

Buffalo Tube Works

BUFFALO TUBE WORKS	
R.C.P.	
L.E.	R.F.H.
S.	C.H.S.
AUG 23 1946	
C.H.	
F.J.F.	
W.C.L.	
R.H.S.	

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Title..... Glass Weathering Tests

By

..... Electronic Tube Engineering **Div.**

Information prepared for..... Electronic Tube Engineering Div.

Tests made by..... R. E. Both

Information prepared by..... R. E. Both

Countersigned by..... K. C. DeWalt

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Glass Weathering Tests

I RESUME: -

Some of the common methods of testing the resistance of glass to attack by atmospheric agencies are noted. A general description of weathering tests is given, together with the availability of apparatus for tests for the Department. References to some articles on the subject are given.

No actual tests have been made by the writer.

II INTRODUCTION: -

"We do not test the properties of the glass at all, but only those of the surrounding atmosphere." This is a modification of a previous statement of Littleton made by F. D. Preston in his article "The Mechanical Properties of Glass" Journal of Applied Physics 13, 10, 623-34 (1942). In the same article Preston gives a brief description of the process of weathering: "Glass spontaneously absorbs a moisture film, which breaks up, apparently, some of the strong silica bondings in the surface layers of glass, and produces a weakened surface structure analogous to a slightly cracked one. If this surface film is driven off, any ordinary specimen of glass (at room temperature) becomes some three times as strong. This is true of pure silica ("quartz") glass as well as of typical commercial glasses."

"The effect of moisture on the surface is very pronounced at room temperature, but it is even more so at autoclave temperatures. The phenomena are a little complex,, but the guilty finger points unmistakably at the absorbed moisture film as one of the major causes of the misbehaviour of glass."

"The ordinary variations of weather, in this part of the world, are sufficient to cause variations of several percent in strength from day to day. The difference between saturated conditions, i.e., obvious wet upon the surface, and a perfunctory drying in warm air, may be as much as 40 percent. Drying in a vacuum readily produces a doubling or tripling of strength."

Despite some marked differences in resistance to attack, all glasses are essentially unstable with respect to water. The differences are those of rate of reaction.

III TEST METHODS: -

To test the various rates of reaction "weathering" tests have been proposed. These vary from simple boiling in water to elaborate cycles of atmosphere in "weatherometers". The only unequivocal test is actual service. (See Morey, J. Soc. Glass Tech. VI, 20 (1922)).

According to Littleton & Morey (Electrical Properties of Glass, John Wiley and Sons 1933) weathering tests are of three kinds (1) sensitive measurement of attack under standard conditions, (2) drastic treatment of the glass (accelerated weathering), (3) a combination of the two methods. For a sensitive method, the iodocine colorometric method of Mylius as given in Silikat Zeitschrift 1, 3 (1913) or Glastech. Bericht 1, 33 (1923) is recommended. This method is that of boiling powdered (and size graded) glass in water and then titrating the solution. It is used for optical glass and is not too successful for general glass testing.

In general, the extraction of powdered glass with water requires very careful standardization of procedure and results on lead glasses or borate glasses cannot be compared with soda-lime-silica glasses to draw any comparisons with actual weathering.

The autoclave is often used for accelerated tests and several "standard" procedures have been set up, but it is generally agreed that these are not certain for the grading of different glasses as to how they will resist attack under actual service conditions.

Committee C-14 of A.S.T.M. of which Dr. L. Navias is chairman, is studying methods for the testing of soda-lime glass with an aim to standardization. They have ten methods under consideration. These methods employ water or dilute acid at 90° or at 120° in an autoclave, and measure the weathering by titration of the solution.

One "autoclave method" (used for 704) is given in the letter of H. R. Black, Director of Libby Division Laboratory to Mr. R. D. Malloy 5/1/46 (H.C. Steiner's file - Glass Design & Test Aug. 8, '45).

"Samples of glass were immersed in a solution of N/50 Na₂CO₃ in an autoclave at a temperature of 100°C for a period of six hours."

"The solubility of the glass was expressed as the loss of weight in milligrams per square centimeter."

Of autoclave methods, Littleton & Morey's book says: "Some experimenters have determined the change in weight of the glass resulting from autoclave treatment, but this is uncertain because the glass retains an unknown amount of water and carbon dioxide so that results cannot be checked." Present methods employ, preferably,

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not good
RM
correct
RM

a titration of the resulting solution to determine amount of reaction.

Compromise methods of various kinds are to be found including water immersion for various periods at various temperatures, "cycles" of humid and dry atmospheres - with or without infra red lighting, continuous exposure to "hot rooms", i.e., a hot humid atmosphere, etc.

IV REFERENCES: -

Methods given by various experimenters are to be found in the following references:

1. A. V. Elden, O. Roberts, H. S. Jones, "The Examination of Optical Glass in Relation to Weathering Properties" J. Soc. Glass Tech. III, 52F, (1919). Suggests that an 80°C test for 30 hours will give a "Dimming" of the glass which is more indicative than an 180°C autoclave water test.
2. F. Spate, "A Simple Weathering test for Glass" Glas-technische Berichte IV, 127, (1925) Abstracted in J. Soc. Glass Tech IX 265 (Abstract 490) (1925). Glass is placed in a dessicator with water in the bottom, CO₂ held for a period of test. Dry CO₂ action may also be used, especially for detection of spots previously attacked by water.
3. F. Friedrichs, "A Simple Method for Determining Chemical Resistance of Glass" Zeitschrift fur angewandte Chemie XXXIX, 611, (1926) Abstracted in J. Soc. Glass Tech. XI, 25 (Abstract 51) (1927). After 12 hours heating in steam or water at 100°C, the glass sample is heated just to the softening point in a porcelain crucible. The sample is then examined for striations showing the weathering.
4. F. Stein, "Easy Methods of Testing Glasses for their Resistance to Weathering", Glashutte LXVII, 130 (1937). Abstracted in J. Soc. Glass Tech. XXI, 204, (Abstract 563) (1937). Hot acid or cold water give good weathering tests - but not hot water. "Tropical tests" of 2 - 4 months duration are also given as well as CO₂ and HCl gas tests.

V CONCLUSIONS: -

1. One evidently cannot place complete confidence in any one method.
2. It is difficult to make tests between any different types of glass to determine, by any of the acceleration methods, which will weather best.
3. It is very difficult to decide, based on tests, as to glasses, which are relatively close to one another, which will be best on actual life.

4. It is very difficult to predict actual results in use from any but a true "life test".

Very true

VI EQUIPMENT AVAILABLE IN GENERAL ELECTRIC:-

1. Autoclave in Bldg. #269 - Schenectady
2. Hot Room in Bldg. #37 - Schenectady
3. Controlled humidity hot room in Bldg. #70 - Pittsfield
4. Weatherometer in Bldg. #70 - Pittsfield (Mr. C.M. Lampman of Pittsfield is now handling some tests for ETE in his hot room - these take several months).
5. Weatherometer is ordered for Schenectady Works Laboratory - see Mr. Zahn Bldg. #7 - Schenectady.

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Raymond E. Roth

R. E. Roth

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KC DeWalt
Aug 20, 1946

rer/ma

OW Pike
AC Gable
KC DeWalt
EF Peterson

WJ Walker

CC Kirchenbauer

A Handry

Buffalo Tube Works
Utica Tube Works
Schenectady Tube Works

Section Leaders

WB Gillen

Ken-Rad Div., Owensboro, KY.