Environ Monit Assess (2007) 124:39–50
DOI 10.1007/s10661-006-9207-8

ORIGINAL ARTICLE

Determination of volatile organic compounds pollution sources in malaysian drinking water using multivariate analysis

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Received: 12 July 2005 / Accepted: 17 February 2006 / Published online: 12 September 2006

Abstract A field investigation was conducted at all water treatment plants throughout 11 states and Federal Territory in Peninsular Malaysia. The sampling points in this study include treatment plant operation, service reservoir outlet and auxiliary outlet point at the water pipelines. Analysis was performed by solid phase micro-extraction technique with a 100 μm polydimethylsiloxane fibre using gas chromatography with mass spectrometry detection to analyse 54 volatile organic compounds (VOCs) of different chemical families in drinking water. The concentration of VOCs ranged from undetectable to 230.2 μg/l. Among all of the VOCs species, chloroform has the highest concentration and was detected in all drinking water samples. Average concentrations of total trihalomethanes (THMs) were almost similar among all states which were in the range of 28.4–33.0 μg/l. Apart from THMs, other abundant compounds detected were *cis* and *trans*-1,2-dichloroethylene, trichloroethylene, 1,2-dibromoethane, benzene, toluene, ethylbenzene, chlorobenzene, 1,4-dichlorobenzene and 1,2-dichlorobenzene. Principal component analysis (PCA) with the aid of varimax rotation, and parallel factor analysis (PARAFAC) method were used to statistically verify the correlation between VOCs and the source of pollution. The multivariate analysis pointed out that the maintenance of auxiliary pipelines in the distribution systems is vital as it can become significant point source pollution to Malaysian drinking water.

Keywords Volatile organic compounds · Drinking water · PCA · Parafac

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1. Introduction

The occurrence of volatile organic compounds (VOCs) in drinking water create a major concern over the possible health risk because, even at very low concentrations, many of these materials are toxic, carcinogenic or mutagens (Sacks and Akard, 1994). As considerable quantities of VOCs are manufactured in Malaysia, their use is certainly ubiquitous. VOCs are contained in many manufactured products, including paints, adhesives, gasoline, and plastics (Nikolaou *et al.*, 2002). Therefore, when these products are not stored, used and disposed off with care, VOCs can contaminate our source of drinking water. But apart from anthropogenic emission, VOCs can gain or lost during the water treatment and distribution process. Trihalomethanes (THMs) can form during chlorination at the water treatment plant in the distribution system (Pauzi *et al.*, 2002) and some