UNIVERSITI TEKNOLOGI MARA

# DEVELOPMENT OF METHOD FOR SIMULTANEOUS MEASUREMENT OF GROSS ALPHA AND BETA IN AQUEOUS ENVIRONMENTAL SAMPLES

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**ABSTRACT**

Measurement of gross alpha and beta in aqeous environmental sample using standard method is a very lengthy, tedious and time consuming process. Alternatively, liquid scintillation counting (LSC) offers a better solution, since the latest model of LSC offer simultaneous counting of gross alpha and beta. The success of LSC technique will depend on two factors; first is the proper setting of the LSC window and its pulse shape analyzer (PSA) concluded in the new protocol for alpha beta simultaneous counting. Secondly, the successful incorporation of the water phase which contains the radionuclides into the organic solvent phase using proper choice of emulsifier which produce a clear stable solution with reasonably high counting rate and figure of merit. This new developed method was validated to ensure that it gave accurate and precise results and the method was verified. Later, the method was applied for measuring various types of environmental water samples including river water, lake water, hot spring water, sea water, mineral and drinking water. The activity concentrations of gross alpha and gross beta in various types of water were above the limit of National Water Quality Standard except for bottled mineral and drinking water. Another aspect of this study was to construct the gross alpha and gross beta spectra using Microsoft excel in order to identify the radionuclides present in the samples through their spectrum. Therefore the result was not only based on the count rate but also the spectrum of the samples. Additional information from the spectrum will help researcher to plan for further analysis if needed.

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# CHAPTER ONE
# INTRODUCTION

## 1.1 LIQUID SCINTILLATION COUNTING

Liquid Scintillation Counting (LSC) is the most sensitive and widely used technique for the detection and quantification of beta emitters in liquid media including aqueous solution. Liquid Scintillation Counting (LSC) system was designed to detect low energy beta particles (e.g. $^{3}H$ and $^{14}C$) to high energy beta particles (e.g. $^{90}Y$, and $^{106}Rh$). LSC was first developed to detect beta emitters in the organic phase only. Later, the applications become wider when the scintillation cocktail was introduced which was capable of incorporating the aqueous phase into the organic phase (Dyer, 1980; Peng, 1992; L'Annunziata, 2012). Depending on the cocktail (i.e. scintillator-solvent-aqueous mixture), the beta detection efficiency is dependent on energy, spectral shape and cocktail (Rodriguez and Carles, 1998; Villa et al., 2003; Zapata et al., 2009). Typically, beta particles with maximum energies ($E_{max}$) more than 0.250 MeV are detected with more than 90 per cent counting efficiency (Salonen, 2006a; Mushin Waleed Mohammed & Al-Badrani et al., 2008).

The principle of this method is to convert the radioactive emissions from a sample to photons of visible light that can be detected by photomultiplier tube. To do this, the radioactive sample placed, into a vial with organic scintillation liquid. This liquid contains a fluor, a compound that fluoresces when it is bombarded with radiation from the radioactive material. Thus, it converts the invisible radioactivity into a visible light.

A liquid scintillation counter is an instrument that takes the 20 mL vial containing organic solvent with scintillator and places it in a dark chamber with a photomultiplier tube. There, the photomultiplier tube detects the light resulting from the radioactive emissions causing the excitation of the fluor. The instrument counts these bursts of light, or scintillations, and records them as counts per minute (CPM) (Cassette & Vatin, 1992; Sanchez and Pujol, 1995).

Alternatively, a radionuclide in aqueous solution is introduced into a scintillation cocktail that contains solvent, organic scintillators and an emulsifier. The