Rapport BIPM-90/1

Influence of gas tubes on the current measurements of the Mg/Ar ionization chambers

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Abstract

Measurements carried out in the BIPM-calibrated ^{60}Co gamma-ray beam show that the responses (i.e. currents) of the Mg/Ar ionization chambers depend on the type and the length of the gas tubes used. This "tubing effect" permits to clarify a discrepancy which has occurred in the international comparison concerning the photon calibration factors of the BIPM Mg/Ar chamber measured at the participating laboratories.

1. Introduction

In the BIPM neutron-dosimetry comparison [1], for which the BIPM supplied the transfer instruments and analyzed the results, it has been observed that for the BIPM Mg chamber, flushed with Ar, the values of the photon calibration factors measured at the BIPM are on an average about 2 % higher than those obtained at the participating laboratories. This seems to indicate that the response of the BIPM Mg chamber, obtained at the BIPM, was too low (by about 2 %) when the chamber was flushed with Ar. In order to clarify the reason for this difference, a study of the Mg chambers has been performed at the BIPM, in the ^{60}Co photon field, by using different types of gas tubes on the one hand, and by doubling the length of some of the tubes on the other hand.

2. Experimental conditions

The measurements are carried out with three Exradin MG2-type magnesium chambers, including chamber n° 139 which has been used in the BIPM neutron-dosimetry comparison. The ionization currents are measured using the Townsend method with an automatic device [2]. For a given Ar gas-flow rate, the pressure in the cavity volume of the chamber is determined by the mean value of two pressures measured in the gas-flow circuit at points situated respectively before (inlet) and after (outlet) the chamber. The temperature of the circulating Ar gas is measured by a thermistor placed inside the gas-flow circuit. Two flow ratemeters, placed before and after the chamber, permit the control of the tightness of the gas-flow system of the chamber.

3. Results and discussion

Figures 1, 2 and 3 give the responses of the Mg/Ar chamber n° 139 which has been measured in the BIPM-calibrated ^{60}Co gamma-ray beam, in terms of the Ar gas-flow rates. The result shows that the responses with the Voltalef-type tubes, which are employed usually at the BIPM, and only at the BIPM, are lower than those obtained by all the other types of tubes of the same length (2 x 2.30 m). For example, differences of 0.2 % (teflon), 0.8 % (PVC), 1.3 % (tygon) and 1.4 % (rubber) have been observed for the gas-flow rate chosen in the comparison (Figure 1), and differences of 2.0 % (tygon) and 2.1 % (rubber) were obtained for tubes of double length (2 x 4.60 m) (Figures 2 and 3, respectively). Similar results have been obtained with the other two chambers. These observations seem to explain the results of the BIPM neutron-dosimetry comparison, in which the responses of the BIPM Mg/Ar chamber n° 139, measured at the BIPM, were on the average about 2 % lower than those obtained at the participating laboratories. The reason is that only the BIPM used the Voltalef-type tubes and that, in general, the other participants used longer tubes.

This "tubing effect" is a result of the well-known Jesse effect which occurs in noble gases when very small amounts of other gases (impurities) are added. The gas then shows a great increase in the ionization produced by a charged particle. A review of this interesting effect can be found e.g. in reference [3].

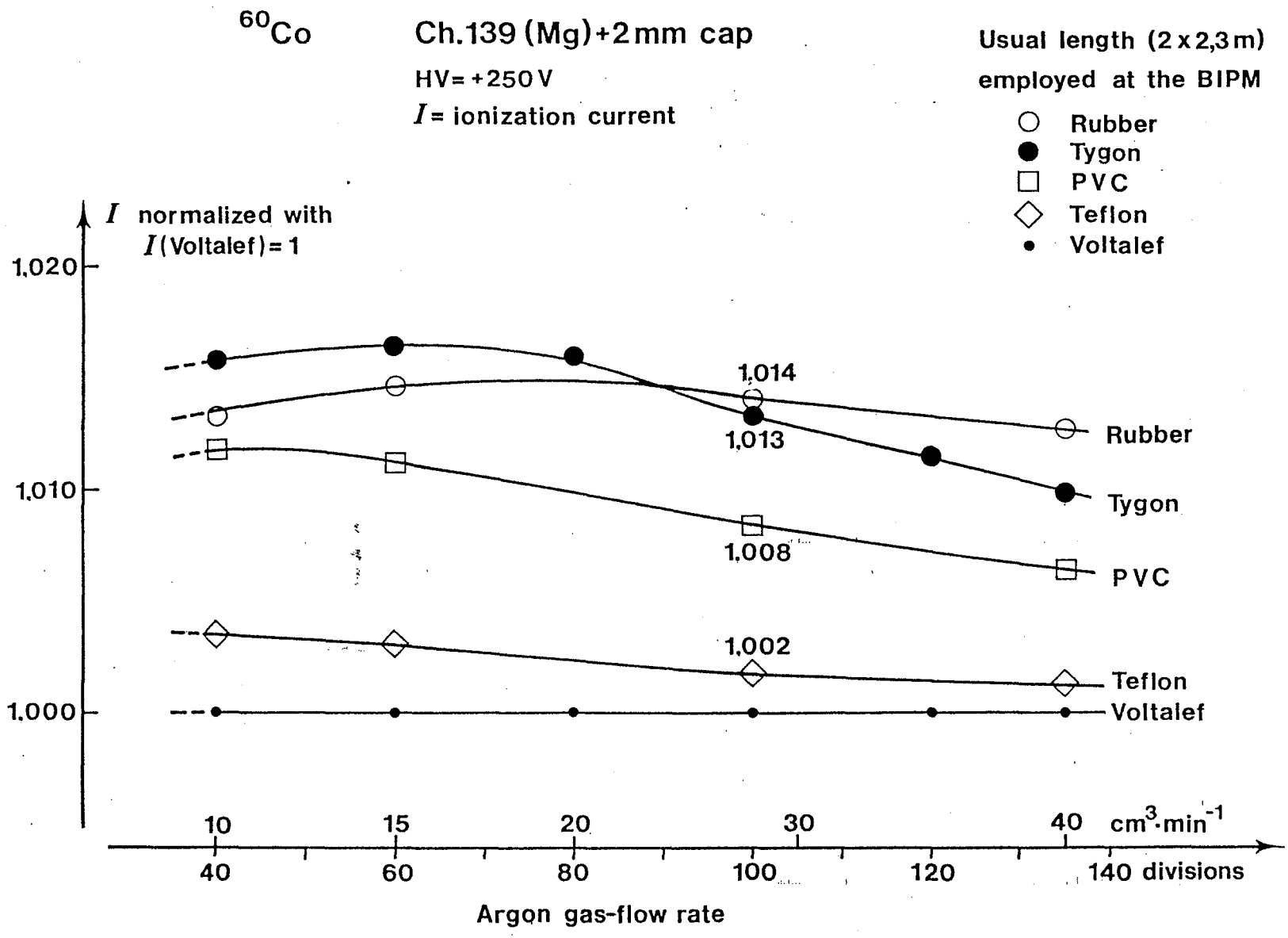

Fig. 1 - Response of the Mg chamber, in terms of Ar gas-flow rate, for different types of tubes

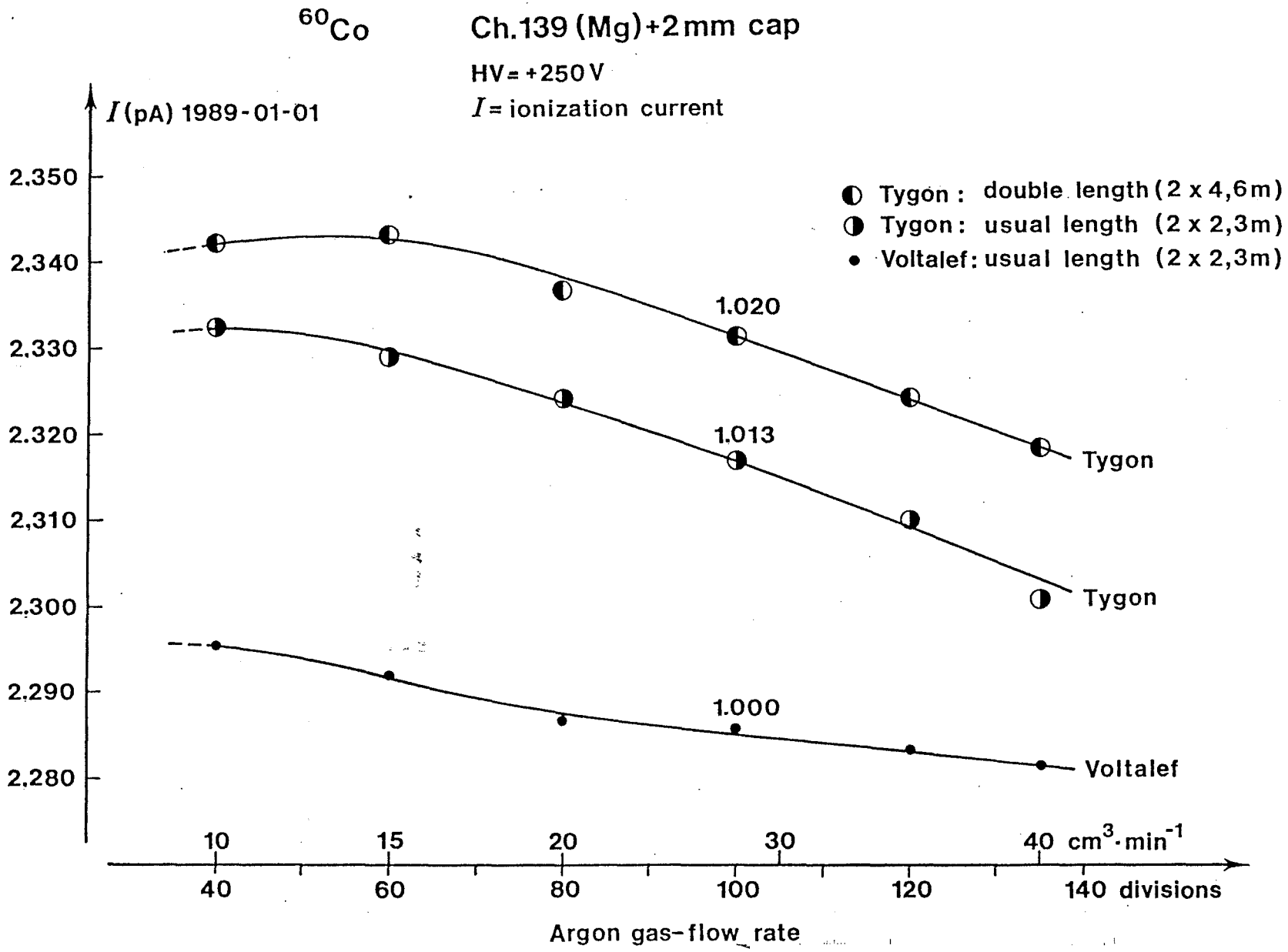

Fig. 2 - Response of the Mg chamber, in terms of Ar gas-flow rate, for double length of tygon tubes

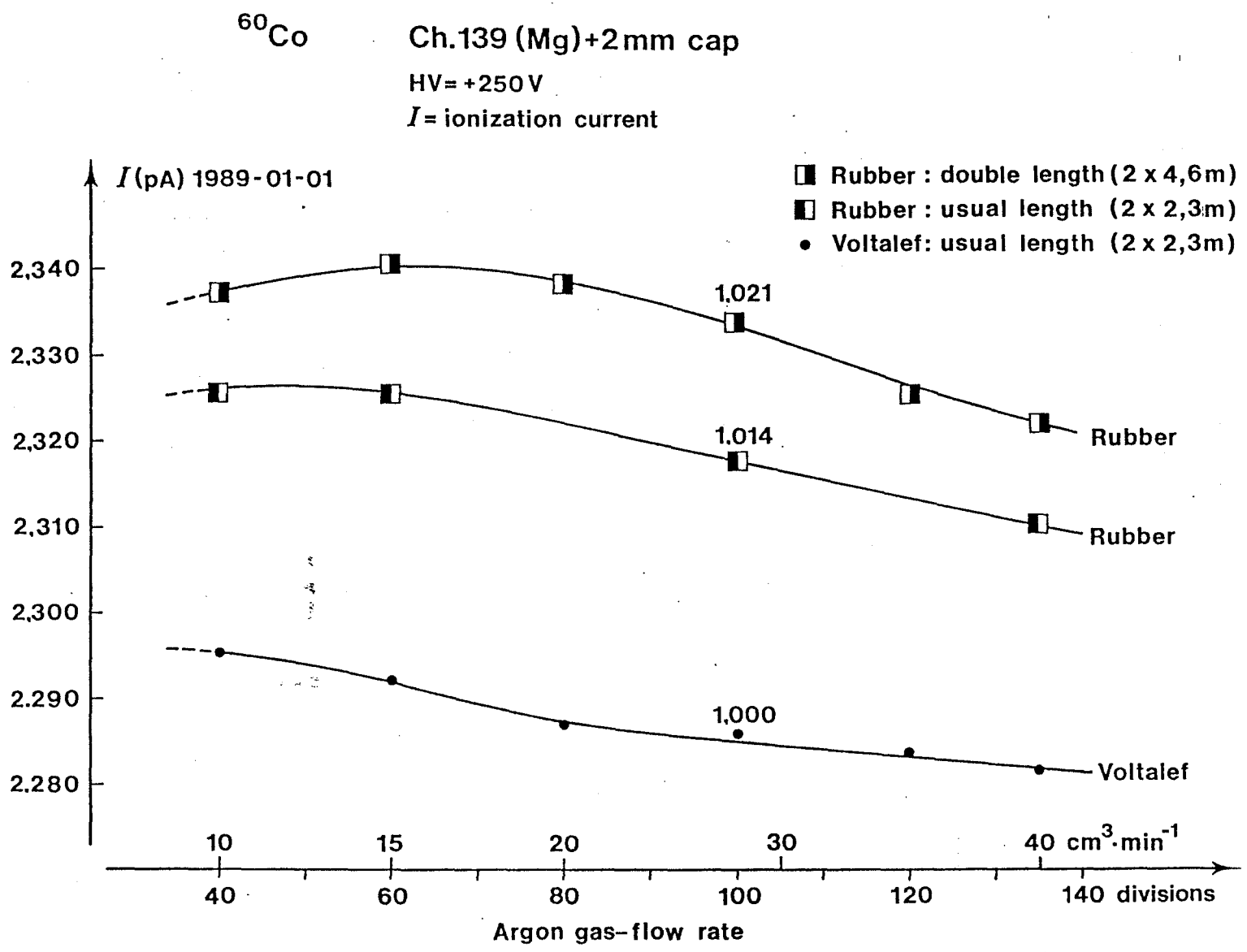

Fig. 3 - Response of the Mg chamber, in terms of Ar gas-flow rate, for double length of rubber tubes

References

[1] HUYNH V.D. Report on the BIPM neutron dosimetry intercomparison. Rapport BIPM-88/5, June 1988, 36 pages

[2] HUYNH V.D. BIPM Proc.-Verb. Com. Int. Poids et Mesures **48**, 1980, p. 76

[3] International Commission on Radiation Units and Measurements. Average energy required to produce an ion pair, ICRU Report 31 (1979) (ICRU, Bethesda MD, USA)

(February 1990)