ometers should be graduated as total or partial immersion thermometers. For the ordinary everyday use of a thermometer it seems to be quite customary to immerse it a few inches in the bath or medium, the temperature of which is to be measured. It also seems to be quite customary to neglect the stem correction. If these are the usual conditions of use it will be seen that more accurate results would be obtained by using partial immersion thermometers, and about as accurate results would be obtained by such usage as would be obtained with total immersion thermometers, even when the stem correction was applied, unless *due care* were taken to determine the stem correction with *sufficient* accuracy.

CONCLUSIONS

The above considerations may be summarized in the statement that in all cases where the application of stem corrections is neglected, which includes a vast majority of ordinary routine laboratory temperature measurements, more accurate temperature measurements would be attained by the use of thermometers graduated as partial immersion thermometers; the same statement would apply for measurements at the higher temperatures (above 200° C. or thereabouts), even if stem corrections are applied, when the ordinary method of estimating average stem temperature is used instead of the more accurate capillary thermometer method. At the lower temperatures, on the other hand, a slight advantage rests with the total immersion thermometer, if the stem correction is determined and applied in the usual manner, *i. e.*, by the intelligent use of an auxiliary thermometer to determine the average stem temperature. Thermometers graduated in intervals smaller than 0.5° C. should not, in general, be graduated as partial immersion thermometers, if the accuracy of which they are capable is desired, unless such finer graduation be deemed of sufficient importance solely from the standpoint of convenience in reading.

The Albany Chemical Company has been ordered by Federal Judge Dietrich to withdraw all applications for a trade-mark of the word "aspirin." The Company was cited by the Federal Trade Commission in complaint of unfair competition, being charged with falsely advertising that no other person or corporation has a right to the use of the word "aspirin." Upon expiration of the patent on the word, it became a descriptive name and not the property of anyone.

The *Journal of Commerce* reports that by the amalgamation of Aniline Dyes & Chemicals, Inc., with the Swiss Society for Chemical Industry, an amalgamation of the three Swiss firms, the Geigy Co., Ltd., The Chemical Works (formerly Sandoz), and the Society for Chemical Industry, with the two American firms of Ault & Wiborg and Aniline Dyes & Chemicals, is accomplished, since the recent sale of Ault & Wiborg to the Geigy Company was really a sale to the Swiss amalgamation.

A car containing 49,494 lbs. of sodium peroxide manufactured by the Niagara Electro-Chemical Company, at Niagara Falls, N. Y., recently exploded while standing on the tracks in the freight yard. No reason for the disaster has been announced.

LABORATORY THERMOMETERS

By W. D. Collins¹

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In the following discussion "thermometer" means the usual mercury-in-glass thermometer with engraved stem. The type with enclosed glass scale is much superior for many operations, but in the ranges regularly used is not yet produced sufficiently generally in the United States to make possible its adoption as stock apparatus.

The mercury thermometer at its best is not an instrument of extreme precision. At its worst it may be very misleading. The large errors which are occasionally found are due to carelessness in manufacture, usually in the process of pointing. Excessive depression of the zero point after heating to a high temperature does not occur unless the maker has failed to use proper glass for the bulb. Irregularities in the bore rarely have any serious effect on the accuracy if the distances between reference points are not too great. If reasonable care in annealing or aging has been exercised the readings do not change much with time. Slight errors due to all these causes will be found in any thermometer and cannot be allowed for with great precision. On the other hand, a well-made, carefully pointed thermometer is as accurate and reliable as many of the other features of regular chemical work in which it is used.

The discussion by Waidner and Mueller in the preceding article covers the question of the accuracy of thermometers made to be used with total immersion or partial immersion. It is well known that a large proportion of the temperature measurements in regular chemical laboratory work are made with a greater or less length of emergent mercury column without correction.

It has been objected that errors may result from introduction of partial immersion thermometers into laboratories where those pointed for total immersion have been in use. It does not seem likely that anyone careful enough to correct for the emergent stem on a total immersion thermometer would fail to use properly one marked for partial immersion. The others would all gain in accuracy.

The specifications given below were prepared by Mr. E. F. Mueller of the Bureau of Standards to include certain features which had been suggested by various members of the Committee on Guaranteed Reagents and Standard Apparatus, and had been discussed at a conference of members of the committee with Dr. Waidner and Mr. Mueller. It was felt that the three thermometers described furnish a good working set for general laboratory use.

The thermometer with a range from -20° to 150° C. in single degrees is much more useful than one with the widely used range from -10° or -5° to 100° or 110° C., and the cost need not be much greater. The length of the degree divisions is better than on a 0° to 100° thermometer of the same length for subdivi-

¹ Chairman, Committee on Guaranteed Reagents and Standard Apparatus, American Chemical Society.

sion by the eye by those without special practice in such reading.

The -10° to 360° thermometer covers as nearly as seems practicable the whole range of temperatures measured in regular chemical laboratory work. It was felt that the danger of breakage in handling and use would be increased more than proportionally by additional length, while a shorter thermometer with this range would have the degree divisions too small. For the sake of added strength the diameter limits have been raised from those for the 150° thermometer.

Thermometer 3 has been added to provide for the more accurate measurement of temperature up to 100° . As explained by Waidner and Mueller, the graduation in 0.2° divisions makes it out of the question to point and use this as a partial immersion thermometer. The uncertainty of the reading may amount to one or two divisions, making the recording of fractions of divisions absurd. Despite the greater length, the diameter has been specified smaller than the 360° thermometer, because it will probably be used more carefully, and it is felt that a small diameter is an advantage except for strength.

The specifications call for accuracy which should be obtainable without excessive cost. If much greater accuracy is desired it is better obtained by careful comparison with standard thermometers and the use of the corrections so determined, rather than by attempting to secure a thermometer which can be used without correction for the more exacting work.

Tests and certificates of corrections for thermometers can be secured from the Bureau of Standards, but the expense and time required are justified for only a small proportion of thermometers used in chemical work. A laboratory may do very well, especially with partial immersion thermometers, by having one or two of each range tested at the Bureau of Standards and comparing all others with them. Serious errors can be detected easily in any laboratory without such standardized thermometers. The zero point can be tested by placing the thermometer up to the immersion point or to the top of the mercury in melting finely cracked ice, keeping the thermometer wet without an excess of water. The 100° point can be tested by placing the thermometer up to the immersion point in steam, applying any necessary correction for departure of atmospheric pressure from 760 mm. Mr. R. M. Wilhelm has suggested¹ the use of naphthalene and anthracene for checking the points 218° and 340° , respectively. He states that the boiling points increase 0.05° and 0.07° , respectively, per mm. of mercury increase in pressure.

The requirements in the General Supply Committee Schedule for purchases by the government laboratories in Washington during the fiscal year 1922 are based on the specifications given below. If other laboratories use these specifications there should be a concentration of production on these items which will bring down the price and improve the quality of thermometers for chemical laboratory work.

¹ "Emergent Stem Correction for Thermometers in Creosote Oil Distillation Flasks," U. S. Bureau of Standards, *Technologic Paper*, 49 (1915), 16.

SPECIFICATION No. 1

Thermometer: -20° to 150° C. in 1° intervals; 8 cm. immersion. Total length 30 to 31 cm. (approximately 12 in.); diameter of stem 5.5 to 6.5 mm.

Bulb, cylindrical; not larger than stem and not over 2 cm. long. Bulb and stem to be of suitable thermometric glass; enamel-backed thermometer tubing; diameter of capillary must be at least 0.1 mm.

Thermometer to be graduated for 8 cm. immersion, a mark being etched on the stem 8 cm. above the lower end of the bulb to indicate this depth of immersion. The -20° graduation must be above the 8 cm. mark. The length of the graduated scale from -20° to $+150^{\circ}$ must be at least 15 cm. If above specifications are complied with, it is permissible to continue graduations below -20° or above 150° . Every fifth line, beginning at -20° , to be longer than the intermediate lines; numbering at 10° intervals; error at any point not to exceed 1° .

The space above the mercury may be evacuated or gas-filled. The reservoir at the top of the capillary shall be large enough to permit heating of the thermometer to 200° C. without danger of breakage due to the heating.

The thermometer shall be marked "8 cm. immersion," and shall also be marked with the manufacturer's name or trade-mark and a serial identification number.

The thermometer shall be made with a small glass ring or loop at the top.

Suitable material and good workmanship shall be employed throughout to produce a usable thermometer. The thermometer is to be supplied in a suitable case.

SPECIFICATION No. 2

Thermometer: -10° to 360° C. in 1° intervals; 8 cm. immersion. Total length 37 to 38 cm. (approximately 15 in.); diameter of stem 6 to 7 mm.

Bulb, cylindrical; not larger than stem and not over 2 cm. long; bulb and stem to be of suitable thermometric glass; enamel-backed thermometer tubing; diameter of capillary must be at least 0.1 mm.

Thermometer to be graduated for 8 cm. immersion, a mark being etched on the stem 8 cm. above the lower end of the bulb to indicate this depth of immersion. The length of the graduated scale from -10° to $+360^{\circ}$ must be at least 26 cm. If above specifications are complied with, it is permissible to continue graduations below -10° or above 360° . It will be necessary to allow a portion of the scale to extend below the 8 cm. mark. Every fifth line, beginning at -10° , to be longer than the intermediate lines; numbering at 10° intervals.

The thermometer must be suitably annealed; error at any point up to 150° not to exceed 1° ; at higher points, up to 300° , not to exceed 1.5° ; above 300° , not to exceed 2° .

The spaces above the mercury must be filled with a dry inert gas at a pressure sufficient to prevent separation of the column at any temperature of the scale. The volume of the space above the 360° graduation must be large enough to permit heating the thermometer to 400° C. without danger of breakage due to the heating.

The thermometer shall be marked "8 cm. immersion," and shall also be marked with the manufacturer's name or trade-mark and a serial identification number.

Suitable material and good workmanship shall be employed throughout to produce a usable thermometer. The thermometer is to be supplied in a suitable case.

SPECIFICATION No. 3

Thermometer: -5° to 105° C. in 0.2° intervals. Total immersion. Total length 45 to 46 cm. (approximately 18 in.); diameter of stem 5.7 to 6.7 mm.

Bulb, cylindrical, not larger than stem and not over 3 cm. long; bulb and stem to be of suitable thermometric glass; enamel-backed thermometer tubing; diameter of capillary must be at least 0.1 mm.

The length of the graduated scale from -5° to $+105^{\circ}$ must be at least 33 cm. If above specifications are complied with, it is permissible to continue graduations below -5° or above 105° . Each degree mark is to be longer than the intermediate marks; numbering at 2° intervals. The error at any point must not exceed 0.3° .

The space above the mercury may be evacuated or filled with dry inert gas. The reservoir at the top of the capillary shall be large enough to permit heating of the thermometer to 140° C. without danger of breakage due to the heating.

The thermometer shall be marked with the manufacturer's name or trade-mark and a serial identification number.

The thermometer shall be made with a small glass ring or loop at the top.

Suitable material and good workmanship shall be employed throughout to produce a usable thermometer. The thermometer shall be supplied in a suitable case.