



Chemical Degradation of Waste Tyre Rubber

Şenay Balbay¹, Çağlayan Açıkgöz²

Abstract

In this study, degradation studies of a small amount of waste tyre rubbers crumb were carried out using oxidative cleavage by inorganic and organic chemicals to decompose easily on account of cross linking and stabilizers. The experiments have been performed three reaction temperatures and time in the range of 130 – 150 °C and 10 – 30 min. under atmospheric pressure. Experimental studies showed that the reaction time, the reaction temperature, acid/waste tyres rubber ratio, can be used to control the break down. The products selected for analysis in this study were obtained in the maximum yield conditions. Solid products were analyzed to determine their elemental composition and the chemical composition of liquid products were investigated spectroscopic techniques (GC/MS). Chemical reclaiming process is a possible method for devulcanizing the vulcanized network through the use of chemical agents that attack the C-S or S-S bonds. The new method seems to be applicable to the recycling of waste tyres.

Keywords: Devulcanization, Chemical Degradation, Waste Rubber, Recycling

1. INTRODUCTION

For several years, waste tyres have been considered to be “black pollution” as they are produced in large quantities by industrialized nations, however the methods for their disposal are somewhat limited[1]. The most desirable approach to the recycling of waste rubber is its reclaiming based on devulcanization[2]. Rubber devulcanization is a process in which the scrap rubber or vulcanized waste product is converted using mechanical, thermal, or chemical energy into the state in which it can be mixed, processed, and vulcanized again[3]. Strictly speaking, devulcanization in sulfur-cured rubber can be defined as the process of cleaving, totally or partially, poly-, di-, and monosulfidic cross links formed during the initial vulcanization. Devulcanization of peroxide- and resin-cured rubber can be defined as the process of cleaving carbon-carbon or other stronger cross links. However, in the present concept, devulcanization is defined as a process that causes the breakup of the chemical network along with the breakup of the macromolecular chains. A number of methods have been applied in an attempt to solve the problem and to find more effective ways of tire rubber recycling and waste rubber utilization. In this study, degradation studies of a small amount of waste tyre rubbers crumb were carried out using oxidative cleavage by inorganic and organic chemicals to decompose easily on account of cross linking and stabilizers. In this study, degradation studies of a small amount of waste tyre rubbers crumb were carried out using oxidative cleavage by inorganic and organic chemicals to decompose easily on account of cross linking and stabilizers. Products were analyzed to determine their elemental composition and the chemical composition of liquid products were investigated spectroscopic techniques (GC/MS). The method seems to be applicable to the recycling of waste tyres.

2. MATERIALS AND METHODS

2.1. Materials

Waste tyre rubbers crumb used for the experimental work were supplied by tire repair factory in Turkey. Waste tyre rubbers crumb samples of maximum 3,51 mm mean diameter and 2,27 cm length were selected and kept at room conditions. About 55 g of material was used for each group of experimental studies. Elemental analysis of the waste tyre rubbers crumb and solid products was performed on a LECO CHNS 628

¹ Corresponding author: ¹Bilecik Şeyh Edebali Üniversitesi, Meslek Yüksekokulu, Kimya Teknolojisi Programı, 11030 BİLECİK senay.balbay@bilecik.edu.tr

² Bilecik Şeyh Edebali Üniversitesi, Mühendislik Fakültesi, Kimya ve Süreç Mühendisliği Bölümü, 11030 BİLECİK caqlayan.acikgoz@bilecik.edu.tr

model (LECO Corporation, U.S.A) elemental analyzer. The HHV values were calculated by Beckman's Formula $HHV \text{ (MJ/kg)} = 0.352C + 0.944H + 0.105(S-O)$. C, H, S, O represent carbon, hydrogen, sulphur and oxygen content of material, respectively, expressed in % by mass on dry basis. Determination of ash, moisture and volatile matter was performed according to ASTM Standards. The proximate and ultimate analysis of waste tyre rubbers crumb are shown in Table 1.

Table 1. Proximate and ultimate analyses of waste tyre rubbers crumb.

Proximate analysis (as received, wt. %)	
Moisture	0
Volatile matter	63,03
Fixed carbon	28,99
Ash	7,98
Ultimate analysis (dry, %)	
C	86,89
H	8,34
N	-
O ^a	3,65
S	1,12
HHV ^b (MJ kg ⁻¹)	38,20
^a Calculated from weight difference.	
^b Higher Heating Value.	

The flow diagram of the experimental set-up is given in figure 1.

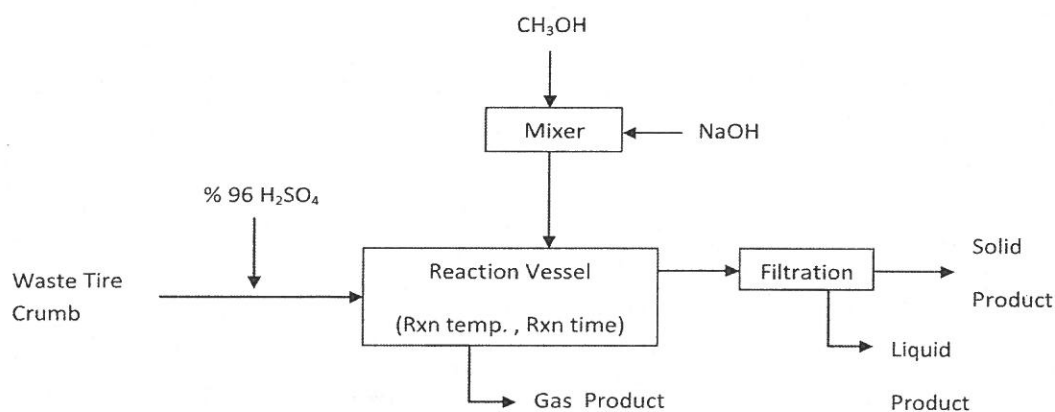


Figure 1. The flow diagram of the experimental set-up

The degradation studies of waste tyre rubbers crumb samples were carried out using oxidative cleavage by inorganic and organic chemicals to decompose easily on account of cross linking and stabilizers. The experiments were carried out in three series. Firstly, three different quantities (3g, 6g and 9 g) of waste tyre rubbers crumb samples were studied at 1400C reaction temperature and 20 minute reaction time to define the optimum quantity samples for the best cleaving carbon-carbon or other stronger cross links in this experimental study. After that, the experiments have been performed three different reaction temperatures and time in the range of 130 – 150 0C and 10 – 30 minute, respectively. Each experiment was carried out three times.

3. RESULTS AND DISCUSSION

The first group of experiments was performed to establish the optimum quantity of waste tyre rubbers crumb samples for maximum solid product yield and also to determine the best cleaving carbon-carbon or other stronger cross links in the experimental study. The results of the first group experiments showed that 6 gram waste samples were used in the experiment gave the maximum product yield (%90) and also the best cleaving carbon-carbon or other stronger cross links (Table2). When the results are investigated with respect to yield, it is clear that optimum waste sample amount is 6 g under the experimental conditions used.

Table 2. The results of first group experiments.

Temperature:140 °C :20 minute			Time
EXP.NO	WASTE SAMPLE (g)	CHAR (g)	CHAR YIELD (%)
1	3	2,3	77
2	6	5,39	90
3	9	7,74	86

The second group of experiments was to determine the effect of the reaction temperature on reaction solid product (char) yields. Table 3 shows the product yields of waste tyre rubbers crumb in relation to final reaction temperatures at 1300C, 1400C and 1500C under atmospheric pressure. As a result of the second group experiments showed that maximum solid product yield obtained as 90% at the reaction temperature of 140, and also 150 0C

Table 3. The results of second group experiments.

Waste sample : 6 g minute			Time :20
EXP.NO	TEMPERATURE(°C)	CHAR (g)	CHAR YIELD (%)
4	130	5,23	87
5	140	5,39	90
6	150	5,40	90

The third group of experiments was to determine the effect of the reaction time on the solid product (char) yields. In fact, the maximum solid product yield obtained as 90% at the reaction temperature of 140, and also 150 0C in the second group experiments. However, the reaction temperature was selected as 1400C in third group experimental studies because of energy saving.

The results of the third group experiments results were given in table 4. Maximum char yield was obtained as 90% at the 20 minute reaction time. As shown in Table 4, the yields of solid product were affected significantly by the reaction time.

Table 4. The results of third group experiments.

Waste sample : 6 g		Temperature :140 0C	
EXP.NO	TIME(min.)	SOLID PRODUCT (g)	CHAR YIELD (%)
7	10	3,43	57
8	20	5,39	90
9	30	3,51	58

The photograph of waste tyre rubbers crumb samples (a) and the solid product (b) were given in Figure 2 . The products(solid/liquid) analysed were obtained under the experimental conditions giving the maximum yield (reaction temperature of 140 °C, reaction time of 20 minute).

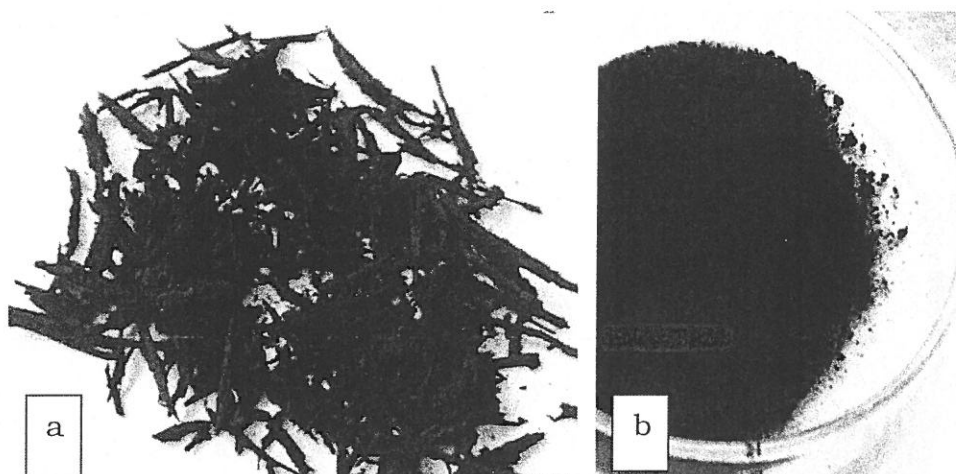


Figure2. The photograph of: (a) waste tyre rubbers crumb samples , (b)the solid product

The elemental composition and calorific values of solid product(char) were determined. The proximate and ultimate analysis of solid products(char) are shown in Table 1. The calorific value of 15,1 MJ kg⁻¹ for the char is also very close to active carbon.

Table 5. Proximate and ultimate analyses of char

Proximate analysis (as received, wt.%)	
Moisture	4,57
Volatile matter	53,37
Fixed carbon	39,84
Ash	2,22
Ultimate analysis (dry, %)	
C	72,41
H	4,55
N	0,57
Oa	18,79
S	3,68
HHVb (MJ kg ⁻¹)	15,1
a Calculated from weight difference.	
b Higher Heating Value.	

The chemical composition of liquid products was investigated spectroscopic techniques (GC/MS). The GC-MS chromatogram of liquid product is given in Fig. 7.

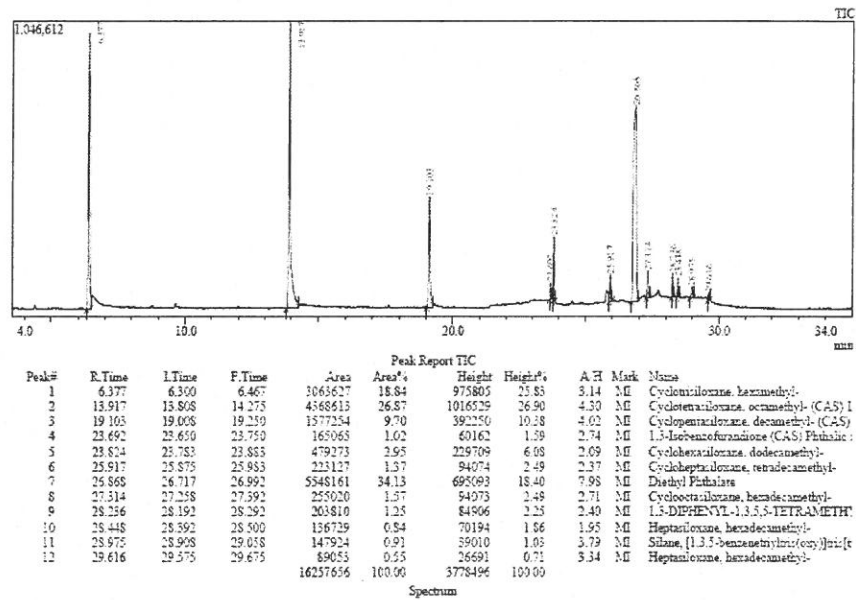


Figure 7. The GC-MS chromatogram of liquid product

The chemical characterization has shown that the liquid product obtained from devulcanizing reaction can be used as chemical feedstock.

4. CONCLUSIONS

In this study, degradation studies of a small amount of waste tire rubbers crumb were carried out in the reaction vessel under atmospheric conditions. In the degradation experiments, the highest solid yield of 90 % was obtained with 6 g waste sample at 140 0C reaction temperature and 20 minute reaction time. Chemical reclaiming process is a possible method for devulcanizing the vulcanized network through the use of chemical agents that attack the C-S or S-S bonds. The new method seems to be applicable to the recycling of waste tires. The findings of laboratory-scale studies are encouraging and warrant larger applications of recycling of waste tire rubbers crumb for the production of active carbon and some chemical feedstock.

REFERENCES

- [1]. Sadaka, F., Campistron, I., Laguerre, A., Pilard, J., 2012, Controlled chemical degradation of natural rubber using periodic acid: Application for recycling waste tyre rubber, *Polymer Degradation and Stability* 97 (2012), 816-828
- [2]. Dubkov, K.A. , Semikolenov, S.V. , Ivanov, D.P. , Babushkin, D.E. , Panov, G.I. , Parmon V.N., Reclamation of waste tyre rubber with nitrous oxide, *Polymer Degradation and Stability* 97 (2012), 1123-1130
- [3]. Hassan, M. M., Aly , R. O., Aal , S.E. A., El-Masry, A. M., Fathy , E.S., Mechanochemical devulcanization and gamma irradiation of devulcanized waste rubber/high density polyethylene thermoplastic elastomer, *Journal of Industrial and Engineering Chemistry* 19 (2013), 1722–1729



EURASIA WASTE MANAGEMENT SYMPOSIUM

28-30 APRIL 2014

YTU 2010 European Capital of Culture Congress & Cultural Center
Istanbul/Turkey

PROCEEDINGS

www.eurasiasyposium.com

Committees

Honorary Committee

Prof. Dr. Veysel Eroğlu	Minister of Water Affairs and Forestry, Turkey
İdris Güllüce	Minister of Environment and Urbanization, Turkey
Prof. Dr. Adem Bağtürk	Former Deputy, General Secretary of Istanbul Metropolitan Municipality, Turkey
Prof. Dr. Mustafa Öztürk	Undersecretary of the Ministry of Environment and Urbanization
Prof. Dr. Lütfi Akça	Undersecretary of the Water Affairs and Forestry, Turkey
Prof. Dr. İsmail Yüksek	Rector of Yıldız Technical University, Turkey
Prof. Dr. M. Talha Gönüllü	Rector of Adiyaman University, Turkey
Prof. Dr. Cumali Kınacı	Ministry of Water Affairs and Forestry, General Manager of the Water Management Division, Turkey
Prof. Dr. Ahmet Demir	General Director of Istanbul Water and Sewerage Administration, Turkey
Prof. Dr. Hayrullah Ağaçoğlu	Dean of Civil Engineering Faculty, Yıldız Technical University, Turkey
Osman Akgül	General Manager of ISTAC Inc

Scientific Committee

Prof. Dr. Fabrizio Adani	The University of Milan, Italy	Prof. Dr. Martin Kranert	University of Stuttgart, Germany
Prof. Dr. Mehmet Emin Aydın	Konya Necmettin Erbakan Üniversitesi, Turkey	Prof. Dr. Anders Lagerkvist	Lulea University of Technology, Sweden
Prof. Dr. Müfit Bahadır	Technical University of Braunschweig, Germany	Prof. Dr. Piet N.L. Lens	UNESCO-IHE Institute For Water Education, Netherlands
Prof. Dr. Erwin Binner	University of Natural Resources and Life Sciences, Austria	Prof. Dr. Irene Lo	Hong Kong University of Science and Technology, Japan
Prof. Dr. Recep Boncukcuoğlu	Atatürk University, Turkey	Prof. Dr. Ilirjan Malollari	University of Tirana, Albania
Prof. Dr. Mehmet Borat	Fatih University, Turkey	Prof. Dr. Pier Paolo Manca	The University of Cagliari, Italy
Prof. Dr. Hanife Büyükgüngör	Ondokuz Mayıs Üniversitesi, Turkey	Prof. Dr. Andjelka Mihajlov	University of Novi Sad, Serbia
Prof. Dr. Thomas H. Christensen	Technical University of Denmark, Denmark	Prof. Dr. Ayşe Muhammetoğlu	Akdeniz University, Turkey
Prof. Dr. Raffaello Cosu	University of Padoa, Italy	Prof. Dr. Aldo Muntoni	The University of Cagliari, Italy
Prof. Dr. Barış Çallı	Marmara University, Turkey	Prof. Dr. Yaşar Nuhoğlu	Yıldız Technical University, Turkey
Prof. Dr. Luis F. Diaz	CalRecovery, Inc., USA	Prof. Dr. Turgut Tüzün Onay	Bogazici University, Turkey
Prof. Dr. Güleda Engin	Yıldız Technical University, Turkey	Prof. Dr. İzzet Öztürk	Istanbul Technical University, Turkey
Prof. Dr. Ertuğrul Erdin	Dokuz Eylül University, Turkey	Prof. Dr. Lucjan Pawlowski Lublin	University of Technology, Poland
Prof. Dr. Ayşen Erdinçler	Bogazici University, Turkey	Prof. Dr. Raffaella Pomi	Sapienza University of Rome, Italy
Prof. Dr. Ayşe Filibeli	Dokuz Eylül University, Turkey	Prof. Dr. Debra Reinhart	University of Central Florida, USA
Prof. Dr. Evangelos Gidarakos	Technical University of Crete, Greece	Prof. Dr. Marco Ritzkowski	Technical University of Hamburg, Germany
Prof. Dr. Pin Jing He	Tongji University, China	Prof. Dr. R.Kerry Rowe	Queens University, Canada
Prof. Dr. Jaehyuk Hyun	Chungnam National University, Korea	Prof. Dr. Takayuki Shimaoka	Kyushu University, Japan
Prof. Dr. Ubeyde İpek	Fırat Üniversitesi, Turkey	Prof. Dr. Rainer Stegmann Nanyang	Technological University, Singapore
Prof. Dr. Somjai Karnchanawong	Chiang Mai University, Thailand	Prof. Dr. Bülent Topkaya	Akdeniz University, Turkey
Prof. Dr. Durmuş Kaya	Karabük Üniversitesi, Turkey	Prof. Dr. İsmail Toroz	Istanbul Technical University, Turkey
Prof. Dr. Bülent Keskinler	Gebze Yüksek Teknoloji Enstitüsü, Turkey	Prof. Dr. Kahraman Unlu	Middle East Technical University, Turkey
Prof. Dr. Jae Young Kim	Seoul National University, Korea	Prof. Dr. C. Visvanathan	Asian Institute of Technology, (Thailand) Thailand
Prof. Dr. Peter Kjeldsen	Technical University of Denmark, Denmark	Prof. Dr. Ülkü Yetiş	Middle East Technical University, Turkey
Prof. Dr. Günay Kocasoy	Bogazici University, Turkey	Prof. Dr. Yılmaz Yıldırım	Bülent Ecevit University, Turkey
Prof. Dr. İsmail Koyuncu	İstanbul Teknik Üniversitesi, Turkey	Prof. Dr. Samuel T.S. Yuen	University of Melbourne, Australia
		Dr. Şenol Yıldız	ISTAC Inc. Turkey

Organizing Committee

M. Sinan Bilgili	Chair, Yıldız Technical University
Eyüp Debik	Co-Chair, Yıldız Technical University
Güleda Engin	Yıldız Technical University
Gamze Varank	Yıldız Technical University
Vahit Balahorli	ISTAC Inc. Turkey
Esra Olmez	ISTAC Inc. Turkey
Fatih Saltabaş	TAYCED Turkey

Program

Day 03

30.04.2014 WEDNESDAY

09:00

TECHNICAL TOUR (ODAYERI SANITARY LANDFILL, LEACHATE TREATMENT PLANT AND LFG TO ENERGY PLANT, ISTANBUL SOLID WASTE RECYCLING AND COMPOST PLANT)

Poster Presentations

POSTER PRESENTATIONS (29.04.2014 - TUESDAY - FOYER AREA)

P1	Treatment of the Landfill Leachate by Electrochemical Methods and Advanced Oxidation <i>V. Orescanin, R. Kollar, D. Ruk, G. Loncar, Z. Vukovic</i>	P43	The Use of Siliceous Waste Material for the Production of Glass and Glass-ceramics from Li2O-Al2O3-SiO2 (LAS) System <i>K. Łączka, K. Cholewa-Kowalska, M. Łączka, M. Jop</i>
P2	Separation of Tellurium in Waste Thermoelectric Materials with Solvent Extraction Method <i>H.Y. Lee, J. C. Choi</i>	P44	Methane Productions and Archaea Communities of Anaerobic Digesters with Different Substrate Feeding Patterns <i>Z.H. Piao, J. Y. Kim</i>
P3	Synthetic Type Surfactant-Segregating Bacteria in the River Environment Identified by FAME and 16S rRNA Sequencing <i>F. Yilmaz, B. Içgen</i>	P45	Removal of Heavy Metal Ions From Aqueous Solutions With Multi-Walled Carbon Nanotubes: Kinetic and Thermodynamic Studies <i>M. Abdel Salam</i>
P4	Prevalence of <i>mecA</i> in Surface Water Contaminated with <i>Staphylococcus</i> <i>E. Seyedmonir, F. Yilmaz, B. Içgen</i>	P46	The Comparison of Dye Bioaccumulation Properties of Adapted and Non-Adapted <i>Saccharomyces Cerevisiae</i> <i>M. Okur, N. Saracoglu, Z. Aksu</i>
P5	Equilibrium Studies of Cobalt Ions Removal Using Fly Ash Class F <i>M.N. Mužek, M. Jelović, S. Svilović, J. Zelić</i>	P47	Synthesis of Magnetic Multi-Walled Carbon Nanotubes/Magnetite/Chitin Magnetic Nanocomposite for the Removal of Rose Bengal From Real and Model Solution <i>M. Abdel Salam</i>
P6	Carbon Dioxide Adsorption in a Fixed Bed of Natural Zeolite Evolved During Composting of Agro-Industrial Waste <i>D. Kučić, N. Kopčić, M. V. Domanovac, F. Briški</i>	P48	Assessment of microbial community signatures during co-composting of active sewage sludge and lignocellulosic waste by TMAH-thermochemolysis coupled with gas chromatography-mass spectrometry <i>L. El feis, L. Lemeze, P. Winterton, G. Merlina, Y. Ouhdouch, M. Zamama, E. Pinelli, A. Ambles, M. Hafidi</i>
P7	Bioremediation of Leachate Generated From Tobacco Dust Waste <i>M. V. Domanovac, L. Karužić, I. Čosić, N. Kopčić, D. Kučić, F. Briški</i>	P49	A comparison of Electrocoagulation and Electrofenton Processes for Pollutant Removal of Hamadan City Solid Waste Leachate <i>A. Seid-Mohammadi, G. Asgari</i>
P8	The Examination of Composting of Organic Waste in Aksaray <i>M. Bilgin, S. Tulun</i>	P50	Agricultural Wastes: Properties and Environmental Effects <i>O. Tepe, M. Tanyol, A. Y. Dursun</i>
P9	Detoxification of Selenium to Elemental Selenium by Exo-Polysaccharide Producing Desert Isolates <i>N. Zia, M. Faisal</i>	P51	Assessment of Agro-Industrial Wastes: Biotechnological Potential <i>M. Tanyol, O. Tepe, G. Uslu</i>
P10	Municipal Solid Waste Composting: Case Study of Istanbul <i>A. Zougrana, H. Elcik, N. Bakarakı, H. A. Kabuk, E. O. Koroglu</i>	P52	Kinetic Studies of Removal of Reactive Blue 221 <i>A.C. Karaerkek, A. Kara, H. Sensoy</i>
P11	Investigation of the Adsorption Properties of Bentonite in Single and Multi-ion Systems <i>N. Baylan, A. E. Mericboyu</i>	P53	Removal of Dyeing Wastewater Using Cross-linked Polymeric Absorbent <i>A.C. Karaerkek, S. Sozucecer, N. Dinibutun, A. Alan, I. Kucuk, G. Kapancik, A. Kara</i>
P12	A Modified Biogas Generator in Cow Farm and Rural Area of Developing Countries <i>M. Malekha, Mohammad. N. Isfahani, Mansour N. Isfahani</i>	P54	Adsorption Properties of Cr6+ onto Magnetic Microspheres: Kinetic and Isotherm Studies <i>A. Kara, S. Sözügecer</i>
P13	Removal of Boron from Aqueous Solution by Using Sorbital Containing Polymer Modified Bentonite <i>E. Yavuz, Z. E. Erel, G.T. Turan, Y. Gurseil, B. F. Senkal</i>	P55	Waste Management and Landfill Gas Production in Kayseri, TURKEY <i>O. Ozkan, I. Uyanik, S. A. Okur, K. Kok, T. Aktepe Genc</i>
P14	Characteristics of Sewage Sludge Ash and Recycling for Lightweight Materials <i>H.Y. Lee, H. B. Ko</i>	P56	Use of Forward Osmosis Technology in Landfill Leachate Treatment <i>B. Ikioglu, N. Manav Demir, E. Arslankaya, E. Debik, U. Kurt, F. Ihan</i>
P15	Use of an Efficient Biomass for the Biosorption of Lead From Industrial Effluents <i>R. Kocak, F. Yilmaz, A. Ergene, B. Içgen</i>	P57	Synthesis, Characterization and Application of a Ferromagnetic Composite in the Removal of Methyl Violet 2B Dye <i>C. D. Marco, F. Ferrarini, J. S. Crespo, L. N. Carli, L. R. Bonetto, M. Giovanela</i>
P16	<i>Enterococcus Faecalis</i> Used to Reduce Chromium From the Polluted Site <i>I. Akin, F. Yilmaz, A. Ergene, B. Içgen</i>	P58	Preparation and Application of Magnetic Chitosan Microspheres for a Dye Removal <i>L.T. Toaldo, J.S. Crespo, M. Giovanela, L.N. Carli</i>
P17	Manganese Biosorption From Surface Water by <i>Serratia Nematodiphila</i> <i>O. Sahin, F. Yilmaz, A. Ergene, B. Içgen</i>	P59	Thin Films of Polyelectrolytes with Silver Nanoparticles as Potential Bactericidal Agents in the Microbiological Treatment of Industrial Wastewater <i>F. Zarpelon, D. Larissa, N. Carli, G. Machado, J. S. Crespo, M. Giovanela</i>
P18	Efficiency of <i>Staphylococcus warneri</i> biomass in cobalt biosorption <i>S. Cerit, F. Yilmaz, A. Ergene, B. Içgen</i>	P60	Removal of Zinc(II) From Aqueous Solutions Using an Eco-Friendly Biosorbent Originating From the Winery Industry <i>L. Gelain, J. S. Crespo, M. Giovanela</i>
P19	Valuation of Liquid Waste of Oil Factories by Adding to Mixtures Manufacturing Building Bricks <i>H. Chemani</i>	P61	Synthesis, Characterization and Application of Montmorillonite-Alginate Hybrids with Silver Nanoparticles in the Industrial Wastewater Treatment for Reuse <i>R.H. Lovatel, R.M. Neves, G.R. Oliveira, J. S. Crespo, L. N. Carli, M. Giovanela</i>
P20	Modelling of Trabzon Province Sığürtü Deep Sea Discharge Line Waste Water Effluents <i>S. Erkebay, E. Kose, C. Erkebay</i>	P62	Biological Disintegration Techniques To Enhanced Sludge Stabilization <i>S. Atay, F. Akbal</i>
P21	Preparation of NaA-Type of Zeolite from Wheat Hull Ash Silica <i>P. Terzioğlu, S. Yucei, M. Ozturk</i>	P63	The Inhibitory Effect of Copper on Performance of Mesophilic UASB Process <i>S. Aslan, N. Sekardag</i>

Poster Presentations

P22	Cereal Wastes as an Alternative Low Cost Adsorbents <i>P. Terzioğlu, Y. B. Elalmis, S. Yucel, B. Karakuzu, M. Metin</i>	P64	The Rehabilitation of the Landfill of Oued Smar, Algiers. Utopia or Reality <i>Y. Kehila, I. Ouali, L. Benkhouil</i>
P23	Study of Incineration Bottom Ash on Properties of Asphalt Concrete <i>D.F. Lin, H.L. Luo, S.C. Chen, X. R. Cai</i>	P65	The Utilization of Sweet Sorghum Residues for Biochar Production <i>D. Ozcimen, B. Inan</i>
P24	Study of Volume Stabilization for Geopolymer Made with Oil Contaminated Clay <i>H.L. Luo, D. F. Lin, C. S. Chang, J. E. Cai</i>	P66	Adsorption of Remazol Brilliant Blue R with Low-Cost Adsorbent Obtained from Anaerobically Digested Sewage Sludge <i>D. Ozcimen, T. Salan</i>
P25	Removal of Boron From Water by Using Tris(hydroxymethyl)aminomethane Modified Resin <i>Z.E. Ereli, E. Yavuz, B. F. Senkal</i>	P67	Biogas Production Potential from Post-Extraction Algal Residue <i>D. Ozcimen, T. Salan, B. Inan</i>
P26	Transport of Conventional Contaminants through Liner Systems <i>E. Adar, A. Demir, G. Varank, S. Top, M. S. Bilgili</i>	P68	Pozzolanic Effect of Wastes Bricks on Physical and Mechanical Properties of Mortar <i>S. M. Mansour, R. Chaid, A. Afalfiz, R. Jaubertie</i>
P27	Integrated Solid Waste Management in Bakirköy <i>A. Pir, O. Apaydin</i>	P69	The Application of Treated Bottom Ash in Mortar as Cement Replacement <i>P. Tang, M.V.A. Florea, P. Spiess, H.J.H. Brouwers</i>
P28	Rehabilitation and Reorganization of Municipal Waste Landfills Through Ecological Landscape Design Approach, The Case of Karaj City Halghe-Darreh Landfill-Iran <i>F. Vamenani, M. Masnavi</i>	P70	Removal of Lead from Waste Waters by Fixed Bed Column Experiments with Natural Zeolites <i>N. Erdol Aydin, G. Nasun Saygili</i>
P29	Environmental Assessment and Landfill Site Detection, Using the Methods of Space Monitoring <i>G. Batrakova, Y. Vaysman, O. Ivenskikh, R. Garifzyanov</i>	P71	Effect of Sand on the Swelling Characteristics of an Expansive Soil <i>B. Louafi, R. Bahar</i>
P30	Chemical Degradation of Waste Tyre Rubber <i>S. Balbay, C. Acikgoz</i>	P72	Removal of Monocrotophos by Clay <i>J. Gulen, S. Karademir</i>
P31	The Effect of Catalyst Use on the Gasification of Olive Mill Wastewater at Supercritical Conditions <i>E. Kipcak, M. Akgun</i>	P73	Effect of Addition of Plastic Wastes on the Creep Performance of Asphalt <i>M. Merbouh, B. Glaou, A. Mazouz, M. Belhachemi</i>
P32	The Influence Factors on Decision Making to Choose the Right Industrial Lubricating Oil: A Research in Bleck Industry <i>A. Akpınar Borazan, E. M. Andoğlu</i>	P74	Disposal of Industrial Waste Water Colored Using Activated Carbon from Cotton Waste Fibers <i>J. Mitic, R. Njic, M. Smelcerovic, D. Djordjevic</i>
P33	Comparison of Organic Matter Degradation in Originally Wet and Pre-dried Tobacco Waste during Composting <i>N. Kopčić, M. V. Domanovac, D. Kučić, I. Čosić, F. Briški</i>	P75	Characterization of an Industrial Waste for Its Use in Civil Engineering - Case of Blast Furnace Slag <i>H. Cherfa, K. Ait Mokhtar</i>
P34	Recycling of Printed Circuit Boards from Waste Mobile Phone by Pyrolysis <i>S. Atasever, P. Acar Bozkurt, M. Canel</i>	P76	PETDER Waste Oil Management Project Results <i>V. Şiğinç, A. Özbeç</i>
P35	Energy and Carbon Footprint of Plastic Coupling Production <i>S. Ustun, H. Buyukgungor</i>	P77	Determination of Heavy Metals Presence in Honey Produced in the Vicinity of Industrial Zone in Mitrovica, Kosovo <i>A. Musliu, M. Kerolli-Mustafa</i>
P36	Kosovo Chemicals and Hazardous Waste Issues <i>V. Lajqi-Makolli, M. Kerolli-Mustafa, I. Malollari, S. Makolli, L. Sopa, F. Tahiri</i>	P78	Agronomic Evaluation of the Effect of Composts Resulting From Treatment by Composting of a Lignocellulosic Substrate <i>F.Z. Elouaqoudi, L. El Fels, A. Goubraim, N. El Ghazi, A. Meddich, M. Hafidi</i>
P37	Investigation of Potential Genotoxic Activity for the Pharmaceutical Wastewater Containing Paracetamol <i>E. Kocak, G. Dalgic, I. Turkdogan, K. Yetilmezsoy, G. O. Erguven</i>	P79	Evaluation of Anaerobic Digestion Method for Sludge Treatment of Municipal Waste Water Treatment Plant <i>S. Cagman, V. Coban, M. Eyidogan, D. Kaya</i>
P38	Changes in Photosynthesis System of Hibiscus Cannibus L. Grown in Soils Contaminated by Trace Metals <i>S. Arbaoui, B. Campanella, R. Paul, T. Bettaieb</i>	P80	Evaluation of the Usage of <i>Lemna gibba</i> L. in Advanced Treatment: Elazığ Municipal Wastewater Treatment Plant <i>M. Topal, G. Uslu, E. Obeç, E.I. Arslan Topal</i>
P39	Removal of Toxic Elements from Wastewater by Activated Carbon Produced by Agricultural by Product <i>A. O. Avci Tuna, E. B. Simsek, U. Beker</i>	P81	Recycling Oily Hot Roll Mill Scale by Using Green Cleaning Agent <i>D.N. Inceoglu, F. Parlak, Z. Ekmekci</i>
P40	Leaching of Industrial Waste to Obtain Ferrioxalate for the Decolourization with Photo-Fenton Process <i>M. Becelic-Tomin, B. Dalmacija, S. Maletic, D. Tomasevic, D. Kerkez, G. Pucar, M. Prica</i>	P82	Ex Situ Bioremediation of Ink Waste <i>Z.M. Munir, N. Sheikh, A. Shams</i>
P41	Solidification/Stabilization of Pyrite Cinder by Applying Three Different Clays and Fly Ash <i>D.V. Kerkez, M. Dalmacija, D. Tomasevic, M. Becelic-Tomin, S. Roncevic, G. Pucar, B. Dalmacija</i>	P83	Rapid Degradation of Azo Dyes Using Nano-Scale Zero Valent Iron <i>N. Rahman, Z. Abedin, M. A. Hossain</i>
P42	Fly Ash As A Source of Catalytic Iron in the Fenton Process <i>G. Pucar, B. Dalmacija, M. Becelic-Tomin, D. Kerkez, D. Tomasevic, A. Leovac, V. Pesic</i>	P84	Evaluation of Elazığ Municipal Wastewater Treatment Plant with Physicochemical Parameters <i>M. Topal, G. Uslu, E. Obeç, E.I. Arslan Topal</i>

INDEX

- 729-731** P15 Use of an Efficient Biomass for the Biosorption of Lead From Industrial Effluents
R. Kocak, F.Yilmaz, A. Ergene, B. Içgen
- 732-734** P16 Enterococcus Faecalis Used to Reduce Chromium From the Polluted Site
I. Akin, F. Yilmaz, A. Ergene, B. Içgen
- 735-737** P17 Manganese Biosorption From Surface Water by Serratia Nematodiphila
O. Sahin, F. Yilmaz, A. Ergene, B. Içgen
- 738-740** P18 Efficiency of Staphylococcus warneri biomass in cobalt biosorption
S. Cerit, F. Yilmaz, A. Ergene, B. Içgen
- 741-746** P19 Valuation of Liquid Waste of Oil Factories by Adding to Mixtures Manufacturing Building Bricks
H. Chemani
- 747-752** P20 Modelling of Trabzon Province Sığürtlü Deep Sea Discharge Line Waste Water Effluents
S. Erkebay, E. Kose, C. Erkebay
- 753-757** P21 Preparation of NaA-Type of Zeolite from Wheat Hull Ash Silica
P. Terzioğlu, S. Yücel, M. Öztürk
- 758-766** P22 Cereal Wastes as an Alternative Low Cost Adsorbents
P. Terzioğlu, Y. B. Elalmis, S. Yücel, B. Karakuzu, M. Metin
- 767-775** P23 Study of Incineration Bottom Ash on Properties of Asphalt Concrete
D.F. Lin, H.L. Luo, S.C. Chen, X. R. Cai
- 776-784** P24 Study of Volume Stabilization for Geopolymer Made with Oil Contaminated Clay
H.L. Luo, D. F. Lin, C. S. Chang, J. E. Cai
- 785-790** P25 Removal of Boron From Water by Using Tris(hydroxymethyl)aminomethane Modified Resin
Z.E. Erel, E. Yavuz, B. F. Senkal
- 791-795** P26 Transport of Conventional Contaminants through Liner Systems
E. Adar, A. Demir, G. Varank, S. Top, M. S. Bilgili
- 796-803** P27 Integrated Solid Waste Management in Bakırköy
A. Pir, O. Apaydin
- 804-811** P28 Rehabilitation and Reorganization of Municipal Waste Landfills Through Ecological Landscape Design Approach,
The Case of Karaj City Halghe-Darreh Landfill-Iran
F. Vamenani, M. Masnavi
- 812-815** P29 Environmental Assessment and Landfill Site Detection, Using the Methods of Space Monitoring
G. Batrakova, Y. Vaysman, O. Ivenskikh, R. Garifzyanov
- 816-821** P30 Chemical Degradation of Waste Tyre Rubber
S. Balbay, C. Acikgoz
- 822-827** P31 The Effect of Catalyst Use on the Gasification of Olive Mill Wastewater at Supercritical Conditions
E. Kipcak, M. Akgun
- 828-832** P32 The Influence Factors on Decision Making to Choose the Right Industrial Lubricating Oil: A Research in Bilecik Industry
A. Akpınar Borazan, E. M. Andoğlu
- 833-838** P33 Comparison of Organic Matter Degradation in Originally Wet and Pre-dried Tobacco Waste during Composting
N. Kopčić, M. V. Domanovac, D. Kučić, I. Čosić, F. Briški
- 839-843** P34 Recycling of Printed Circuit Boards from Waste Mobile Phone by Pyrolysis
S. Atasever, P. Acar Bozkurt, M. Canel
- 844-847** P35 Energy and Carbon Footprint of Plastic Coupling Production
S. Ustun, H. Buyukgungor