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Water filtration with the Help of Rice Husk Ash

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Water purification is one of the important needs for people around the world. As it prevents from many diseases that are caused from water. Main motive of the research in this thesis is to purify water from rice husk which is a waste product and disinfection through PET whose containers are also considered as waste after its use of liquid which it contains.

I. RICE HUSK ASH

India is a major rice producing country, and the husk generated during milling is mostly used as a fuel in the boilers for processing the paddy, and generating energy through direct combustion and by gasification. About 20 million tonnes of Rice Husk Ash or (RHA) is produced annually. This RHA is a great environment threat causing damage to the land and to the surrounding area in which it is dumped. Lots of ways are being thought of for disposing them by making commercial use of this RHA. Rice is a important cereal grain which is one of the important food product in many countries around the world. Rice milling generates a by-product know as husk. This surrounds the paddy grain. During milling of paddy of the rice about 78 % of weight is received as rice, broken rice and bran. Rest 22 percent of the weight of paddy is received as husk. This husk is used as fuel in the rice mills to generate steam for the parboiling process. This husk have about 75 percent organic volatile matter and the balance 25 % of the weight of this husk is converted/turn into ash during the firing process, which is known as rice husk ash (RHA). This RHA in turn contains around 85 percent to 90 percent amorphous silica. This is a very large amount. So for every 1000 kgs of paddy milled, about 220 kg's (22 %) of husk is produced, and when this husk is burnt into the boilers, about 55 kg's (25 %) of RHA is generated. Of the agricultural wastes, rice husk has been identified as one with having the greatest potential as it is widely available and, on when it is combust, produces a relatively large proportion of ash in it, which contains around 90% silica. And about 1 tonne of husk is produced from five tonnes of rice paddy and it has been estimated that around 120 million tonnes of husk could be their annually on a global basis for pozzolana production. As the ash content by weight is about twenty percent there are most potentially 24 million tonnes of RHA available as a pozzolana. Rice is grown in large quantities in many Asian countries including China, the Indian sub-continent, Thailand, South-east Asia and, in smaller quantities, in some of the regions of Africa and South America. Traditionally, husk of rice has been considered as a waste and not a useful material and has generally been disposed of by dumping or burning, although some has been count on its use as a low-grade fuel. but, RHA has been successfully used as a pozzolana in commercial production in various number of countries including Columbia, Thailand, China, Thailand and India.

II. CARBON FILTRATION

Carbon filtering is a method of filtering of water which uses a bed that has activated carbon to remove contaminants and impurities, using of chemical absorption.

Each single particle or granule of carbon (C) provides a much large surface area/pore structure, which allowing for contaminants to the maximum possible exposure to the active sites which are in the filter media. One pound (450 grams) of activated carbon contains a surface area of approx 100 of acres i.e. 40 Hectares.

Activated carbon works with the help of a process called adsorption, whereby pollutant molecules which are in the fluid/liquid to be treated or filtered are trapped inside the pore structure of the carbon substrate. Carbon filtering is commonly used for water purification, industrial gas processing, etc and in purifications of air for example the removal of siloxanes and hydrogen sulphide from biogas. It is also used in a various other applications, including respirator masks, the purification of sugarcane and for the recovery of precious metals, especially gold. It is also used in the filters of cigarettes. Active carbon filters are very much effective in removing chlorine, sediment, volatile organic compounds (VOCs), odour and taste from water. They are not effective at removing minerals, salts, and dissolved inorganic compounds present in water.

Typical particle sizes that are use to removed by carbon filters range from 0.5 to 50 micrometres. The particle size will then be used as part of the filter description. The efficacy of a carbon filter is also based upon the flow rate regulation. When the water sample is allowed to flow through the filter at a slower rate, the contaminants are exposed to the filter media for a longer expand of time.

Carbon filtering is usually used in water filtration systems. In this illustration given, the activated carbon is in the fourth level (when counted from bottom).

There are 2 predominant types of carbon filters used in the filtration industry: powdered block filters and granular activated filters. In general, carbon block filters are more effective at removing a most number of contaminants, based upon the increased surface area of carbon. Many carbon filters also use secondary media, which are like silver or Kdf-55, to prevent bacteria growth within the filter. Alternatively, the activated carbon itself can be impregnate with Ag (silver) to provide this bacteriostatic property.

III. SOLAR DISINFECTION MECHANISMS

A couple of studies and experiment contains that SODIS owes a large part of its disinfection power to photochemical action. Since ultraviolet radiation known to has the power to destroy

Micro organisms, as we will see, it has been claimed that the ultraviolet segment accompany with the visible portion when water is exposed to the sunlight is responsible for the germicidal action. The truth is like that only a very minor truly germicidal portion of the ultraviolet component, under the range of UV-C (100-280 nm), is present in solar radiation. Assuming that the germicidal portion were large enough to offer some disinfection power, most materials, including those which are transparent in sunlight, for example glass and plastic, have been scientifically proven that to be completely opaque in the case of ultraviolet radiation. That is why, as the chapter explains, the ultraviolet pipes that are used for disinfection are cased in the protective sleeves made of quartz, the only type material that is truly transparent to this type of radiation (teflon, used in some equipment, is the only partially transparent plastic). The conclusion that is to be reached in this simple analysis is that if water is exposed to very poor radiation and a filter that is almost opaque to that for UV is inserted between the two, the capacity of disinfection of that radiation will be practically nil or zero, in the best of cases, negligible. Obviously, then, solar disinfection does not operate on the basis of photochemistry, but of a thermal process, pasteurization.

High temperatures have capacity to strongly affect all microorganisms; vegetative cells perish as protein is denatured and other components undergo hydrolysis. Although some bacteria in the water are there which capable of forming spores, making them particularly heat-resistant, most are generally killed off between 40 to 100 °C, while algae, protozoa and fungi perish at between 40°C to 60 °C. Disinfection by boiling consists of raising the temperature of water to 100°C and then keeping it at that level from one to five minutes. Most if not all, of the microorganisms which are present are eliminated as a result. Pasteurization, , is defined as exposing a substance (generally a food, including water) “where for a long enough span of time to a temperature which is high enough to kill the microorganisms which can cause illness or spoil food.” Although heat tolerance is affected by factors such as water physiological state, turbidity, cell concentration and other parameters, pasteurization destroys coliforms and other bacteria which are non heat-tolerant this is fortunate, because most of the pathogens are non heat-tolerant.

Specially ..., in the case of water, an effort has been made to find the optimum relationship between length of time and temperature which is needed to destroy pathogenic germs. As a rule of thumb, although not any exact one, either of the following ratios will ensure a good reasonable level of safe disinfection of the clear water (with a turbidity of less than 5 NTU):

65 °C for 30 to 35 minutes or 75 °C for 15 to 18 minutes.

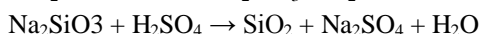
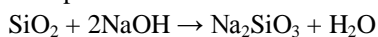
From a highly practical and operational point of view, these conditions are ensured that in sunny zones with four to five hours of exposure during the period of maximum radiation (from 11:00 to 16:00 hours).

How To Make Rice Husk Suitable For Filtering Water (Activated)

IV. MATERIALS & METHODS

A. Analysis Of Rice Husk Ash

Precipitation of Silica – Chemical Reaction Involved



B. General Process For Precipitation Of Silica And Activated Carbon From Rice Husk

A known amount of weight of rice husk should be taken and sieved through mesh of size 20. It is then to be washed, cleaned and then heated or carbonized to around 600°C for different time to time intervals. It is then treated with an activating reagent like such as sodium hydroxide, zinc chloride or phosphoric acid for about an hour at around 60°C. The activated rice husk (ARH) and the solution that containing the activating agent are then filtered. The activated rice husk then obtained is heated or carbonised at a

temperature of 900°C to get the activated carbon. The filtered solution that containing the activating agent is titrated with acid to precipitate silica powder.

The temperature at which the rice husk is carbonized is very very important since the surface area characteristic of the ash depends upon the temperature of formation of ash. The ash which is obtained as follows rice husk is cleaned up from dirt by sieving it with 20 mesh sieve. The rice husk ash obtained by this produces a lot of smoke if it is kept directly in the furnace. So in order to avoid this scenario, the husk is first charred or combust to black mass on a Bunsen burner. This mass is then heated and oxidized in an electric or normal furnace at controlled temperature to obtain the required ash. The ash now obtained is finely ground and sieved through a 150 mesh sieve. The fraction ha is passing through this sieve is then used for experimental procedure. The charred husk fraction is then further carbonized at 700°C for about 3 hours.

The activation of the RHA (rice husk ash) is done either by thermal or chemical activation. In the thermal activation (coal, lignite and coconut shell) process, raw material is carbonized to drive off the gases. A char with a high carbon content is obtained. This obtained char is then treated with air at 400 to 450°C or with the steam or with carbon dioxide (CO₂) in the temperature which ranges of 850 to 1000°C (figure 3.1.1). In activation step the oxidizing gas reacts with carbon atoms in the interior of char to form gaseous reactant products and develop the channels and pores that contributes to high internal surface area.

In chemical activation, dehydrating agents such as zinc chloride is used to chemically decompose cellulose of the raw material. The raw material is mixed with the chemical agent and soaked for known amount of time. It is then dried and carbonized in the absence of air. Obtained char is treated with alkali to form sodium silicate. Sodium silicate is treated with mineral acid and water to get precipitated silica. Filtrate is washed until pH is neutral.

Following are the sieving mesh sizes, composition of rice husk and the parameter employed in the procedure:

C. Rice Husk Gradation (Sieving)

Rice Husk is sieved using 20-200 mesh size sieves. The major fraction, which usually consists of 20 mesh size, is used for the experiment.

D. Composition Of Rice Husk Ash

SiO₂=80-90 %

Alumina=1-2.5%

Ferric oxide=0.5%

Trace elements=remaining

E. Carbonization Of Rice Husk

The rice husk obtained above in step 1 is first carbonized for 2 hours at and above 700°C. If the temperature is below 500°C, the rice husk is not carbonized completely.

F. Effect of Temperature

Below 500°C incomplete carbonization, at and above 700°C, nano-silica obtained.

G. Treating With Activating Agent

The carbonized rice husk is then treated with activating agents such as listed below at 0.2 N for a minimum time of 2 hours at 60°C. This makes the silica soluble in the activating agent and subjects the rice husk to have more surface area during the carbonization step mentioned below.

H. Types Of Activating Agents Used

Sodium hydroxide, phosphoric acid and Zinc chloride

1) Concentration: Sodium Hydroxide - 0.2 N

2) Length of Time: Minimum 2 hours

3) Temperature: Rice Husk on being treated with activating agent - 60°C

Temperature of carbonization – 500°C, 600°C, 650°C, 700°C

Concentration of sodium hydroxide – 5%, 10%, 15%, 20% (w/v)

Temperature of activation – 800°C, 850°C, 900°C

I. Precipitated Silica

The silica is precipitated by adding concentrated sulphuric acid to the filtered solution of Step 3 at room temperature. This yields very pure silica. The types of silica obtained depend on the carbonization temperature and the any pre-treatment before carbonization. The yield is between 95-98% of the amount of silica present in the initial rice husk.

- 1) *Acid Used:* Sulphuric acid
- 2) *Concentration Used:* Concentrated
- 3) *Temperature:* Room temperature
- 4) *Types of Silica Obtained:* Depends on carbonization temperature
- 5) *Purity:* Very pure silica can be obtained (Rice husk is burnt under controlled conditions gives amorphous silica of high purity)
- 6) *Size:* Nano-silica, powder, different grades of silica (small particle size)
- 7) *Yield:* 95-98 %
- 8) *Surface Area*
 - a) *Nature:* Amorphous powder
 - b) *Appearance:* White fluffy powder
 - c) *Purity:* > 98 %
 - d) *Surface Area:* 150 - 200 m²/gm
 - e) *Bulk density:* 120 - 200 g/litre
 - f) *Loss on Ignition:* 3.0 - 6.0 %
 - g) *pH of 5 % slurry:* 6.3 + 0.5
 - h) *Heat loss:* 4.0 - 7.0 % the properties like surface area, pH, Tap density can be tailor made for the requirement.

J. Activated Carbon

The activated rice husk which has been treated with sodium hydroxide in Step 2 and 3 is further carbonized at temperatures of 700 to 900 °C for 2 hours to obtain activated carbon of wastewater grade.

- 1) *Temp Effect:* 700-900 °C
- 2) *Duration/Time:* Minimum 2 hours
- 3) *Types/Grades of Carbon Obtained:* Mechanical grade and electronic grade
- 4) *Surface Area:* High surface area

K. Application

Activated carbon obtained by the above procedure can be used in wastewater treatment as an adsorbent to remove organics. Elemental silica is used as a constituent of building material. In amorphous form it is used as desiccant, adsorbent, refining agent filter, catalyst compound, etc.

V. RESULTS AND DISCUSSION

Although there are different procedures to obtain silica from rice husk, the most important step is to first treat the rice husk with acid treatment to remove any impurities such as metals that are present in the rice husk. The acid treatment also gives a high surface area for the silica when it is precipitated. The next important aspect of producing nano-silica powder depends on the carbonization temperature and duration of carbonization.



Figure 3.1.1



Figure 3.1.2



Figure 3.1.3

Figure 3.1.4



Figure 3.1.5

Figure3.1.6

- 1) FIGURE 3.1.1 & PICTURE 3.1.2: BURNING RICE HUSK SO TO FORM RICE HUSK ASH.
- 2) FIGURE 3.1.3: KEEPING RICE HUSK ASH FOR COOLING AFTER HEATING AND PROCESSING
- 3) FIGURE 3.1.4: AGAIN KEEPING IT FOR DRYING AFTER TREATING IT WITH SODIUM HYDROXIDE AT 60°C.
- 4) FIGURE 3.1.5: SOLID MASS OF ARHA FORMED AFTER COMPACTING IT.
- 5) FIGURE 3.1.6: DRYING SOLID ARHA MASS AFTER TAKING IT OUT OF THE MOULD.

Procedure To Filter Water From Activated Rice Husk ASH

A. Elements Used

- 1) An hollow cylinder =5 cm radius
- 2) ARHA = 1kg
- 3) Cotton cloth (to retain ARHA in cylinder)
- 4) Water = 5 l

B. Procedure

- 1) First we tie the cotton cloth in the bottom of hollow cylinder.
- 2) Fill ARHA to the thickness of 5 cm.
- 3) Pour 5l of water in cylinder.
- 4) Allow the water to filter from arha.
- 5) Note the retaining time.
- 6) Collect the filter water in a container and measure it.
- 7) Test the quality of water.

VI. RESULT

- A. Water retaining time = 4:30 min.
- B. Filtered water.
- C. Amount of filtered water = 4.9 l.



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