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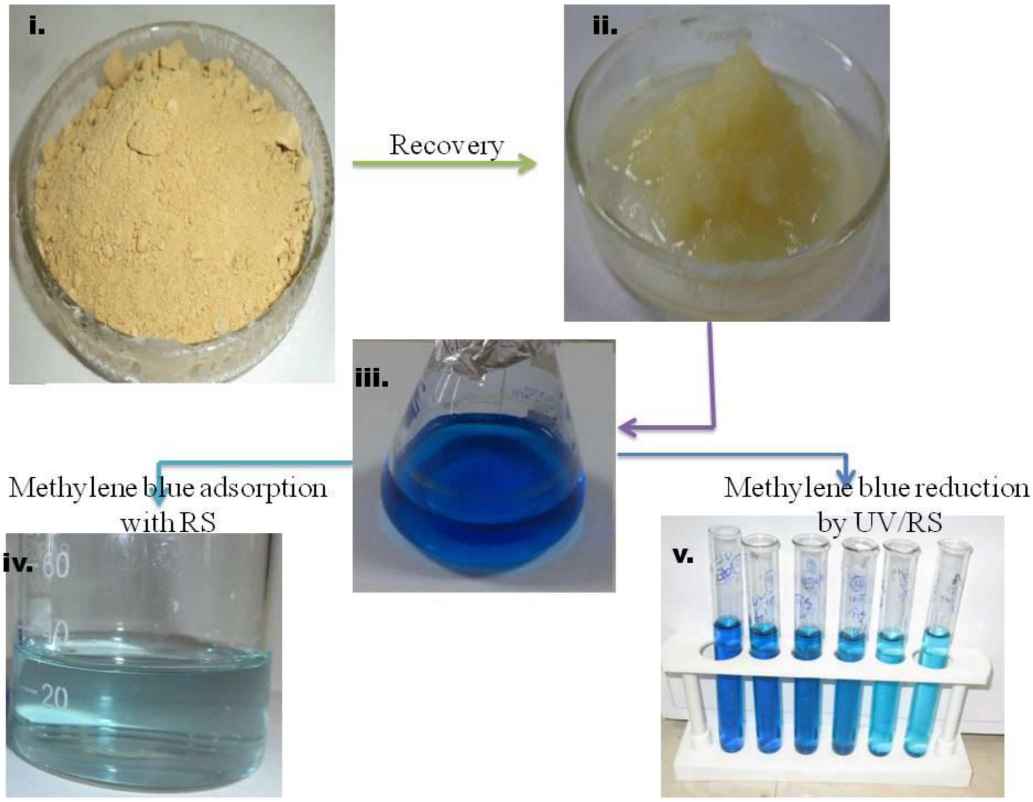
# Silica application for the dye removal from aqueous solution: Extracted from ETP sludge

Yamuna Rani. M[1], Bhagawan. D[1], Saritha Poodari[1], V.Himabindu[1], Venkateswara Reddy. V[2]

*1. Center for Environment, Institute of Science and Technology, Jawaharlal Nehru Technological University, Hyderabad 500 085, India*
*2. Department of Civil Engineering, College of Engineering, Jawaharlal Nehru Technological University, Hyderabad 500 085, India*




**Abstract:**
Increasing concerns about the environmental consequences of such disposal have led to investigations into possible utilization and recycling avenues. The present research includes a cost benefits process under optimized conditions for produce wealth out of waste. A simple method based on alkaline extraction followed by acid precipitation and acid dissolution has been used to produce pure amorphous silica from ETP sludge. About 64 % pure $SiO_2$ (RS) precipitation has been achieved. Systematic batch experiments with the heterocyclic aromatic chemical compound (Methylene blue) as sorbate and the recovered material $SiO_2$ (RS) as sorbent has been conducted with the aim of characterizing the sorption on charged surfaces, this characteristic is supported by Zeta potential measurement. Finally, the study demonstrates recovered $SiO_2$ can effectively utilize for the environmental remedial processes.

**Keywords:** Solid waste, Recovery, Silica, Methylene blue, Adsorption.

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## I. INTRODUCTION:

Amounts of industrial waste products have been increased in the forms of waste solvents and solids. This problem challenges to effective disposal methods (Bhagawan D et al. 2014). India playing an enormous role in pharmaceutical industry, where the heterogeneous waste generates and silica compound is one type of cake waste (Solomon shcherhan 1995).

The disposal of these industrial wastes in landfill sites has increasingly caused concern about possible adverse health effects for populations living nearby, particularly in relation to those sites where hazardous waste is dumped. Studies on the health effects of landfill sites have been carried out mainly in North America and existing reviews focus entirely on this literature (Idrisa Wazamtu 2013; Oxford 1990). Up-to-date knowledge about epidemiologic evidence for potential human health effects of landfill sites is important for those deciding on regulation of land fill sites, to respond the concerns from the public in a satisfactory way (Martine vrijheid 2000). The rose of the south intensified land-use conflicts revolving around "use value" (neighborhood interests) and "exchange value" (business interests). Government and business elites became primary players in affecting land-use decisions and growth potentialities (Oxford 1990). This urgent problem requires a solution in the beneficial way. The alternative solution for this problem is waste recovery, which is an effective strategy to avoid the fast drain of natural resources. This has been accepted at great importance in many countries (Solomon shcherhan 1995).

The silica material could be used for the capture of abundant $CO_2$, greenhouse gas, photo catalytic degradation and Energy production (Liu S. et al. 2010; Mohamed R M et al. 2012; Balachandran K et al. 2013; Venugopal A et al. 2007). However, such silica materials are mainly made from pure chemical sources, which have been in shortage due to large demands of silicon in semiconductor, photonic and solar cell industries etc., As well as the colloidal silicon dioxide is largely used in pharmaceutical, beauty and food products (powdering and tableting) and other industries. It is also used to stabilize emulsions and as a thixotropic agent, thickening and suspending gels and for semisolid preparation. In addition, it can be used as a disintegrating agent in tablets and as a dispersant for powders or suppositories (Ledesma E F et al. 2012). It is generally used at a concentration ranging from 0.5 to 25% of the finished product (Anon 1997). Coming to environmental concern silica is useful to bring the waste water free from pollutants (adsorption and photo remediation) (Ana P L Batista at al. 2008; Shaozheng Hu et al. 2012; Mohammad W Kadi1 and Mohamed R M 2013; Safa O zcan A et al. 2005).

Previously acid leaching and gasification methods have been investigated for recovering silica from waste materials. But the solubility of amorphous silica is very low at pH< 10 and increases sharply pH >10. This unique solubility behavior enables silica to be extracted in pure form from admixes by solubilizing under alkaline conditions and subsequently precipitating at a lower pH. This low energy method based on alkaline solubilization of amorphous silica could be more cost effective compared to the other method (Pouretedal H R and Kazemi M 2012).

Present work is a systematic study on recovery of the silica from the ETP sludge sample. This recovered silica is applied for environment remediation through adsorption and Photocatalytic remediation activities, where methylene blue is used as a pollutant. The recovered silica sample is characterized by varies methods for compositional evaluation.

## II. MATERIALS AND METHODS:

### 2.1 Materials:

Methyl blue purchased from S.D Fine Chemical Limited, NaOH provided by Merck, Glass distilled water is used for the entire study.

### 2.2. Extraction procedure:

Silica has been extracted from ETP sludge sample by adapting the method of Kamath and Proctor (1998). Accordingly 60 ml of 1N NaOH has added to the cake samples and boiled in covered 250 ml Erlenmeyer flasks for 1 h with constant stirring to dissolve the silica, which produce a sodium silicate solution. The solutions are filtered through Whatman No. 41 ash less filter paper, and the cake residues are washed with 100 ml of boiling water. The filtrates and washings are allowed to cool to room temperature and are titrated with 1N HCl with constant stirring to pH 7. Silica gels started to precipitate when the pH decreased to <10. The silica gels formed are aged for 18 h. Deionized water (100 ml) is added to gels and then the gels are broken to make slurry. This slurry has then centrifuged for 15 min at 2,500 rpm, the clear supernatants have discarded and the washing step is repeated. The gel has been transferred into a beaker and dried at 80$^{o}$C for 12 h to produce $SiO_2$. Silica sample has been ground and subjected to additional washing with water. All the samples have been stored in airtight plastic bottles. A flow diagram of the procedure is shown in Figure 1(Kalapathy U 2000).

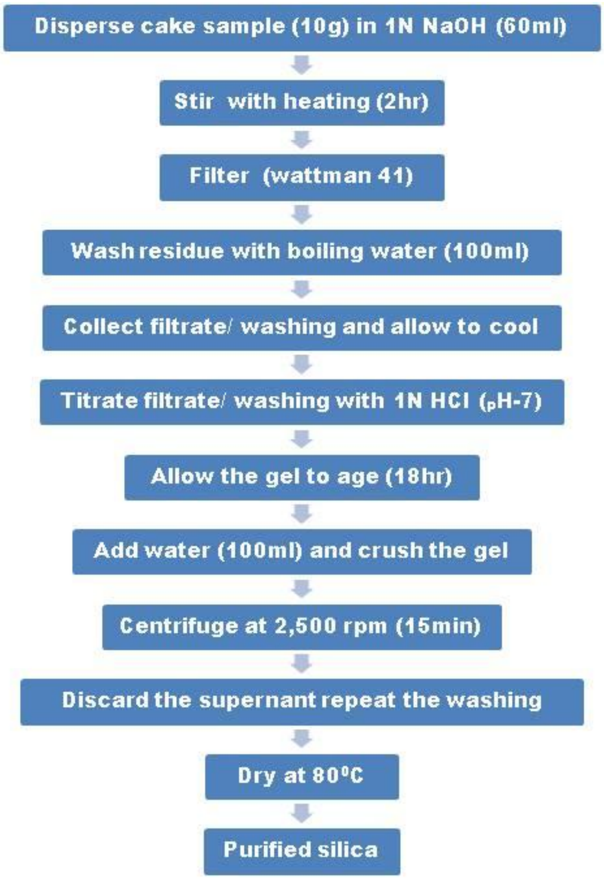


**Figure 1 Flow chart of procedure used for Silica extraction**

**2.3. Zeta Potential:** Horiba SZ Nanoparticle analyzer is used to analyze zeta potential of the RS sample.

**2.4. Preparation of MB solutions:** a monovalent cationic dye Methylene Blue (MB) is a model sorbate in the present study. It has a molecular formula $C_{16}H_{18}N_3ClS$ and molecular weight of 319.85. A stock solution of 1000 mg $L^{-1}$ has been prepared by dissolving an appropriate quantity of MB in a liter of deionized water. The working solutions has prepared by diluting the stock solution with deionized water to give the appropriate concentration of the working solutions.

**2.5. Adsorption studies:** The adsorption of MB on the RS has been investigated in a batch system. All adsorption experiments are conducted using 100 mL flasks, 50 mL of 15mg/l concentrated MB solution and weighted (1.2g/l) RS is used. This mixture is shaken in orbital shaker for 60min.

## III. RESULTS AND DISCUSSION:

The results of the present investigation has been represented and discussed in detail.

**3.1. Zeta potential analysis:** Zeta potential is the most widely used experimental approach to the study of charged surfaces is through the use of electrokinetic technique, which attracts a thin layer of ions of opposite charge. Besides having the advantage of being experimentally accessible, the zeta potential correlates with particle stability. Highly stable systems are characterized by high zeta potentials, whereas low zeta potentials indicate less stable systems. Similarly, deposition of particles on to surfaces is very often controlled by the zeta potential of particles and collectors. It is generally accepted that these potentials are useful parameters for prediction of colloid attachment kinetics within the framework based on Derjaguin, Landau, Verwey and Overbeek (DLVO) theory (Elimelech M et al. 2000).

The Zeta potential of the RS has been observed to be -17.8MV. This has been compared with different chemical compounds, which are readily available as adsorbents in the global market ($Al_2SO_4$, $Al_2O_3$, Activated carbon, Silica fume, Zeolite and Bentonite). The Zeta potential of these compounds ordered as $Al_2SO_4$ (-4.2MV) < RS (-17.8 MV) < Bentonite (-24.2 MV) < Activated carbon (-37.8MV) < Silica fume (-38.8MV) < $Al_2O_3$ (-40.8MV) < Zeolite (-61.2MV). The surface electrical conductivity of the solute particle is also a representative to adsorption capacity. In this study $SiO_2$ surface electrical conductivity has been observed (Table 2) to be more than other adsorbents. This might be due to the presence of the hydroxyl formation on the surface of the $SiO_2$, which plays a main role for adsorption (Jinkeun Kim and Desmond F Lawler 2005).

**3.2. RS for environment remediation application (Adsorption capacity evaluation of RS)**

The adsorption experiment has been carried at different intervals and finding of these experiments have been plotted in figure 2, it clearly indicated that the decrease in absorption peak. Removal of the MB has observed to be good till 60min and no more removal observed after 60min reaction time. It is the evidence that the recovered $SiO_2$ is good for adsorption of the dyes.

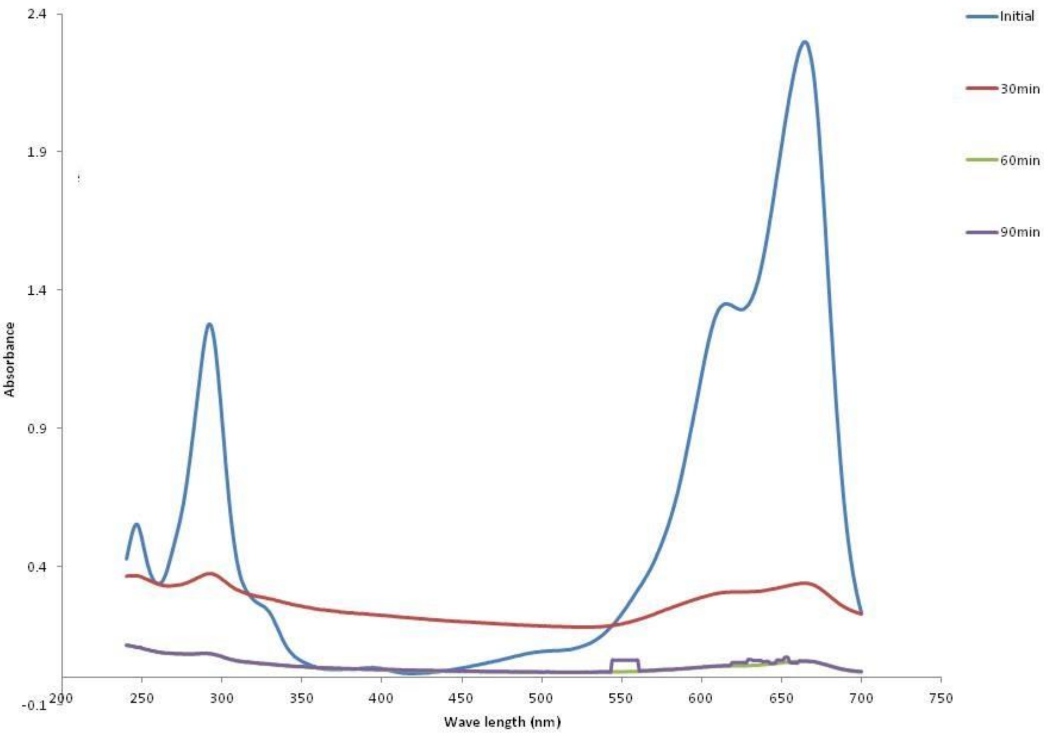


**Figure 2 RS for color removal**

## IV. CONCLUSION:

Silica successfully extracted from ETP Sludge, that is of 64%.

Extracted silica useful for the removal of color from wastewater sample.

ETP sludge may acts as a source for amorphous silica.

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