Journal of Environmental Radioactivity 233 (2021) 106574

Contents lists available at ScienceDirect

Journal of Environmental Radioactivity

journal homepage: http://www.elsevier.com/locate/jenvrad

Measurements of alpha radioactivity in thermal power plant effluents employing CR-39 detector based improved alpha track detection method

Sushma S. Chavan, Hemlata K. Bagla *

Department of Nuclear & Radiochemistry, Kishinchand Chellaram College, Vidyasagar Principal K. M. Kundnani Chowk, D.W. Road, Churchgate, Mumbai, 400020, India

ARTICLE INFO

Keywords:
CR-39
Tetraethyl ammonium bromide
Alpha tracks
^{238}U
^{232}Th
ICP-MS

ABSTRACT

Natural radioactivity is released into the environment during the combustion process of coal at various thermal power plants. Coal contains higher contents of α-emitting radionuclides such as ^{238}U, ^{232}Th along with their decay elements, which pose a potential health risk to the population. In the present studies, the effluent waste samples were collected from a coal fired Thermal Power Plant. Samples were collected in the form of solid residues and filtrates. CR-39 detector pieces were then exposed for varying time with residue and filtrate samples for registering the alpha tracks for α-detection and measurement. Thus, registered alpha particles in CR-39 detectors were revealed by employing the conventionally used 6M NaOH/KOH etchant and 5% tetraethyl ammonium bromide (TEAB) as a phase transfer catalyst in 6M NaOH/KOH etchant. Under both compositions of the etchants, CR-39 detectors were etched at 60 °C for 6 h for developing alpha tracks for observations under optical transmission microscope. Alpha track densities (T_d) and alpha track diameters in the etched CR-39 detectors for all samples were measured. The introduction of new chemical etchant effectively improved the uniformity in distribution of alpha tracks, enhanced the track density, and reduced the time of track revelation in CR-39 detectors. Therefore, it could be concluded that the phase transfer catalyst TEAB was highly effective in the etchant for alpha track revelation and detection as compared to conventionally used 6M NaOH etching method. Apart from measuring alpha radio activities, the amounts of ^{238}U & ^{232}Th in the samples were also measured by ICP-MS for understanding the alpha radio activities measured in the coal samples.

1. Introduction

With advancement in the industrial and technological growth and applications, a general awareness has also arisen regarding the adverse side effects of disturbing natural environment. Non-nuclear industries utilizing natural raw materials are spread all over India and are steadily increasing. These industries may significantly contribute to the alpha radioactive discharges, due to pre-concentrations of naturally occurring α-emitting radionuclides such as ^{238}U, ^{232}Th along with their decay elements into the environment as waste waters. In these industrial units including thermal power plants, coal is used as the main fuel and consumption of coal for power production is highly associated with the release of some naturally occurring radionuclides along with other toxic pollutants to the environment (Central Statistics Office, 2015; Chakarvarti and Kant, 2003a). According to the Environmental Protection Act, the thermoelectric power plants alone contribute to 50–60% of all toxic contaminants released into surface waters by all industrial groups under the Clean Water Act (CWA). Coal-burning as well as discharges from these power plants dump millions of gallons of wastewater loaded with toxic pollutants like arsenic, lead, mercury, boron, cadmium, chromium, and selenium into rivers, lakes, streams, and bays. This pollution is discharged directly into surface water from power plants and impoundments in the form of dispose of coal ash and smokestack scrubber sludge etc. Toxic chemicals also percolate from unlined impoundments and landfills into ground and surface waters (Chakarvarti et al., 2005; Agrahari and Sengupta, 2017). In the combustion process, most of the mineral material in coal is converted into ash. Coal found in nature also contains trace quantities of naturally occurring radionuclides such as ^{238}U, ^{232}Th and ^{4}K and their decay elements (Mishra et al., 2008; Chauhan et al., 2013; Kumar et al., 2015). The exposure of these radionuclides on human beings has been enhanced due to burning of coal in thermal power plants and its subsequent release into the environment. The exposure of the population to high concentration of radionuclides due to their long half lives and their daughter elements leads

* Corresponding author.
E-mail addresses: hemlata.bagla@kccollege.edu.in, hemabagla@gmail.com (H.K. Bagla).

https://doi.org/10.1016/j.jenvrad.2021.106574
Received 12 October 2020; Received in revised form 2 January 2021; Accepted 28 February 2021
Available online 30 March 2021
0265-931X/