



UTM
UNIVERSITI TEKNOLOGI MALAYSIA



PROCEEDING BOOK

3rd International Science Postgraduate Conference 2015

**Steering Innovation, Serving Society in
Achieving Global Excellence Towards Science and Technology**

24-26 FEBRUARY 2015
Synergy . Innovation . Excellence

Ibnu Sina Institute for Fundamental Science Studies,
Universiti Teknologi Malaysia,
81310 UTM Johor Bahru, Johor

innovative • entrepreneurial • global

3rd INTERNATIONAL SCIENCE POSTGRADUATE CONFERENCE 2015
(ISPC 2015)

CONFERENCE PROCEEDING

24 – 26 FEBRUARY 2015

UNIVERSITI TEKNOLOGI MALAYSIA

Edited by

Postgraduate Student Society Faculty of Science (PGSSFS)

ISBN: 978-967-0194-51-6

Organised by

**Postgraduate Student Society Faculty of Science,
Faculty of Science**

In collaboration with

**School of Graduate Studies
UNIVERSITI TEKNOLOGI MALAYSIA**

Website: www.utm.my/ispc2015/

EDITORIAL BOARD

PROF. DR. WAN AINI WAN IBRAHIM
ASSOC. PROF. DR. ZAINAB RAMLI
ASSOC. PROF. DR. NOR'AINI ARIS
ASSOC. PROF. DR. YUSOF MUNAJAT
SITI AFIQAH MOHAMMAD
MOHAMAD AFIQ MOHAMED HURI
SITI MUNIRAH ABD WAHIB
NOR FAZILAH MUHAMAD
MUHAMMAD AZRIN BIN AHMAD
NOR ATHIRAH MOHD ZIN
WONG SZE TING
NOR AFIFAH HANIM ZULKEFLI
ADNIN AFIFI BINTI NAWI

TABLE OF CONTENTS

| CODE | TITLES | PAGES |
|------|---|-----------|
| KO05 | Synthesis, Characterization and Antibacterial Activity of Hystatin Derivatives <i>Muhamad Fadzli Abd Razak, Asnuzilawati Asari, Ahmad Sazali Hamzah and Siti Nor Khadijah Addis</i> | 1 – 11 |
| KO06 | Synthesis, Characterization and Catalytic Application of Lanthanum Modified Mcm-41 in Henry Reaction: Investigation on Temperature Effect <i>Kamelia Karimnezhad, Hamid Kazemi Esfeh and Salasiah Endud</i> | 12 – 23 |
| KO08 | Comparison Pesticide Residue Levels in The Surface Water of Bertan River in Cameron Highlands, Pahang <i>Siti Humaira Haron, Ismail B. S.</i> | 24 – 34 |
| KO14 | Adsorption of Copper (II) onto Activated Carbon Prepared From Dessicated Coconut Residue <i>Nurul Izzah Mansor And C.W. Zanariah C.W. Ngah</i> | 35 – 45 |
| KO18 | Characterization of Getso Kaolin And Evaluation of Its Industrial Potentials <i>Abdu Muhammad Bello, Abdul Rahim Yacob and Kamaluddeen Suleiman Kabo</i> | 46 – 55 |
| KO20 | Synthesis and Characterization of Eugenol Derivatives <i>Nurul Hazwani Che Abdul Rahim, Asnuzilawati Asari, Noraznawati Ismail, Hasnah Osman and Fatin Nur Ain Abdul Rashid</i> | 56 – 65 |
| KO22 | Corrosion Inhibition of Crude Extracts of <i>Alpinia Galanga</i> on Mild Steel in Acidic Medium <i>Sunday Osinkolu Ajeigbe, Madzlan Aziz, Farediah Ahmad and Norazah Basar</i> | 66 – 75 |
| KO25 | Sudanese Modified Clays for Catalytic Heterogeneous Transesterification of Castor Oil <i>Ahmed Mahgoub Saied Mohmedahmed and Abdul Rahim Yacob</i> | 76 – 91 |
| KO26 | Gelatin-Alginate Coated Cellulose Acetate Membrane for The Extraction of Heavy Metal Ions From Water Samples <i>Eviomitta Rizki Amanda, Mohd Marsin Sanagi, Wan Aini Wan Ibrahim and Yanuardi Raharjo</i> | 92 – 101 |
| KO30 | Solid Phase Extraction of Organophosphorus Pesticides Using Sorbent Material Based on Sol-Gel Cyanopropyltriethoxysilane <i>Zahra Soutoudehnia Korrani, Wan Aini Wan Ibrahim, Abdolhamid Alizadeh and Mohd Marsin Sanagi</i> | 102 – 107 |
| KO33 | Natural Radioactivity From Non-Nuclear Power Generation Industries: Regulatory Control of Naturally Occurring Radioactive Material (NORM) for Environmental Sustainability. | 108 - 118 |

| | | |
|------|--|-----------|
| KO36 | Comparison of Different Methods on The Extraction of Moringa Oleifera Leaves <i>Mohd Amzar Mohamed Zahari and Liza Md Salleh</i> | 119 – 132 |
| KP03 | Preparation and Characterization of Phosphate Glass Potentially as A Controlled Release Glass <i>Siti Hafizah Mohamad and Mohd Al Amin Muhamad Nor</i> | 133 – 142 |
| KP06 | Limestone as Material to Reduce Sulphate and Arsenic Content in Acid Mine Drainage <i>Anuar Othman, Azli Sulaiman and Shamsul Kamal Sulaiman</i> | 143 – 152 |
| KP07 | Preparation of Precipitated Calcium Carbonate Using Sorbitol ss Additive <i>Anuar Othman, Nasharuddin Isa and Rohaya Othman</i> | 153 – 162 |
| KP08 | The Development of Microemulsion System as Sunscreen Based on <i>Melaleuca Cajuputi</i> Extract <i>Muhammad Hanif Sainorudin, Mohd Zul Helmi Rozaini, Habibah Hamzah, Ainatul Azilah Mohamad Saupi, Nurfaezatil Farhana Norazemi, Zalikha Ismail, Jenny Sin Poh Ying and Mohd Hussin Zain</i> | 163 – 173 |
| KP09 | Phytochemical Constituents and Antioxidant Activity of The Stem Bark of <i>Garcinia Parvifolia</i> Miq <i>Muhammad Aizam Hassan, Norazah Basar and Farediah Ahmad</i> | 174 – 180 |
| MO01 | One Dimensional Advection Diffusion of River Pollution in Semi Infinite Media. (Problem 1: Fast and Slow Flow) Using Inverse Laplace Transforms <i>Ahmad Zaki Mohamad Amin and Shamsuddin Ahmad</i> | 181 – 187 |
| MO06 | Classification of Infectious Diseases Via Hybrid <i>K</i> -Means Clustering Technique <i>Dauda Usman and Ismail Bin Mohamad</i> | 188– 196 |
| MO07 | Improving the Performance of <i>K</i> -Means Cluster Analysis Via Singular Value Decomposition <i>Dauda Usman and Nuraddeen Sayyadi</i> | 197 – 207 |
| MO09 | Transient Analysis of M/M/1 Queuing Theory: An Overview <i>Tan Yu Ting, Zaitul Marlizawati Zainuddin and Badrisyah Idris</i> | 208 – 217 |
| MO10 | Procedures for Estimating the Population Total in Unequal Probability Sampling Designs <i>Ibrahim Elabid and Zuhaimy Ismail</i> | 218 – 228 |
| MO11 | Singular Spectrum Analysis for Forecasting of Malaysian Gold Price <i>Norhafizah Yusof and Ani Shabri</i> | 229 – 235 |

| | | |
|------|---|-----------|
| MO13 | A Numerical Simulation of Blood Flow Through Arterial Stenosis with Hall Current Effect <i>Nik Nabilah Nik Mohd Naser and Ilyani Abdullah</i> | 236 – 247 |
| MO23 | Unsteady Flow of a Second Grade Fluid Between Two Oscillating Vertical <i>Aiza Gul, Arshad Khan, Taza Gul, Ilyas Khan, Saeed Islam and Sharidan Shafie</i> | 248 – 263 |
| MO30 | An Integral Equation for Conformal Mapping of Multiply Connected Regions onto a Circular Region <i>Ummu Tasnim Husin and Ali Hassan Mohamed Murid</i> | 264 – 273 |
| MO34 | On Some Abelian p -Groups and Their Capability <i>Rosita Zainal, Nor Muhainiah Mohd Ali, Nor Haniza Sarmin and Samad Rashid</i> | 274 – 281 |
| MO35 | Improved Performance of Mcusum Control Chart with Autocorrelation <i>Abbas Umar Farouk and Ismail Bin Mohamad</i> | 282 – 290 |
| MO36 | Multivariate Process Variability Monitoring For General Sampling Design <i>Revathi Sagadavan, Maman Abdurachman Djauhari and Ismail Mohamad</i> | 291 – 300 |
| MP03 | Concentration Profile of Spherical Drops in Rotating Disc Contactor (Rdc) Column Using Finite Difference Method (Fdm) <i>Nurul Nadiya Binti Abu Hassan and Jamalludin Talib</i> | 301 – 310 |
| LO02 | Strength Properties of Polymer Self-Healing Mortars <i>Ghasan Fahim, Nur Farhayu Binti Ariffin and Mohd Warid Hussin</i> | 311 – 319 |
| LO03 | Microstructure and Mechanical Properties of Aluminum- Silicon Carbide Composite Fabricated By Powder Metallurgy <i>Mustafa Khaleel Ibrahim and Jamaliah Idris</i> | 320 – 326 |
| LO04 | Isolation and Identification of Surfactin Producer From Local Isolates Of <i>Bacillus subtilis</i> <i>Nurul 'Awatif Ahmad, Mohd Hafez Mohd Isa and Najeeb Kaid Al-Shorgani</i> | 327 – 337 |
| LO05 | Optical Remote Sensing and Geographic Information System Approach for Water Quality Modelling in Marsh Zones <i>Hashim Ali Hasab, Anuar Bin Ahmad, Maged Marghny and Abdul Razzak Ziboon</i> | 337 – 347 |
| LO07 | Photocatalytic Inactivation of <i>Escherichia Coli</i> : Effect Of TiO_2 Concentration In A Suspended Uv/ TiO_2 Reactor <i>Mojtaba Khani, Nor Aishah Saidina Amin, Seyed Nezamedin Hosseini and Mahshid Heidarrezaei</i> | 348 – 354 |
| LO08 | Degradation of Dichloroacetic Acid Using Marine Bacteria <i>Mahshid Heidarrezaei, Nor Aishah Saidina Amin, Fahrul Zaman Huyop and Mojtaba Khani</i> | 355 – 361 |

| | | |
|------|--|-----------|
| LO19 | The Influence of Particle Size Distribution in Urban Environmental Pollution <i>Mahadi Lawan Yakubu, and Zulkifli Yusop</i> | 362 – 372 |
| LO20 | Environmental Risk Assessment and Management: A Review <i>Adilah Abdul Kadir, Zulkifli Yusop, Noor Bakhiah Baharim, Zainura Zainon Noor and Noor Ai'han Mujar</i> | 373 – 382 |
| LO22 | Energy Efficient Distillation Columns Sequence for Hydrocarbon Mixtures Fractionation Process <i>Mohamad Firdaus Azizan, Mohd. Faris Mustafa, Norazana Ibrahim, Kamarul Asri Ibrahim and Mohd. Kamaruddin Abd. Hamid</i> | 383 – 390 |
| LO23 | Controversial Development for Shiraz City, a City in Iran <i>Iraj Karimi, Baba Adams Ndalai And</i> | 391 – 400 |
| LO28 | Lecturers Instructional on Problems-Based Learning and The Relational with Critical Thinking and Generic Skills <i>Ainun Rafieza Binti Ahmad Tajuddin, Shafarizan Binti Abd Samad and Abd Razak Bin Hashim</i> | 401 – 408 |
| LP01 | Pembudayaan Teknologi dalam Kalangan Guru <i>Haiza Atmareni Harmenidan and Zolkepli Haron</i> | 409 – 418 |
| LP03 | Hybrid Filter-Wrapper Feature Selection Methods for Detecting New Malware Variants <i>Bushra M. Ali, Haitham A. Jamil, Sulaiman M. Nor and Ismahani Ismail</i> | 419 – 429 |
| FO05 | Assessment Of Natural Radionuclides In Rivers Of Pahang State Malaysia <i>Gabdo H.T, Ramli A.T, Garba N.N, Saleh M.A and Sanusi M.S</i> | 430 – 440 |
| FO06 | Natural Environmental Radioactivity In The Soil Of Terengganu State, Malaysia <i>Nuraddeen Nasiru Garba, Ahmad Termizi Ramli, Muneer Aziz Saleh, Hamman Tukur Gabdo, Mohd Syazwan Bin Mohd Sanusi and Abubakar Sadiq Aliyu</i> | 441 – 450 |
| FO08 | A Detecting Unit For A Visible Optical Time Domain Reflectometer <i>Hannis Sazwani Abdul Wahid and Yusof Munajat</i> | 451 – 460 |
| FO10 | Assessment Of Natural Radionuclides At Kinta River, Malaysia: Relationship Between The Turbidity To Uranium And Thorium Concentrations <i>Siti Syafika Selamat, Ahmad Termizi Ramli, Arien Heryansyah and Muneer Aziz Saleh</i> | 461 – 470 |
| FO16 | Ground State Energy, Electronic And Chemical Properties Prediction Of Acenes Derivatives For Organic Electronic: A Dft Insight <i>Auwalu Musa, Mohammad Alam Saeed and Amiruddin Bn Shaair</i> | 471 – 482 |

| | | |
|------|--|-----------|
| FO21 | Silver Nanoparticles Assisted Spectral Features Enhancement Of Samarium-Zinc-Tellurite Glass <i>M.S.Affendy, S.K.Ghoshal, M.R. Sahar and A. Awang</i> | 483 – 489 |
| FO22 | Optimization Of Thermoluminescence Response Of Copper Doped Zinc Lithium Borate Glass Co-Doped With Na ₂ O <i>A. Saidu, H. Wagiran, M. A. Saeed, Y. S. M. Alajeram, H. K. Obayes, A.B.A. Kadir</i> | 490 – 500 |
| FO24 | Spectral Characteristics Of Antimony-Phosphate Glass <i>Soham Younis, M.R. Sahar and S.K. Ghoshal</i> | 501 – 510 |
| FP04 | Nanosecond Pulse Generator Using High Speed Comparator <i>Amirul Ridhwan Bin Sazali, Hazri Bin Bakhtiar and Irosly Abdul Rahman</i> | 511 – 518 |
| FP05 | ²²² Rn Concentration In Bottle (Mineral) Water Sold In Abu, Zaria - Nigeria <i>Nuraddeen Nasiru Garba, Nasiru Rabiu, Bala Bello Muhammad Dewu, Sadiq Umar, Aminu Ismaila, Aminu Saidu</i> | 519 – 526 |
| FP09 | Impact Of Europium Concentration On Thermal And Absorption Features Of Amorphous Tellurite Media <i>Khaidzir Hamzah, Ahmad Farhan Suffian, Sib Krishna Ghoshal</i> | 527 – 533 |

LIMESTONE AS MATERIAL TO REDUCE SULPHATE AND ARSENIC CONTENT IN ACID MINE DRAINAGE

^{1,2}ANUAR OTHMAN, ^{1,2}*AZLI SULAIMAN AND ²SHAMSUL KAMAL SULAIMAN

¹Department of Chemistry, Faculty of Science, Universiti Teknologi Malaysia,
81310, UTM Johor Bahru, Johor Darul Ta'azim, Malaysia

²Mineral Research Centre, Minerals and Geoscience Department Malaysia,
31400 Ipoh, Perak Darul , Malaysia

¹azli@kimia.fs.utm.my, ^{1,2}anuar@jmg.gov.my, ²shamsul@jmg.gov.my

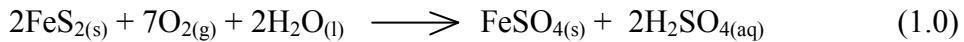
*Corresponding author

Abstract. In this paper, limestone was used to reduce sulphate and arsenic content in acid mine drainage (AMD). The sample of acid mine drainage was collected from tailing tin mine pond located in Perak. The sulphate content in acid mine drainage was analysed before and after treatment with limestone by using DR 2800 spectrophotometer. ICP-OES was used to analyse water sample before and after treatment for arsenic content analysis. pH multi parameter was used to determine pH value, oxidation reduction potential and electrical conductivity (EC) of water sample before and after treatment. Limestone used was collected from a quarry in Simpang Pulai, Ipoh. The size of limestone used was less than 2 mm. The experiment was carried out by using experimental column. After treatment with limestone the result showed that the pH value increased from 2.4 to 6.5, whilst sulphate and arsenic content decreased. The best parameter was 500 g limestone with 75 minutes retention time.

Keywords Limestone; sulphate; arsenic; acid mine drainage; experimental column

1.0 INTRODUCTION

Acid mine drainage (AMD) is caused when sulphide minerals had exposed to oxygen and water [1] and assisted by sulphate oxidising bacteria (SOB). Acid mine drainage can be categorized as low pH and high concentration of toxic elements such as arsenic, copper, cadmium etc. The reaction is shown in equation 1.0:



Limestone rock is a sedimentary deposition of calcium carbonate caused by combination of dissolved calcium ions and carbon dioxide. Limestone deposits cover about 10% on the land surface of earth and can be found around the world [2] especially in Malaysia. Limestone is a versatile material that can be used in many fields such as in construction, agricultural, environmental, and industrial material.

Chemical property of limestone gives pH values in water between 8.0 and 9.0 [2] and is suitable to be used in acid mine drainage treatment despite encrustation by iron and aluminium hydroxides [3]. A major anion, sulphate that present in natural waters and industrial effluents either in acid mine drainage or neutral mine drainage can be adsorbed by limestone because calcium ion on the solid surface can bind anion [4]. Sulphate is only mildly hazardous anion compared to other toxic elements [4] such as arsenic, cadmium, copper etc. However, sulphate can cause laxative effect and can affect the taste of water at concentration above 600 mg/L. Therefore, certain countries especially WHO and Europe countries have set maximum values of sulphate content in mine drainages and industrial effluents around 250 mg/L to 500 mg/L [4]. The reaction between limestone and sulphuric acid is shown in equation 1.1.



Another toxic element that present in acid mine drainage is arsenic. Arsenic is an element with a name derived from the Greek word known *arsenikon* meaning potent [4]. The arsenic presents in an environment with different oxidation states such as As (V), As (III), As (0) and As (-III). Arsenic is very difficult to vanish

and it can only be transformed into insoluble compounds combined with other elements especially iron [5]. Arsenite, As (III) and arsenate, As (V) are the most toxic compounds compared to other arsenic oxidation states and both are the most abundance in water [6].

Other parameters studied besides pH were ORP and EC. Oxidation reduction potential (ORP) is a measure of the water cleanliness and an indicator the level of breakdown contaminants. Acidic water has positive ORP and alkaline water has negative ORP and is an antioxidant. Electrical conductivity (EC) is a measurement to determine the capability of water to pass electrical flow and its related to concentration of ions in water. These conductive ions exist from dissolved salts and non organic materials such as alkalis, sulphides, chlorides and carbonate compounds.

2.0 EXPERIMENTAL

2.1 Materials

The materials used in this study were limestone from quarry in Simpang Pulai, Ipoh and water sample from a tin mine pond tailing in Perak.

2.2 Method

2.2.1 Sampling

50 kg limestone was collected from a quarry in Simpang Pulai, Ipoh. Limestone was dried in a tray before sieving by using 2 mm sieve size. After sieving with 2 mm sieve the size of limestone less than 2 mm was used for acid mine drainage treatment.

Water samples from tailing pond of an active tin mine located in Perak were collected. In situ pH, ORP, EC and temperature values were recorded from this pond. pH values recorded were less than 4. The water samples were kept in 15

L jerry can and another two 2 L bottles samples were preserved in ice box before brought back to laboratory. The pond is a detention reservoir which is the overflow water from retention pond. The water of this pond was pumped from the nearest river and the discharge water from the tin processing plant.

2.2.2 Experimental Column

The experiments were carried out using experimental column as shown in Figure 2.0.

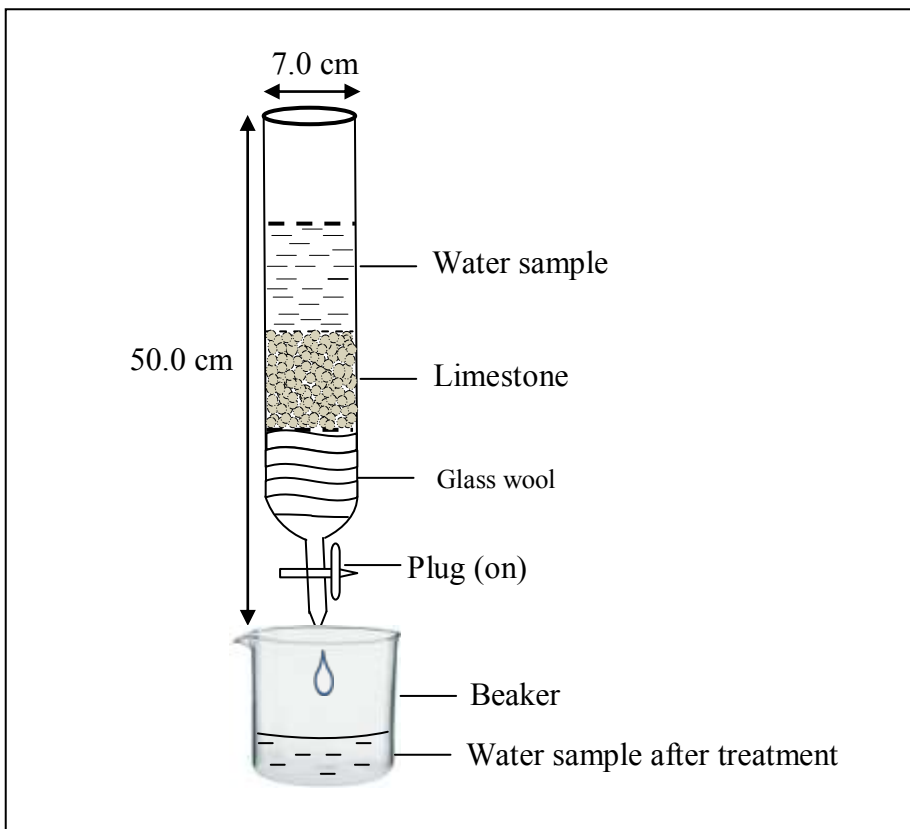


Figure 2.0: Experimental column

10 g glass wool was packed into the column. The limestone with size less than 2 mm and different weights 200 g, 300 g and 500 g were packed into the column one at a time. 500 ml water sampel was poured into the column. The retention times used for every weight of limestone were 15 minutes, 30 minutes, 45 minutes, 60 minutes and 75 minutes. pH, ORP and EC values of water sample before and after treatment were recorded. The experiment was carried out at room temperature. Water sample was analysed before and after treatment to detect sulphate and arsenic.

2.2.3 Instrumentations

ICP-OES (Optima 5300 DV, Perkin Elmer, USA) was used to detect arsenic, Portable spectrophotometer (DR2800, Hach, USA) was used to detect sulphate content in water samples and Portable multi parameter meter (A329, Thermo Scientific, Indonesia).

3.0 RESULTS AND DISCUSSION

Table 3.0 shows the values in situ parameters of pH, EC, ORP and temperature in the studied pond. The results showed that the values of pH, EC and ORP were 2.48, 699.2 $\mu\text{s}/\text{cm}$ and 681.8 mV respectively. The pH value 2.4 indicated that the AMD problem occurred in this pond because any pH value around 2 to 4 can be assumed as AMD problem [7].

Table 3.0: In situ reading of pH, EC and ORP.

| pH | | | | EC ($\mu\text{s}/\text{cm}$) | | | | ORP (mV) | | | | Temperature ($^{\circ}\text{C}$) | | | |
|------|------|------|------|--------------------------------|------|------|------|----------|-------|-------|-------|------------------------------------|------|------|------|
| 1 | 2 | 3 | mean | 1 | 2 | 3 | mean | 1 | 2 | 3 | mean | 1 | 2 | 3 | mean |
| 2.49 | 2.47 | 2.48 | 2.48 | 2425 | 2338 | 2399 | 2387 | 699.2 | 696.9 | 649.4 | 681.8 | 36.1 | 36.1 | 36.1 | 36.1 |

Table 3.1, Table 3.2 and Table 3.3 show the result of experimental column carried out by using different weights of limestone 200 g, 300 g and 500 g respectively. The size of limestone used in this study was less than 2 mm and

retention times used in this study were 15 minutes, 30 minutes, 45 minutes, 60 minutes and 75 minutes.

Table 3.1(a): Reading of pH value

| Retention Time (min) | Weight of Limestone (g) | Before | | | | After | | | |
|----------------------|-------------------------|--------|------|------|------|-------|------|------|------|
| | | pH | | | | pH | | | |
| | | 1 | 2 | 3 | Mean | 1 | 2 | 3 | Mean |
| 15 | 200 | 2.56 | 2.56 | 2.55 | 2.56 | 5.94 | 5.95 | 5.95 | 5.95 |
| 30 | 200 | 2.58 | 2.60 | 2.58 | 2.59 | 5.93 | 5.91 | 5.91 | 5.92 |
| 45 | 200 | 2.56 | 2.55 | 2.54 | 2.55 | 6.00 | 6.01 | 6.02 | 6.01 |
| 60 | 200 | 2.58 | 2.59 | 2.60 | 2.59 | 6.08 | 6.08 | 6.09 | 6.08 |
| 75 | 200 | 2.57 | 2.56 | 2.55 | 2.56 | 5.80 | 5.79 | 5.81 | 5.80 |

Table 3.1(b): Reading of EC value

| Retention Time (min) | Weight of Limestone (g) | Before | | | | After | | | |
|----------------------|-------------------------|-------------------------|------|------|------|-------------------------|------|------|------|
| | | EC ($\mu\text{s/cm}$) | | | | EC ($\mu\text{s/cm}$) | | | |
| | | 1 | 2 | 3 | Mean | 1 | 2 | 3 | Mean |
| 15 | 200 | 2684 | 2682 | 2679 | 2682 | 2449 | 2451 | 2452 | 2451 |
| 30 | 200 | 2707 | 2708 | 2709 | 2708 | 2456 | 2457 | 2456 | 2456 |
| 45 | 200 | 2702 | 2703 | 2704 | 2703 | 2473 | 2469 | 2471 | 2471 |
| 60 | 200 | 2674 | 2674 | 2674 | 2674 | 2438 | 2438 | 2438 | 2438 |
| 75 | 200 | 2689 | 2688 | 2688 | 2688 | 2433 | 2433 | 2444 | 2433 |

Table 3.1(c): Reading of ORP value

| Retention Time (min) | Weight of Limestone (g) | Before | | | | After | | | |
|----------------------|-------------------------|----------|-------|-------|-------|----------|-------|-------|-------|
| | | ORP (mV) | | | | ORP (mV) | | | |
| | | 1 | 2 | 3 | Mean | 1 | 2 | 3 | Mean |
| 15 | 200 | 780.2 | 779.1 | 779.2 | 779.5 | 455.4 | 455.3 | 454.4 | 455.0 |
| 30 | 200 | 733.4 | 732.7 | 731.9 | 732.7 | 343.4 | 343.2 | 341.8 | 342.8 |
| 45 | 200 | 786.7 | 785.9 | 785.2 | 785.9 | 483.6 | 481.5 | 482.5 | 482.5 |
| 60 | 200 | 741.3 | 742.1 | 742.2 | 741.9 | 359.2 | 358.7 | 356.9 | 358.3 |
| 75 | 200 | 775.5 | 774.3 | 774.0 | 774.6 | 418.5 | 418.3 | 417.8 | 418.2 |

Table 3.2(a): Reading of pH value

| Retention Time (min) | Weight of Limestone (g) | Before | | | | After | | | |
|----------------------|-------------------------|--------|------|------|------|-------|------|------|------|
| | | pH | | | | pH | | | |
| | | 1 | 2 | 3 | Mean | 1 | 2 | 3 | Mean |
| 15 | 300 | 2.49 | 2.50 | 2.51 | 2.50 | 6.12 | 6.12 | 6.13 | 6.12 |
| 30 | 300 | 2.46 | 2.47 | 2.46 | 2.46 | 6.21 | 6.20 | 6.22 | 6.21 |
| 45 | 300 | 2.48 | 2.48 | 2.48 | 2.48 | 5.99 | 6.00 | 6.01 | 6.00 |
| 60 | 300 | 2.48 | 2.49 | 2.47 | 2.48 | 5.87 | 5.87 | 5.85 | 5.86 |
| 75 | 300 | 2.48 | 2.47 | 2.47 | 2.47 | 6.07 | 6.08 | 6.09 | 6.08 |

Table 3.2(b): Reading of EC value

| Retention Time (min) | Weight of Limestone (g) | Before | | | | After | | | |
|----------------------|-------------------------|-------------------------|------|------|------|-------------------------|------|------|------|
| | | EC ($\mu\text{s/cm}$) | | | | EC ($\mu\text{s/cm}$) | | | |
| | | 1 | 2 | 3 | Mean | 1 | 2 | 3 | Mean |
| 15 | 300 | 2753 | 2754 | 2753 | 2753 | 2515 | 2514 | 2513 | 2514 |
| 30 | 300 | 2760 | 2762 | 2763 | 2762 | 2532 | 2533 | 2535 | 2533 |
| 45 | 300 | 2708 | 2708 | 2708 | 2708 | 2396 | 2395 | 2394 | 2395 |
| 60 | 300 | 2750 | 2749 | 2752 | 2750 | 2438 | 2437 | 2436 | 2437 |
| 75 | 300 | 2751 | 2749 | 2748 | 2749 | 2463 | 2462 | 2463 | 2463 |

Table 3.2(c): Reading of ORP value

| Retention Time (min) | Weight of Limestone (g) | Before | | | | After | | | |
|----------------------|-------------------------|----------|-------|-------|-------|----------|-------|-------|-------|
| | | ORP (mV) | | | | ORP (mV) | | | |
| | | 1 | 2 | 3 | Mean | 1 | 2 | 3 | Mean |
| 15 | 300 | 806.0 | 806.1 | 806.6 | 806.2 | 485.3 | 484.2 | 484.1 | 484.5 |
| 30 | 300 | 804.5 | 805.4 | 805.9 | 805.3 | 477.6 | 477.5 | 477.8 | 477.6 |
| 45 | 300 | 805.7 | 803.3 | 803.1 | 804.0 | 487.9 | 486.3 | 479.5 | 484.6 |
| 60 | 300 | 808.9 | 807.4 | 806.9 | 807.7 | 490.8 | 489.2 | 487.9 | 489.3 |
| 75 | 300 | 808.2 | 809.1 | 808.8 | 808.7 | 470.0 | 469.9 | 469.3 | 469.7 |

Table 3.3(a): Reading of pH value

| Retention Time (min) | Weight of Limestone (g) | Before | | | | After | | | |
|----------------------|-------------------------|--------|------|------|------|-------|------|------|------|
| | | pH | | | | pH | | | |
| | | 1 | 2 | 3 | Mean | 1 | 2 | 3 | Mean |
| 15 | 500 | 2.50 | 2.49 | 2.48 | 2.49 | 6.46 | 6.47 | 6.48 | 6.47 |
| 30 | 500 | 2.50 | 2.48 | 2.49 | 2.49 | 6.34 | 6.35 | 6.35 | 6.35 |
| 45 | 500 | 2.45 | 2.45 | 2.46 | 2.45 | 6.42 | 6.41 | 6.42 | 6.42 |
| 60 | 500 | 2.48 | 2.47 | 2.48 | 2.48 | 6.35 | 6.36 | 6.36 | 6.36 |
| 75 | 500 | 2.47 | 2.48 | 2.49 | 2.48 | 6.59 | 6.59 | 6.58 | 6.59 |

Table 3.3(b): Reading of EC value

| Retention Time (min) | Weight of Limestone (g) | Before | | | | After | | | |
|----------------------|-------------------------|-------------------------|------|------|------|-------------------------|------|------|------|
| | | EC ($\mu\text{s/cm}$) | | | | EC ($\mu\text{s/cm}$) | | | |
| | | 1 | 2 | 3 | Mean | 1 | 2 | 3 | Mean |
| 15 | 500 | 2788 | 2789 | 2794 | 2790 | 2495 | 2495 | 2495 | 2495 |
| 30 | 500 | 2788 | 2789 | 2790 | 2789 | 2511 | 2512 | 2512 | 2512 |
| 45 | 500 | 2797 | 2796 | 2797 | 2797 | 2538 | 2537 | 2538 | 2538 |
| 60 | 500 | 2782 | 2781 | 2782 | 2782 | 2544 | 2545 | 2546 | 2545 |
| 75 | 500 | 2744 | 2745 | 2746 | 2745 | 2537 | 2536 | 2536 | 2536 |

Table 3.3(c): Reading of ORP value

| Retention Time (min) | Weight of Limestone (g) | Before | | | | After | | | |
|----------------------|-------------------------|----------|-------|-------|-------|----------|-------|-------|-------|
| | | ORP (mV) | | | | ORP (mV) | | | |
| | | 1 | 2 | 3 | Mean | 1 | 2 | 3 | Mean |
| 15 | 500 | 810.0 | 811.5 | 813.3 | 811.6 | 482.3 | 480.6 | 480.5 | 481.1 |
| 30 | 500 | 815.6 | 815.4 | 815.5 | 815.5 | 447.3 | 446.9 | 446.0 | 446.7 |
| 45 | 500 | 816.6 | 817.3 | 815.7 | 816.5 | 470.2 | 470.3 | 471.3 | 470.6 |
| 60 | 500 | 810.9 | 811.1 | 811.2 | 811.1 | 449.9 | 450.0 | 451.2 | 450.4 |
| 75 | 500 | 811.9 | 813.3 | 812.2 | 812.5 | 457.2 | 456.4 | 455.6 | 456.4 |

Tables 3.1, 3.2 and 3.3 show that reaction had occurred between water sample and limestone. There were demonstrated by the increase in the pH values and decrease in electric conductivity (EC) and oxidation reduction potential (ORP) The highest pH value achieved after treatment was 6.59 by using 500 g limestone with retention time 75 minutes.

Table 3.4 and Table 3.5 show the result of sulphate content and arsenic content respectively in water sample before and after treatment by using experimental column.

Table 3.4: Sulphate content in water samples before and after treatment

| Retention Time (min) | Weight of Limestone (g) | Before | | | | After | | | |
|----------------------|-------------------------|-----------------|------|------|------|-----------------|------|------|------|
| | | Sulphate (mg/L) | | | | Sulphate (mg/L) | | | |
| | | 1 | 2 | 3 | mean | 1 | 2 | 3 | mean |
| 15 | 200 | 1400 | 1400 | 1300 | 1367 | 1390 | 1304 | 1252 | 1315 |
| 30 | 200 | 1400 | 1400 | 1300 | 1367 | 1287 | 1313 | 1364 | 1321 |
| 45 | 200 | 1400 | 1400 | 1300 | 1367 | 1322 | 1397 | 1273 | 1331 |
| 60 | 200 | 1400 | 1400 | 1300 | 1367 | 1340 | 1362 | 1267 | 1323 |
| 75 | 200 | 1400 | 1400 | 1300 | 1367 | 1447 | 1371 | 1445 | 1421 |
| 15 | 300 | 1400 | 1400 | 1300 | 1367 | 1240 | 1383 | 1358 | 1327 |
| 30 | 300 | 1400 | 1400 | 1300 | 1367 | 1378 | 1368 | 1385 | 1377 |
| 45 | 300 | 1400 | 1400 | 1300 | 1367 | 1355 | 1364 | 1328 | 1349 |
| 60 | 300 | 1400 | 1400 | 1300 | 1367 | 1352 | 1332 | 1351 | 1345 |
| 75 | 300 | 1400 | 1400 | 1300 | 1367 | 1371 | 1335 | 1261 | 1322 |
| 15 | 500 | 1400 | 1400 | 1300 | 1367 | 800 | 1400 | 1200 | 1133 |
| 30 | 500 | 1400 | 1400 | 1300 | 1367 | 1100 | 1000 | 900 | 1000 |
| 45 | 500 | 1400 | 1400 | 1300 | 1367 | 1000 | 900 | 1100 | 1000 |
| 60 | 500 | 1400 | 1400 | 1300 | 1367 | 1100 | 1200 | 1300 | 1200 |
| 75 | 500 | 1400 | 1400 | 1300 | 1367 | 1385 | 1378 | 1355 | 1373 |

The results from Table 3.4 show that the content of sulphate decreased slightly after treatment with limestone. The use of 500 g limestone seems more effective compared to others especially with retention times of 30 minutes and 45

minutes. The content of sulphate in these retention times had decreased from 1400 mg/L to 1000 mg/L after treatment.

Table 3.5: Arsenic content in water samples before and after treatment

| Retention Time (min) | Weight of Limestone (g) | Before | | | | After | | | |
|----------------------|-------------------------|----------------|-------|-------|-------|----------------|--------|--------|-------|
| | | Arsenic (mg/L) | | | | Arsenic (mg/L) | | | |
| | | 1 | 2 | 3 | mean | 1 | 2 | 3 | mean |
| 15 | 200 | 2.368 | 2.405 | 2.527 | 2.433 | -0.002 | 0.001 | 0.000 | 0.001 |
| 30 | 200 | 2.368 | 2.405 | 2.527 | 2.433 | 0.003 | -0.002 | 0.003 | 0.003 |
| 45 | 200 | 2.368 | 2.405 | 2.527 | 2.433 | 0.000 | 0.004 | -0.003 | 0.004 |
| 60 | 200 | 2.368 | 2.405 | 2.527 | 2.433 | 0.002 | 0.000 | -0.001 | 0.002 |
| 75 | 200 | 2.368 | 2.405 | 2.527 | 2.433 | 0.011 | 0.005 | 0.008 | 0.024 |
| 15 | 300 | 2.368 | 2.405 | 2.527 | 2.433 | 0.006 | 0.003 | 0.001 | 0.003 |
| 30 | 300 | 2.368 | 2.405 | 2.527 | 2.433 | 0.007 | 0.005 | 0.006 | 0.006 |
| 45 | 300 | 2.368 | 2.405 | 2.527 | 2.433 | 0.005 | 0.009 | 0.010 | 0.008 |
| 60 | 300 | 2.368 | 2.405 | 2.527 | 2.433 | 0.007 | 0.005 | 0.002 | 0.005 |
| 75 | 300 | 2.368 | 2.405 | 2.527 | 2.433 | 0.004 | 0.008 | 0.003 | 0.005 |
| 15 | 500 | 2.368 | 2.405 | 2.527 | 2.433 | 0.007 | 0.006 | 0.011 | 0.008 |
| 30 | 500 | 2.368 | 2.405 | 2.527 | 2.433 | 0.008 | 0.004 | 0.010 | 0.007 |
| 45 | 500 | 2.368 | 2.405 | 2.527 | 2.433 | 0.011 | 0.009 | 0.010 | 0.010 |
| 60 | 500 | 2.368 | 2.405 | 2.527 | 2.433 | 0.006 | 0.008 | 0.009 | 0.008 |
| 75 | 500 | 2.368 | 2.405 | 2.527 | 2.433 | 0.010 | 0.015 | 0.013 | 0.013 |

Table 3.5 shows that limestone was capable to reduce arsenic content in water sample after treatment in all experiments that had been carried out.

4.0 CONCLUSIONS

The results show that limestone can reduce sulphate content in water sample but the concentrate value is much more than international standard (WHO standard 500 mg/L ; Europe standard 250 mg/L). However, limestone can reduce arsenic content in water sample effectively based on the ICP-OES analysis result. Overall result indicated that arsenic content in water sample after treatment had complied with Environmental Quality Act 1974 (Standard A 0.05 mg/L ; Standard B 0.10 mg/L). The highest pH value recorded in this experiment after treatment was 6.59.

REFERENCES

- [1] Akcil, A. and Koldas, S. (2006). Acid Mine Drainage (AMD) : causes, treatment and case studies. *J. Clean. Prod.* **14**, 1139-1145.
- [2] Oates, J.A.H. (1998). Lime and Limestone; Chemistry and Technology, Production and Uses. German: Wiley-VCH.
- [3] Cravotta III, C.A. and Trahan, M.K. (1999). Limestone drains to increase pH and remove dissolved metals from acid mine drainage. *Appl. Geochem.* **14**, 581-606.
- [4] Silva, A. M., Lima, R.M.F. and Leao, V.A. (2012). Mine water treatment with limestone for sulphate removal. *J. Hazardous Mat.* **221-222**, 45-55.
- [5] Chong, T.S.Y., Chuah, T.G., Robiah, Y. Gregory Koay, F.L. and Azni, I. (2007). Arsenic toxicity, health hazards and removal techniques from water: an overview. *Desalination* **217**, 139-166.
- [6] Lievremont, D., Bertin, P.N. and Lett, M.C. (2009). Arsenic in contaminated waters: Biogeochemical cycle, microbial metabolism and biotreatment processes. *Bio.* **91**, 1229-1237.
- [7] Pradhan, A. and Deshmukh, J. P. (2008). Utilization of Fly Ash for Treatment of Acid Mine Drainage. *J. of Environ. Res. and Devel.* **3**, 137-142.

ISBN 978-967-0194-51-6



9 789670 194516