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Dispose of spent wood sleepers using a supercritical extraction process

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Abstract

Every year after the repair of railways, a huge amount of reinforced concrete and wood sleepers are accumulated. For all types of repairs, about 10,000 thousand wooden sleepers are not suitable for re-laying. The approximate volume of the track complex and in the right of way already accumulated at the bases amounts to 70 million pcs. sleepers. In the Russian Federation, due to the overflow of regional landfills for industrial waste, an enormous amount of used wood sleepers impregnated with substances of Hazard Class 3 is not authorized to be stored in non-designated open areas. The legislation of the Russian Federation for environmental damage to the environment provides for strict administrative liability and the enormous size of penalties, which are constantly being tightened, to the owner of the waste.

Due to its properties, SCF technology can be used for the process of cleaning contaminated porous matrices and utilization of spent railway sleepers. SCF extraction process allows extraction of the impregnating compound (coal oil) from wood sleepers. At the same time, after carrying out the process, we get coal oil that can be reused and separately noted wood shep.

To carry out the process of extracting the impregnating composition from spent wooden sleepers, an experimental setup described in this work was created. Also in the framework of this work, the kinetics of the process of extraction of coal oil from impregnated wood sleepers was investigated. Supercritical carbon dioxide and supercritical propane / butane were chosen as the extractant, and the effectiveness of the extractants was compared.

References

[1] V.F. Khairutdinov, F.M. Gumerov, F.R. Gabitov, Z.I. Zaripov, R. Gaifullina, M.I. Farakhov. Wood drying and impregnation with propiconazole using supercritical CO_2. *Supercritical Fluids: Theory and Practice.* **2017**. Vol.12. No.1. P.29-40. (russian)
[2] V.F. Khairutdinov, F.M. Gumerov, R.F. Gabitov, M.I. Farakhov, Z.I. Zaripov, I.Sh. Khabriev, T.R. Akhmetzyanov. Increasing the functionality of carbonate rubble through supercritical fluid impregnation with bituminous compounds. *Supercritical Fluids: Theory and Practice.* **2015**. Vol.10. No.2. P.4-16. (russian)
[3] F.M. Gumerov, F.D. Yuzmukhametov, R.F. Gabitov, N.Z. Shakirov. Thermophysical properties of solvents as applied to supercritical fluid sas polymer dispersion process. *Bulletin of Kazan Technological University*. **2012**. Vol.15. No.12. P.64-70. (russian)
[4] L.Yu. Yarullin, F.R. Gabitov, A.N. Sabirzyanov, R.F. Gabitov, G.F. Kamalova. Water solubility in individual hydrocarbons. *Bulletin of Kazan Technological University*. **2012**. Vol.15. No.23. P.156-158. (russian)
[5] T.R. Akhmetzyanov, I.Sh. Khabriev, V.F. Khairutdinov, F.R. Gabitov, F.M. Gumerov. Impregnation of rubble with components of oil sludge using a propane-butane impregnation process carried out in supercritical fluid conditions. *Bulletin of Kazan Technological University*. **2014**. Vol.17. No.22. P.311-314. (russian)

[6] V.F. Khairutdinov, A.R. Gabitova, F.M. Gumerov, A.I. Kurdyukov. Extraction of petroleum products and tar-asphaltene mixtures from highly watered oil sludge by the method of supercritical fluid extraction. *Supercritical Fluids: Theory and Practice*. **2018**. Vol.13. No.3. P.1-6. (russian)
[7] J.W. King. Advances in critical fluid technology for food processing. *Food Science and Technology Today*. **2000**. Vol.14. P.186-191.
[8] J.W. King, F. Favati, & S.L. Taylor. Production of tocopherol concentrates by supercritical fluid extraction and chromatography. *Separation Science and Technology*. **1996**. Vol.31. P.1843-1857.
[9] A. Kuva´tova, A.J.M. Lagadec, D.J. Miller, & S.B. Hawthorne. Selective extraction of oxygenates from savory and peppermint using subcritical water. *Flavour and Fragrance Journal*. **2001**a. Vol.16. P.64-73.
[10] A. Kuva´tova, D.J. Miller, & S.B. Hawthorne. Comparison of subcritical water and organic solvents for extracting kava lactones from kava root. *Journal of Chromatography A*. **2001b**. Vol.923. P.187-194.
[11] P.F. Leal, M.E.M. Braga, D.N. Sato, J.E. Carvalho, M.O.M. Marques, & M.A.A. Meireles. Functional properties of spice extracts obtained via supercritical fluid extraction. *Journal of Agricultural and Food Chemistry*. **2003**. Vol.51. P.2520-2525.
[12] E. Anklam, H. Berg, L. Mathiasson, M. Sharman, & F. Ulberth. Supercritical fluid extraction (SFE) in food analysis: a review. *Food Additives and Contaminants*. **1998**. Vol.15. P.729-750.
[13] M.M. Barth, C. Zhou, K.M. Kute, & G.A. Rosenthal. Determination of optimum conditions for supercritical fluid extraction of carotenoids from carrot (Daucus carota L.) tissue. *Journal of Agricultural and Food Chemistry*. **1995**. Vol.43. P.2876-2878.
[14] A. Basile, M.M. Jime´nez-Carmona, & A.A. Clifford. Extraction of rosemary by superheated water. *Journal of Agricultural and Food Chemistry*. **1998**. Vol.46. P.5205-5209.
[15] D. Bauman, M. Hadolin, A. Rizner-Hras, & Z. Cnes. Supercritical fluid extraction of rosemary and sage antioxidants. *Acta Alimentaria*. **1999**. Vol.28. P.15-28.
[16] T. Baysal, S. Ersus, & D.A.J. Starmans. Supercritical CO_2 extraction of b-carotene and lycopene from tomato paste waste. *Journal of Agricultural and Food Chemistry*. **2000**. Vol.48. P.5507-5511.
[17] E. Iban˜ ez, A. Cifuentes, A.L. Crego, F.J. Sen˜ora´ns, S. Cavero, & G. Reglero. Combined use of supercritical fluid extraction, micellar electrokinetic chromatography, and reverse phase highperformance liquid chromatography for the analysis of antioxidants from rosemary (Rosmarinus offininalis L). *Journal of Agricultural and Food Chemistry*. **2000a**. Vol.48. P.4060-4065.
[18] E. Iba´n˜ ez, A. Kuva´tova´, F.J. Sen˜ora´ns, S. Cavero, G. Reglero, & S.B. Hawthorne. Subcritical water extraction of antioxidant compounds from rosemary plants. *Journal of Agricultural and Food Chemistry*. **2003**. Vol.51. P.375-382.
[19] K.P. Johnston, D.H. Ziger, C.A. Ekert. Solubility of hydrocarbon solids in supercritical fluids. The augment van der Waals treatment. *Industrial & Engineering Chemical Fundamentals*. **1982**. Vol.21. P.191-197.
[20] E. Kosal, G.d. Holder. Solubility of anthracene and phenanthrene mixtures in supercritical carbon dioxide. *Journal of Chemistry Research*. **1987**. Vol.26. P.148-150.
[21] J.M. Dobbs, K.P. Johnston. Selectivities in pure and mixed supercritical fluid solvents. *Industrial & Engineering Chemistry Research*. **1987**. Vol.26. P.1476-1482.
[22] T.W. Zerda, B. Wiegand, J. Jonas. FTIR measurments of solubilities of anthracene in supercritical carbon dioxide. *Journal of Chemical & Engineering Data*. **1986**. Vol.31. P.274-277.
[23] J. Kwiatkowski, Z. Lisicki and W. Majewski. Ber. Busenges. *Phys. Chem*. **1984**. Vol.88. P.865.
[24] G. Rossling and E.U. Franck. Ber. Bunsenges. *Phys. Chem*. **1983**. Vol.87. P.882.
[25] G. Anitescu, L.L. Tavlarides. Solubilities of solids in supercritical fluids – I.New quasistatic experimental method for polycycylic aromatic hydrocarbons (PAHs) + pure fluids. G. Solubilities of solids in supercritical fluids. *Jourbnal of supercritical fluids*. **1997**. Vol.10. P.175-189.
[26] R.A. Van Leer, M.E. Paulaitis. Solubilities of phenol and chlorinated phenols in supercritical carbon dioxide. *Journal Chemical & Engineering Data*. **1980**. Vol.25. P.257-259.