unsafe for human use. Some of the major sources of ground water contamination are as follows:

a) Surface Contamination

Surface water migrates into the groundwater by infiltration through the soil, or by runoff into areas where the water table is above the surface of the ground. Carried by the surface water, pollutants such as agricultural pesticides and fertilizers, oils and salts from roadways, and industrial effluents can make their way into the groundwater. Above-ground storage tanks and pipelines for petroleum products and other chemicals can leak or break, releasing their contents to seep into an aquifer. Mine tailings and industrial waste stored in surface pits can leach into groundwater.

b) Subsurface Contamination

Some forms of groundwater contamination can come from buried or drilled sources. Corroded underground storage tanks for gasoline or oil can leak their contents into an aquifer. Faulty septic systems and leaky sewer lines can cause bacterial contamination of water, sickening those who drink it. Injection wells designed to lock hazardous materials far below ground can leak through porous rock or soil and contaminate groundwater.

c) Landfills and Waste Disposal

Modern landfills that meet federal standards are designed to prevent runoff from leaching into the groundwater, both through careful site selection and through installation of a protective landfill liner and leachate collection and treatment system. Monitoring wells are placed to check that nothing is getting into the groundwater. Sometimes these protective measures may fail. Additionally, older dumps and landfills did not have these protections. Runoff and leaching can carry a wide variety of pollutants from such sites, contaminating streams, groundwater, springs and wells. Improperly discarded hazardous wastes, such as those buried or placed in open pits, or just dumped on the land, can filter through the soil and find their way into the groundwater.

d) Atmospheric Contamination

Pollutants released into the atmosphere eventually return to the earth, carried by rain, snow and other forms of precipitation. Surface water leaches through the soil or flows as runoff into streams to contaminate groundwater. Nitrates and sulphates emitted from power plants or factories can cause acid rain, which percolates through the soil and acidifies groundwater supplies.

e) Saltwater Contamination

Saltwater intrusion is a major concern for many coastal communities that rely on wells as a freshwater source. The natural flow of groundwater toward the ocean normally prevents saltwater intrusion into wells. However, when groundwater is overdrawn by wells, salt water may flow in to replace it, contaminating the freshwater source and rendering the wells unusable.

1.3.2 Main Groundwater Related Problems in India

The main ground water quality problems in India are salinity, arsenic, nitrates, fluorides, etc. Salinity in ground water can be of broadly categorized into two types, i.e., coastal Salinity and Inland salinity. Inland salinity in ground water is prevalent mainly in the arid and semi-arid regions of Punjab, Rajasthan, Haryana, Gujarat, Delhi, Uttar Pradesh, Andhra Pradesh, Maharashtra, Tamil Nadu and Karnataka. In some areas of Gujarat and Rajasthan, salinity in ground water is so high that the well water is directly used for salt manufacturing by solar evaporation. Inland salinity is also caused due to practice of surface water irrigation without consideration of ground water status.

High concentration of fluoride in ground water beyond the permissible limit of 1.5 mg/l poses some of the health problems. The occurrence of arsenic in ground water was first reported in 1980 in West Bengal in India. The occurrence of Arsenic in ground water is mainly in the intermediate aquifers up to the depth of 100m and the deeper aquifers are free from contamination of arsenic.

Apart from West Bengal, contamination of arsenic in ground water has been found in the states of Bihar, Chhattisgarh, Punjab, Uttar Pradesh and Assam. Arsenic in ground water has been reported in 15 districts in Bihar, 9 districts in U.P and one district each in Chhattisgarh & Assam states.

Quite high concentration of Iron (>1.0 mg/l) in ground water has been observed in more than 1.1l akh habitations in the country. Iron contamination in ground water has been reported from the states of Assam, Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Goa, Haryana, J&K, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Meghalaya, Manipur, Maharashtra, Orissa, Punjab, Rajasthan, Tripura, Tamil Nadu, Uttar Pradesh, UT of Andaman & Nicobar and West Bengal.

Nitrate is a very common constituent in the ground water of shallow aquifers. The main source is from the anthropogenic activities. High concentration of Nitrate in ground water beyond the permissible limit of 45 mg/l poses health problems.

The Punjab State is mainly underlain by quaternary alluvium of considerable thickness, which is next against the rocks of Siwalik system towards North-East. The presence of salt impregnated strata below these soils is responsible for the poor quality of ground water in some of the areas of Punjab. The southwest part of Punjab comprising 34% of area faces severe groundwater quality problems that prevent its withdrawal from source. In this region, the salinity, alkalinity or both are responsible for the poor quality of groundwater. For a long time, access to clean drinking water has remained a big problem for people of Punjab.

High values of uranium (more than 9 mg/1) present in drinking water may lead to harmful biological effects in humans. The chemical toxicity of natural uranium is a major hazard to the kidneys. In Punjab, it has been reported that uranium concentrations in the groundwater samples from hand pumps/shallow tube-wells are in general high wherever the leftover residue (Total Dissolved Salt) after drying of water is high (2-7g/L), pesticides and herbicides are also reported to be high.

Arsenic in ground water is largely the result of minerals dissolving from weathered rocks and soils. The underground waters contain elevated arsenic concentration, which are usually above the WHO permissible safe limits of 10 ppb .The problem is more severe at several sites in south-western districts of Punjab where the arsenic concentration exceeded more than 20 to 30 folds of the WHO safe limit. The world health organization and US Environment Protection Agency recently established a new maximum contaminant level of 10 ppb in drinking water for arsenic. The arsenic concentration of deep-water tube wells located in Amritsar city used for domestic supply for population in urban areas ranged from 3.8 to 19.1 ppb with average value of 9.8 ppb. The content of arsenic in hand pump water varied from 9 to 85 ppb with a mean value of 29.5 ppb. Arsenic has been known to cause a variety of adverse health effects which includes skin and several internal cancers and cardiovascular and neurological effects.

High concentration of Fluoride (>1.5mg/l) has been reported in Amritsar, Bhatinda, Faridkot, Firozepur, Fatehgarh Sahib, Gurdaspur, Muktsar, Moga, Patiala, Sangrur districts of Punjab. High Chloride content (>1000mg/l) has been observed in Firozepur and Muktsar. Chloride contributes to osmotic activity of body fluids. Elevated levels of chloride may impart a noticeable salty flavour to water, but the threshold depends upon the associated cations.

Iron content (>1.0 mg/l) has been reported in Bhathinda, Faridkot, Firozepur, Fatehgarh Sahib, Hoshiarpur, Gurdaspur, Rupnagar, Mansa, Sangrur districts. Nitrate occurs in water supplies as a result of decomposition of organic matter from excessive use of fertilizers and contamination by surface drainage. The high levels of nitrate in water samples may cause stomach cancer in human beings. High level of Nitrate (>45 mg/l) has been reported in several districts of Punjab.

The Salinity, EC>3000 μS/cm at 25° C, has been reported in the Ferozepur, Faridkot, Bathinda, Mansa, Muktsar, Sangrur districts. The sulphate ranges between 10mg/l at Bhagi Bhandar and 480mg/l at Dadde (Bhatinda district). In majority of ground water samples, the concentration of sulphate is below 400mg/l and its average concentration in the district is 201mg/l. The sulphate content varies widely and ranges from 13 mg/l at Dhak Raba to 1174mg/l at Antala (Patiala district).

Total Dissolved Solids measures the solids remaining in a water sample filtered through a1.2 μm filter. According to the World Health Organization (WHO), the compounds and elements remaining after filtration are commonly calcium, magnesium, sodium, potassium, carbonate, bicarbonate, chloride, sulphate, silica and nitrate. High TDS affects the taste and odour of water and in general, levels above 300 mg/L become noticeable to consumers. As TDS increases ,the water becomes increasingly unacceptable. Although the SMCL for TDS is 500 mg/L, levels above 1200 mg/L are unacceptable to most consumers. Because TDS measurements may include a variety of parameters which can be naturally occurring or anthropogenic, its value as an indicator of nonpoint source pollution is limited.

Table 1.2 shows various land-use activities and threats they cause to the ground water quality.

Table1.2:Land-Use Activities and Related Threat to Ground Water Quality

Land use	**Activities Potential to Ground Water Pollution**
Residential	• Un-sewered sanitation • Land and stream discharge of sewage • Sewage oxidation ponds • Solid waste disposal, sewer leakage, landfill leachate • Road and urban run-off, aerial fall out

Industrial & Commercial	• Process water, effluent lagoon etc. • Land and stream discharge of effluents • Tank and pipeline leakage and accidental spills • Well disposal of effluent • Aerial fall out • Landfill disposal and solid wastes and Hazardous wastes • Poor housekeeping • Spillage and leakage during handling of material
Mining	• Mine drainage discharge • Process water and sludge lagoons • Solid mine tailings • Oilfield spillage at stations
Rural	• Cultivation with agrochemicals • Irrigation with wastewater • Soil Stalinizations • Livestock rearing
Coastal	• Soil water intrusions

1.4 VARIOUS TREATMENT TECHNOLOGIES

Several treatment techniques have been used for the treatment of groundwater so as to make it suitable for drinking purpose. These are ultra-violet treatment, reverse osmosis filters, slow sand filters, bamboo charcoal filter, bone char filtration, solar sterilization solar distillation, biosand filter activated carbon and ceramic filters.

Ultra-Violet treatment is a disinfection process that inactivates harmful microorganisms. UV treatment is not intended to treat water that is contaminated and this treatment is also expensive.

Reverse Osmosis (Ro) water filters are typically used to improve drinking and cooking water quality in household system. RO water filtration is one of the finest water filtration methods which reduces almost all microorganisms, bacteria, metals, salts, organic and inorganic chemicals and particulate matters that are found in contaminated water. It also improves tastes, odour and appearance but the cost of treatment is high due to requirement of change of membrane and also the disposal of rejected water containing high TDS is a problem. Pre filters also need to be changed at least annually.

Unlike all the other water filtration methods, the slow sand water filters utilize biological processes in a non-pressurized system to purify water. Slow sand filters are effective at removing heavy metals, and it is often combined with activated carbon to remove organic material as well as to improve odour and taste but these can only filter water up to a certain turbidity level, as water with high turbidity clogs up the filter bed quickly. A slow sand filtration system is a combination of several parts: water storage tanks, an aerator, pre-filters, slow sand filters, disinfection stages, and filtered water storage tanks. The number of filters and filter types that are used in a given slow sand filtration system will depend on the quality of the source water and will be different for each community.

A team of E4C members in Bangalore proposed a filter made of locally available materials including charred bamboo, gravel and natural adsorbents. The process was indigenous, eco-friendly, low cost and entails minimum maintenance, according to the team members. It was estimated that their filter can handle 30liters of water per hour, and it would be affordable for average households in the region.

Bone char is a permeable, dark, granular material delivered by scorching creature bones. Its composition differs depending upon how it is made, in any case it comprises principally of tricalcium phosphate 57-80%, calcium carbonate 6-10% and initiated carbon 7- 10%. It is primarily utilised for filtration and decolourisation.

Solar sterilization is a process in which solar heat is used to purify water from an impure water source by evaporation and condensation.

Solar distillation purifies even muddy, salty or otherwise undrinkable water through evaporation and condensation. The power of distillation to purify saltwater makes it unique among the other treatment methods. For distillation, a solar still (made of plastic or glass) is used. To work, the still allows sunlight to shine through a clear panel onto the impure water. The water heats and evaporates, then condenses on the underside of the panel and runs off into a container of some kind.

Biosand Water Filter is just a plain cement box that contains gravel, sand and a biofilm layer aligned to filter water. The biofilm acts as a filter for microorganisms. Terracotta filters are commonly used in Jharkhand state in India. It consists of river sand, red clay and wood sawdust mixture sintered at high temperature so that the plate or disk is made into a porous arrangement to act as a filter.

Activated carbon is processed carbon with a slightly positive charge added to it and is more attractive to chemicals and impurities. It is extremely-porous, thus provides high surface area to volume ratio which increases the rate of absorption. Because of this property, activated carbon is commonly used in water treatment systems. The activated carbon can be used to improve odour and taste alone, and also it is most effective at removing organic compounds including radon, and chlorine but they are not effective in removing bacteria and viruses.

Ceramic filter is one of the most economical filtration methods and it is already being widely used in some third world countries. Ceramic filter blocks anything larger than a water molecule, allowing only water to pass through the pores**.** Clay, sawdust and a plastic bucket can make a water filter that catches dirt and disease-causing microbes. In the classic design, a combustible material like sawdust or rice husks is mixed with clay, given a flower pot shape and fired in a kiln. The sawdust or rice husks burn away, leaving tiny pores in the ceramic through which water filters. Organizations around the world have been using this kind of ceramic filter to reduce disease in impoverished communities for years.

1.5 RICE HUSK ASH

Rice is one of the chief grains of India. Moreover, India has the largest area under rice cultivation as it is one of principal food crops. India is the 2nd largest producer of rice after China. For every ton of paddy processed, an average mill produces 200 kg of Rice Husk and 40 kg of RHA (Rice Husk Ash). The total amount of rice husk produced in India is estimated to be about 24 million tons, while the RHA production is estimated to be about 4.4 million tons per year.

Rice milling industry generates a lot of rice husk during milling of paddy which comes from the fields. During milling of paddy about 78 % of weight is received as rice, broken rice and bran. Rest 22 % of the weight of paddy is received as husk. This husk is used as fuel in the mills to generate steam for the heating applications. This husk contains about 75% organic volatile matter and the balance 25% of the weight of this husk is converted into ash during the firing process, is known as rice husk ash (RHA).

Rice husk is an agricultural waste, obtained from the rice mills after the separation of rice from paddy. It is mostly used as a fuel in the boiler furnaces of industries like paper, sugar, etc. to produce steam. The rice husk ash (RHA) is collected from the particulate collection equipment attached upstream to the stack of the rice husk-fired boilers.

RHA is available in plenty and almost free of cost. This RHA in turn contains around 85 -90% amorphous silica and small proportion of alumina, iron oxide, calcium oxide, etc. So, for every 100 kgs of paddy milled, about 220 kgs (22%) of husk is produced, and this husk is burnt in the boilers, to generate about 55 kgs (25%) of RHA. It is estimated that about 70 million tons of RHA is produced annually worldwide. Some of this RHA is utilized in industries such as steel, cement, bricks, etc. while the remaining is usually dumped in open land. This rice husk ash is a great environment threat causing damage to the land and the surrounding area in which it is dumped. So, there is a need to look for the alternative use of Rice Husk Ash for environment-friendly purpose.

1.5.1 Chemical Composition of RHA

The rice husk ash possesses a chemical composition similar to many of the organic fibers. Rice husk ash consists of the following:

- Cellulose
- Lignin
- Hemicellulose

• Silicates
• Holocellulose

These are compounds within them in common. The rice husk ash may vary depending upon the source as well as the type of treatment. Treatment in the sense the rice husk is burned to have proper properties. So, the method of heating can also bring changes in the overall chemical composition of the ash.

Compositionally depending upon the conditions at which the hulls are burnt RHA is approximately 63-98% silica and 3-6.5% carbon. The silica in RHA carries a negative surface charge thus making it an ideal absorbent for positively charged species like Cd, Ni, Zn. At the same time carbon in the RHA is an ideal absorbent of negatively charged species, such as fluorides and organic compounds such as phenols. Due to these unique properties and its abundant availability at nominal cost RHA has been used for a variety of applications.

The silicates are one of the primary components of the rice husk ash. The rice husk ash (RHA) has more than 92% by wt. of silica with high porosity and large surface area, because it retains a cellular structure skeleton. The physical characterizations of rice husk and RHA have pointed out some properties such as the presence of functional groups (carboxyl, silanol.etc.) that make adsorption processes possible.

During the burning process, the components that can evaporate are evaporated and the only component left are the silicates. The rice husk ash to be more precise have characteristics based on the components, the temperature of burning and the time of burning.

The silicates are the component that gives the pozzolanic reactivity capacity for rice husk ash. So, to gain this, the silica must remain in its non-crystalline form. They should gain a highly porous structure within their microstructure. So, this makes it clear that a proper quality burning of rice husk to get rice husk ash would remove the cellulose and rice husk components preserving the original cellular structure of the rice husk particles.

The chemical composition of rice husk ash is given in Table1.3 which shows that major component in rice husk ash, as described earlier, is silica, also 1.5% alumina is present and rest are the minor components such as iron oxide, calcium oxide, potassium oxide , manganese oxide, phosphorous pentoxide, sulphur trioxide etc.

Table 1.3: Chemical Composition of RHA

S No.	Component	Proportion
1	Silica	92.1%
2	Alumina	0.51%
3	Iron oxide	0.40%
4	Calcium oxide	0.3-2.25%
5	Potassium oxide	1.5%
6	Manganese oxide	0.2-0.6%
7	Phosphorous pentoxide	0.36%
8	Sulphur trioxide	0.12%

1.5.2 Properties of RHA

RHA is greyish black in colour due to unburned carbon. At burning temperature of 550-800°C, amorphous silica is formed, while crystalline silica is produced at higher temperatures. The specific gravity of RHA varies from 2.11 to 2.27. It is highly porous and light weight, with a very high specific area.

RHA possess adsorption properties. Adsorption is a mass transfer process which involves the accumulation of substances at the interface of two phases, such as, gas— liquid, liquid—liquid, liquid—solid interface or gas—solid. The adsorbate is the substance being adsorbed and the absorbing material is termed the adsorbent. The driving force for adsorption process is Surface affinity. Chemical reactivity, pH, surface area for adsorption per unit volume and reduction in surface tension is key parameter for adsorption.

Adsorption is a sorption operation, in which certain components of a fluid phase, called solutes, are selectively transferred to insoluble and rigid particles suspended in a vessel or packed in a column. Adsorption is a separation process in which certain components of the fluid phase are transferred to the surface of the solid adsorbents. RHA has the potential to be used as an adsorbent, because of the presence of carbon and silica. Table 1.3 shows the properties of RHA.

Table 1.4: Properties of RHA

S No.	Parameter	Value
1	Average particle size	412µm
2	Bulk density	175.3kg/m ^{3}
3	Volatile matter content	7.36%
4	Moisture content	1.1%
5	Ash content	80.58%
6	Fixed carbon content	10.96%

According to a morphological study of the husk published in Industrial and Engineering Chemistry Research, the husk possesses a "corrugate structural outer epidermis that is highly ridged and that its ridges are punctuated with prominent globular protrusions." This polymorphous, interlocking assemblage of RHA allows for diverse adsorption capabilities.

1.5.3 Application of RHA in Water Purification Systems

Ceramic filter is one of the most economical filtration methods and common form of house hold water treatment and it is reported to be used in some third world countries. Ceramic filter blocks anything larger than a water molecule, allowing only water to pass through the pores. Two styles of ceramic filters exist on the current market, pot and candle ceramic filters.

Candle ceramic filters are sometimes filled with activated carbon to increase water purity. The flow rate of ceramic water filters are controlled by surface area and the amount of additives. Ceramic filters are made with clay and combustible additives, all materials are inexpensive and can be easily found. Ceramic filters are brittle and require high maintenance in comparison with candle filters.

Clay suitable for pottery production can be used for making filters; however, plasticity is particularly important as 50-60% non-plastic (burn-out) material is added to the clay. Clay should have an acceptable level of plasticity, rate of dry shrinkage, and after firing, acceptable rates of total shrinkage and absorption.

Burn-out material, such as sawdust, rice husks, or other agricultural by-product is added to the clay to create the required porosity of the fired element, which affects the flow rate of the filters. The material can vary depending on local availability. Since sediments fill up the pores on the filter surface, they need to be cleaned regularly.

There are many variables in the design of candle filters which are considered to influence the flow rate and/or effectiveness of the filtering element including the type of clay (particle size, distribution, sand content and plasticity), the burn-out material (type and size, humidity of burn-out material), the clay to burn-out ratio, the amount of water added to the mixture, the manufacturing method (molded by hand, pressed, wheel thrown), drying time and conditions, firing temperature, size of the filtering element, capacity and the thickness of the filter.

Traditionally, colloidal silver has been applied to the ceramic filters after firing. Water flowing through the ceramic filter is thus treated by a combination of physical filtration and silver disinfection. A colloidal silver solution is either painted on, elements are dipped in a silver solution, or colloidal silver is integrated into the filter mix prior to pressing and firing the filters. Silver is added to improve the microbiological effectiveness of filters.

Colloidal silver, a suspension of silver nano-particles, acts as a disinfectant but reduces the pore size and structure of the filter medium, that increases clogging which subsequently reduces flow rate. Silver nitrate is applied to filters instead of colloidal silver at some factories. Microbiological efficacy of filters painted with silver nitrate is reported to be comparable to filters with no silver nitrate applied. The amount of silver measured in effluent water should be below United States Environmental Protection Agency (USEPA)and WHO guideline values for silver (0.1mg/L), and therefore should not pose a risk to human health. The candle filter has also been reported to be efficient in bacterial trapping and turbidity reduction.

In developing countries like India, the problems associated with ground water and waste water reuse arise from lack of treatment. The challenge thus is to find such low-cost, low-tech, user friendly methods, which on one hand avoid threatening our substantial waste dependent livelihood and on the other hand protect degradation of our valuable natural resources. The use of RHA for water and waste water purification will be an efficient method as compared to the conventional treatment systems as it is environment-friendly, easily operated, low-construction, maintenance and operation cost and can be maintained by untrained personnel.

1.5.4 Other Environment-Friendly Applications Of RHA

RHA can be used for a number of environment friendly purposes. Some of the environment-friendly applications of RHA are as follows:

- RHA can be used as a cementitious material for concrete construction.
- It can be used as an alternative source of silica in ceramics.
- It can be used as a pozzolan in the construction industry.
- It can also be used as filler, additive, abrasive agent, oil adsorbent, sweeping component etc.
- RHA can be used as a suspension agent for porcelain enamels.
- It can be used for removal of fluoride, oxides of sulphur and nitrogen and heavy metals.
- It can also be used for the removal of humic acid.
- It can also be used for the removal of crude oil and diesel fuel.
- It can be used for soil stabilization.
- It can be used in the manufacturing of bitu-block bricks which is used in the construction of bitu-block walls.

CHAPTER-2

LITERATURE REVIEW

2.1 GENERAL

One of RHA's greatest strengths lies in the fact that it is widely available and routinely underutilized. 2015 findings from the journal Reviews in *Environmental Science and Biotechnology* claim that around 600 million tons of rice are produced worldwide annually, and its cultivation covers approximately 1% of the Earth's surface. For every 100 kg of rice produced, 22 kg of rice husk is generated alongside of it.

There is a problem of disposal of Rice Husk and also it cannot be used for cattle feed. So, there is a need to find alternative uses of RHA so that its disposal problem can be reduced. RHA has good adsorptive properties and has been used for the removal of various dyes heavy metals *and* other compounds like chlorinated hydrocarbons palmitic acid.

The temperature at which the rice husk is carbonized is very important since the surface area characteristics of ash depends upon the temperature of formation of ash. Heating of rice husk at different temperatures produces RHA containing different contents of carbon and silicon dioxide.

pH is one of the most vital parameters for metallic adsorption. There are two possible mechanisms for the effect of pH on adsorption on any adsorbent:

(a) electrostatic interaction between the protonated groups of carbon and acidic adsorbate, and

(b) the chemical reaction between the adsorbate and the adsorbent.

RHA particles contain a large number of functional groups —CO-, -OH, -Si-OH. -Si-H, - C-OH**,** etc. Adsorbate molecules may interact with these functional groups via pathways which are extremely complicated. Also, there may be weak electrostatic interaction between the electron-deficient sites on the surface of the RHA particles and adsorbate molecules.

According to a morphological study of the husk published in *Industrial and Engineering Chemistry Research*, the husk possesses a "corrugate structural outer epidermis that is highly ridged and that its ridges are punctuated with prominent globular protrusions." This polymorphous, interlocking assemblage of RHA allows for diverse adsorption capabilities. The epidermis of the husk is visibly marked by such ridges and protrusions, which cause the other particulate matter in the frame to pale in comparison. Essentially, these folds, wrinkles, and pockets on the surface provide a unique physical binding site for contaminants.

RHA can be used for a variety of environment-friendly purposes like for the removal of dye, humic acid, crude oil, heavy metals, for concrete making, in construction of bitublock wall, in road surfacing, water purification system. The literature review gives the insight of applications of RHA in water purification system and other applications of RHA.

2.2 USE OF RHA IN WATER PURIFICATION SYSTEM AND OTHER APPLICATIONS OF RHA

*Mittal,1*997[1], described a simple chemical process for extracting amorphous silica from rice husk. He also found that a by-product, Sodium Silicate, formed during this process which can be used for making of good quality bricks.

Kalapathy et *al.,1999*[2], developed a simple method based on alkaline extraction followed by acid precipitation to produce pure silica xerogels from RHA, with minimal mineral contaminants.

Saha et al.,2001[3], investigated removal of arsenic with the use of various adsorbents including RHA. Various parameters such as, coagulant dose, pH, anions concentration and reaction time were studied to establish optimum conditions. He reported that 10 g/L of RHA dosage can remove Arsenic by 5-12%.

Prasad ,2002 [4],made an attempt to prepare a low-cost water filter for which there is a definite need in rural India. He used nylon membrane along with the concrete mixture of RHA, pebbles and cement to design a filter using sanitary pipes. He found a considerable reduction in turbidity and bacteria when this filter was used for water purification in laboratory conditions.

Ganvir et al., 2002[5], also prepared filtration system using RHA. In his filter he used perforated food grade plastic container and mixture of RHA, pebbles and cement. He found that this filter was helpful in the reduction of the turbidity and bacterial count of water in rural areas. He also compared this design of filter with the candle filter and concluded that the that the RHA based filter is cost effective than the ceramic candle filter. He concluded that RHA based filter was 25% more efficient in removal of bacteria and turbidity. Also, the filtration rate of RHA filter was greater than ceramic candle filters.

Muntohar,2002[6], studied on the potential use of silica waste, resulting from burnt rice husk, as a pozzolanic material. He used various combination of RHA with Lime in soil and observed a decrease in soil swelling and improvement in strength and bearing capacity.

Basha et al.,2004[7], studied stabilization of residual soils by chemically using cement and rice husk ash. Investigation included the evaluation of such properties of the soil as compaction, strength, and X-ray diffraction. Test results showed that both cement and rice husk ash reduce the plasticity of soils. In term of compatibility, addition of rice husk ash and cement decreased the maximum dry density and increased the optimum moisture content.

Feng et al.,2004 [8], made an attempt at the use of rice husk ash, an agricultural waste, as an adsorbent for the adsorption of lead and mercury from aqueous water in his studies. Studies were carried out as a function of contact times, ionic strength, particle size, and pH. Rice husk ash was found to be a suitable adsorbent for the adsorption of lead and mercury ions.. The main finding of this research was that the finer the RHA particles used, the higher the pH of the solution and the lower the concentration of potassium nitrate supporting electrolyte solution, the more lead and mercury are absorbed by rice husk ash.

Sivapullaiah et al.,2004[9], *explored* the possibility of using Rice Husk Ash as a cushion. He found that that RHA stabilized with 3-9% of lime or 10% cement and cured for about a week develops the properties required for an effective cushion material.

Amin et al.,2006[10], investigated the possibility of the use of rice husk adsorption technology without any pre-treatment in the removal of arsenic from aqueous media. Various conditions that affect the adsorption/desorption of arsenic were investigated. He found that the mechanism of adsorption of metal anions onto RHA generally occurs in two steps. First, carbon in contact with the water reduces oxygen to a hydroxyl group, leaving electrically-neutral hydroxyl ions intact. When a metal-bearing solution comes along with anions more strongly attracted to the carbon than the hydroxyl groups, the latter are exchanged, adsorbing the contaminants.

Chandrasekhar et al.,2006[11], investigated the possible utilization of Rice Husk Ash as adsorbent for the removal of Methylene Blue dye (MB) from aqueous solution. The rice husk ash is a potential and cost-effective adsorbent for the removal of methylene blue dye from aqueous systems. The samples were also analyzed for bulk density, pH, nitrogen adsorption properties and lime reactivity. Adsorption of Methylene Blue on RHA was reported to favorably influenced by an increase in the temperature of the operation.

Forth et al., 2006[12], investigated the use of Rice Husk Ash in bitumen with other aggregates was reported in manufacture of building blocks "Bitublocks" which can be used to construct a Bitublock wall. He founded that the properties of those blocks were at least equivalent to current concrete blocks.

Saraswathy et al., 2006[13], made detailed investigations on the corrosion performance of rice husk ash blended concrete. It was reported that addition of rice husk ash to Portland cement not only improved the early strength of concrete, but also form a calcium silicate hydrate (CSH) gel around the cement particles which was highly dense and less porous which might increase the strength of concrete against cracking.

Mane et al., 2007[14], studied the potential for adsorptive removal of Brilliant Green (BG) dye using Rice Husk Ash. He also evaluated the influences of various experimental parameters like initial pH, contact time, adsorbent dose and initial concentration on the removal of BG. He found that adsorption of BG on RHA was favorably influenced by an increase in the temperature of the operation.

Mohan et at., 2007[15]surveyed arsenic adsorption by commercially available carbons and other low-cost adsorbents and their adsorption efficiencies are compared. He found that Rice Husk Ash can be used as an adsorbent for removal of Arsenic from water

Sud et al.,2007[16], studied the use of agricultural waste in the removal of heavy metal from water. He concluded that agricultural waste material, being highly efficient, low cost and renewable source of biomass, can be used as a potential adsorbent for removing heavy metal ions from aqueous solutions.

Alhassan,2008[17], studied potential of Rice Husk Ash for Soil Stabilization. Performance of the soil-RHA was investigated with respect to compaction characteristics, California bearing ratio (CBR) and unconfined compressive strength

(UCS) tests. The results obtained, indicates a general decrease in the maximum dry density (MDD) and increase in optimum moisture content (OMC) with increase in RHA content.

Dahlan et al.,2008[18], reported the work on the desulphurization of flue gas by using RHA/CaO sorbent with other additives. The SSC of RHA/CaO sorbent prepared with NaOH addition increases as the water vapor increases.

Lakshmi et al.,2008[19], in her studies, explored the adsorptive characteristics of Indigo Carmine (IC) dye from aqueous solution onto Rice Husk Ash. The influence of parameters like initial pH, contact time, adsorbent dose and initial concentration were also determined on the removal of IC. Adsorption of IC on RHA was favorably influenced by an increase in the temperature of the operation.

*Lenox et al.,*2008[20], studied the use of Rice Husk Ash for building of roads which prove to be environment-friendly. He mentioned that rice husk ash has been used to fire kilns making bricks for road construction and the ash could be also be used as a cement substitute for sub- base/surface strengthening or in bio-asphalt blends thus achieving a double benefit.

Brooks et al.,2009[21], made an attempt to upgrade expansive soil as a construction material using rice husk ash. RHA and fly ash, which are waste materials. Remoulded expansive clay was blended with RHA and fly ash and strength tests were conducted. The potential of RHA-fly ash blend as a swell reduction layer between the footing of a foundation and subgrade was studied.

Chan et al.,2009[22], designed a low-cost and easily manufactured water filtration for use in third world countries. He compared this filtration system with other conventional water treatment techniques. By using different agricultural waste for designing a filter, he compared the flow rate, different nutrients present in water like nitrate, nitrite and total phosphorous and the parameters like turbidity, alkalinity and pH. He concluded that by providing affordable water filters to third world countries will greatly improve quality of life of people, and reduce the risk of any water born disease therefore saving lives.

Rayner, 2009[23], identified the current Practices in manufacturing of ceramic pot filters for water treatment. Colloidal silver was applied for pathogen removal. Parameters were altered and its usage for different period was analyzed. Additional quality control, flow meter test and packaging were also taken into consideration. He used clay as the binding material and found that pressing, heating in furnace and drying are important procedures to be followed while making filters using clay and RHA.

Srivastava et al., 2009[24], has made an attempt to analyze the competitive adsorption of cadmium (Cd (II)), nickel (Ni (II)), and zinc (Zn (II)) ions onto rice husk ash (RHA) from ternary metal ion. He founded RHA as an effective adsorbent for the removal of Cd (II) and Zn (II) metal ions from aqueous solution.

Dongmin et al.,2010[25], investigated a green route for preparation of silica powders with rice husk ash and waste gas. Na_2CO_3 was used as the silica extraction reagent and waste gas was the precipitator. The synthetic procedure is inexpensive. environment-friendly and straightforward. which was suitable for large-scale production.

Ganvir et al.,2010[26], studied the removal of fluoride from drinking water using rice husk ash. RHA is obtained by burning rice/paddy husk which is an abundantly available and is an inexpensive raw agricultural material. The results depicted the excellent fluoride removal efficiency when Rice Husk Ash was coated with aluminum hydroxide.

Givi et al.,2010,[27], studied the compressive strength, water permeability and workability of concrete by partial replacement of cement with agro-waste rice husk ash. It was concluded that partial replacement of cement with rice husk ash improves the compressive strength and workability of concrete and decreases its water permeability.

Imyim et al.,2010[28], studied the use of RHA in the removal of humic acid from water. He found that the RHA modified with aminopropylation reaction with 3-aminopropyltriethoxysilane is a suitable adsorbent for humic acid.

Lau et al.,2010[29], studied the use of RHA for the simultaneous removal of SO_2; and NO from flue gas using effective sorbent. He found that the sorbents synthesized from RHA and impregnated with CuO were found to be effective in removing SO_2 and NO simultaneously.

Liu et al.,2010,[30], worked on the production of Silica and activated carbon simultaneously from rice husk ash with Potassium carbonate, K_2CO_3. Potassium carbonate could be recycled. The entire synthetic procedure was simple. environmental-friendly and economical-effectively.

Thanaya, 2010[31], investigated and evaluated the properties of masonry building block materials that incorporate rice husk ash (RHA). The properties of the blocks evaluated were: compressive strength, density, porosity, initial rate of suction (IRS), creep, and volume stability.

Wongjunda et al.,2010[32], investigated the adsorption ability and determine the suitable condition for adsorption of Chromium (Cr (VI)) in synthetic wastewater by Rice Husk Ash (RHA). He found that the modified RHA (MRHA) formed by treatment of RHA with NaOH has increased adsorption capacity for chromium removal.

Ahmaruzzaman et al.,2011[33], investigated RHA as an adsorbent for the removal of various pollutants from water and wastewaters. He also considered the adsorption mechanism, influencing factors, favorable conditions, etc., in his studies on the adsorption of various pollutants by rice husk materials.

Hossain,2011[34], had done the study on the stabilization of soil using Rice Husk Ash with cement kiln dust and RHA. He found that the developed stabilized soil mixtures had shown satisfactory strength and durability characteristics and can be used for low-cost construction to build houses and road infrastructures. The use of locally available soils, rice husk ash, and cement kiln dust (waste from the cement industry) in the production of stabilized soils for such applications can provide sustainability for the local construction industry.

Johan et al.,2011[35], had made an attempt to use microwave incinerated rice husk ash for the adsorption of copper and found that it can be effectively used for the removal of copper through adsorption. Microwave Incinerated Rice Husk Ash (MIRHA), produced from the rice husk is one of the low-cost materials that were used as adsorbent of heavy metal.

Khan et al.,2011[36], studied the use of rice-husk ash (RHA) as a partial replacement of cement in concrete. He concluded that the use of Rice Hush Ash in concrete showed the reduction in environmental problem and cost reduction.

Rao et al.,2011[37], used Rice Husk Ash and Lime in combination with gypsum to upgrade expansive soil as a construction material. It was concluded that RHA can be used to stabilize the residual soil with or without mixing the cement. Its utilization is an alternative to reduce construction cost in the rural area of developing countries.

Vlaev et al.,2011[38], in his studies, made an attempt to establish the possibilities to obtain black rice husk ash (BRHA) and white rice husks ash (WRHA) via pyrolysis of raw rice husks. The kinetics was studied and the adsorption capacities of crude oil and diesel fuel at different temperatures as well as some hydrocarbons at 298K onto BRHA and WRHA are determined. It was established that BRHA has high adsorption capacity and low cost and may successfully be used as an effective absorbent for purification of crude oil or oil products spilled in water basins or bilge water.

Ayswarya et al.,2012[39], studied the use of Rice Husk Ash as reinforcement for high density polyethylene. It was found that the use of RHA as a filler in HDPE reduces the pollution potential of RHA and modify the properties of HDPE by a cost effective and reliable method

Gandhi et al.,2012[40], studied on removal of fluoride from water and wastewater using low-cost adsorbents. The study was done for different parameters like dosage, concentration, time, temperature, etc.

Ghorbani et al., 2012[41], reported the results of study on the synthesis and performance of polypyrrole nanocomposite coated on rice husk ash in removing the heavy metals such as iron, zinc, copper and manganese from waste water. The adsorbent materials adopted were found to be an efficient media for the removal of heavy metals in continuous mode using fixed bed column.

Krishna, 2012[42], made an attempt to bring out the effectiveness of rice husk ash as a versatile concrete admixture and discussed some versatile application of rice husk ash concrete. RHA increases the resistance of concrete towards Chlorine and Sulphate and make it corrosion resistant.

Manique et al.,2012[43], h*ad* studied the purification of biodiesel from waste frying oil using RHA at different concentration. The high concentration of silica in its composition and the presence of meso and macro pores can explain its high- adsorption capacity.

Mondal et al.,2012[44], had done comparative study for removal of fluoride by activated silica gel and activated rice husk ash. The fluoride removal performance of both adsorbents was evaluated as a function of the initial concentration, adsorbent dose, contact time and pH.

Olawale et al.,2012[45], in his studies characterized RHA using atomic absorption spectrometer for optimal silica production. He reported that optimal silica was produced at characterization temperature of 7000°C. This will also reduce the environmental pollution caused by opening burning of rice ash.

Pham,2012[46], works on and takes into account the burning conditions affect to the rice husk ash applications in Geoengineering. He identified burning conditions to produce the rice husk ash and characterized the rice husk ash activity and estimated soil improvement ability of the rice husk.

Sadon et al.,2012[47], had also studied the use of rice husk ash and modified rice husk ash by some chemical and physical treatment for the effective adsorption. Different parameters like contact time, temperature, pH were also studied.

Singh et al.,2013[48], investigated study on the potential of adsorption of heavy metals from electroplating water using various agricultural adsorbents like rice husk ash, activated charcoal etc.

CHAPTER-3

MATERIALS AND METHODOLOGY

This chapter deals with the materials and instruments used and the method followed for the preparation of RHA based filters and treatment of the samples.

3.1 MATERIALS USED

Following materials are used in this study:

Ordinary Portland Cement: OPC is used as a binding material. It provides strength to the matrix prepared as filter bed.

Rice Husk ASH: It was prepared by proper burning. It acts as an adsorbent.

Sand: It provides strength to the mixture.

3.2 CHEMICALS USED

All the chemicals were used as received. In all the experiments double distilled water was used. Following chemicals were used for various tests:

• Hydrochloric acid (HCl)

• Barium chloride solution-dissolve 100g BaCl2.2H2O in one litre distilled water.

• Potassium chromate indicator or solution

• Buffer solution.

3.3 INSTUMENTS USED

The following instruments were used in the measurement of various parameters during the treatment of water samples with RHA based filter :

1. Turbidity meter: Turbidity of the samples were measured by using Hatch Radio turbidity meter as per Standard Methods for the examination of water samples.

Figure.3.1: Turbidity meter

2. pH meter: pH of the samples were measured using a digital pH meter. pH was adjusted with the help of 0.1 N NaOH and 0.1 N HCl. Instrument was calibrated using buffer solutions of pH 4 and 9.

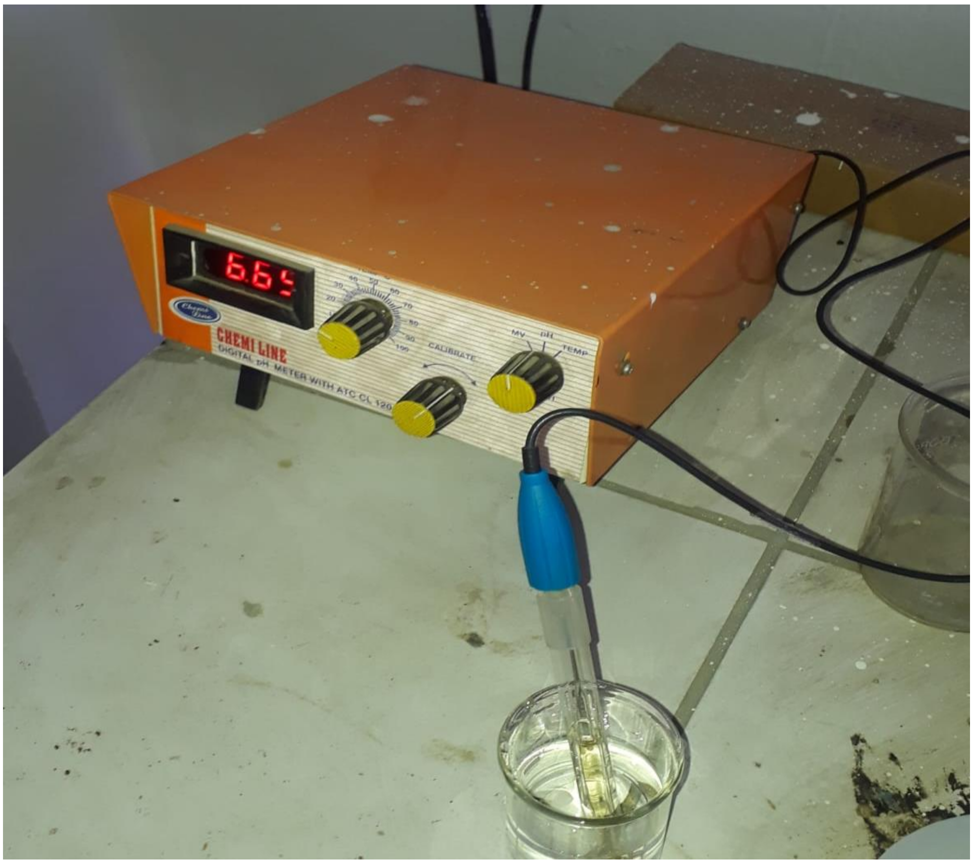

Figure. 3.2: pH meter

3. TDS meter: The TDS of the water samples were measured using a digital TDS meter.

Figure3.3: TDS meter

3.4 METHODOLOGY

The steps involved in the preparation of RHA based filter are as follows:

3.4.1 Preparation of RHA

Rice Husk was collected from agricultural area in Kunda Kala, Chandauli and was washed and dried. Rice husk was made into rice husk ash by proper burning. This rice husk ash was used to make filter pats which acts as an adsorbent.

Figure.3.4: Burning of Rice Husk

3.4.2 Preparation of filter

70 gm of RHA and 100 gm of cement were taken and thoroughly mixed. After that, the mixture was turned over number of times with 30gm of sand until an even colour and consistency was observed. 75 ml water was added slowly and the mixture was further turned manually until a mixture of a sufficient workability was achieved. For filter, the mixture was filled in the mould. Thereafter, the filters were dried for 20 minutes in an oven at a temperature of 105°C and then air dried for 24 hours. Then this filter is cured for 3 days by sprinkling water on it twice a day.

Figure.3.5: Filter Blocks

Curing process is the most important part of the preparation of filters using rice husk ash and cement because the strength gained by the filter depends upon the curing. Curing was commenced after 24 hours of the drying by spraying normal water onto filters twice a day for 3 days.

After curing this filter block was adjusted in a conical vessel as shown in the figure 3.6.

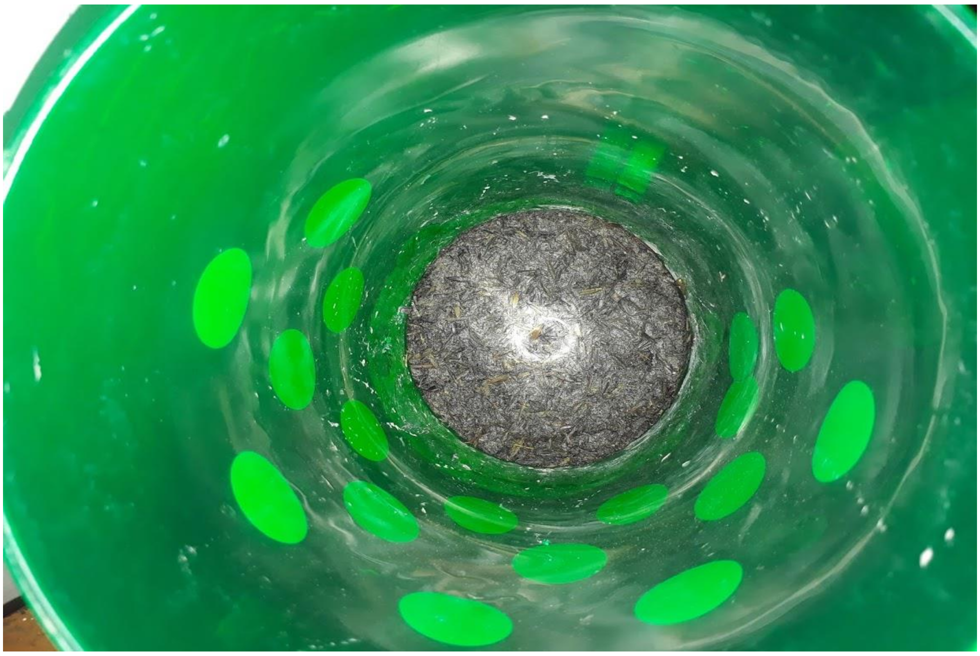

Figure.3.6: Adjustment of Filter Block in Conical Vessel

The apparatus was then setup as shown in the figure below:

Figure.3.7: Filter Setup

3.4.3 Collection of Water Sample

Two type of water samples were collected for this study:

a) Ground water sample from residential area, Alinagar, Chandauli.

b) River water sample of river Ganga (near Kunda Kala village).

3.4.4. Experiments conducted

a) pH Test
b) Alkalinity
c) Hardness Test
d) Determination of Dissolved Solids
e) Turbidity
f) Iron Test
g) Chloride Test
h) Sulphate Test
i) Dissolved Oxygen Test

CHAPTER-4

TEST RESULTS AND DISCUSSIONS

The mixture of cement, sand and RHA was used to make the filters which was used for water purification.

4.1 CHARACTERIZATION OF WATER SAMPLES

Characterization of the collected ground water and river water was carried out by measuring its various parameters such as pH, Alkalinity, Hardness, TDS, Turbidity shown below in Table 4.1.

Table 4.1: Characteristic parameters of Ground & River water sample

Parameter	**Water Sample**			
	Ground Water	River Water	Desirable Limit	Permissible Limit
pH	6	4	6.5-8.5	No relaxation
Alkalinity (mg/l)	80	42	200	600
Hardness (mg/l)	60	340	200	600
TDS(mg/l)	605	700	500	2000
Turbidity (NTU)	3	78	1	5
Iron (mg/l)	0.7	4.8	0.3	1
Chloride(mg/l)	495	26	250	1000
Sulphate (mg/l)	40	140	200	400
Dissolved Oxygen (mg/l)	9.4	4	8	_

4.2 ASSESSMENT OF FILTERED WATER

The parameters such as pH, Alkalinity, Hardness, TDS, Turbidity were also measured for the samples filtered through the RHA based filter. The tests done for measuring these parameters are as follows:

a) pH Test

Samples of unfiltered ground water and river water and filtered ground water were tested for determining their pH. pH of the sample was measured using a digital pH meter. pH was adjusted with the help of 0.1 N NaOH and 0.1 N HCl. Instrument was calibrated using buffer solutions of pH 4 and 9. The results of the tests are shown in Table 4.2. The results show a considerable increase in pH of the filtered water samples. It may be due to the basic nature of cement present in the composition of filter pats.

b) Alkalinity Test

Samples of unfiltered ground water and river water and filtered ground water were tested for determining their alkalinity. The results of the tests are shown in Table 4.2. The results in Table 4.2 shows a considerable increase in alkalinity of the filtered water samples. It may be due to the alkaline nature of cement present in the filter pats.

c) Hardness Test

Samples of unfiltered ground water and river water and filtered ground water were tested for determining their hardness. The results of the tests are shown in Table 4.2. The results in Table 4.2 shows a considerable decrease in hardness of the filtered water samples. It is due to the adsorption of calcium and magnesium ions in the voids of the filter pats

d) Determination of TDS

Samples of unfiltered ground water and river water and filtered ground water were tested for determining the amount of total dissolved solids before and after filtration. The TDS of the water samples were measured using a digital TDS meter. The results of the tests are shown in Table 4.2. The results in Table 4.2 shows a considerable decrease in TDS of the filtered water samples.

e) Determination of Turbidity

Samples of unfiltered ground water and river water and filtered ground water were tested for determining the turbidity before and after filtration. The results of the tests are shown in Table 4.2. The results in Table 4.2 shows a considerable reduction in TDS of the filtered water samples.

f) Determination of Iron

Samples of unfiltered ground water and river water and filtered ground water were tested for determining the iron contents of the water samples before and after filtration. The results of the tests are shown in Table 4.2. The results in Table 4.2 shows a considerable reduction in iron content of the filtered water samples.

g) Determination of Chloride

Samples of unfiltered ground water and river water and filtered ground water were tested for determining the chloride contents of the water samples before and after filtration. The results of the tests are shown in Table 4.2. The results in Table 4.2 shows a considerable reduction in chloride content of the filtered water samples.

h) Determination of Sulphate

Samples of unfiltered ground water and river water and filtered ground water were tested for determining the sulphate contents of the water samples before and after filtration. The results of the tests are shown in Table 4.2. The results in Table 4.2 shows a considerable reduction in sulphate content of the filtered water samples.

i) Determination of Dissolved Oxygen

Samples of unfiltered ground water and river water and filtered ground water were tested for determining the dissolved oxygen contents of the water samples before and after filtration. The results of the tests are shown in Table 4.2. The results in Table 4.2 shows the dissolved oxygen content of the filtered and unfiltered water samples. There is no change in the D.O. content of the water sample after filtration. For aquatic life, the minimum D.O. content required is 4mg/l and for drinking water, it is 8mg/l. Hence the river water samples are fit for survival of aquatic life as well as drinking as per dissolved oxygen content criteria while the groundwater samples (both filtered and unfiltered) suitable only for the survival of aquatic life.

The test results for determining various parameters of the water samples before and after filtration are shown below in the Table 4.2.

Table4.2: Various Parameters of the Water Samples before and after Filtering

Parameters	**Unfiltered Water Samples**		**Filtered Water Samples**	
	Ground Water	River Water	Ground Water	River Water
pH	6	4	7	5
Alkalinity (mg/l)	80	42	200	150
Hardness (mg/l)	60	340	40	190
TDS (mg/l)	605	700	490	580
Turbidity (NTU)	3	80	1	45
Iron (mg/l)	0.7	1.5	0.6	1.2
Chloride (mg/l)	495	26	480	25.5
Sulphate (mg/l)	40	140	37	130
Dissolved Oxygen (mg/l)	9.4	4	9.4	4

By analysing the results of the tests conducted on the filtered and unfiltered water sample, we conclude that:

- pH was increased, it may be due to the basic nature of cement present in the composition of filter pats.
- Alkalinity was increased, it may be due to the alkaline nature of cement present in the filter pats.
- Hardness was reduced, it is due to the adsorption of calcium and magnesium ions in the voids of the filter pats.
- Turbidity was reduced.
- TDS was reduced.
- Iron content was reduced. It may be due to the adsorption of ferrous ions in the voids of the filter pats.
- Chloride content was reduced. It may be due to the adsorption of chloride ions in the void of the filter pats.
- Sulphate content was reduced. It may be due to the adsorption of sulphate ions in the void of the filter pats.
- Dissolved oxygen remains constant even after filtration. It shows that there was no effect of filtration on the D.O. content of the water sample.

CHAPTER-5

CONCLUSION

The presence of safe and reliable water is an essential prerequisite for a stable community. Water used for drinking becomes unpalatable when the TDS level is >500 mg/l, but lack of any better source enables people consuming such water to get used to its taste. Practically, all industrial and some commercial uses, the purity levels required are very much higher and in most cases demand water with virtually no residual dissolved solids at all. The potential of use of RHA as an adsorbent for the reduction of TDS in water samples has been explored. The RHA based filter was prepared and subjected to water purification.

One of RHA's greatest strengths lies in the fact that it is widely available and routinely underutilized. around 600 million tons of rice are produced worldwide annually, and its cultivation covers approximately 1% of the Earth's surface. For every 100 kg of rice produced, 22 kg of rice husk is generated alongside of it. In fact, the amount of RHA by-product available is in such great excess that it has quickly evolved into a disposal problem for developing nations such as India and Malaysia, which rely heavily on rice for nutrition.

This rice husk has several potential modifications which potentially make it even more useful for adsorption. As an illustration, this commodity waste product can be made into activated carbon. Activated carbons have been the subject of intense research in chemistry recently, though their biggest barrier to industry applications is their cost: around $600 per ton or more. RHA, by contrast, results in activated carbons at only a quarter of that price, running between $100-200 per ton, according to Foo and Hameed. These activated carbons purchased separately also experience difficulties associated with regeneration, which RHA does not.

Characterization of the collected river water was carried out by measuring its various parameters such as pH, Alkalinity, Hardness, TDS and Turbidity.The results depict that RHA based filter showed a very good treatment efficiency in terms of pH, hardness, TDS and turbidity. The high concentration of silica in its composition and the presence of meso and macro pores can explain its high capacity of adsorption.

On the basis of foregoing studies available we came to the conclusion that rice husk is viable to be used in a filter plant. The abundant availability of Rice Husk at low cost in our country makes it more feasible than other materials like coconut husk, crushed glass which can also be used as adsorbents. From the previously conducted tests we found that, turbidity removal on an average using rice husk was around 95%. Owing to its great adsorption properties it can remove the smallest of the impurities and microorganisms. Rice husk has proved to be very efficient in bacterial inactivation (Escherichia Coli) with an efficiency of 99 %. It is much safer to use RHA for bacterial inactivation as it does not react with naturally occurring organic compounds found in water to form carcinogenic compounds.

All the tests using rice husk ash showed results which were in compliance with permissible limits of B.I.S. Moreover, it can be concluded that replacement of sand with rice husk ash from filter bed is not possible but it can be used as an additional filtration unit or can be used in rural areas with low cost. The possible suitability of such a material which is considered as agricultural waste can prove its ability for environmental conservation and has the potential to benefit millions of people who suffer from water borne diseases such as cholera and typhoid.

The use of rice husk ash in making of the filters for water purification will provide two-fold advantage to the environmental management. First, the large volume of rice husk waste could be partly reduced, converted to useful, value added adsorbent. Secondly. the development of the low-cost adsorbent may overcome the groundwater and river water pollution problems at an affordable cost. The utilization of rice husk would solve both a disposal problem and also access to less expensive filter medium in the waste water treatment and these types of filters may be used by rural people to treat drinking water at low cost.

5.1 FUTURE PROSPECTS

The used RHA based balls after the treatment. can be further utilized for construction purpose i.e, in the constriction of bitublock wall, in concrete making or it can be used in road surfacing in addition with the bitumen These ball filters can be coated with lime for the removal of fluoride from water. Additional modification of RHA can be done for remover of other constituents and heavy metals from wastewater.

Additional research will be required in many interconnected areas to make a firm decision on the viability of RHA for its currently attempted applications. The most glaring of these has to do with the use of RHA in the situation of multiple contaminants. Understanding how organic and inorganic anions interact competitively on the globular surface will be critical for water sources contaminated by, for example, textile effluent, as was seen in Bangladesh.

By increasing the predictive and descriptive advantages of accurate isotherm modelling for a greater number of contaminants, the efficiency of RHA filters, and the reliability of their claims as a product would certainly be bolstered as well. Moreover, the same ingenuity which led to the integration of RHA into cement and plastic filters begs the question: what other innovative, judicious applications of RHA lie waiting for researchers to discover next? Maybe the thermal insulation properties of RHA could be coupled with a source of heat to stave off bacterial activity through unconventional means. Maybe its high mechanical strength will cross over from the realm of supplementary construction material to a durable and effective filter in its own right. The future of RHA may not be crystal clear, but its record of past successes positions it a strong combatant to the world’s shrinking water resources.

REFERENCES

1. Mittal D. (1997). Silica from Ash: A Valuable Product from Waste Material, *Resonance*, Vol. 2, Issue 7, pp.64-66.
2. Kalapathy U., Proctor A., Shultz J. (1999). A simple method for production of pure silica from rice hull ash. *Bio resource Technology*, Vol. 73, Issue 3, pp. 257-262.
3. Saha J.C., Dikshit K., Bandyopadhyay M. (2001). Comparative studies for selection of technologies for arsenic removal from drinking water. *BUET-UNU International Workshop on Technologies for Arsenic Removal from Drinking Water*, Bangladesh.
4. Prasad V.C.S. (2002). Low-Cost Domestic Water Filter : The Case for a Process-Based Approach for the Development of a Rural Technology Product. *African Journal*, Vol. 28, Issue 2, pp.139-148.
5. Ganvir V., Biswas K., Kokil S. (2002). A Novel Water Filter Technology For Rural Areas. *Sustainable environmental sanitation and water services*. 28th WEDC Conference, Kolkata.
6. Muntohar A S (2002). Utilization of Uncontrolled Burnt Rice Husk Ash in Soil Improvement. *Dimensi Teknik Sipil (DTS)*, Vol. 4, Issue 2, pp.100–105.
7. Basha E A, Hashim R, Mahmud H B, Muntohar A S (2004). Stabilization of Residual Soil with Rice Husk Ash and Cement. *Construction and Building Materials*, Vol. 19, Issue 6, pp. 448–453.
8. Feng Q., Lin Q., Gong F., Sugita S., Shoya M. (2004). Adsorption of Lead and Mercury by Rice Husk Ash. *Journal of Colloid and Interface Science*, Vol.278, Issue 1, pp. 1–8.
9. Sivapullaiah P.V., Subba Rao K.S. and Gurumurthy J.V. (2004). Stabilization of Rice Husk Ash for Use as Cushion below Foundations on Expansive Soils, *Ground Improvement*, Vol. 8, Issue 4, pp. 137-149.
10. Amin M.N, Kaneko S., Kitagawa T., Begum A., Katsumata H., Suzuki T., and Ohta K. (2006). Removal of Arsenic in Aqueous Solutions by Adsorption onto Waste Rice Husk. *Industrial & Engineering Chemistry Research 2006*, Vol. 45, Issue 24, pp. 8105-8110.

11. Chandrasekhar S., Pramada P.N (2006), Rice Husk Ash as An Adsorbent for Methylene Blue-Effect Of Ashing Temperature. *Adsorption*, Vol 12, Issue 1, pp.27–43.
12. Forth J.P., Zoorob S.E. (2006). Non-Traditional Binders for construction material. *IABSE Henderson Colloquium*, Cambridge.
13. Saraswathy V., Song H.W. (2006). Corrosion Performance of Rice Husk Ash Blended Concrete. *Construction and Building Materials*, Vol. 21, Issue 8, pp.1779–1784.
14. Mane V.S., Mall I.D., Srivastava V.C. (2007), Kinetic and Equilibrium Isotherm Studies for the Adsorptive Removal of Brilliant Green Dye from Aqueous Solution by Rice Husk Ash, *Journal of Environmental Management*, Vol.84, Issue 4, pp. 390-400.
15. Mohan D., Pittman Jr. C.U. (2007). Arsenic Removal from Water/Wastewater using Adsorbents-A critical review. *Journal of Hazardous Materials*, Vol. 142, Issues 1-2, pp.1-53.
16. Sud D., Mahajan G., Kaur M.P. (2007). Agricultural Waste Material as Potential Adsorbent for Sequestering Heavy Metal Ions from Aqueous Solutions –A review. *Bioresource Technology*, Vol. 99, Issue 14, pp. 6017–6027.
17. Alhassan M. (2008). Potentials of Rice Husk Ash for Soil Stabilization. *Assumption University Journal of Technology*, Vol 11, Issue 4, pp. 246-250.
18. Dahlan I., Lee K.T., Kamaruddin A.H., Mohamed A.R. (2008). Evaluation of Various Additives on the Preparation of Rice Husk Ash (RHA)/Cao-Based Sorbent for Flue Gas Desulfurization (FGD) at Low Temperature. *Journal of Hazardous Materials*. Vol. 161, Issue1, pp. 570–574.
19. Lakshmi U.R., Srivastava V. C., Mall I.D., Lataye D.H. (2008), Rice Husk Ash as an Effective Adsorbent: Evaluation of Adsorptive Characteristics for Indigo Carmine dye, Journal *of Environmental Management*, Vol.90, Issue 2, pp.710-720.
20. Lennox R., Mackenzie M. (2008). Eco-Road Building for Emerging Economies: An Initial Scan for Promising Alternative Technologies, pp.1-19.
21. Brooks R.M. (2009). Soil Stabilization with Fly Ash and Rice Husk Ash. *International Journal of Research and Reviews in Applied Sciences*, Vol.1, Issue 3, pp. 209-217.
22. Chan L, Chan M, Wang J (2009), Design of water filter for third world countries, pp.1-71

23. Rayner J (2009). *Current Practices in Manufacturing of Ceramic Pot Filters for Water Treatment*. WEDC Resources Centre, Loughborough University.
24. Srivastava V.C., Mall I.D., Mishra I.M. (2009). Removal of Cadmium (II) and Zinc (II) Metal Ions from Binary Aqueous Solution by Rice Husk Ash. *Colloids and Surfaces: A Physicochemical and Engineering Aspects*, Vol.312, Issues 2-3, pp.172–184.
25. Dongmin A.N, Guo Y., Zhu Y., Wang Z. (2010). A Green Route To Preparation Of Silica Powders With Rice Husk Ash And Waste Gas. *Chemical Engineering Journal*, Vol.162, Issue.2 pp.509-514.
26. Ganvir V., Das K. (2010). Removal of Fluoride from Drinking Water using Aluminum Hydroxide Coated Rice Husk Ash. *Journal of Hazardous Materials*, Vol. 185, Issues 2-3, pp.1287–1294.
27. Givi A.N., Rashid S. A., Aziz F. N., Salleh M.A., (2010). Assessment of the Effects of Rice Husk Ash Particle Size on Strength, Water Permeability and Workability of Binary Blended Concrete. *Construction and Building Materials*, Vol. 24, Issue 11, pp. 2145–2150.
28. Imyim A., Prapalimrungsi E. (2010). Humic Acids Removal from Water by Aminopropyl Functionalized Rice Husk Ash. *Journal of Hazardous Materials*, Vol. 184, Issues 1-3, pp. 775–781.
29. Lau L.C., Lee K.T., Mohamed A.R. (2010). Simultaneous Removal of SO_2 and NO using Sorbents derived from Rice Husks: An Optimization Study. *Journal of Hazardous Materials*, Vol. 183, Issues 1-3, pp.738-745.
30. Liu Y, Guo Y, Gao W, Wang Z, Ma Y, Wang Z (2012), Simultaneous preparation of silica and activated carbon from rice husk ash, *Journal of Cleaner Production* Vol.32, Issue 3, pp.204-209.
31. Thanaya I.N.A. (2010). Building Blocks Incorporating Waste Materials Bound with Bitumen. *Civil Engineering Dimension*, Vol.12, Issue 1, pp. 36-43.
32. Wongjunda J., Saueprasearsit P. (2010). Biosorption of Chromium (VI) using Rice Husk Ash and Modified Rice Husk Ash. *Environmental Resource Journal*, Vol. 4, Issue 3, pp. 244-250.
33. Ahmaruzzaman M., Gupta V. K. (2011). Rice Husk and its Ash as Low-Cost Adsorbents in Water and Wastewater Treatment. *Industry and Engineering Chemistry Research*, Vol. 50, Issue 24, pp. 13589–13613.

34. Hossain K.M.A. (2011). Stabilized Soils Incorporating Combinations of Rice Husk Ash and Cement Kiln Dust. *Journal of Material in Civil Engineering*, Vol. 23, Issue 9, pp.1320-1327.
35. Johan N.A., Kutty S.R.M., Isa M.H., Muhamad N.S., Hashim H. (2011). Adsorption of Copper by using Microwave Incinerated Rice Husk Ash (MIRHA). *International Journal of Civil and Environmental Engineering*, Vol.3, Issue 9, pp. 211-215.
36. Khan R., Jabbar A., Ahmad I., Khan W., Khan A. N., Mirza J. (2011). Reduction in Environmental Problems using Rice-Husk Ash in Concrete. *Construction and Building Materials*, Vol. 30, pp. 360–365.
37. Rao D.K., Pranav P.R.T, Anusha M. (2011). Stabilization of Expansive Soil with Rice Husk Ash, Lime And Gypsum. An Experimental Study. *International Journal of Engineering Science and Technology*, Vol. 31, Issue 1, pp. 8076-8085.
38. Vlaev L., Petkov P., Dimitrov A., Genieva S. (2011). Cleanup of Water Polluted with Crude Oil or Diesel Fuel using Rice Husks Ash. *Journal of the Taiwan Institute of Chemical Engineers*, Vol. 42, Issue 6, pp. 957–964.
39. Ayswarya E.P., Francis K.F.V, Renju V S, Thachil E.T.(2012). Rice husk ash – A valuable reinforcement for high density polyethylene. *Materials and Design*, Vol. 41, pp. 1–7.
40. Gandhi N., Sirisha D., Shekar K.B.C., Asthana S. (2012). Removal of Fluoride from Water And Wastewater by using Low-Cost Adsorbents. International *Journal of Chemical Technology and Research*, Vol. 4, Issue 4, pp.1646-1653.
41. Ghorbani M., Eisazadeh H. (2012). Fixed Bed Column Study for Zn, Cu, Fe and Mn Removal from Wastewater using Nanometer Size Polypyrrole Coated on Rice Husk Ash. *Synthetic Metals*, Vol. 162, Issues 15-16, pp.1429–1433.
42. Krishna R.N. (2012). Rice Husk Ash–An Ideal Admixture for Concrete in Aggressive Environment. *37th Conference on our World in Concrete & Structures*, Singapore.
43. Manique M.C., Faccini C.S, Onorevoli B., Benvenutti E.V., Caramao E.B. (2012). Rice Husk Ash as an Adsorbent for Purifying Biodiesel from Waste Frying Oil. *Fuel*, Vol. 92, Issue 1, pp. 56–61.
44. Mondal N.K., Bhaumik R., Banerjee A., Datta J.K., Baur T. (2012). A Comparative Study on the Batch Performance of Fluoride Adsorption by Activated Silica Gel and Activated Rice Husk Ash. *International Journal of Environmental Sciences*, Vol. 2, Issue 3, pp.1643-1661.

45. Olawale, Olamide, Oyawale F. A. (2012). Characterization of Rice Husk via Atomic Absorption Spectrophotometer for Optimal Silica Production, *International Journal of Science and Technology*, Vol. 2, Issue 4, pp. 210-213.

46. Pham V. (2012). Utilization of Rice Husk Ash in Geo Technology: Applicability and Effect of the Burning Conditions, pp1-68.

47. Sadon F.N., Ibrahim A.S., Ismail K.N. (2012). An overview of Rice Husk Applications and Modification Techniques in Wastewater Treatment. *Journal of Purity, Utility Reaction and Environment.* Vol. 1, Issue 6, pp. 338-364.

48. Singh U., Kaushal R.K. (2013). Treatment of Wastewater with Low Cost adsorbent. *International Journal of Technical & Non-Technical Research*, Vol.4, Issue 3, pp.33-42.

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