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Atmospheric concentrations and air–sea exchanges of phthalates in the North Sea (German Bight)

Zhiyong Xie[a,b,*], Ralf Ebinghaus[a], Christian Temme[a], Armando Caba[a], Wolfgang Ruck[b]

[a]*GKSS Research Centre, Institute for Coastal Research, Max-Planck-Str. 1, D-21502 Geesthacht, Germany*
[b]*Institute of Ecology and Environmental Chemistry, University of Lueneburg, Scharnhorststr. 1, D-21335 Lueneburg, Germany*

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Abstract

Phthalates, e.g. dimethyl phthalate (DMP), diethyl phthalate (DEP), di-n-butyl phthalate (DBP), benzylbutyl phthalate (BBP), and di-(2-ethylhexyl) phthalate (DEHP) were measured in the atmosphere and sea water of the North Sea (German Bight). The air and water samples were collected during an expedition cruise with German research ship '*Gauss*' in the North Sea from 29th February to 10th March 2004. The concentrations of phthalates in the atmosphere ranged from below the method detection limit to 3.4 ng m^{-3}. DBP, BBP, and DEHP were determined in the water phase with concentrations ranging from below the method detection limit to 6.6 ng L^{-1}.

Air–sea vapour exchange of DBP, BBP, and DEHP was estimated using the two-film resistance model based upon relative air–water concentrations. The average of air–sea exchange fluxes was $-338\,ng\,m^{-2}\,day^{-1}$ for DBP and $-13\,ng\,m^{-2}\,day^{-1}$ for BBP, which indicates a net deposition is taking place. The air–sea exchange fluxes of DEHP were ranging from -95 to $+686\,ng\,m^{-2}\,day^{-1}$. The average value of $+53\,ng\,m^{-2}\,day^{-1}$ for DEHP suggested a net volatilization from the North Sea. Moreover, the particle-associated fractions were calculated as 2%, 46%, 75% and 78% for DEP, DBP, BBP and DEHP, respectively. These results indicate that the air–sea vapour exchanges is an important process that intervenes in the mass balance of phthalates in the North Sea.

Keywords: Phthalate; Atmosphere; Sea water; Air–sea exchange

1. Introduction

Phthalates are widely used as plasticizers in polyvinylchlororide (PVC) resins and other industrial consumer products (ECETOC, 1988; Giam et al., 1984; Graham, 1973). Since these additives are not chemically bound in the polymer, they are available to leach from the matrix. Furthermore, phthalates are commonly components of detergents, building products and carriers in pesticide formulations. Release of phthalates into the environment during manufacture, use, disposal and their environmental fate has been reviewed (Wams, 1987; Cadogan et al., 1993; Staples et al., 1997). The United States Environmental Protection Agency (USEPA) and its counterparts in several other countries have classified the most commonly occurring phthalates as priority pollutants and endocrine disrupting compounds.

Toxicity of phthalates has been a subject of discussion and public concern. Some phthalates have been linked to

*Corresponding author. GKSS Research Centre, Institute for Coastal Research, Max-Planck-Str. 1, D-21502 Geesthacht, Germany. Tel.: +49 4152 872372; fax: +49 4152 872366.
E-mail address: zhiyong.xie@gkss.de (Z. Xie).

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