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# FEASIBILITY OF TREATMENT OF REFINERY WASTEWATER BY A PILOT SCALE MF/UF AND UF/RO SYSTEM FOR REUSE AT BOILERS AND COOLING TOWERS

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*A pilot-scale hybrid membrane system, consisting of a ceramic microfilter (MF), two differentpolyvinyl chloride (PVC) and polyacrylonitrile (PAN) ultrafilters (UF), and a polyamide reverse osmosis (RO) filter, has been utilized to decrease harmful and damaging components in wastewater produced from Tehran Refinery with aim to be reused at boilers and cooling towers. Taguchi method was employed to find optimum operating conditions including transmembrane pressure, cross flow velocity (CFV), temperature, and backwash time. Further, analysis of variance (ANOVA) was performed to determine the significance of controlling factors on total organic carbon rejection and normalized permeate flux. MF (ceramic)/UF (PVC) system reduced, %: oil 99.7; chemical oxygen demand (COD) 82; biochemical oxygen demand (BOD) 79.3; conductivity 60.5; total dissolved solids (TDS) 52.6; turbidity 99.7 and total hardness 73.2. MF(ceramic)/UF (PAN) system reduced: oil, COD, BOD, conductivity, TDS, turbidity, and total hardness by 99.8; 84.2; 80.8; 62.72; 55; 99.9 and 78.4%, respectively. UF (PAN)/RO system decreased, %: oil 99.5; COD 99; BOD 99; conductivity 98; TDS 98; turbidity 98.7 and total hardness 99.94. Obtained treated wastewater by this system can be reused as feed water of boilers.*

**Keywords**: microfiltration; reverse osmosis; taguchi; ultrafiltration; wastewater.

## 1. Introduction

There are different methods applied in the field of wastewater treatment such as physical, chemical and biological methods that have been developed to

[14] *Melo M., Schluter H., Ferreira J. et al.* // Ibid.– 2010. – **250**. – P. 1016 – 1018.
[15] *Reyhani A., Sepehrinia K., Seyed Shahabadi S.M. et al.* // Desalination. Water Treatment. – DOI: 10.1080/19443994.2014.904821.
[16] *Mohammadi T., Moheb A., Sadrzadeh M., Razrni A.* // Desalination. – 2004. – **169**. – P. 21 – 31.
[17] *Montgomery D.C.* Design and analysis of experiments. – [6th ed.]. – New York: Wiley, 2005.
[18] *Bah'ado E., Prieto F., Vega M., Ferandez-Polanco F.* // Water Res. –1998. – **32**, N10. – P. 3055 – 3061.
[19] *Luftig J.T., Jordan V.S.* Design of Experiments in Quality Engineering. – New York: McGraw-Hill, 1998.
[20] *Mohammadi T., Razmi A., Sadrzadeh M.* // Desalination.– 2004. – **167**. – P. 379 – 385.
[21] *Sun D., Duan X., Li W., Zhou D.* // J. Membr. Sci. –1998. – **146**. – P. 65 – 72.
[22] *Ezzati A., Gorouhi E., Mohammadi T.* // Desalination. – 2005. – **185**. – P. 371 – 382.
[23] *Rezvanpour A., Roostaazad R., Hesampour M. et al.*// J. Hazard. Mater. – 2009. – **161**. – P. 1216 – 1224.
[24] *Reyhani A., Rajaei F., Shahmoradi M., Kahkesh A.* // Desalination. Water Treatment. – 2015. – **53**, N2. – P. 340 – 351.
[25] *Gonder Z.B., Kaya Y., Vergili I., Barlas H.* // Separ. Purif. Technol. – 2010. – **70**. – P. 265 – 273.
[26] *Reyhani A., Rekabdar F., Hemmati M. et al.* // Desalination. Water Treatment. – 2013. – **51**, N40/42. – P. 7499 – 7508.
[27] *Salahi A., Mohammadi T.* // Water Sci. Technol. – 2011. – **63**, N7. – P. 1476 – 1484.
[28] *Masters I., Khoei A.R., Gethin D.T.* // Book of Proceedings. – Vienna, 1991. – P. 115 – 124.
[29] *Micheletti W. C., Noblett J. G., Wilde K. A.* Design and Operating Guidelines Manual for Cooling-Water Treatment, EPRI, 1982.
[30] *Code* of Practice for Water-cooled Air Conditioning Systems. Pt. 2. Operation and Maintenance of Cooling Towers, EMSD, HKSAR, Jan. 2007.
[31] http://www.scribd.com/doc/57027533/Boiler-Water-Limits
[32] *Water* Pollution Control Ordinance, Cap 358AK – Technical memorandum standards for effluent discharge into drainage and sewage systems, inland and coastal waters. Special Gazette Supplement No. 5.

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