ENGINEERING SCIENCES AND TECHNOLOGY

ESTD No. 1

PURIFICATION OF CITRONELLAL FROM CITRONELLA OIL THROUGH PRECIPITATOIN AND DISSOLUTION

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Essential oils are widely used in soap and cosmetic production as perfumes, in food technology as flavorings, in medicine, and in rubber and paint industry as masking agent to hide objectionable odor.

In the Philippines, oils of peppermint, spearmint, lemon, pachouli, and eucalyptus are being exported. This study aimed to isolate and purify the citronella component of citronella oil through precipitation and dissolution.

Citronellal, an aldehdyde, was precipitated using sodium bisulfite by mixing 25 ml of citronella oil and 50 ml of concentrated sodium bisulfite. The precipitate formed was washed with 50 ml of hexane. After washing, the solid was allowed to dissolve in aqueous Na_2CO_3 and the oil obtained after separation was analyzed through gas chromatography-mass spectrometry.

Effects of Na_2CO_3 concentration and its temperature before dissolution were determined. Ratios of Na_2CO_3 (g) to water (ml) studied were: 5:75, 15:75, and 25:75, while temperatures of Na_2CO_3 used were 60°C, 70°C and 80°C.

Results showed that at a ratio of 5:75 the oil obtained contained 52.7% of citronellal and recovery was about 29%. Using 15:75 ratio, recovered oil has 61.3% citronellal and percent recovery of citronellal was calculated to be 50.6. While dissolving the precipitate in 25:75 ratio of Na_2CO_3 (g) to water (ml), obtained an oil with 64.8%citronellal and recovery was computed to be 69.21%.

At 60°C, the produced oil after dissolution contained 53.3% citronellal and recovery was equal to 34.4%. Sodium carbonate heated up to 70°C obtained

an oil with 53.8% citronellal and recovery was 47.25% citronellal. Heating aqueous Na_2CO_3 to 80°C before dissolution, recovered an oil with 64.8% citronellal and a recovery of 69.21%.

Increasing the concentration of Na_2CO_3 and the temperature of Na_2CO_3 before dissolution also increased the yield.

Keywords: citronellal, citronella oil, essential oils

ESTD No. 2

UTILIZATION OF RICE HULL ASH AND SOLSONA WHITE CLAY FOR THE MANUFACTURE OF CERAMIC WATER FILTERS

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Various types of filter elements ranging from organic materials, to metals and to ceramics are used to make water potable. Ceramics are preferred because these materials are inert, heat resistant, lightweight and porous. Its porosity can be designed to different sizes; hence, it can be used for various applications.

The use of locally available raw materials has been evaluated in the manufacture of ceramic filters. The materials were the following: calcined rice hull ash, which is highly siliceous and used as the primary raw material; beneficiated Solsona white clay, used to increase the plasticity and workability of the mixture; and coconut shell charcoal as a pore forming agent. The materials were mixed at different combinations. The formulations were pressed using a hydraulic press and dried in an oven for 110°C. The formed filters were fired at 1000°C to 1200°C.

Results of the evaluation indicate the filters have higher water absorption and lower apparent porosity (60.65 to64.89%) compared to diatoms and the commercial filters. The bulk density (0.55 to 0.56 g/cc) was also lower. These physical properties of the locally formulated filters are in accordance with the properties of a workable water filter. The utilization of indigenous local materials such as rice hull ash, Solsona white clay and charcoal were found to be promising for the manufacture of ceramic filters.

Keywords: ceramic, clay, coconut shell charcoal, filters, porous, rice hull ash, water.

ESTD No. 3

EFFECTS ON THE MICROSTRUCTURE OF COMMERCIAL BRICKS IN ILOCOS NORTE USING DIFFERENT FIRING METHODS

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A JSM-35C Scanning Electron Microscope was employed to determine the morphology of commercial structural clay bricks (SCB) in Ilocos Norte.

Bulk commercial SCB was prepared and formed using the existing traditional way of manufacturing process with clay sand composition ratio of 100% clay and 85%:15% clay sand ratio respectively.

The commercial SCB sample was fired inside the kiln in controlled temperature on set at 950°C. The same sample was fired but in an open field firing (Open firing). The effect on the microstructure of commercial SCB using different firing methods was evaluated.

Results show that the presence of open pores and microcracks at varying locations in the system are evident in an open field firing (open firing) at both 100% clay and 85%:15% clay-sand ratio. More compact, dense, uniform texture and even distribution of particles are evident in commercial SCB fired in controlled temperature at 950°C was both 100% and 85%:15% Clay Sand ratio.

Keywords: microstructure, commercial bricks, open firing, controlled temperature

ESTD No. 4

PHYSICAL ANALYSIS OF STRUCTURAL CLAY BRICKS IN ILOCOS NORTE

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Physical analysis of commercial clay bricks in Ilocos Norte from local manufacturer was conducted and compared to the standard set by the American Standard for Testing Materials (ASTM).

On-site and laboratory experiment were conducted and the results were compared. Both commercial, on site and laboratory experiment correlated with ASTM standards.

Results show that laboratory formulations passed the ASTM standard in terms of water of plasticity, drying shrinkage, firing shrinkage, apparent porosity, water absorption, modulus of rupture and compressive strength.

The correlation analysis of the chosen best body formulation against the standards for bricks set by the ASTM give positive remarks in all properties tested. Comparative analysis with the best body formulation and locally produced commercial structural clay bricks indicate that the chosen best laboratory formulation is more superior than the existing locally produced commercial clay bricks.

Keywords: structural clay bricks, physical analysis, ASTM standard for bricks

ESTD No. 5

PERFORMANCE AND EMISSION TESTING OF A PROTOTYPE C³ LOG BURNER HEATING APPLIANCE

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A prototype C³ (Caves Clean Combustion) woodburner was tested on the basis of burn rate, efficiency, power output and particulate emission based on the flue gas composition and airflow measurement. The procedure involves measurement of parameters: wood type and log size to test the sensitivity of the test method.

Results showed that hardwoods, eucalyptus gum, have a lower emission than softwoods with a solid particulate level of 0.046g/m³ compared to 0.059g/m³, 0.065g/m³, for radiata pine and larch. The efficiency of the burner does not vary with wood type. The irregular-shaped radiata pine produced 0.047g/m³ compared to the regular-shaped of 0.059g/m³. The unsteady state condition emission yielded 0.243g/m³.

The over-all efficiency of the C³ Log Burner is between 75-79% with emission ranging between 0.046 to 0.065g/m³ (0.206 to 0.700g/kg oven-dry wood) on a steady state condition. Based on the test method used, the C³ log Burner passes the 1.5g/kg limit producing an emission level 10 times lower than the limit set by the Canterbury Regional Council.

Keywords: woodburner, particulate emission, eucalyptus gum, Radiata pine, larch

ESTD No. 6

FORMULATION OF LEAD GLAZE USING LOCAL RAW MATERIAL FOR RED CLAY BODY

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Lead has a long history of being essential to many low maturing glazes. Its contribution to the formulation of good, acid resistant glaze is known.

The study was focused on the formulation of lead glaze utilizing locally available raw materials such as calcined rice hull ash, Solsona white clay with the addition of commercial oxide, to determine the suitability of the materials as alternative replacement for the imported glaze materials.

The lead glaze was based on the empirical formula:

$$\begin{matrix} 0.60\,PbO \\ 0.15\,K_2O\;0.20\,Al_2O_3 \\ 0.25\,CaO \end{matrix} \qquad 1.60\,SiO_2$$

and the body composed of 70% red clay (Baligat red clay in Batac, Ilocos Norte) combined with 30% sand dunes as filler were developed. Forming by slabbing, glaze application by dip method. The prepared lead glaze was fired (monofiring – body/glaze) at 1050°C.

Results show that all the formulated glaze specimens exhibit a transparent appearance especially formulation A. Some defects were evident in the test samples such as pinholes but for decorative and facing red tiles this are minors defects.

Keywords: slip glaze, local red clays, slabbing, lead glaze formulation, monofiring

ESTD No. 7

ADSORPTION OF DISPERSE MIKETON BLUE, REACTIVE PROCION BLUE AND BASIC BLUE GRL DYES FROM SYNTHETIC TEXTILE MILL EFFLUENT USING CHARRED AND ACTIVATED CARBON FROM RICE HULL

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Rice hull is a potential material for activated carbon. Rice hull, the covering structure of the rice grain, constitutes about 18 to 28% of the rough rice weight.

The general objective of the study was to compare the percent dye removal of rice hull, in its charred and activated form.

The experiment investigated the kinetics of adsorption and adsorption isotherms of Disperse Miketon Blue (DMB), Reactive Procion Blue (RPB) and Basic Blue GRL (BB) on charred and activated carbon (AC) from rice hulls. The adsorptive capacity of charred and AC from rice hulls was also determined. Results revealed that the order of adsorption using charred and activated carbon (at 800°C) from rice hull for DMB, RPB and BB were 1.14, 0.93, 1.40, 2.10, 2.33 and 2.37 respectively. The adsorptive capacity of charred and AC as adsorbent for DMB, RPB and BB were 141.71, 117.33, 128.25, 273.14, 246.67, and 145.01 mg/g, respectively. The adsorption isotherm of the dyes fitted the Freundlich isotherm model.

Statistical analysis using analysis of variance (ANOVA) showed that adsorptive capacity and percent of removal of the three dyes on charred and activated carbon was significant at 5 % level of confidence.

Keywords: rice hull, adsorptive capacity, adsorption kinetics, adsorption isotherms, activated charcoal

ESTD No. 8

ENTHALPY, ENTROPY AND GIBBS' FREE ENERGY OF THE ADSORPTION OF BASIC DYES FROM SYNTHETIC TEXTILE WASTEWATER USING SUGARCANE BAGASSE PITH AS ADSORBENT

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Present technology uses activated carbon as adsorbent for the removal of color, taste, odor and many other organic contaminants, specifically those that are biologically resistant. Others use agricultural wastes as adsorbents. Sugarcane bagasse is a potential adsorbent for color removal. Generally, bagasse is used as fuel in sugar factories, Depithing bagasse is a good practice of separating pith (a good adsorbent) from about 5.5 million tons bagasse produced annually by the sugar industry.

The general objective of this study was to determine the enthalpy, entropy and Gibbs' free energy on the adsorption of basic dyes from synthetic textile wastewater using sugarcane bagasse pith as adsorbent.

The ability of sugarcane bagasse pith to adsorb basic dyes, namely Basic Rhodamine Blue (RBR), Basic Auranine Orange (BAO) and Basic Malachite Green (BMG) from synthetic textile wastewater was investigated.

The kinetic parameters for the three dyes were determined. For Basic Rhodamine Blue Dye, the adsorption was of 4.81^{th}, 4.82^{th}, 4.90^{th}, and 4.83^{th} order for room temperature, 40°C, 50°C and 60°C, respectively. For Basic Auramine Orange Dye, the adsorption was of 5.45^{th}, 5.40^{th}, 5.53^{th}, and 5.25^{th} order for room temperature, 40°C, 50°C and 60°C, respectively. Finally, for Basic Malachite Green Dye, the adsorption was of 5.50^{th}, 5.52^{th}, 5.60^{th}, and 5.70^{th} order for room temperature, 40°C, 50°C and 60°C, respectively.

The eight-hour concentration-decay curves of each dye at different temperatures show that elevated temperatures increased the overall rate of adsorption of dyes onto an adsorbent.

The eight-hour adsorption isotherms of each dye at different

temperatures were constructed. The adsorption isotherms of the three dyes were of the Langmuir Class. For Basic Rhodamine Blue Dye, it was of Type L-2. For Basic Auramine Orange and Basic Malachite Green Dye, it was of Type L-4.

The eight-hour maximum adsorptive capacities of bagasse pith for the three dyes at different temperatures were determined. The eight-hour maximum adsorptive capacities of bagasse for the three dyes increase with an increase in temperature.

The affinity of dyes onto an adsorbent can be described using the three thermodynamic properties computed. The higher the isosteric heat of adsorption, the higher the entropy of adsorption, the lower the Gibbs' free energy, the higher is the affinity of the dye onto the adsorbent.

Keywords: bagasse, adsorbent, dyes, adsorption isotherms

ESTD No. 9

FLOCCULATION OF COPPER (II) FROM WASTEWATER BY *Rhizobium* sp. EXOPOLYSACCHARIDE (EPS) BIOPOLYMER

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Biopolymers such as exopolysaccharides (EPS), exhibit heavy metal-binding property and are becoming an interesting option for the sequestration of heavy metal in wastewater treatment. Aside from the low cost of production, exopolysaccharides produced by microorganisms are considered more environmental friendly than their synthetic polyelectrolyte counterpart.

In this work, the potential of *Rhizobium sp.* (BJVR-12) exopolysaccharide (EPS) in combination with cationic polyelectrolytes such as polyethyleneimine (PEI) and chitosan (CHI) to flocculate cupric ions from aqueous solutions was investigated. Qualitative evaluation of the process revealed that the presence of any of the cationic polyelectolytes enhanced the flocculation of EPS-heavy metal

complex. Results showed that heavy metal removal was influenced by the EPS-polycation ratio, pH, and type of the polycation used. The optimum [EPS]/[polycation] ratios were both 15 for PEI and chitosan respectively. At optimum ratio, residual EPS and cationic polymers of the filtrate was found minimum. Also, at optimum [EPS]/[polycation] ratio, the Cu^{2+} removal was found to increase as the EPS concentration increased. The EPS-PEI flocculant system was found effective at a wide range of pH for so that even at a solution pH of 2, more than 50 % Cu^{2+} removal was achieved. EPS-Chitosan flocculant system was found effective at above pH 4. Both systems were able to reduce Cu^{2+} concentration of synthetic Cu^{2+} solutions to effluent standard.

Copper (II) removal by EPS–PEI flocculant system from a semiconductor company wastewater was further studied. The optimum EPS/PEI mass ratio for such wastewater was found to be 26.67. Under this condition, clear filtrates and readily separable flocs were obtained. The Cu^{2+} concentration of the treated wastewater was also reduced beyond regulatory standards. A capacity of around 31.120 mg Cu/ g EPS-PEI was achieved.

Keywords: Copper(II); exopolysaccharide (EPS); flocculation; polyelectrolyte; wastewater treatment

ESTD No. 10

DESIGN AND DEVELOPMENT OF CROP GATHERING ATTACHMENT TO PHILRICE-JICA ROTARY REAPER

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Mechanically reaped and windrowed crop still requires 8 persons to gather in a day. To further increase mechanical reaping efficiency, a crop gathering device was conceptualized as an attachment to a commercial rotary reaper.

Three different designs, namely: 1) a vertical gatherer, 2) a horizontal collector with scraper, and 3) a rake-type gatherer were fabricated and tested. The rake-type gatherer was found to perform better and was simpler in construction and could be easily attached to and detached from the reaper. It consisted of three