Iran Polym J (2012) 21:669–681
DOI 10.1007/s13726-012-0071-9

ORIGINAL PAPER

Migration of organic compounds from PET/clay nanocomposites: influences of clay type, content and dispersion state

Siamak Motahari · Lida Dornajafi · Iman Fotovat Ahmadi

Received: 26 February 2012 / Accepted: 10 July 2012 / Published online: 14 August 2012
© Iran Polymer and Petrochemical Institute 2012

Abstract Polyethylene terephthalate (PET) bottles are widely used for packaging mineral water or soft drinks. Migration of toxic residual phthalate esters from PET could potentially change the quality of the bottled contents. The main purpose of this study is to control the migration of five different phthalate esters from PET bottles into the water they contained. To achieve this goal, three different types of nanoclay particles were added to PET to slow down the migration of the toxic phthalate esters. The concentration of phthalate esters in the water in contact with PET and PET/nanoclay was measured by gas chromatography (GC-FID) combined with the directly suspended droplet microextraction method. Good precision, accuracy and reproducibility over a wide linear range were achieved by the proposed technique under optimal conditions. The experimental results reveal that adding nanoclay fillers to the PET decreases the release of the above-mentioned chemicals from PET into the water considerably due to attainment of a tortuous diffusive path. Data also indicate the significant effect of nanoclay volume fraction and exfoliated morphology on obtaining efficient barrier properties. Furthermore the effects of parameters such as storage time, temperature, and amount and type of nanoclay inclusions were studied on the migration rate, as well.

Keywords Nanocomposites · Polyethylene terephthalate · Directly suspended droplet microextraction · Gas chromatography · Barrier properties

S. Motahari (✉) · L. Dornajafi · I. Fotovat Ahmadi
School of Chemical Engineering, College of Engineering, University of Tehran, P.O. Box: 11155-4563, Tehran, Iran
e-mail: smotahari@ut.ac.ir

Introduction

The increasing demand for versatile properties, such as good impact resistance, chemical resistance, transparency, being light weight and possibility of recycling in food, beverages and cosmetic packaging industries, have made polyethylene terephthalate (PET) one of the most widely applied thermoplastics. However, it should be noticed that diffusion and migration of by-products, catalysts, additives as well as hydrolysis and thermal degradation residues of either virgin or recycled PET into food or water may contaminate its content. Phthalate esters are potential migrant compounds which are not covalently bound to plastic materials [1]. Their presence and migration from PET into water and foods have been investigated by several authors [2–6]. Prokupková et al. [5] showed the presence of various phthalate esters including dimethyl phthalate (DMP) diethyl phthalate (DEP), dibutyl phthalate (DBP), and bis 2-ethylhexyl phthalate (DEHP) in water and concluded that the type of packaged material could affect the concentrations of these esters. Rios et al. [7] analyzed olive oils that were kept in a PET containers for several months and determined the presence of DBP, DEHP, benzyl butyl phthalate (BBP) and di-iso butyl phthalate (DIBP) in the samples, but none of DMP and DEP was detected. Substantial considerations have been given to the influence of phthalate esters on human health recently due to their potential toxicity [8, 9]. Scientific researches have shown that phthalate esters may adversely affect the human body and impair human fertility comprising a reduction in the level of sex hormones in both genders [10–13]. Bearing in mind their potential risks to human health and the environment, these phthalates are on the first three priority lists for risk assessment in accordance with the European Union's Regulation 793/93 on existing substances. The US