Journal of Coal Chemistry 2026 No2 pages 40-52 *ISSN 1681-309X*
DOI: 10.31081/1681-309X-2026-0-2-40-52 Specialty G1(161). U.D.C.: 667.633.2

PERFORMANCE ASSESSMENT OF REGENERATED METHYL ACETATE IN INDUSTRIAL ENAMEL MANUFACTURING WITH THE ECO PLUS 122 UNIT

© V.V. Marchenko[1], S.A. Naboka[2]

National Technical University “Kharkiv Polytechnic Institute”, 61002, Kharkiv, 2 Kirpichova St., Ukraine

[1] Marchenko Viktor V., Postgraduate Student of the Department of Oil, Gas and Solid Fuel Processing Technologies (TPNG and TP), ORCID: 0009-0003-5287-5415, e-mail: 0997727@gmail.com
[2] Naboka Serhii A., Postgraduate Student of the TPNG and TP, ORCID: 0009-0005-3632-997X, e-mail: naseanua@gmail.com

---

This paper analyzes the technical feasibility of reusing regenerated methyl acetate to produce industrial enamel and evaluates contamination levels and its impact on the regeneration efficiency, the performance of physicochemical restorations and coating-films. The regeneration and reuse of organic solvents is also relevant for coke-chemical enterprises where significant volumes of solvent-containing waste streams are generated during the processing of coal-derived products and coating materials. Solvent was industrially degraded and the five different levels of contamination (MXL0-MXL4) were identified, and distinguished by the differences in the contents and the level of acidity, moisture, density, colour and non-volatile residue. The regeneration was done on the ECO PLUS 122 thermal-distillation unit under controlled working conditions which were adjusted to low boiling point and high pressure of methyl acetate. Feedstock and regenerated solvent (RMXL0-RMXL4) were subjected to measure the extent of purification, and enamel films prepared using regenerated solvent were tested in regards to gloss, hardness and drying behavior. The thermal behavior of the regeneration cycle showed a steady plateau of vapour-temperature at 55-60º C, which proved the selective evaporation of the ester. The form of regeneration yield decreased predictably with a 93 % being the highest and 81 % being the lowest regeneration yield in MXL0 and MXL4 respectively. Nevertheless, the recovered solvent had a great physicochemical recovery: ester content was between 98.4-99.3%, moisture content was below 500 ppm and acid value was not more than 0.11 mg KOH/g. Density, colour and non-volatile residue were close to those of normal industrial grade methyl acetate, implying the retention of hydrolysed and high-boiling impurities in the evaporator. The performance of the enamel-films was also consistent in all of the regenerated samples with the gloss not varying over 1-5 units, HB hardness not deviating over 1-2 and drying time within 39-45 min. These findings verify that regenerated methyl acetate has retained functional qualities necessary to enamel production despite the use of very contaminated feedstock. The results substantiate the technology and environmental-based reason of the use of solvent-regeneration systems like ECO PLUS 122 in the manufacturing coating industry.

Keywords: coke chemical production; methyl acetate; solvent regeneration; physicochemical properties; distillation efficiency; coating film quality.

Corresponding author*: V.V. Marchenko, e-mail: 0997727@gmail.com*
Manuscript received 2026/02/16
Accepted for publication 2026/03/30
Published 2026/04/17

How to Cite:
1. Marchenko V.V. Otsinka produktyvnosti rehenerovanoho metylatsetatu v promyslovomu vyrobnytstvi emalei za dopomohoiu ustanovky ECO PLUS 122 / V.V. Marchenko, S.A. Naboka // Vuhlekhimichnyi zhurnal. – 2026. – № 2. – S. 40-52. https://doi.org/10.31081/1681-309X-2026-0-2-40-52
2. Marchenko, V. V. & Naboka, S. A. (2026). Otsinka produktyvnosti rehenerovanoho metylatsetatu v promyslovomu vyrobnytstvi emalei za dopomohoiu ustanovky ECO PLUS 122. *Vuhlekhimichnyi Zhurnal*, (2), 40–52. https://doi.org/10.31081/1681-309X-2026-0-2-40-52

References

1. Elehinafe, F. B. (2021). Waste polyethylene terephthalate packaging materials in developing countries – Sources, adverse effects, and management. Journal of Ecological Engineering, 22(1), 135–142. https://doi.org/10.12912/27197050/132222
2. Alaraby, M., Abass, D., Velázquez, A., et al. (2025). Occurrence, analysis, and toxicity of polyethylene terephthalate microplastics: A review. Environmental Chemistry Letters, 23, 1025–1059. https://doi.org/10.1007/s10311-025-01841-8
3. Andreasi Bassi, S., Tonini, D., Saveyn, H., & Astrup, T. F. (2022). Environmental and socioeconomic impacts of poly(ethylene terephthalate) (PET) packaging management strategies in the EU. Environmental Science & Technology, 56(1), 501–511. https://doi.org/10.1021/acs.est.1c00761
4. Jovanovic, A., Buharchyħ, M., Petrović, M., & Pejić, J. (2025). The global market of PET production: From origins to recycling. Metallurgical and Materials Data, 2(4), 113–118. https://doi.org/10.30544/MMD46
5. Duan, C., Wang, Z., Zhou, B., & Yao, X. (2024). Global polyethylene terephthalate (PET) plastic supply chain resource metabolism efficiency and carbon emissions co-reduction strategies. Sustainability, 16(10), 3926. https://doi.org/10.3390/su16103926
6. Avasthi, K., Bohre, A., Teržan, J., Jerman, I., Kovač, J., & Likozar, B. (2021). Single step production of styrene from benzene by alkenylation over palladium-anchored thermal defect rich graphitic carbon nitride catalyst. Molecular Catalysis, 514, 111844. https://doi.org/10.1016/j.mcat.2021.111844
7. Fadzil, N. A. M., Rahim, M. H. A., & Maniam, G. P. (2014). A brief review of para-xylene oxidation to terephthalic acid as a model of primary C–H bond activation. Chinese Journal of Catalysis, 35(10), 1641–1652. https://doi.org/10.1016/S1872-2067(14)60193-5
8. Lashkar, V. T., Minhas, G., Fisher, G., et al. (2023). Production of greener styrene-butadiene rubber (SBR) composites through partial substitution of carbon black with bi-modal cellulose fibers. Cellulose, 30, 9485–9499. https://doi.org/10.1007/s10570-023-05463-7
9. Mohanty, S., & Gupta, V. K. (2023). Polybutadiene rubber. In Kirk-Othmer Encyclopedia of Chemical Technology (pp. 1–20). https://doi.org/10.1002/0471238961.1615122508011201.a01.pub2
10. Berdnikova, P., Zhizhina, E. G., & Pai, Z. P. (2021). Phenol-formaldehyde resins: Properties, fields of application, and methods of synthesis. Catalysis in Industry, 13(2), 119–124. https://doi.org/10.1134/S2070050421020033
11. Demirpolat, A. B., & Aydoğmuş, E. (2023). Development of composite materials from phenol formaldehyde resins and evaluation of their uses. International Journal of Advanced Natural Sciences and Engineering Researches, 7, 158–162. https://doi.org/10.59287/ijanser.2023.7.4.643
12. Alegbe, E. O., & Uthman, T. (2024). A review of history, properties, classification, applications and challenges of natural and synthetic dyes. Heliyon, 10(13), e33646. https://doi.org/10.1016/j.heliyon.2024.e33646
13. Wang, F., Wang, L., Cai, X., & Sun, Y. (2012). Synthesis of branched azo dyes based on benzene sulphonamide intermediates and their spectral properties. Review of Progress in Coloration and Related Topics, 128(6), 425–433. https://doi.org/10.1111/j.1478-4408.2012.00395.x
14. Trotsenko, O., Grigorov, A., Nazarov, V., & Nahliuk, M. (2022). Modern trends in the use of additives in fuel and oil materials (overview). Petroleum and Coal, 64(3), 714–724. https://www.vurup.sk/wp-content/uploads/2022/10/PC-X_Trotsenko_206.pdf
15. Kabatc, J., Jurek, K., Czech, Z., & Kowalczyk, A. (2015). Xylene-1,4-bis4-(p-pyrrolidinostyryl) benzothiazolium borate salt as new functional dye. Dyes and Pigments, 114, 144–145. https://doi.org/10.1016/j.dyepig.2014.10.023
16. Turaev, K. K., & Nabiev, D. A. (2023). New pigments based on terephtal acid: Synthesis and properties. Multidisciplinary Journal of Science and Technology, 3(1), 134–238. https://mjstjournal.com/index.php/mjst/article/view/81
17. Doğan, M. S., & Celik, H. (2023). Organic compounds containing aromatic structure used in pharmaceutical production. Journal of Biochemical Technology, 14(2), 102–111. https://doi.org/10.51847/lwwtXbfdou
18. Matys, Z., Powała, D., & Orzechowski, A. (2016). Badania nad zastąpieniem toluenu onitrotoluenem w przemysłowej metodzie otrzymywania trotylu. CHEMIK, 70(3), 158–160. https://yadda.icm.edu.pl/baztech/element/bwmeta1.element.baztech-1ce31a5a-2246-4357-9110-2d092c4655f4
19. Kobrakov, K. I., Kuznetsov, D., Ruchkina, A. G., & Sharpar, N. M. (2019). Synthesis and properties of azo compounds based on nitroanilines - 2,4,6-trinitrotoluene derivatives and 1,3,5-trinitrobenzene. Chemical Engineering, 20(10), 440–444. https://doi.org/10.31044/1684-5811-2019-20-10-440-444
20. Cruz, S. L., Rivera-García, M. T., & Woodward, J. J. (2014). Review of toluene action: Clinical evidence, animal studies and molecular targets. Journal of Drug and Alcohol Research, 3, 235840. https://doi.org/10.4303/jdar/235840
21. Kandyala, R., Raghavendra, S. P. C., & Rajasekharan, S. T. (2010). Xylene: An overview of its health hazards and preventive measures. Journal of Oral and Maxillofacial Pathology, 14(1), 1–5. https://doi.org/10.4103/0973-029X.64299
22. Yang, J., Roth, P., Durbin, T., & Karavalakis, G. (2019). Impacts of gasoline aromatic and ethanol levels on the emissions from GDI vehicles: Part 1. Influence on regulated and gaseous toxic pollutants. Fuel, 252, 799–811. https://doi.org/10.1016/j.fuel.2019.04.143
23. Jin, H., Yuan, W., Li, W., Yang, J., Zhou, Z., Zhao, L., Li, Y., & Qi, F. (2023). Combustion chemistry of aromatic hydrocarbons. Progress in Energy and Combustion Science, 96, 101076. https://doi.org/10.1016/j.pecs.2023.101076
24. Mamytov, K. Z., Beisenbayev, O. K., Shvets, V. F., & Syrmanova, K. K. (2012). The multifunctional automobile gasoline additive on the basis of amino-aromatic hydrocarbons and oxygen-containing compounds. Eurasian ChemTech Journal, 14, 249–252. https://doi.org/10.18321/ectj121

25. Slear, W., Testa, A., Reasons, K., Guirguis, P., Savage, P. E., & Pester, C. W. (2024). Fast hydrolysis for chemical recycling of polyethylene terephthalate (PET). RSC Sustainability, 2, 1508–1514. https://doi.org/10.1039/D4SU00034J
26. Ma, S. M., Pereira, P., Pester, C. W., Savage, P. E., Bakshi, B. R., & Lin, L.-C. (2025). Understanding PET hydrolysis via reactive molecular dynamics simulation and experimental investigation. Journal of Physical Chemistry B, 129(26), 6594–6603. https://doi.org/10.1021/acs.jpcb.5c03080
27. Zhou, W., Xin, H., Yang, H., Du, X., Yang, R., Li, D., & Hu, C. (2018). The deoxygenation pathways of palmitic acid into hydrocarbons on silica-supported Ni12P5 and Ni2P catalysts. Catalysts, 8(4), 153. https://doi.org/10.3390/catal8040153
28. Valle, E., Duyar, M. S., Snider, J. L., Regli, S. K., Ronning, M., Gallo, A., & Jaramillo, T. F. (2022). In situ studies of the formation of MoP catalysts and their structure under reaction conditions for higher alcohol synthesis: The role of promoters and mesoporous supports. Physical Chemistry C, 126(12), 5575–5583. https://doi.org/10.1021/acs.jpcc.2c00837
29. Garcia de Castro, R., Devers, E., Digne, M., Lamic-Humblot, A.-F., Pirngruber, G. D., & Carrier, X. (2021). Surface-dependent activity of model CoMoS hydrotreating catalysts. Journal of Catalysis, 403, 16–31. https://doi.org/10.1016/j.jcat.2021.01.026
30. Solanki, B. S., & Rode, C. V. (2019). Selective hydrogenolysis of 5-(hydroxymethyl)furfural over Pd/C catalyst to 2,5-dimethylfuran. Journal of Saudi Chemical Society, 23(4), 439–451. https://doi.org/10.1016/j.jscs.2018.08.009
31. Tanco, M., Viles, E., Ilzarbe, L., & Alvarez, M. J. (2009). Implementation of design of experiments projects in industry. Applied Stochastic Models in Business and Industry, 25(4), 478–505. https://doi.org/10.1002/asmb.779
32. Yao, C., Hou, Y., Ren, S., Wu, W., & Liu, H. (2019). Selective extraction of aromatics from aliphatics using dicationic ionic liquid-solvent composite extractants. Journal of Molecular Liquids, 291, 111267. https://doi.org/10.1016/j.molliq.2019.111267
33. Albright, L. F. (2003). Alkylation of isobutane with C3–C5 olefins to produce high-quality gasolines: Physicochemical sequence of events. Industrial & Engineering Chemistry Research, 42(19), 4283–4289. https://doi.org/10.1021/ie0303294
34. Subtelnyy, R. O., Zhuravskyi, Y. V., & Dzinyak, B. O. (2023). Suspension oligomerization of C9 hydrocarbon fraction initiated by aliphatic n-substituted aminoperoxides. Voprosy Khimii i Khimicheskoi Tekhnologii, 4, 105–112. https://doi.org/10.32434/0321-4095-2023-149-4-105-112