A tandem system for quality control in mammography beams

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A tandem ionization chamber system has been developed to be applied in mammography energy range dosimetry [1]. This system consists of two ion chambers with different collecting electrode materials: aluminum and graphite. Both chambers have a sensitive volume of 6 cm^3 that is suitable for the mammography range. Characteristics as saturation, ion collection efficiency, linearity of chamber response versus air kerma rate and energy dependence were determined. The results of energy dependence allowed the determination of the tandem curve. The advantage of this system is that it can be used in the determination/confirmation of half-value layers (without the use of absorbers) in quality control programs of X-rays. All measurements were carried out in the Calibration Laboratory of IPEN.

The ionization chambers were irradiated in a Pantak Seifert Isovolt 160HS X-ray system with a tungsten target that operates from 5 to 160 kV (the currents can be varied between 0.1 and 45 mA). This equipment has an inherent filtration of 0.8 mmBe. The detectors where exposed to mammography radiation qualities presented in Table 1 [2].

Table 1. Mammography radiation qualities used in this work for a current of 10 mA and an additional filtration of 0.07 mmMo

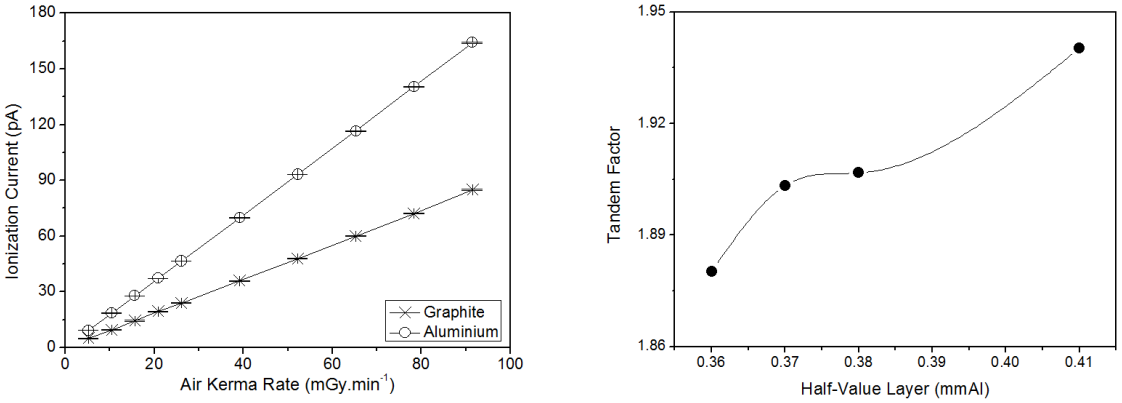
Radiation Quality	Tube Voltage (kV)	Half-Value Layer (mmAl)
WMV25	25	0.36
WMV28	28	0.37
WMV30	30	0.38
WMV35	35	0.41

The measurements taken by the ionization chamber system proposed in this work were compared with those taken with the reference ionization chamber Radcal RC6M, calibrated at PTB.

The ion collection efficiency for both ionization chambers was higher than 99.0%, as recommended for ionization chambers [3]. For the linearity test the ionization chambers were exposed to the WMV28 radiation quality. Ten air kerma values were measured with the chambers; for each point five measurements were taken and the mean values were considered. The results for the linearity test are presented in Fig. 1a, with correlation coefficients of 0.99999 for the aluminum and 0.99997 for the graphite colleting electrode ionization chambers. For the energy dependence test the ionization chambers were exposed to the radiation qualities presented in Table 1. The calibration factors were determined using the reference ionization chamber. These test results are presented in Fig. 1b, as a tandem curve,

where the tandem factor is defined as the ratio between the responses of both ionization chambers. This curve allows the confirmation and determination of effective energies of unknown X-ray beams. The response variation for aluminum collecting electrode it was 3.3% and for graphite collecting electrode it was only 0.06%. The standard deviation values were lower than 1.0%, therefore not visualized in Fig. 1b.

The results show that this chamber system is suitable to be used in mammography energy range.



(a) (b)

Fig. 1.(a) Linearity of the response of the ionization chamber with graphite and aluminum colleting electrodes; (b) Tandem curve of the ionization chambers for the gaphite and aluminum colleting electrodes.

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