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Paris (France), 22-24 July 2015

Adsorption Behaviors for Sequestration of Anionic Surfactant (Linear Alkyl Benzene Sulphonic Acid, LABSA) from Aqueous Solution on The Solid Product(CHAR) Obtained from The Waste Tyre Rubber via Chemical Devulcanization

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1. Introduction – Surfactants or surface active agents have a wide range of applications in industries, agriculture, textile, detergent, food, cosmetics and the drug or pharmaceutical (Cuzzola, Bernini and Salvadori, 2002). Adsorption of anionic surfactants onto a surface generates charge, anionic surfactants will give a negatively charged surface (Malvern Instruments Inc., 2006). Linear Alkylbenzene Sulphonates (LABSA), is an anionic surfactant, are highly water soluble surface active agents widely used in synthetic laundry detergent formulation and household cleaning products. LABSA frequently present in domestic and civil wastewater. LABSA is a mixture of closely related isomers and homologues, each containing an aromatic ring sulphonated at the para position and attached to a linear alkyl chain (HERA, 2013).The aim of the present study is to investigate the adsorption behaviours for sequestration of linear alkyl benzene sulphonic acid (LABSA) from aqueous solution on the solid product (char) obtained from the waste tyre rubber via chemical devulcanization.

2. Experimental - LABSA has been adsorbed over under batch measurements and adsorption process is monitored using UV spectrophotometer. Adsorbent amount (0.01, 0.05, 0.1 and 0.15 g/100ml), contact time (10-180 minute), PH (3-9), initial LABSA concentration (50-200 mg/L) and temperature (25, 35 and 45 ^{0}C) were chosen as parameters. The aim of the present study is to investigate the adsorption behaviours for sequestration of linear alkyl benzene sulphonic acid (LABSA) from aqueous solution on the solid product (char) obtained from the waste tyre rubber via chemical devulcanization.

3. Results and Discussion – As a result of the first series of experiment, the maximum adsorption of LABSA (>74%) at 0.07 mm > particular particle size has been achieved in aqueous solutions using 0.1 g/100ml adsorbent dose at 100 mg/L LABSA concentration within 60 minute. As a result of the second series of experiment, it was showed that no effect of pH on three different particle size. As a result of the third series of experiment, it was showed the maximum adsorption of LABSA at temperature of 25, 35 and 45 ^{0}C using 0.1 g/100ml adsorbent dose at 100 mg/L LABSA concentration within 90 minute, 82-83-82 %, respectively. As a result of the fourth series of experiment, maximum adsorption of initial LABSA concentration of 150-200 mg/L has been achieved respectively as 89-87 % in aqueous solutions at a PH of 7.0 with adsorbent amount of 0.1 g/100 ml in 180 minute. As a result of the fifth series of experiment, maximum adsorption of LABSA concentration of 100 mg/L has been achieved as 86% at 0.01 g/100 ml adsorbent amount in 85 minute.

4. Conclusions - The absorption data obtained at various temperatures were successfully applied to pseudo-first-order and pseudo-second-order models. The study showed to use that different particle size were efficient and evaluate as adsorbents for removal of LABSA from industrial effluents, domestic and civil wastewater.

5. References

[1] Cuzzola, A., Bernini, M., Salvadori, P.,Applied Catalysis B: Environmental, 36, (2002) p. 231–237
[2]Malvern Instruments Inc., (2006), Surfactant micelle characterization using dynamic light scattering, Zetasizer Nano application note
[3]Human and Environmental Risk Assessment (HERA), (2013), Report

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1. Introduction – Surfactants or surface active agents have a wide range of applications in industries, agriculture, textile, detergent, food, cosmetics and the drug or pharmaceutical (Cuzzola, Bernini and Salvadori, 2002). Adsorption of anionic surfactants onto a surface generates charge, anionic surfactants will give a negatively charged surface (Malvern Instruments Inc., 2006). Linear Alkylbenzene Sulphonates (LABSA), is an anionic surfactant, are highly water soluble surface active agents widely used in synthetic laundry detergent formulation and household cleaning products. LABSA frequently present in domestic and civil wastewater. LABSA is a mixture of closely related isomers and homologues, each containing an aromatic ring sulphonated at the para position and attached to a linear alkyl chain (HERA, 2013).The aim of the present study is to investigate the adsorption behaviours for sequestration of linear alkyl benzene sulphonic acid (LABSA) from aqueous solution on the solid product (char) obtained from the waste tyre rubber via chemical devulcanization.

2. Experimental - Waste tyre rubbers crumb used for the experimental work were supplied by tire repair factory in Turkey. CHAR was obtained from the waste tyre rubber via chemical degradation by our laboratory. The particle size distribution of char was determined by sieving the samples through stainless steel ASTM sieves with openings of standard 0.07-0.09 mm, 0.09-0.18 mm and 0.18-0.85 mm. A commercial mixture of linear alkylbenzene sulphonic acids (LABSA),with purity > 96 %, was used without further purification for this study.

LABSA has been adsorbed over under batch measurements and adsorption process is monitored using UV spectrophotometer. LABSA were determined by finding out the absorbance characteristic wavelength using UV- spectrophotometer. A standard solution of the LABSA was taken and the absorbance was determined at different wavelengths(200-600 nm) to obtain a plot of absorbance versus wavelength. The wavelength corresponding to maximum absorbance (λmax) was determined from this plot. The λmax for LABSA found to 286 nm. Calibration curves were plotted between absorbance and concentration of the LABSA solution.

Adsorbent amount (0.01, 0.05, 0.1 and 0.15 g/100ml), contact time (10-180 minute), PH (3-9) and temperature (25, 35 and 45 ^{0}C) were chosen as parameters. A specific amount of adsorbent of three different particular particle size was added into each flask and was periodically agitated at 300 rpm, until the equilibrium was reached (approximately 85-180 minute). Each experiment was carried out three times.

In the first series of experiment, the effect of particular particle size (0.18-0.85 mm, 0.09-0.18 mm, 0.07-0.09 mm) and contact time for the absorption of LABSA was studied for initial LABSA concentration, adsorbent amount, PH and temperature as 100mg/L, 0.1g/100 ml, 7.0 and 25 ^{0}C, respectively. In the second series of experiment, the effect of PH on particular particle size (0.18-0.85 mm, 0.09-0.18 mm, 0.07-0.09 mm) was studied for initial LABSA concentration of 100mg/L and adsorbent amount of 0.1 g/100ml at 25 ^{0}C. Experiments were carried out at initial PH values ranging 3 to 9; initial pH was controlled by addition of dilute HCl or NaOH solutions. In the third series of experiment, the effect of temperature of 25, 35 and 45 ^{0}C on particular particle size 0.18-0.85 mm was examined for initial

LABSA concentration of 100mg/L and adsorbent amount of 0.1 g/100ml at PH 7. In the fourth series of experiment, the effect of initial LABSA concentration of 50-100-150-200 mg/L on particular particle size 0.18-0.85 mm was examined for temperature of 25 ^{0}C and adsorbent amount of 0.1 g/100ml at PH 7. In the fifth series of experiment, the adsorbent amount (0.01, 0.05, 0.1 and 0.15 g/100ml) and contact time (10-85 minute) were studied for LABSA concentration, pH and temperature as 100mg/L, 7.0 and 25 ^{0}C, respectively.

The aim of the present study is to investigate the adsorption behaviours for sequestration of linear alkyl benzene sulphonic acid (LABSA) from aqueous solution on the solid product (char) obtained from the waste tyre rubber via chemical devulcanization.

3. Results and Discussion – The result of first series experiments was given in Figure1. The maximum adsorption of LABSA (>90%) at 0.18-0.85 mm particle size has been achieved in aqueous solutions using 0.1 g/100ml adsorbent dose at 100 mg/L LABSA concentration within 180 minute.

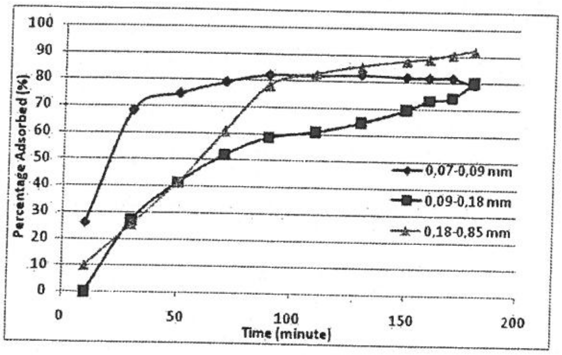

Fig. 1. Effect of contact time and different particle size of LABSA on removal efficiency: 100 mg/L LABSA solution, 0.1 g/100ml adsorbent dose, pH 7, T= 25 ^{0}C

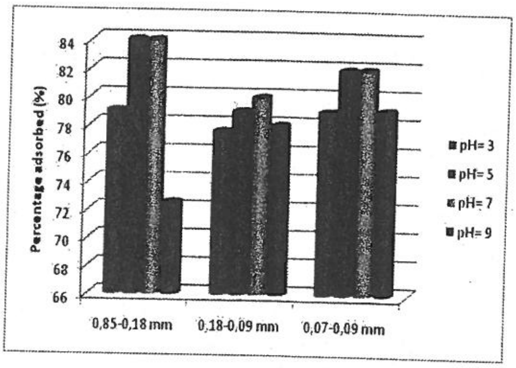

Fig. 2. Effect of particle size and pH of LABSA on removal efficiency: 100 mg/L LABSA solution, 0.05 g/100ml adsorbent dose, contact time 120 min., T= 25 ^{0}C

As a result of the second series of experiment, it was showed that maximum adsorption obtained at pH=5-7 for all particle sizes (Fig 2).

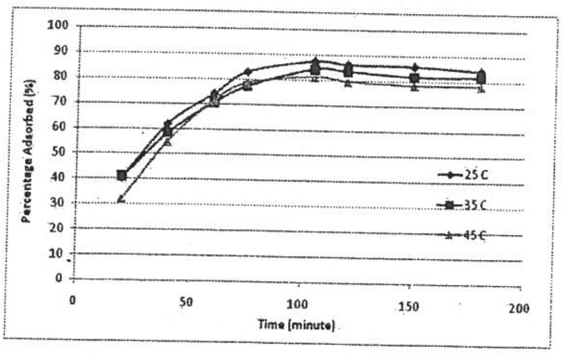

Fig. 3. Effect of contact time and temperature of LABSA on removal efficiency: 100 mg/L LABSA solution, 0.1 g/100ml adsorbent dose, particle size 0.18-0,85 mm, pH=7

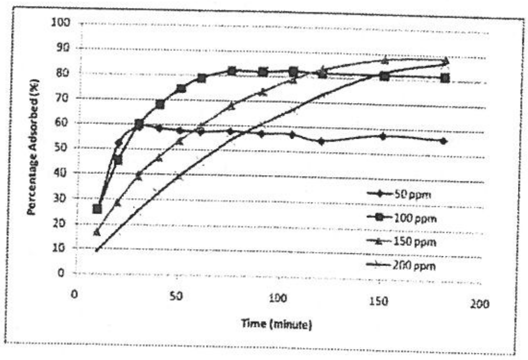

Fig. 4. Effect of contact time and initial concentration of LABSA on removal efficiency: 0.1 g/100ml adsorbent dose, particle size 0.18-0,85 mm, pH=7,T=25 ^{0}C

As a result of the third series of experiment, it was showed the maximum adsorption of LABSA at temperature of 25, 35 and 45 ^{0}C using 0.1 g/100ml adsorbent dose at 100 mg/L LABSA concentration within 90 minute, 82-83-82 %, respectively (Fig.3).

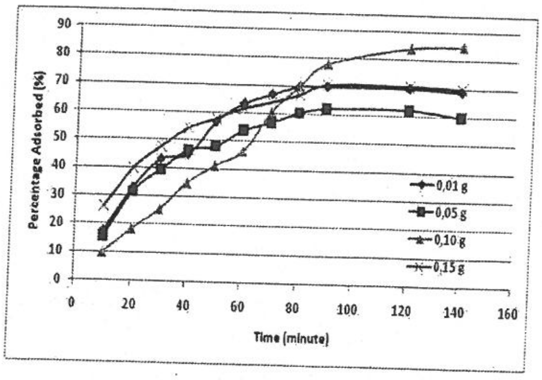

Fig. 5. Effect of contact time and adsorbent amount of LABSA on removal efficiency: 100 mg/L LABSA solution, particle size 0.18-0.85 mm, pH 7, T= 25 ^{0}C

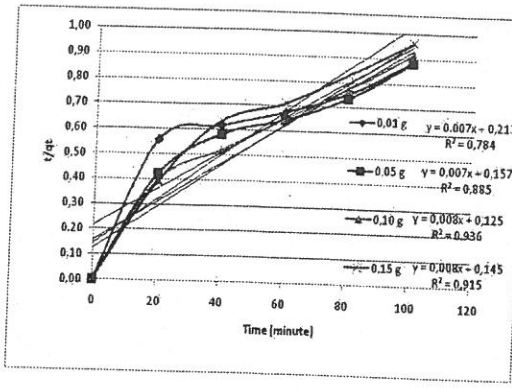

Fig. 6. Pseudo-second-order plot for adsorption of LABSA on Char : 100 mg/L LABSA solution, 0.01 – 0.05 - 0.1- 0,15g/100 ml adsorbent amount, pH=7, particle size 0.85-0.18 mm, T=25 ^{0}C

As a result of the fourth series of experiment, maximum adsorption of initial LABSA concentration of 150-200 mg/L has been achieved respectively as 89-87 % in aqueous solutions at a PH of 7.0 with adsorbent amount of 0.1 g/100 ml in 180 minute (Fig.4).

As a result of the fifth series of experiment, maximum adsorption of LABSA concentration of 100 mg/L has been achieved as 86% at 0.1 g/100 ml adsorbent amount in 140 minute(Fig.5).

Adsorption kinetic study results indicated that the adsorption fits to the pseudo-second-order model better than the pseudo-first-order model (Fig.6). The R^2 value given in Fig.7 is close to unity confirming that the rate limiting step is actually the intra-particle diffusion process.

The calculated ΔH^0 and ΔS^0 values of thermodynamic parameters were found -12704 kj.mol^{-1} and -33 kj.mol^{-1} , respectively. The ΔG^0 values for each of the 25-35-45 ^{0}C temperature were found -2911,15 kj.mol^{-1}, -2407,07 kj.mol^{-1}, -2257,85 kj.mol^{-1}, respectively. The obtained negative ΔG^0 value reveals the thermodynamically feasible and spontaneous LABSA adsorption. In Fig.8 shows plot 1/T-InKd for thermodynamic parameters.

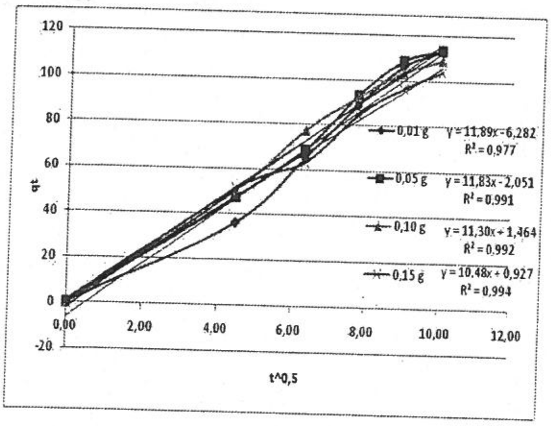

Fig. 7. Intra-particle diffusion plot for adsorption of LABSA on Char : 100 mg/L LABSA solution, 0.01 – 0.05 - 0.1- 0,15g/100 ml adsorbent amount, pH=7, particle size 0.85-0.18 mm, T=25 ^{0}C

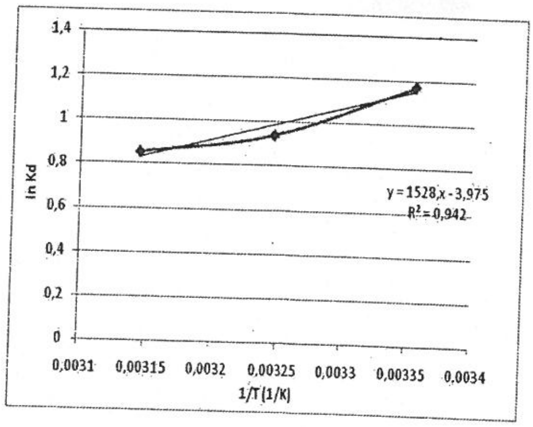

Fig. 8. In Kd vs. 1/T for estimation of ΔH^0 and ΔS^0

The SEM analysis was performed to determine forms of LABSA in the adsorbed char. SEM image of the char before and after adsorption(Fig.9) showed that some LABSA polymeric particles which were found in the adsorbed char, these particles had relatively bigger size.

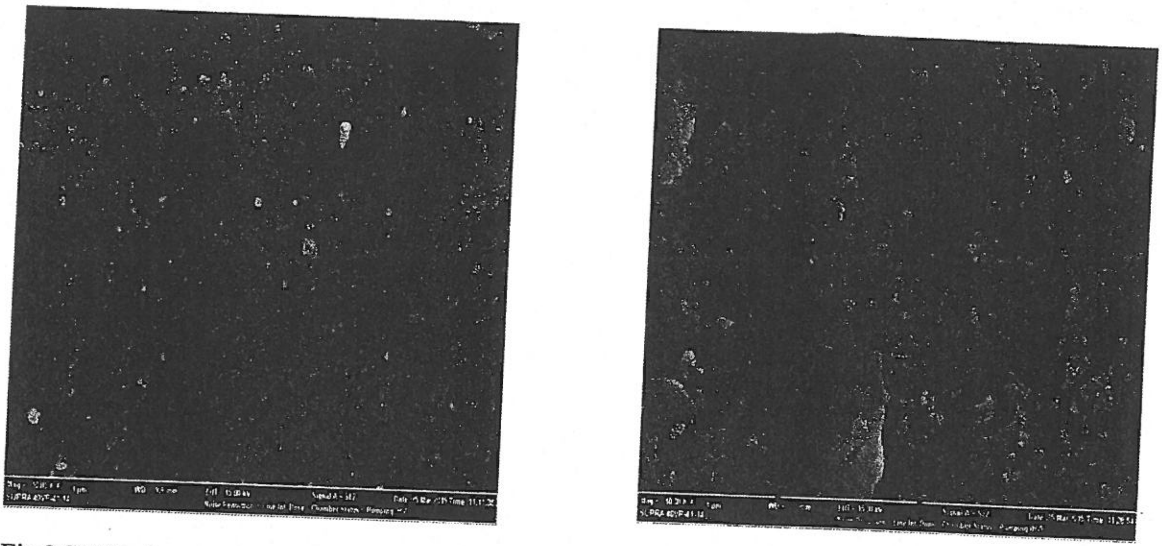

Fig.9 SEM micrographs of char at mag. 10.000 (left: char and right: adsorbed char)

4. Conclusions –

The experimental results indicate that char can be used as an adsorbent to reduce the concentrations of LABSA from aqueous solution. LABSA removal effciency isn't affected to pH change and temperature. The results indicated that the adsorption fits to the pseudo-second-order model better than the pseudo-first-order model. The calculated ΔH^0 and ΔS^0 values of thermodynamic parameters were found -12704 $kj.mol^{-1}$ and -33 $kj.mol^{-1}$, respectively. The ΔG^0 values for each of the 25-35-45 ^0C temperature were found -2083,64 $kj.mol^{-1}$, -2407,07 $kj.mol^{-1}$, -1985,53 $kj.mol^{-1}$,respectively. The obtained negative ΔG^0 value reveals the thermodynamically feasible and spontaneous LABSA adsorption. Adsorption shows exothermic adsorption that on char adsorption LABSA. The study showed to use that different particle size were efficient and evaluate as adsorbents for removal of LABSA from industrial effluents, domestic and civil wastewater.

5. References

[1] Cuzzola, A., Bernini, M., Salvadori, P.,Applied Catalysis B: Environmental, 36, (2002) p. 231–237

[2]Malvern Instruments Inc., (2006), Surfactant micelle characterization using dynamic light scattering, Zetasizer Nano application note

[3]Human and Environmental Risk Assessment (HERA), (2013), Report

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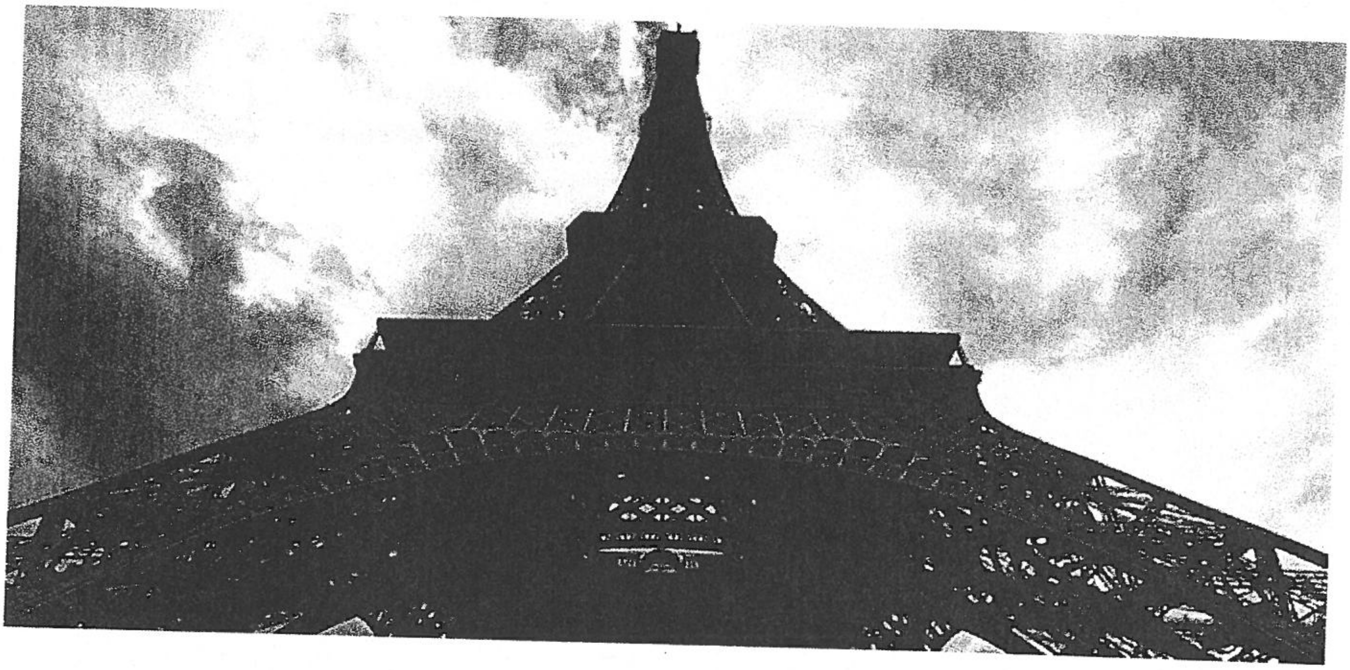

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GENERAL SCIENTIFIC PROGRAM FOR ORAL COMMUNICATIONS

(10 minutes for presentation + 5 minutes for questions)

Wednesday, 22nd July 2015

Schedule	Main Room	Room 1	Room 2
15h00-16h00	**Documentation delivery**	-	-
16h00-16h15	**Opening session**	-	-
16h15-17h00	**Plenary talk** **Formation of Particulate Matter in Biomass Combustion** by PhD. Mário Costa, Lisbon Technical University, Portugal	"	"
17h00 – 18h15	**ORAL COMMUNICATIONS (ENGLISH)** **Environment. Environment Engineering** **Solvent Extraction for Oil Recovery from Petroleum Sludge using Ultrasound and Mechanical Shaking,** Guangji Hu, Jianbing Li, University of Northern British Columbia, Canada **Fullerene aggregates on soils and river sediments from Santa Catarina (Brazil),** Esdras Filho, C. Ramos, B. Dutra, M. Oliveira, R. Kautzmann, La Sala University Center, Brazil	**ORAL COMMUNICATIONS (ENGLISH)** **Renewable Energies** **Thermal Analysis of Wind Turbine Nacelle of 2.5 MW Turbine at Severe Weather Conditions,** Tahir Yavuz, Kadir Nuri Tekin, Emre Koç, Baskent University, Turkey **A Performance assessment of a desalination unit driven by wind energy in Saudi Arabia,** Morad Boumaaza, Emad Ali, Abdilhamid Ajbar, King Saud University, Saudi Arabia	**ORAL COMMUNICATIONS (ENGLISH)** **Energetic Instalations / Renewable Energies** **Earth-Air Heat Exchanger Design for Achieve Energy Saving in HVAC System of Sample Building,** Farivar Fazelpour, Reza Asnaashari, Islamic Azad University– South Tehran Branch, Tehran, Iran **Sustainability of Nuclear Energy: Panel Data Analyses,** F. Ozkan, A.O. Pektas, O. Ozkan, Sakarya University, Turkey

	Arsenic removal using iron-oxide modified quartz sand, S.Arikan, D.Dolgen, Dokuz Eylul University, Turkey **Implementation of Efficient Irrigation Management for a Sustainable Agriculture: IRRIMAN Life+ European Project**, A. Molina-García, A. Pérez-Pastor, R. Domingo, R. Torres-Sánchez, Polytechnic University of Cartagena, Spain **Ten key research issues for integrated and sustainable wastewater reuse in the Middle East**, Basem Shomar, Anne Dare, Qatar Environment and Energy Research Institute (QEERI), Qatar	**Direct CO2 capture from ambient air for power-to-gas renewable energy storage**, J.V. Veselovskaya, V.S. Derevschikov, A.G. Okunev, Novosibirsk State University, Russia **An Intelligent Control Approach to Home Energy Management under Forecast Uncertainties**, Zhongyi Chen, Yan Zhang, Tao Zhang, National University of Defense Technology, China **Thermodynamic model of Stirling engine considering convection heat transfer to working fluid**, K. S. Ghumman, S. Sandhu, PEC University of Technology, India	**A Unified Analytical Model for Characterization of Cable Faults in VSC DC Systems**, J.J. Mesas, Ll. Monjo, L. Sainz, J. Pedra, ETSEIB, Spain **Thermal Drying of Solid Biomass Residues**, A. Al-Kassir, A. Macías-García, J. Gañán, Raúl Kassir Al-Karany, University of Extremadura, Spain **Micro-Generation Renewable Energy: A Solution to Energy Problems South Asia**, M. Asif, King Fahd University of Petroleum & Minerals, Saudi Arabia
[illegible]	Coffee-break POSTER SESSION	Coffee-break POSTER SESSION	Coffee-break POSTER SESSION
18h45 – 20h00	**ORAL COMMUNICATIONS (ENGLISH)** **Environment, Environment Engineering** **Impacts of suspended solids on aquatic ecosystems: case study of Eucalyptus globulus forest in Portugal**, Paula Quinteiro, Marijn V. de Broek, Ana C. Dias, Bradley Ridoutt, Luís Arroja,	**ORAL COMMUNICATIONS (ENGLISH)** **Materials** **Study on PID temperature control performance of a novel PTC material with room temperature Curie point**, Wen-long Cheng, Jia-liang Song, University of Science and Technology of	**ORAL COMMUNICATIONS (ENGLISH)** **Environment Education, Human Ecology** **Walkability Assessment of Mavişehir-Alaybey Coast Region in İzmir**, Turkey: Building, Green Area and Path Analyses, A. Kirimtat, E. Paykoç, Yaşar University,

	University of Aveiro, Portugal **Adsorption Behaviors for Sequestration of Anionic Surfactant (Linear Alkyl Benzene Sulphonic Acid, LABSA) from Aqueous Solution on The Solid Product(CHAR) Obtained from The Waste Tyre Rubber via Chemical Devulcanization**, S. Balbay, C.Acikgoz, Bilecik Şeyh Edebali University, Turkey **Buildings recovery during an emergency: the Ecological Footprint of its foundation reconstruction**, Antonio Ferreira Sánchez, Mª Desirée Alba Rodríguez, Madelyn Marrero, University of Seville, Spain **Influence of Green Roof on the Energy Performance of Buildings in Hot and Humid Climates**, Abubakar S. Mahmoud, Mohammad Asif, King Fahd University of Petroleum Minerals KFUPM, Saudi Arabia	China, China **Nanoparticle size evaluation through Dynamic Light Scattering (DLS) technique in a nitrate salt doped with ceramic nanoparticles**, B. Muñoz-Sánchez, J. Nieto-Maestre, I. Iparraguirre-Torres, A. García-Romero, Solar Energy Unit. Tecnalia Research and Innovation, Spain **Transesterification of Palm Cooking Oil using Titanium-based Oxides**, W. L. Tan, K.Y. Chew, N. H. H. Abu Bakar, M. Abu Bakar, University Sains Malaysia, Malaysia **Production of biodiesel using sodium zirconate and silicate as heterogeneous catalysts**, I. Romero-Ibarra, H. Pfeiffer, Metropolitan Autonomous University, Mexico **Estimate of Mechanical Features for Structural Material with Superficial Image Technic**, Gamze Dogan, Ahmet Ozkis, Musa Hakan Arslan, Selcuk University, Turkey	Turkey **Waste management of health services in units of emergency and emergency in University Hospital, São Paulo / Brazil**, M.J.T.Nitsche, S.R.L.R.Olbrich, M.V.M.F.F.Alves, I. Godoy, A.E.Oliveira, C.G.Bueno, M.G. D'Avila, S.F.B.Fusco, M.R.Cirne, UNESP, Brazil **Analysis of the impact of climatic factors on rice yield at different spatial and temporal scales in China (1961-2040)**, Yingbin He, Weimin Cai, Mingjie Gao, Qiyou Luo, Jianping Li, Chinese Academy of Agricultural Sciences, China **Individual Health Benefits of Renewable Energy Use**, Recai Ogur, Gulhane Medical Faculty, Turkey

Thursday, 23rd July 2015

POSTER COMMUNICATIONS PROGRAM

22nd July 2015		
Energetic Instalations	**Renewable Energies**	**Energetic and Environmental Project Management**
S. Cuccuru The preliminary map of the potential thermal conductivity in Sardinia (Italy): a tool for the geothermal heat pumps University of Sassari, Italy	**Juan A. Conesa, L. Rey,N. Ortuño,I. Aracil** Thermogravimetric decomposition of different automotive shredder residues (ASR) at different oxygen ratios University of Alicante, Spain	R. Hameed ,P. Pilidis ,E. Pagone Comparative Risk Analysis of Carbon Abated Simple Cycle Gas Turbine Power Plant Cranfield University, United Kingdom
A. García ,P. Zamorano ,J. González Background for the implementation of an Energy Management System in the South Campus of the University of Chile University of Chile, Chile	**Juan A. Conesa,M. A. Garrido,R. Font** Pollutant production during the thermal decomposition of flexible polyurethane foam at different temperatures and oxygen ratios University of Alicante, Spain	**R. Segura ,O. Gutierrez ,I. Velazquez** Developments of systems for power generation from waste on rabbit farm, for energetic self-sufficiency AIT GROUP - RASE Proyectos Productivos, Mexico
P. F. Morim,L. M. S. Silva ,C. S. A. Sá ENERGY ASSESSMENT IN AN INDOOR SWIMMING POOL AND ITS INTEGRATION WITH A COMBINED HEAT AND POWER PLANT Polytechnic Institute of Porto, Portugal	**M. Asif** Potential for Building Integrated Solar PV in Industrial Sector of Saudi Arabia King Fahd University of Petroleum & Minerals, Saudi Arabia	**Dmitriy Anufriev,EkaterinaKargapolova,Ludmila Boronina,** Modernization of regional housing complex: Imbalances and contradictions, advantages, issues, challenges, Astrakhan Institute of Civil Engineering, Russia
M. G. Sousa,L. M. P. Braga ,L. M. S. Silva ,C. S. A. Sá Prediction Model for Utilities Consumption Plan in a Chemical Process Industry Polytechnic Institute of Porto, Portugal	**E. Sendzikiene,I. Kazanceva** Influence of storage and ageing on biodiesel and multicomponent fuel quality change Akademija, Kauno r., Lithuania	**An artificial neural network model for river flow forecasting,** Zahra. Khodabakhshi, Paria. Soleimani, Mohammad Hossein, Askari Azad, Islamic Azad University, Iran
M. Samipour Giri,M. Alizadeh,D. Safarvand Exergy Analysis of NGL Recovery Plant Using a Hybrid ACOR-BP Neural Network Modeling: A Case Study Islamic Azad University, Iran	**E. Avallone ,D. Garcia Cunha ,A. Padilha ,V. Luiz Scalon** Electronic multiplex system using the Arduino platform to control and record the data of the temperatures profiles in heat storage tank for solar collector São Paulo State University "Júlio de Mesquita Filho" –	

Korea **S.N.Mokhtar,N.Z.Mahmood,C.R.C.Hassan** Approach in construction industry: A study on refurbishment waste index of different types of building University of Malaya, Malaysia **D.H. Kim ,C. Moon ,S. Kang** Effect of Cultivation pH on Biohydrogen Production from Food Waste without Inoculum Addition Inha University, South Korea **H. Shokry Hassan,A. B. Kashyout,I. Morsi,A. A. A. Nasser,H. Abuklill** Gas Sensing Performances for Nanowires Polypyrrole Coated Copper Thin films Advanced Technology and New Materials Researches Institute (ATNMRI), Egypt **S. Balbay,E.M. Andoglu** Micelle Behaviors of Anionic Surfactant (Linear Alkyl Benzene Sulphonic Acid, LABSA) and Nonionic Surfactant (Tergitol, NP-10) in Aqueous Solution on Carbon Black Bilecik Şeyh Edebali University,			