Informative progress report on the standards for water absorbed dose at PTB

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Water calorimetry

At the PTB, a water calorimeter will be established as a primary standard for realising the unit Gy for water absorbed dose, D_W, at ^{60}Co-γ-radiation, shortly after upgrading the existing ^{60}Co-γ-source (see below). The final detector version of the water calorimeter is a plane-parallel glass cylinder in which two thin glass pipettes containing a thermistor each are mounted opposite to each other. The diameter and the length of the glass cylinder are 95 mm and 41 mm, respectively. The wall thickness of the flat front and rear walls, which are directed perpendicularly towards the beam axis, is 0.75 mm. The geometry of the detector cylinder can be adequately modelled within a finite element computer program, allowing the verification of simulated radiation induced heat conduction effects by comparison with the corresponding experimental data. In a recent investigation [1], it could be demonstrated that good agreement between measured and calculated data is achieved and that corrections for heat conduction effects in the order of 0.2 % arise for the typical operation mode of the calorimeter. Investigations are now being prepared for the determination of the perturbation effect of the plane-parallel detector in the ^{60}Co-γ-radiation field. This will be done by comparative ionisation chamber measurements in the water phantom of the calorimeter with and without the plane-parallel glass cylinder. The corresponding results will be compared to the results of Monte Carlo calculations, taking into account the real geometry of the caloric detector.

New irradiation facility

Currently PTB is in the process of acquiring a new ^{60}Co irradiation facility. The facility will be equipped with one source in a fixed position with a strength of about 300 TBq. The radiation will be switched on and off by a moving shutter. For a transitional period beginning at the end of 2001 the new 300 TBq source will be accommodated in the irradiation facility existing at PTB now. This will be the starting point for operating the water calorimeter under conditions close to those envisaged in the long term perspective.

D_w/K_a intercomparison

In February 2001 PTB participated in an intercomparison between primary laboratories of the standards for absorbed dose to water and air kerma in ^{60}Co radiation, denoted by the symbol CCRI(I)-K4. The measurements were conducted as routine calibrations. The primary absorbed dose to water standard used in this comparison was PTB's 'traditional' one i.e. the one based on total absorption of electron radiation in ferrous sulfate solution. For reasons of continuity the air kerma calibration factor used in this exercise was based on k_{wall} factors determined by the extrapolation method (see also the report on cavity chambers by Büermann, Kramer and Csete). This allows a direct comparison with the results of a similar exercise conducted in 1989. Three ionisation chambers of different types, supplied by BIPM, were calibrated. The ratio of calibration factors N_{Dw} / N_{Ka} for chamber NE2571-2106 was 1.092. This value is close to the long long term average for chambers of this type. The relative uncertainty of the calibration factor N_{Dw} is 1.4 % (coverage factor k=2). The intercomparison results are to be published by BIPM.

Chemical dosimetry

A project is under way for replacing Fricke by Alanin dosimetry. The shift will be a gradual one. Fricke dosimetry will be kept operational until the Alanin/EPR system is in orderly operation. The reasons behind this change are described in detail in a PTB laboratory report (in German language) by Anton [2].

Dosimetry for Brachytherapy

After the completion of numerous clinical studies on intravascular brachytherapy the dosimetry for this kind of treatment is gaining rapidly importance. It is anticipated that there will be at least 60.000 patients per year in Germany undergoing intravascular irradiations. In view of this development PTB is currently working on two standards for water absorbed dose in fields of beta sources. One is designed for operation in the field of extended sources with an area of typically 1 cm^2 and the other one in fields of train seeds. It is hoped to be able to offer calibrations with the first mentioned chamber during the course of the year 2001. The second chamber, which will be developed as a primary standard and which is based on a proto-type of similar design by Bambynek [3] is a multielectrode extrapolation chamber possessing an array of measuring electrodes each with an area as small as 1 mm by 1 mm, where the gap between the measuring and the surrounding guard electrode is 2 µm in width.

[1] A. Krauss, Thermochim. Acta (to be published)
[2] M. Anton, Dosimetrie mit Eisensulfat, Alanin/ESR und TLD – Ein Vergleich – (to be published 2001)
[3] M Bambynek, Entwicklung einer Multielktroden-Extrapolationskammer als Prototyp einer Primärnormal-Meßeinrichtung zur Darstellung der Meßgröße Wasser-Energiedosis von Beta-Brachytherapiequellen, Dissertation, Universität Dortmund, Germany, 2000.