Factors Limiting the Linearity of Response of Tissue Equivalent Proportional Counters Used in Micro- and Nano – Dosimetry

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The ideal gas detector which may be used in micro- or nano-dosimetry to determine the energy transferred by radiation and its distribution in the biological objects must fulfill a number of requirements. From one side, the counter must be microdosimetry and on the other side must be proportional. Most of the currently used microdosimetric detectors are a compromise between the method of their construction and of their use and the extent to which a counter simulates the biological object. The best are spherical gas proportional counters because of their perfect symmetry of the directional absorption of the incident radiation. Cylindrical counters are also used because of the simplicity of their design and construction. Cylindrical counters should have the active length equal to their diameter. This is in contradiction with preserving the counters proportionality. In too short counters there is a deformation of the electric field associated with the fitting of the anode. Of course, the system of potential rings can improve the field distribution but not fully.

In this paper the limitations in counters use from the side of counters proportionality will be presented. Tissue Equivalent Proportional Counters (TEPC) are proportional counters that can be used to simulate interactions and energy transferred to small tissue volumes, which allows the absorbed dose to be determined. TEPCs operate to simulate site sizes in the micro-meter range. To achieve this size scaling, the physical size of the detector and the density of the TEG gas are used as variables, as they form a conjugate pair controlling the site size simulation.

Systematic measurements of the gas multiplication factor over the range 1.0 - 7×10^5 have been made in a cylindrical Methane- and Propane based TEG filled proportional counters as a function of the applied voltage between cathode and anode, for mixture pressure from 9 hPa to 500 hP. For these mixtures following characteristic parameters have been determined: the highest stable gas gain, its dependence on mixture pressure and counter geometry, photon feedback parameters, radius of electron avalanche as the function of gas gain and mixture pressure, the critical current (maximal dose) over which the reduction in gas gain due to space charge is observed.

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