# SPECIFICATIONS FOR GERBER GLASSWARE FOR DETERMINING THE FAT CONTENT OF MILK AND CREAM

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Before Gerber *(1)* described the volumetric method, now identified by his name, for determining the fat content of milk and other dairy products, he probably compared many series of determinations thereby with results by the then prevailing gravimetric methods for fat determinations in different types of dairy products. From such calculations he selected a combination of reagents that gave fat mixtures the volumes of which serve as a basis for marking graduations on necks of Gerber butyrometers or test bottles. That Gerber was able to arrive at such a close approximation to the true value as he did with the apparatus and comparative methods of analysis available prior to 1892 is most amazing.

The columns to be measured above the acid-digest mixture consist of a mixture of milk fat and amyl alcohol, the proportions of which vary with different compositions of the acid-digest mixture resulting when different types of dairy products are tested. Inquiries from various sources and an examination of the original text *(1)* have revealed no documented data on which to establish the correct proportion of amyl alcohol in mixtures in the graduated necks of bottles. Current observations herein reported disclose that the proportion of milk fat to amyl alcohol remains practically constant throughout the column regardless of the fat content in the sample when either whole milk or cream are tested.

Among the earlier sales announcements released in this country on equipment for the Gerber method *(2)*, including the multiple pieces of apparatus for the test as applied both to fluid milk and cream and to other dairy products, the following items were specifically listed for the milk fat test:

1. Sulfuric acid, $H_2SO_4$, water clear, containing 9-10% $H_2O$ so that sp. gr. is 1.820-1.825 at 15°C.
2. Amyl alcohol, fat free special for Gerber, with sp. gr. 0.815-0.818 at 15°C. and boiling point at 128°-130°C.
3. Pipette, with straight side bulb, *to deliver* when last drop is blown from tip, 11 ml. milk at 15°C. (As determined in part by calculation, average delivery is 11.24 g. or 10.90 ml. milk, sp. gr. 1.0315 at 20°C.)
4. Pipette, 10 ml. for transfer of $H_2SO_4$ test acid.
5. Pipette, 1 ml. for transfer of amyl alcohol.
6. Milk test bottle or butyrometer, neck graduations for 5%, 7% and 9% bottles. No procedure for checking the accuracy of graduations was given.
7. Special stoppers and key for adjusting height of columns for reading their length.

Since 1911 major changes in specifications for glassware and materials have become official in England *(3)* and in the Netherlands *(4)*. On June 2, 1951, C. F. Vester, Secretary to the Netherlands Standards Commission, Rijks Zuivelstation, Vrewykstraat 12, Leiden, Netherlands, advised that on October 1, 1951, the Gerber milk pipette to be used officially in the Netherlands will be constructed to contain 10.77 ml. at 20°C. Their former pipette was constructed to deliver 10.969 ±0.025 g. water at 20°C.

Extensive unpublished comparative data submitted December 5, 1951, to the authors by D. B. Rogers, General Milk Products, Ltd., Dumfries, Scotland, using both the 10.77-ml. and the 10.969-ml. pipette (latter usually referred to as the 11-ml. pipette) and using for reference determinations by the Mojonnier method, substantiates the accuracy of the recent decision by the Netherlands Standards Commission. The new Netherlands pipette will deliver approximately 11.006 g. or 10.67 ml. of milk with a sp. gr. of 1.0315. The significance of this modification is explained later.

Assuming that the old style 11-ml. milk pipette transfers approximately 11.24 g. of milk, sp. gr. 1.0315, the weight equivalent to an 8.0% reading of fat alone will be 0.8992 g. Dividing this value by 0.9 the commonly used sp. gr. of milk fat, the volume occupied by the fat *only* in the graduated neck of the test bottle will be 0.999 ml. Obviously this measurement fails to include the volume increase attributable to the amyl alcohol in the column. (Because of the small percentage of amyl alcohol, sp. gr. 0.815-0.818, present in the alcohol-fat mixture, the effect of differences in sp. gr. between the two substances on the calculated total volume in the column is for all practical purposes disregarded in the above and subsequent calculations. Furthermore, because of the small volume of mixture measured, differences in sp. gr. at

$$\frac{15°}{15°} \quad \frac{40°}{15°} \text{ and } \frac{60°}{15°}$$

for milk fat and amyl alcohol are disregarded also.)

Because of the range in the sp. gr. of normal milk and the practical need in this country to pipette test portions of composite samples at about 38°C. (instead of at 20°C.), it is necessary in the calculations herein to recognize average values and accept certain deviations from standard analytical technic. For milk, these include recognizing *(a)* an average sp. gr., *(b)* an average weight delivery from the pipette, and *(c)* measurement of the fat column at about 60°C. The degree to which some of these factors influence the results is explained subsequently. Over the ususal range for sp. gr. for unadulterated milk, variations in the weight of milk delivered at 20°C. by the Babcook pipette will not exceed 18.00±.05 g., and by the Gerber pipette will not exceed 11.006±.04 g. Calculations for charges with the Babcock and Gerber pipettes corrected for temperature differences from 20°C. and for cubical coefficient for glass expansion as per Smithsonian Physical Tables, but not for differences in residual milk adhering to interior of pipette, show average amounts of milk delivered at different temperatures as follows:

WEIGHTS OF MILK DELIVERED BY VOLUMETRIC PIPETTES, ASSUMING AVERAGE SP. GR. OF MILK TO BE 1.0315

| Temperature | | | |
|---|---|---|---|
| °C. | °F. | Babcock | Gerber[a] |
| 4.44 | 40.0 | 18.027 g. | 11.032 g. |
| 15.00 | 59.9 | 18.005 g. | 11.009 g. |
| 15.56 | 60.0 | 18.004 g. | 11.009 g. |
| 20.00 | 68.0 | 18.000 g. | 11.006 g. |
| 21.11 | 70.0 | 18.000 g. | 11.006 g. |
| 32.22 | 90.0 | 17.992 g. | 11.000 g. |
| 37.78 | 100.0 | 17.986 g. | 10.996 g. |

[a]10.77-ml. capacity at 20°C.

The magnitude of the above differences indicates that they may be ignored in the practical application of the test, because *(a)* the accumulative effect of the above range and temperature deviations would be positively undetectable on the neck graduations on bottles the specifications for which permit a much wider graduation tolerance error, and *(b)* sometimes the width of the graduation lines on bottles are such as to cause differences in readings by different technicians which approach or exceed in magnitude the differences in the charges of milk delivered to bottles at the above temperatures.

Furthermore, attempts to correct determinations by adding or subtracting a variable value, depending upon the extent to which the reading on the Gerber test bottle is more or less than a selected reference value, ascribes a degree of accuracy which the method inherently does not possess as it is used in this country by commercial licensees for reading tests to the nearest first decimal place. When reading tests closer than the first decimal, frequent disagreements over intangible opinionated differences in the position of the slowly but continually shrinking meniscus between the closely-spaced parallel lines add confusion in reporting results by a volumetric method which possesses an inherent series of (fortunately) nearly-compensating errors. Despite the above limitations, the test serves a very useful purpose. In the hands of more highly skilled workers using selected glassware, readings can be estimated at closer than 0.1% intervals.

In the State Food Laboratory the following procedure was used for determining the volume in the graduated necks of the test bottles. A sufficient portion of the bulb on the Gerber cream test bottle was ground off to permit fitting a rubber stopper in the hole. After performing the test in the usual manner, 2 successive portions of the column (each nearly 0.5 ml.) were removed. The fat in each portion was extracted by the Roese-Gottlieb method and the percentage of milk fat determined. The above steps were repeated on a number of samples to establish a mean value for the proportion of milk fat to amyl alcohol. Similarly, the bulb on the Gerber milk test bottle was ground off and the proportion in the column of milk fat to amyl alcohol was determined.

Determinations showed that amyl alcohol will mix with the milk fat in the column of Gerber milk and cream test bottles in essentially a constant portion of about 214 (range 212-217) parts of amyl alcohol to 9786 parts of milk fat. It is believed because of different compositions of the acid-digest mixture beneath the column that this proportion will differ when dairy products other than fluid milk and cream are tested. It was concluded that the graduated columns for both milk and cream test bottles should be constructed so that they contain essentially 2.14% of material calculated as amyl alcohol in addition to milk fat.

Calculated values, based on the above determinations, support the adoption by Netherlands Standards Commission of a Gerber milk pipette that *contains* 10.77 ml. at 20°C. Assuming that the 10.77-ml. pipette will deliver 10.67 ml. of milk, sp. gr. 1.0315, the weight of milk testing 8% fat so delivered will be 11.006 g. and the weight of the fat therein will be about 0.8805 g. (With this amount of milk, the residual traces of fat in the acid layer and the traces of water, amyl alcohol, etc. in the fat column are such that the total errors nearly compensate for each and the corresponding readings, by appropriately increasing the volume in the graduated portion of the test bottle to include the amyl alcohol mixed with the fat, closely indicate

the correct percentage by weight of fat in milk. An appropriate allowance is made uniformly in the graduated portion of the bottle for the distribution of about 2.14% of amyl alcohol in the fat column.) Dividing this value by 0.9, the volume of such fat is about 0.978 ml. Since the mixture is approximately 97.86% milk fat, the total volume for the mixture would then be 1.0 ml. (more exact 0.999-ml.)

The British Standards Institution in B. S. 696 (1936) provided for a 70% Gerber cream test bottle with a 5-g. charge. The volume prescribed for the corresponding total graduations in this bottle is 3.974 ml. Since in America preference is for a 50% Gerber cream test bottle with a 5-g. charge *(5)*, it is expected that the weight of the fat from a 5 g. charge of a 50% cream in such a bottle will be 2.5 g. (The above parenthetic explanation applies similarly to the cream charge.) Dividing this figure by 0.9, the commonly used sp. gr. of the milk fat, the volume of such fat in the 50%, 5-g. charge cream test bottle will be 2.777+ml. Then, dividing this volume of milk fat by 0.9786, the total volume of the mixture in the graduated neck of the Gerber cream test bottle will be 2.84 ml. (more exact 2.8395 ml.).

By direct proportion computation of the volumes of amyl alcohol-milk fat mixtures in the 70%, 5-g. British cream test bottles, and in the 50%, 5-g. American cream test bottles, the calculated volume is found to be essentially 2.84 ml., also. Other calculations show that the 3.974 ml. (more exact probably 3.9739 ml.) graduated volume on the 70%, 5-g. British cream test bottle, is constructed to contain a mixture of about 3.888+ml. of milk fat and 0.0851 ml. of amyl alcohol.

The above record on volume measurements was presented to representatives of the Corning Glass Works, Corning, N. Y., an American manufacturer of certain types of Gerber glassware. Subsequent to quoting the figure of 2.84 ml. for the total graduation in the 50%, 5-g. Gerber cream test bottle, it was disclosed that a specification of 2.839 ml. had been furnished the Corning Glass Company. To arrive independently at such close agreement on specifications was gratifying.

A comparison of the calculations and measurements between the Babcock and Gerber test bottles follows:

| | Babcock bottle | Gerber bottle |
|---|---|---|
| | (8% milk) | (8% milk) |
| Pipette, $H_2O$ capacity at 20°C. | 17.60 ml. | 10.77 ml.[a] |
| Milk, sp. gr. 1.0315 capacity | 18.00 g. | 11.006 g. |
| Milk, sp. gr. 1.0315 delivered | 17.45 ml. | 10.67 ml. |
| Weight of fat in charge of 8% milk | 1.44 g. | 0.8805 g. |
| Volume of fat in charge of 8% milk | 1.6 ml. | 0.978 ml. |
| Graduated neck capacity | 1.6 ml. | 1.0 l.[b] |
| | (9 g., 50% cream) | (5 g., 50% cream) |
| Cream charge | 9.0 g. | 5.0 g. |
| Weight of fat in charge of 50% cream | 4.5 g. | 2.5 g. |
| Volume of fat in charge of 50% cream | 5.0 ml. | 2.84 ml.[b] |
| Graduated neck capacity | 5.0 ml. | 2.77+ml. |

[a]Since 1951 the British Standard Institution have announced a different pipette specification.

[b]Allowance included for amyl alcohol in milk fat-amyl alcohol mixture in column.

## SUMMARY

Application of the revised specification for the Gerber milk transfer pipette, authorized by the Netherlands Standards Commission on October 1, 1951, is discussed. For the first time, the basis for the overgraduation of the volume in the necks of Gerber test bottles for milk and cream is explained. The determination is based on the quantity of milk fat recovered by the Roese-Gottlieb method from the amyl alcohol-milk fat mixture in the column.

The above determinations provided a basis for the test portions of milk and cream used in the Gerber method and the graduations designed to include approximately 2.14% of amyl alcohol in the milk fat-amyl alcohol columns measured above the acid digest in the Gerber bottles.

It is concluded that the Gerber milk transfer pipette should be graduated to contain 10.77±.03 ml. $H_2O$ at 20°C. The volume of the total graduated portion should be 1.00 ml. in the neck of the 8.0% milk test bottle and 2.84 ml. in the neck of the 50%, 5-g. charge cream test bottle.

## REFERENCES

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