# Determination of $^{14}$C-DDT Radioactivity in Sea Water and Marine Suspended Matter by Liquid Scintillation

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Organic pollutants play an important role in general marine pollution. Additional knowledge of their concentration processes and their distribution among various components of marine environment is desirable. Investigations of the fate of various organic pollutants in an aquatic environment are frequently carried out by radiotracer method. In such investigations $^{14}$C is often used as a radiotracer for pesticides, fatty acids, phenols, hydrocarbons, etc. Most of the published papers on this subject deal with the measurements of $^{14}$C radioactivity in liquid phase, and procedures are often limited to small volumes.

Various pretreatment techniques have been used for $^{14}$C radioactivity distribution measurements in aquatic system. Lotse et al. (1) extracted $^{14}$C labelled pesticides from water phase and then measured preconcentrated solvent phase. Yaron et al. (2) measured directly from water phase, while Cox (3) applied the same procedure for sea water. Very limited number of papers exist describing the $^{14}$C labelled pesticides radioactivity measurements in solid phase (4,5). Mentioned authors applied their methods to the solid phase radioactivity measurements in samples where the amount of water was not higher than 1 ml, while the total volume of scintillator plus water was 20 mls. According to our best knowledge, there are no published experimental procedure and data on the measurement of $^{14}$C radioactivity of solid phase in samples of sea water larger than 1 ml. Such an experimental technique should yield more accurate results than the previous low quantity techniques because it will eliminate many sources of the experimental errors in laboratory systems.

## MATERIALS AND METHODS

$^{14}$C labelled DDT used in this work was obtained from the Radiochemical Centre, Amersham, England, as benzene solution containing 100 µCi/1 ml benzene. Specific activity was 23.9 mCi/mM and the compound had labelled $^{14}$C in benzene ring.

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All measurements were performed at 6°C using a Packard Tri Carb Model 3375 liquid scintillation spectrometer at the optimum settings. Applied high voltage was 430 V and amplification 5.0 %. The lower and the upper discriminators of two channels were set at 50 and 1000 divisions. It was assumed that the standard counting error was less than 0.5 %.

Two types of scintillation fluids were used during the course of this work: (a) a mixture of two volume parts of toluene scintillator and one volume part of Tritone-X-100 (Tritone scintillator); (b) InstaGel obtained from Packard.

Sea water samples for the radioactivity measurements were prepared either by the contamination of sea water with known activity of $^{14}$C-DDT of $^{14}$C-DDT was added as an internal standard in the form of toluene solution of known radioactivity. A known volume of such prepared sea water was transferred into a flask for scintillation counting. Certain volume of the scintillation fluid was also introduced into a flask and a resulting solution was shaken for about 1 minute. Samples prepared in such a manner were deposited for at least 20 minutes at constant temperature of ±6°C and then counted.

Preparation of $^{14}$C-DDT contaminated suspended matter was done by the addition of $^{14}$C-DDT to the sea water samples. Then the contaminated sea water was introduced to the flasks where already were placed weighed amounts of various solid phase. Systems were shaken and then 10 ml of scintillation fluids were added and the radioactivity measurements performed.

## RESULTS AND DISCUSSION

The mixture of Tritone and InstaGel scintillator with sea water would yield homogeneous clear emulsion if the concentration of water in mixture is below 10 %. When the concentrations of water used in mixtures were above 10 %, two separate layers formed or solution turned turbid. These phenomena influence on the efficiency and the reproducibility of counting measurements.

Our experimental conditions required the measurements of radioactivity in the volumes of 10 ml of the sea water samples. Even under such unfavourable experimental conditions when the samples containing liquid scintillator and sea water were turbid, the application of external standards made measurements reproducible. A calibration curve for the relation of efficiency factor of $^{14}$C-DDT measurement in sea water (under the mentioned experimental conditions) to external standard ratio is presented in Fig. 1. Results are given for two different scintillation mixtures, and they speak themselves in favour of InstaGel because of better efficiency.

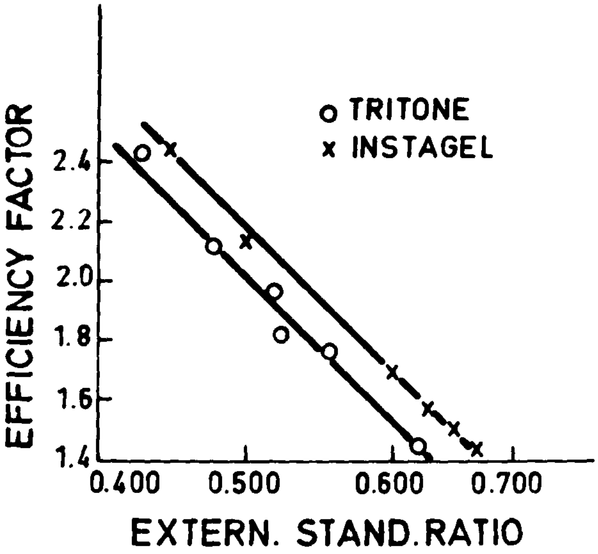

Fig. 1. Relation of efficiency factor to external ratio for $^{14}C$-DDT radioactivity measurements in the presence of Tritone and InstaGel scintillators in sea water medium.

Data presented in Fig. 2 correspond to Tritone scintillator and show the relation of various efficiency factors and the external standard ratios for Adriatic sediments, Pacific sediments, Mediterranean sediments, heated Adriatic sediments, and limestone samples. Detailed characterization of used sediments and limestone, as well as their treatment, has been already published (6). Results indicate that the applied method using Tritone scintillator produced satisfactory reproducibility in measuring $^{14}C$ radioactivity when solid phase were limestone or heated Adriatic sediment. Moreover, in the case of Adriatic sediment, and especially Pacific and Mediterranean sediments data were not reproducible. The main reason for this effect is beleived to be the organic matter content of those samples.

Fig. 3 shows experimental data obtained by InstaGel scintillator for Adriatic, Pacific and Mediterranean marine sediments. Calibration curves indicate that the reproducibility of $^{14}C$ measurements in these cases is fairly good.

In Table I are listed the results on external standard ratio and the counting efficiency of the investigated systems.

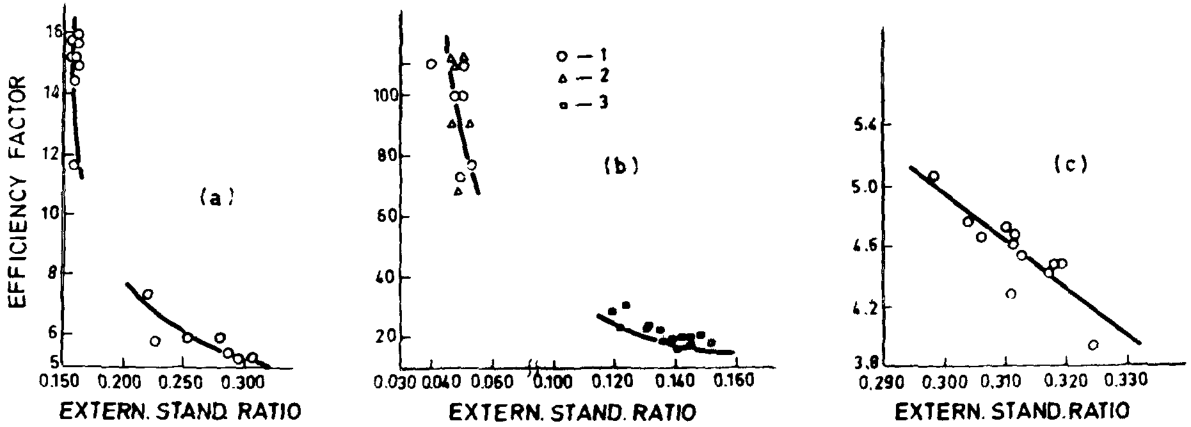

Fig. 2. Relation of efficiency factor to external standard ratio for (a) Adriatic marine sediment; (b) Pacific (1), Mediterranean (2) and previously heated Adriatic sediments (3); (c) limestone when Tritone scintillator was used.

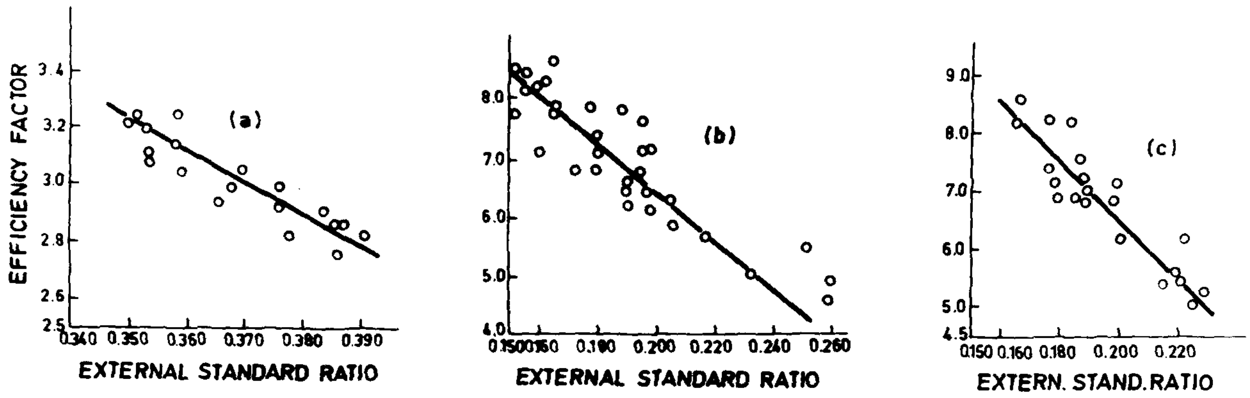

Fig. 3. Relation of efficiency factor to external standard ratio for (a) Adriatic marine sediment; (b) Pacific marine sediment; (c) Mediterranean marine sediment when InstaGel scintillator was used.

TABLE I

External Standard Ratio and Counting Efficiency of the Investigated Systems

| Solid phase | Scintillator | No. of measurem. | Range of efficiency % | External standard ratio |
|---|---|---|---|---|
| Marine sediment | Tritone | 15 | 6.3-19.6 | 0.155-0.305 |
| | InstaGel | 26 | 30.5-38.2 | 0.340-0.392 |
| Heated marine sediment | Tritone | 15 | 3.2- 8.0 | 0.120-0.155 |
| | InstaGel | 16 | 29.3-32.0 | 0.301-0.322 |
| Pacific marine sediment | Tritone | 16 | 0.9- 1.4 | 0.038-0.055 |
| | InstaGel | 30 | 11.2-22.1 | 0.152-0.252 |
| Mediter. marine sediment | Tritone | 16 | 0.9- 1.5 | 0.045-0.058 |
| | InstaGel | 21 | 11.6-19.6 | 0.165-0.228 |
| Limestone | Tritone | 17 | 18.0-25.5 | 0.288-0.325 |
| | InstaGel | 22 | 42.0-49.2 | 0.423-0.442 |
| Quartz | Tritone | 17 | 20.5-25.0 | 0.312-0.328 |
| | InstaGel | 30 | 40.4-49.5 | 0.411-0.436 |

The comparison of the applied InstaGel method for $^{14}$C scintillation measurements, in the presence of solid particles in sea water medium to the previously used liquid scintillation techniques with Tritone scintillator showed that the efficiencies of InstaGel systems are much higher.

In conclusion it should be stressed that the proposed method with InstaGel scintillator is suggested for the measurement of $^{14}$C in the presence of solid particles and under conditions where the content of water in samples is relatively high.

LITERATURE

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