This booklet was originally published by the Glass Manufacturers Federation. It is now published by the British Glass Manufacturers Confederation, which is an organisation formed on 1 July 1988, by the amalgamation of the Glass Manufacturers Federation and the British Glass Industry Research Association.

First published May 1973 by the Glass Manufacturers Federation

Reprinted May 1980 by the Glass Manufacturers Federation

Revised edition March 1994 published by British Glass

ACCURATE DETERMINATION OF GLASS CONTAINER CAPACITY

1. INTRODUCTION

Glass container manufacturers are obliged to make frequent, accurate determinations of the capacity of containers produced. This must be carried out day and night, close to the production area. Large quantities of water are used daily so there is no question of using distilled water or water whose temperature is accurately controlled.

A great many variables are involved if consistent results between customers and suppliers are to be assured. This publication presents the main variables and their relative importance and sets out a practical and easy-to-use method for reliably determining container capacity in the glassworks and in the bottling hall.

Towns tap-water is used and, providing its temperature can be accurately measured, the results have a precision consistent with current legislation and commercial requirements over the size range of glass container commonly used in retail packaging.

The factors given in this publication are in accordance with those commonly used in the UK by glass manufacturers, customers, glass users, and legislative authorities. For practical purposes, they also give similar results to those obtained using the conversion factors recommended by CETIE (Centre Technique International de l' Embouteillage et du Conditionnement) in Data Sheet DT9 entitled 'Factors to convert the mass of water, in gm, to true volume in ml, as required by the Measuring Container Directive, 75/107/EEC.'

2. ACCURATE DETERMINATION OF GLASS CONTAINER CAPACITY

Glass container capacities are normally determined by weighing the empty container, filling it with water to the appropriate level, weighing the full container and then establishing the weight of water by subtracting the weight of the empty container from the weight of the full one. When working in metric units, it may be thought that because the density of water is very close to one gramme/cubic centimetre, it is sufficiently accurate to assume that the number of grammes weight of water is identical to the number of cubic centimetres or millilitres that the water occupies. In fact, this assumption would be almost true if pure water were used and weighed in a vacuum at about 4°C, in which case the measurement would give an almost true capacity of the container when it was itself at a temperature of 4°C.

Theoretically, we set out to measure the capacity when the container is at a standard temperature of 20°C. In practice, the 'apparent' capacity obtained as above may sometimes be sufficiently accurate for the purpose required, but we need to know the size of the error, so that a correction can be made if and when necessary.

Before discussing the sources of the error we may dispose of one factor which since 1964 does not contribute to any possible error, that is the choice of capacity unit. Before that time the millilitre was legally larger than the cubic centimetre by a factor of 1.000028, but the 1964 Conference Generale des Poids et Mesures redefined the millilitre to be exactly equal to the cubic centimetre. So the two units are now completely interchangeable. Since the UK adopted the metric system, glass container capacities have been specified in millilitres and litres. The Conference Generale also decided that when expressing volumes with very high precision, the cubic centimetre and cubic decimetre should be used rather than the millilitre and litre. We will observe this convention when discussing the very small errors of measurement by using the cubic centimetre unit.

The introduction of the International Temperature Scale of 1990 (ITS 90) does not change our practical recommendations but those interested in more fundamental data may find the paper by H. Preston-Thomas in Metrologia 27 (1990), pages 3 - 10, of interest.

Altogether there are four factors contributing to the possible error:

1. The water used will usually be at a temperature higher than 4°C,

2. The weighing will be carried out in the ordinary atmosphere.