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A STUDY OF THE EFFECTS OF CHEMICALS ON THE PROPERTIES OF PARACHUTE FABRICS

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FOREWORD

This report was prepared by the School of Textiles at the North Carolina State College of Agriculture and Engineering of the University of North Carolina under USAF Contract No. AF 33(616)-2530. This Contract was initiated under Project No. 7320 "Air Force Textiles Materials" Task No. 73201, "Textile Materials for Parachutes" and was administered under the direction of the Materials Laboratory, Directorate of Research, Wright Air Development Center, with 1st. Lt. Richard A. Sublette and 1st. Lt. Malcolm J. Rogers as Co-project engineers.

Those who assisted in the laboratory work and in the preparation of this report are commended for their valuable contribution. They were Dr. David M. Cates, Mrs. Winifred Cranor, Miss Shirley Slocum, Miss Mary Glen Randall, and Mr. Henry A. Rutherford.

This report covers period of work from June 1954 to September 1955.

ABSTRACT

During routine inspection of parachutes, several badly degraded nylon parachutes were discovered. Preliminary evaluation by chemical analysis indicated the presence of mineral acids. To provide background data, nylon and Dacron fabrics were exposed to sulfuric, hydrochloric, nitric, phosphoric, sulfurous, hydrosulfuric, and nitrous acids. The exposures were conducted under various concentrations for periods of time up to six months. The evaluation was conducted by establishing the breaking strength of the exposed fabrics and comparing them to the original breaking strength.

Additional phases of the work consisted of studying the effect of light in combination with the acids, studying the effect of sulfur dioxide, hydrogen sulfide, and oxides of nitrogen, and examinations of procedures for detecting, by visual means, degradation by acids.

Dacron was found to be quite resistant to attack by mineral acids in comparison with nylon. Acid-treated nylon was more sensitive to light than acid-treated Dacron.

PUBLICATION REVIEW

This report has been reviewed and is approved

FOR THE COMMANDER:

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Technical Director
Materials Laboratory
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I. INTRODUCTION

The Wright Air Development Center in the past has received several parachutes that were badly degraded in localized areas. It was not clear, however, whether the parachutes had been used and then put in storage or whether the degradation had occurred in new parachutes because of contact with some harmful substance. The deterioration, discovered during routine inspection, was generally in the panels at the outside of the pack, suggesting the latter situation. Preliminary evaluation by chemical analysis indicated that mineral type acid was present in those areas that were weakened, but the concentration was apparently quite low. Because a survey of the literature revealed that no satisfactory data were available to indicate the resistance of nylon to acids, it became desirable to determine the minimum concentrations of acid required to produce a significant amount of degradation, and more especially to devise a simple method for detecting degradation of this type, during the inspection procedure. Accordingly, a program to investigate the effect on nylon fabrics of several acids and acid-forming substances at different concentrations and temperatures during various conditions of treatment was initiated. Because of the potential importance of Dacron as a parachute material, it was decided to include this also.

II. MATERIALS AND CONDITIONS OF TREATMENT

A. Acid Substances

The following acids were used in this investigation:

Sulfuric acid	H_2SO_4
Hydrochloric acid	HCl
Nitric acid	HNO_3
Phosphoric acid	H_3PO_4
Sulfurous acid	H_2SO_3
Hydrosulfuric acid	H_2S
Nitrous acid	HNO_2

As a control, distilled water was also used as one treatment throughout this work. The nitrous acid was generated in solution by the addition of acetic acid to sodium nitrite. The control solution used in this case was a solution of acetic acid and sodium acetate of the appropriate concentrations.

B. Fabrics

The nylon material for this work was standard undyed nylon parachute fabric which conformed to the following Military Specification: MIL-C 7020B, Type I.

Weave	Rip-stop
Weight	1.1 ounces per sq. yd.
Warp	30 denier continuous filament yarn
Filling	30 denier continuous filament yarn
Construction	120 ends per inch 120 picks per inch

Two types of Dacron material were used for this work. The work was started using Type I Dacron parachute material which had the following specifications:

Weave	Plain
Weight	1.7 ounces per sq. yd.
Warp	45 denier continuous filament yarn
Filling	90 denier continuous filament yarn
Construction	137 ends per inch 74 picks per inch

This was a light-weight fabric and proved difficult to handle in physical testing. The material was sleazy and the warp ends deformed from their normal position very easily when the sample was folded or handled without the utmost care. A heavier material was substituted for the lighter material for the major portion of the work. This fabric conformed to Military Specification MIL-C-7350, Type II.

Weave	Plain
Weight	2.9 ounces per sq. yd.
Warp	150 denier filament continuous yarn
Filling	150 denier filament continuous yarn
Construction	63 ends per inch 64 picks per inch

C. Phases of the Project

The work was divided into several phases.

1. The degrading effects of different concentrations of each of the various acids under relatively short periods of time on the nylon and Dacron fabrics were determined first. This provided fundamental information upon which to design the remaining experimental work.

2. The effects of lower concentrations of these acids over a six-month ageing period were then determined with the samples in three ways: namely, (1) immersed in the solution; (2) first immersed in the solutions, then extracted and aged under low humidity conditions; and (3) first immersed in the solution, then extracted and aged under high humidity conditions.

3. The effects of light in combination with the effects of the acids dried on the fabrics were determined.

4. The effects of sulfurous, hydrosulfuric and nitrous acids in degrading the nylon and Dacron when the fabrics were exposed to the vapors of these acids were determined.

5. A method of determining the degradation of the nylon and Dacron fabrics by visual means using both visible and ultraviolet light was investigated.

D. Temperature Conditions

The nylon and Dacron fabrics treated with each of the acids were aged at the following temperatures: 80°F (Room), 100°F, 120°F, and 150°F. These temperatures were selected to cover the range of temperatures to which the parachute material might normally be exposed, with 150°F being assumed as the maximum temperature likely to be met in storage. Room temperature was selected as the lower limit, and temperature condition in actual work turned out to be near 82°F. The results were based on this value. The 100°F and the 120°F conditions were picked as intermediate points.

III. EXPERIMENTAL PROCEDURE

A. Preparation of Acid Solutions

The following acids were prepared at the various concentrations by diluting stock reagent-grade acids with the required amounts of distilled water: sulfuric, hydrochloric, nitric, phosphoric, and sulfurous. The final concentration in each case was checked by titrating an aliquot with standard sodium hydroxide solution. The nitrous acid was generated in solution by the reaction of acetic acid on sodium nitrite. This solution was buffered with sodium acetate to increase its stability. The "Nitrous Acid Control" was a solution containing only the acetic acid and sodium acetate at the same concentrations as used to generate the nitrous acid. The hydrosulfuric acid was generated by forming a saturated solution of hydrogen sulfide gas in water. In order to dissolve the maximum amount of gas in the water saturation was carried out at reduced temperatures, i.e., 4° to 6°C. With this acid, saturated solutions of the gas in water were used at each ageing temperature. Therefore, the concentration of the acid used for treating samples depended upon the ageing temperature.

In the first phase of the project the fabrics were treated with 0.1 N, 1.0 N, 2.0 N, and 5.0 N concentrations of sulfuric, hydrochloric, nitric and phosphoric acids. The sulfurous acid was used at the following concentrations: 0.25 N, 0.5 N, 0.7 N, 1.0 N, 1.4 N, and 2.0 N. The maximum concentration used was dependent upon the solubility of the sulfur dioxide gas in water at the ageing temperature used. The nitrous acid was used as 0.1 N and 1.0 N solutions as the stability of the acid at higher concentrations was very much reduced. The hydrosulfuric acid was used at the following concentrations: 0.08 N, 0.11 N, 0.14 N, and 0.18 N in order of decreasing ageing temperatures.

In the second phase of the project, low concentrations of each acid were used on the nylon, and concentrations to 5 N were used on the Dacron. The actual concentration used in each case is listed in each Table. The comparison between the normality of each acid and the concentration of the acid in grams of acid per hundred milliliters of solution over the range of concentrations of acids used for this work is shown in Table I.

B. Preparation of Fabric Samples

The nylon and Dacron fabrics were cut into pieces large enough (7 in. x 15 in.) to be divided into twelve raveled strips 1 in. x 6 in. The samples were cut so that the strips would be prepared in the warp direction of the fabric. The cut samples were randomly mixed and then separated into groups of four samples each for every testing condition. One sample from each set was removed after each ageing period for testing. The nylon and Dacron samples were handled separately.

C. Treatment of Samples

The samples of nylon of Dacron fabric that were aged immersed in solution were folded into bundles and placed in one-pint glass jars. The jars were then filled with the proper concentration of acid solution and sealed, and placed in the oven at the proper temperature for ageing.

The samples to be aged under high humidity conditions were wet out in the proper concentration of acid solution, rolled up into a tight bundle and placed in the top of a 75 ml. test tube. A small amount of the acid solution was placed in the lower end of the tube to keep the relative humidity in the tube at approximately 100%. The tubes were stoppered tightly and placed in the proper oven for ageing. By this means the samples were exposed at almost saturated humidity conditions during ageing without being in contact with the acid solution in the tube.

The samples to be aged under low humidity conditions were wet out in the proper concentration of acid solution and then dried. The dried samples were folded and placed in petri dishes which were stacked in the ovens so as to allow circulation of air around the samples.

At the end of each ageing period the containers were removed from the ovens and allowed to come to the room temperature. One sample was removed from each bottle and the containers returned to the ovens for further ageing. The samples were rinsed in running water with gentle agitation to remove the acids from the fabric. The rinsed samples were dried at room temperature and then conditioned at 65% R. H. and 70°F for at least 8 hours before testing.

D. Ageing Methods

The samples of nylon and Dacron were aged separately. Those aged at room temperature were stored in a room controlled at approximately 82°F. This temperature varied over short intervals as much as 5° because of occasional failure of the conditioning unit. This was not believed to influence the results appreciably.

The samples aged at elevated temperatures were stored in electrically-heated ovens. The 100°F, 120°F, and 150°F ovens were controlled within plus or minus 2°F. The ovens were heated using low intensity heating units, i. e., units that did not have a surface temperature above 300°F and were controlled through relays by either Aminco or Finwall bimetallic thermostats. Low-velocity forced-draft circulation within the ovens was used to insure uniform temperatures throughout.

E. Exposure of Samples in The Fade-Ometer

The effects of light in combination with the various acids on nylon and Dacron were determined by exposing samples of each fabric treated with selected concentrations of each acid in the Atlas Fade-Ometer FDA-R for various periods of time. The acid concentrations used for this work were based on the results obtained in the first two phases of the project. The samples of fabric were wet out in the proper concentration of acid and then dried. The dried samples were mounted on white cards and placed in the Fade-Ometer for exposure to light. The nylon material was exposed for 10, 20, 40, and 80 hours. The Dacron material was exposed for 40, 80, 160, and 320 hours. Higher concentrations of acid and longer exposure times in the Fade-Ometer were used for the Dacron as it was much more resistant to degradation than was the nylon. After exposure these samples were rinsed free from acid, dried, and conditioned for testing.

F. Exposure of Samples to Acids in the Vapor Phase

Samples of nylon and Dacron fabric were exposed to various concentrations of sulfur dioxide, oxides of nitrogen, and hydrogen sulfide gases produced from sulfurous, nitrous and hydrosulfuric acids respectively. The amount of gas in the vapor phase was determined by the concentration of acid placed in the containers and by the temperature at which the samples were aged. The fabric samples were folded and placed over glass holders which kept them out of contact with the acid solution used to produce the gas. The samples were thus exposed to the gases for one month under conditions of high humidity where the degradative effects were the greatest. The concentrations used and conditions selected were based on the results obtained in exposure of the fabrics to the various acids under conditions of 100% R. H.

G. Physical Testing Procedures

The conditioned fabric samples were cut into warp-wise strips 1 x 6 inches and raveled to a standard number of ends. The breaking strengths of the raveled strips were determined on the Instron machine using the "C" cell with a 3 inch gage length and a cross-head speed of 10 inches per minute and a chart speed of 5 inches per minute. The jaws used had 1 x 1 1/2 in. faces. The testing procedure conformed to Federal Specification Method 5104 (CCC-T-191b) except that the samples were raveled to a standard number of ends rather than to a standard width. Five or ten replicas were tested for each sample. The average value for each sample was reported as percent loss in strength based on the original strength of the fabric. The shrinkage of the fabric was compensated for by using a standard number of ends in each test strip rather than the standard sample width.

For some of the preliminary work, the samples were screened by a bursting test according to Federal Specification Method 5122(CCC-T-191b.) using a Mullen diaphragm burst tester. This method was discontinued and subsequent data were obtained using the Instron machine. The only data given in this report which was obtained on the Mullen burst tester are shown in Tables XXVI and XXVII. All of the other results were obtained on the Instron machine.

H. Evaluation of the Visual Appearance of Aged Fabrics

The acid-treated nylon and Dacron samples were evaluated after ageing for their appearances under visible light and under ultraviolet light in order to determine if it was possible to observe degradation of the fabrics without the necessity of running a physical test. The fabrics were observed in north daylight and compared to known standards for changes in color, and each sample was classified as to its color against a chart. The samples were also observed under the ultraviolet radiation produced by a Hanovia type 7420 light and graded for the color and intensity of the fluorescence of the sample. The samples were compared with control samples and graded on a chart as to the color of the fluorescence and the degree of change from the untreated sample. Diagrams of the charts for grading the nylon material under visible and ultraviolet light are shown in Figures 145 and 146. There were only very slight changes in the appearance of the Dacron fabric both in visible light and in ultraviolet light. These differences were not great enough so that the samples could be readily graded. There were distinct changes in the appearance of the nylon samples under both lighting conditions.

The results of the above tests were arranged to show the number of times noticeable changes in appearance of the samples under each lighting condition compared to the number of times no changes in appearance occurred. On this basis, the results were tabulated for each acid, for each temperature condition, and for the following levels of degradation: 0-5%, 5-15%, 15-25%, 25-35%, 35-45%, 45-100%.

IV. EXPERIMENTAL RESULTS

A. Effect of Concentration

In the first phase of the work the effects of variations in concentration of each acid on the strength of the nylon and Dacron fabrics were determined. The results are shown in Tables II through VII and in Figures 1 through 12. The fabrics were evaluated for loss in strength after two weeks and four weeks ageing periods at each temperature condition.

The nylon fabric was increasingly degraded as the concentration of each acid was increased and as the ageing temperature was increased. Moreover, higher levels of degradation were obtained generally with the four-weeks ageing as compared to the two-weeks ageing. With the hydrosulfuric acid the degradation levels were very low. All the other acids used caused moderate to high degree of degradation under the conditions of the tests. Sulfuric, phosphoric, nitrous, and hydrosulfuric acids had no effect on the Dacron fabric. With the remaining acids, Dacron was increasingly degraded as the concentration of the acid was increased and as the ageing temperature was increased.

In all the preliminary work above, the nylon and Dacron samples were aged immersed in solution so that better control over the concentration of the acid in contact with the sample could be maintained. From these results, the concentrations of acids used in the second phase of the project were selected.

B. Effects of Prolonged Ageing Times

The degrading effects of the various acids on nylon and Dacron at each temperature condition over a six-months ageing period were determined for the samples (1) immersed in solution, (2) under low humidity conditions, and (3) under high humidity conditions. The acid concentrations needed to produce a 10% loss in strength in the samples during one-month ageing were estimated by interpolation of results of the first phase of the work. For the nylon fabric these concentrations were very low. The Dacron fabric, being much more resistant, required acid concentrations in some cases as high as 5 N. The results of this phase of the work are shown in Tables VIII through XXVIII and in Figures 13 through 82. Figures 13 through 48 show the percent losses in strength of the fabric in each treatment plotted against ageing time in months. Figures 49 through 82 show the percent losses in strength plotted against temperature.

As might be expected, the nylon samples aged immersed in solution showed greater losses in strength as the temperature was increased and as the ageing time was increased, with the maximum losses being at the six-months ageing period and at the 150°F temperature. The fabric was degraded the most by sulfuric acid, nitric acid and the nitrous acid control. The fabric was degraded to a moderate extent by hydrochloric, phosphoric, sulfurous and nitrous acids. The fabric was degraded only slightly or not at all by hydrosulfuric acid and distilled water. The nitrous acid caused the greatest amount of degradation at the 120°F temperature level. At 150°F the acid was rapidly decomposed and there was not sufficient nitrous acid left in solution to greatly affect the fabric.

All of the nylon fabrics aged under low humidity conditions, i.e., with the acid dried on the fabric, as well as the fabric treated with distilled water alone, showed moderate to high strength losses. The amount of degradation increased as the temperature increased and as the ageing time increased. The nitrous acid showed the highest degrading effect at 120°F.

The nylon fabrics aged under high humidity conditions showed generally greater strength losses as the temperature and ageing time were increased. The greatest degree of degradation occurred with nitric, sulfurous and nitrous acids. The sulfuric acid caused only slight to moderate strength losses and the hydrochloric, phosphoric, hydrosulfuric acids and water showed no or only slight strength losses. The nitrous acid control showed only slight strength losses except at the 150°F level. In this case the strength losses were quite high.

The Dacron fabric, aged immersed in solution, showed generally higher degrees of degradation as the ageing time and temperature were increased. Hydrochloric and nitric acids caused large strength losses. Sulfuric acid and the nitrous acid control caused slight to moderate strength losses. The distilled water and the acids phosphoric, sulfurous, hydrosulfuric, and nitrous caused only slight strength losses. This information generally held true for both the types I and II Dacron fabrics. The data for the results of ageing both of these fabric types immersed in solution are reported. In all later work only the type II Dacron material was used.

The Dacron fabric aged under low humidity conditions, i.e., with the acid dried on the fabric, showed generally more degradation as the temperature and ageing time were increased. Generally the material was only moderately degraded with no or only slight degradation caused by the nitrous acid, hydrosulfuric acid, nitrous acid control and the distilled water. Slight to medium degradation was caused by the nitric, hydrochloric, phosphoric, and sulfurous acids. Sulfuric acid degraded the fabric to a large extent.

The Dacron fabric aged under high humidity conditions showed generally increasing amounts of degradation as the time of ageing and temperature were increased. Large strength losses occurred when the samples were treated with hydrochloric and nitric acids. Slight to relatively moderate strength losses occurred with sulfuric and sulfurous acids and the nitrous acid control. No or only slight losses occurred with phosphoric, hydrosulfuric and nitrous acids and with water.

By observing the relative degradation of the fabric treated with each acid under the three ageing conditions one may estimate the relative severity of each ageing condition. Under moist conditions either with the samples immersed in solution or exposed at about 100% relative humidity the Dacron fabrics were most severely degraded by nitric and hydrochloric acids. The phosphoric, nitrous, hydrosulfuric, and sulfurous acids caused only slight to moderate degradation of Dacron. Under moist conditions the nylon fabric was degraded the most severely by nitric, sulfurous, sulfuric, and nitrous acids. The other acids caused only slight to moderate degradation under these conditions. Under dry conditions all of the acids degraded the nylon.

C. Time, Temperature, and Concentration Conditions Necessary to Cause Specific Losses in Strength.

The data from Figures 1 through 82 was replotted to show the interaction of time, temperature and concentration to cause specific strength losses. This information was obtained for the following levels of degradation of the fabrics: 5%, 10%, 25%, and 50%. This information is shown in Figures 83 through 120.

Figures 83 through 112 show the effects of time in relation to temperature for all of the acids under the conditions: immersed in solution, aged at low humidity conditions, and aged at high humidity conditions. Ideally, this set of figures would show the conditions of time and temperature necessary to produce specific strength losses when the concentration of the treating solutions was held constant over the range of temperatures. However, as explained earlier, the experiments were originally set up in such a way that the concentration was different for each temperature. In spite of these variations in concentration, the time-temperature relationships are presented in Figures 83 through 112 for whatever value they may have. In many cases the differences in concentrations at the various temperatures were not great; the initial concentration of the acid used at each temperature condition is marked on the individual graphs.

The relationships between concentration and time, and concentration and temperature necessary to cause the specific losses in strength are shown in Figures 113 through 120. This information was determined for samples aged immersed in solution as only in these cases could the actual concentration of the acid in contact with the cloth be definitely known. From these data the following conclusions may be drawn: The nylon can withstand long ageing at low temperature conditions, or short ageing periods at high temperature when only very dilute acids are applied to the fabrics without excessive degradation of the fabric, in most cases. For example, nylon material was degraded 5% or less after one-month's ageing at 100°F by 0.1 N sulfuric, hydrochloric, nitric, and phosphoric acid and was degraded 5% or less after two week's ageing by 1 N sulfuric acid, and nitric acids and 1.5 N phosphoric acid. At room temperature the nylon withstood approximately 0.1 N acid for relatively long periods of time but when the temperature was raised to 150°F even traces of acid caused definite degradation of the fabric. Phosphoric acid and the gaseous acids were tolerated by the fabric in slightly higher concentrations than was the case with the other acids. The nylon was not noticeably degraded by hydrosulfuric acid.

The Dacron was very resistant to dilute acids under all ageing temperatures. Concentrations of sulfuric acid through 5 N had no effect on the Dacron except at extreme conditions of temperature and ageing time. Hydrochloric acid at 5 N concentration degraded the Dacron less than 5% after a month's ageing at 100°F. Nitric and phosphoric acids degraded the Dacron less than 5% after a month's ageing at 100°F when used at concentrations of 2 N. The nitric acid degraded the fiber less than 5% during one month ageing at 150°F when used at a concentration of 0.1 N and the phosphoric acid degraded the material to the same degree under the same conditions, when used at 0.5 N concentration. In general the Dacron can be considered quite resistant to attack by acids in comparison with nylon.

D. Effect of Light in Combination with Various Acids

The effects of light in combination with the effects of each acid on nylon and Dacron fabrics were determined by treating the fabrics with selected concentrations of each acid and then exposing the treated samples in the Atlas Fade-Ometer FDA-R for various period of time. The results of this phase of the work are shown in Tables XXIX and XXX and in Figures 121 through 136. The percent degradation of the fabrics plotted against length of exposure to light is shown in Figures 121 through 124 and Figures 129 through 132. The nylon was quickly degraded by the light and showed a 70% loss in strength at 80 hours of exposure, while the Dacron fabric was only moderately degraded by the effects of light up to 320 hours of exposure. The degree of degradation of the nylon samples treated with each acid was only slightly increased over the effects of the light alone. This is shown by Figures 125 through 128.

All of the acids, other than sulfuric, caused only moderate increases in the degradation of the Dacron fabric over and above the effect of light alone. In the case of sulfuric acid the 5 N acid caused the sample to be completely degraded by 160 hours exposure and the 1 N acid caused the sample to be completely degraded by 320 hours exposure in the Fade-Ometer. This acid caused relatively more degradation of the Dacron fabric than did the ultraviolet radiation of the carbon arc. The other acids had apparently less effect on the degradation of the fabric than did the radiation. This information is shown in Figures 133 through 136.

From the results of this phase of the work it may be concluded that nylon is much more sensitive to the effects of acids and to light than is the Dacron, as much higher concentrations of acid and longer exposure times were used with the Dacron material and yet lower levels of degradation were obtained. Moreover, the degradation of nylon was more likely caused by light alone than by the combined effects of light dilute acids dried on the fabrics.

E. Effect of the Vapor Phase of the Unstable Acids

The effects of sulfur dioxide, oxides of nitrogen, and hydrogen sulfide gases on nylon and Dacron fabrics are shown in Table XXXI and in Figures 137 and 138. The fabrics were exposed for one month to selected concentrations of these gases under conditions of high humidity. The concentration of the gas in the vapor phase was dependent upon the concentration of the acid solution itself and the temperature of ageing. The results shown in Figures 137 and 138 are marked to show the concentration of the acid solutions used to generate the gases.

The Dacron material was unaffected at all temperature conditions by sulfur dioxide and hydrogen sulfide gases. Dacron was very slightly affected by the oxides of nitrogen generated from 1 N nitrous acid solution at 150°F and unaffected by less severe conditions. The nylon was unaffected by the hydrogen sulfide gas at all temperature conditions. Nylon was degraded to a moderate degree by sulfur dioxide, and the degree of degradation was increased as the temperature was increased. The nylon was completely degraded by the oxides of nitrogen generated from 1 N nitrous acid and moderately degraded by the oxides of nitrogen generated by 0.1 N nitrous acid. In general the results obtained in this phase of the work agree with the results obtained by exposure of the samples wet out with the acids and aged at 100% relative humidity.

F. Determination of the Degradation of the Fabrics by Visual Means

The results of a study of the possibility of visually determining the degree of degradation of nylon and Dacron fabrics treated with acids are shown in Tables XXXII through XXXV and in Figures 139 through 144. Diagrams showing the methods of grading the nylon samples for changes in hue and brightness of the color of the samples observed under visible light, and the hue and intensity of the fluorescence of the samples observed under ultraviolet light are shown in Figures 145 and 146. The changes in the color and fluorescence of the Dacron samples in visible and ultraviolet light were so slight that it was not possible to grade this fabric for various degrees of degradation. Very close comparison of each sample with the standards was necessary in order to see any changes in color or fluorescence. On the other hand, the nylon fabric showed distinct color changes in visible light and very distinct changes in fluorescence under ultraviolet light between the control and many of the samples. These changes were readily observed without the necessity of actually comparing the samples with the control.

The changes in appearance of the nylon and Dacron samples were tabulated for each acid, for each ageing temperature, and for various levels of degradation of the samples having an appearance similar to the controls and the actual number of samples having an appearance distinctly different from the controls were noted. The controls consisted of the appearances of the untreated fabrics under visible light and under ultraviolet light, respectively.

From the data the following conclusions may be drawn. This method cannot be used to determine the degradation of Dacron by acids. The Dacron showed no significant change either in visible light or in ultraviolet light as the degree of degradation increased. In the instance of nylon a color change or a change in the fluorescence of the sample was noted. Above 20% loss in strength of the fabric, there was a difference in fluorescence in better than 50% of the cases. Above 40% degradation, the likelihood of a change in fluorescence increased to above 80% probability.

In visible light the same trend held true but to a lesser extent. Better than 50% degradation of the sample was required before the probability of a distinct color change was likely to occur in 50% of the cases.

The likelihood of an increasing percent of the samples having a difference in color or fluorescence from the control increased as the ageing temperature was increased. The changes in fluorescence occurred in a greater percentage of the cases than did changes in color. The samples aged at 150°F had better than a 70% probability of being different in fluorescent properties but only about a 50% probability of being different in color under visible light.

All of the acids with the exception of nitrous, showed a predominant tendency not to change the fluorescence of nylon under ultraviolet light, or color under visible light, without consideration of the temperature at which the samples were aged or their degree of degradation. On the other hand, the nitrous acid changed the fluorescent characteristics and visible color of the nylon in almost all cases irrespective of the ageing temperature or of their degree of degradation.

Thus, it is apparent that while visual observation of the nylon fabric under visible light showed that the samples were degraded in some cases, observation of the samples under ultraviolet light had a much more significant tendency to show degradation. As a matter of practical application it is therefore recommended that nylon parachute materials be inspected under ultraviolet light and if they show distinctly different fluorescent qualities from normal, they should be examined by Physical means for loss in strength at the points of fluorescence. It is believed that this method of inspection would reveal about 70% to 80% of the cases where degradation had occurred.

V CONCLUSIONS

The following conclusions were reached in this work·

Phase 1. The preliminary work indicated that an increase in concentration of acid, in time of treatment, or in the temperature of treatment resulted in progressively higher strength losses in the nylon and the Dacron fabrics. It was further indicated that Dacron was more resistant to acid than nylon, and that fairly high concentrations were necessary to produce significant losses in strength during a resonably short period of treatment.

Phase 2. The experiments on the effects of prolonged ageing were conducted under three kinds of conditions: Namely, with the fabric immersed in the solution; with the fabric first immersed in solution, then extracted and aged under low humidity conditions; with the fabric first immersed in solution, then extracted and aged under high humidity conditions. Under all three conditions, the same general trend was found. With the concentration of acid held constant, the losses in strength increased as the temperature of ageing increased. The nylon fabric withstood long ageing periods at low temperature or short ageing periods at high temperature when acid below a concentration of 0.01 $\underline{N}$ was applied. Dacron was resistant to the dilute acid under all ageing temperatures, 150°F being the maximum temperature used in this work. From the overall results, Dacron may be considered quite resistant to attack by mineral acids in comparison with nylon.

Phase 3. Acid-treated nylon was very much more sensitive to light than acid-treated Dacron. Moreover, the losses in strength that were observed were more likely caused by the effect of the light itself than by the effect of the acid in combination with light. An exception to this general conclusion was found in the case of Dacron treated with sulfuric acid. In this instance,, pretreatment with the acid appeared to accelerate the degradation by light.

Phase 4. Sulfur dioxide, hydrogen sulfide, and oxides of nitrogen showed no outstanding effect on Dacron. Nylon was shown to be sensitive only to oxides of nitrogen.

Phase 5. No satisfactory method for the detection of acid degradation by visual means was found The most promising, but applicable only to nylon, was an examination of fluorescent characteristics under ultraviolet light. Eighty percent of the fabrics that were degraded to the extent of a 40% loss in strength showed fluorescent properties different from that of the control. It appears that an inspection of nylon under ultraviolet light would reveal a majority of cases where significant degradation by acid had occurred.

Inasmuch as the data obtained is extremely voluminous, the data is being statistically summarized to give a more complete evaluation. These additional data will be prepared and issued as WADC TR 55-340, Supp. 1.

APPENDIX I

TABLES

TABLE I

Concentration of acid used to treat nylon and Dacron fabrics

Acid	Normality of Acid							
	0.01	0.05	0.1	0.2	0.5	1.0	2.0	5.0
	Concentration of Acid in gms/100 ml.							
H_2SO_4	0.049	0.245	0.49	0.98	2.45	4.9	9.8	24.5
HCl	0.036	0.182	0.36	0.73	1.82	3.6	7.3	18.2
HNO_3	0.063	0.315	0.63	1.26	3.15	6.3	12.6	31.5
H_3PO_4	0.033	0.164	0.33	0.65	1.64	3.3	6.5	16.4
H_2SO_3	0.041	0.205	0.41	0.82	2.05	4.1	8.2	*
HNO_2	0.047	0.235	0.47	0.94	2.35	4.7	**	**
H_2S	0.017	0.085	0.17	0.34	*	*	*	*

*Could not be made at these concentrations

**Highly unstable at these concentrations and therefore not used.

TABLE II

Loss in strength when nylon is treated in different solutions and aged two weeks in solution at different temperatures

Acid	Temp. °F	Strength Loss % Acid Concentration (Normality) 0.1	1.0	2.0	5.0
H_2SO_4	Room	5.6	.6	4.3	12.0
	100	+1.1	+0.2	8.9	34.8
	120	.6	56.2	65.0	100.0
	150	37.2	90.1	100.0	100.0
HCl	Room	+ 0.2	2.1	5.1	100.0
	100	1.9	8.1	34.4	100.0
	120	1.5	80.5	93.2	100.0
	150	32.0	100.0	100.0	100.0
HNO_3	Room	+5.3	7.1	11.8	100.0
	100	+4.5	20.0	44.7	100.0
	120	22.0	79.9	100.0	100.0
	150	66.9	100.0	100.0	100.0
H_3PO_4	Room	+1.5	+0.6	8.0	10.5
	100	+1.7	+1.1	8.9	11.8
	120	+0.9	+5.6	12.8	27.8
	150	+3.2	2.6	37.2	80.6
HNO_2	Room	+2.5	6.4	*	*
	100	3.4	20.3	*	*
	120	+2.5	28.6	*	*
	150	3.8	72.0	*	*

*See first paragraph, page 4

TABLE III

Loss in strength when nylon is treated in different solutions and aged one month in solution at different temperatures

		Strength Loss % Acid Concentration (Normality)			
Acid	Temp. °F	0.1	1.0	2.0	5.0
H_2SO_4	Room	1.2	10.0	20.4	34.8
	100	3.6	17.5	33.4	69.5
	120	18.0	73.4	79.2	100.0
	150	66.8	100.0	100.0	100.0
HCl	Room	+3.4	21.9	21.2	100.0
	100	4.8	35.9	64.8	100.0
	120	31.9	85.6	100.0	100.0
	150	64.6	100.0	100.0	100.0
HNO_3	Room	3.1	21.7	30.0	100.0
	100	3.6	50.9	63.9	100.0
	120	41.7	86.8	100.0	100.0
	150	77.6	100.0	100.0	100.0
H_3PO_4	Room	+4.6	+2.2	+7.3	0.7
	100	+3.4	2.6	0	+1.5
	120	0	+0.2	0.2	50.5
	150	5.1	26.3	55.4	100.0
HNO_2	Room	7.1	22.0	*	*
	100	6.3	25.6	*	*
	120	7.1	40.5	*	*
	150	*	*	*	*

*See first paragraph, page 4.

TABLE IV

Loss in strength during ageing when nylon is treated in different solutions and aged in solution at different temperatures

Acid	Temp. °F	Conc. N	Strength Loss % Ageing Time Two weeks	Strength Loss % Ageing Time One month
H_2SO_3	Room	2.0	+ 4.2	8.8
	Room	1.0	+ 2.7	6.3
	100	1.4	+ 1.2	9.0
	100	0.7	+ 1.2	3.4
	120	1.0	3.2	40.5
	120	0.5	+ 1.1	8.5
	150	0.5	11.3	*
	150	0.3	+ 1.9	34.1
H_2S	Room	0.2	+ 2.3	+ 1.4
	100	0.1	+ 2.1	+ 1.4
	120	0.1	+ 2.7	+ 1.2
	150	0.08	+ 3.2	+ 0.7
HNO_2 Control	Room	1.0	+ 1.4	5.4
	100	1.0	+ 2.5	+ 7.8
	120	1.0	0	+ 3.4
	150	1.0	28.2	*

*The result was not obtained for the one month ageing period

TABLE V

Loss in strength when Dacron (Type I) is treated in different solutions and aged two weeks in solution at different temperatures

Acid	Temp. °F	Strength Loss, % Acid Concentration (Normality) 0.1	1.0	2.0	5.0
H_2SO_4	Room	1.4	0	0.7	+0.7
	100	0	2.0	0	0
	120	+0.7	+2.7	+0.7	+3.4
	150	+1.4	0	+1.4	2.7
HCl	Room	0.7	2.0	1.4	0.7
	100	1.4	+2.7	+1.4	0
	120	0.7	+2.0	+4.0	10.8
	150	+2.7	+2.7	26.3	45.9
HNO_3	Room	0.7	+3.4	+2.7	26.4
	100	0	1.4	0.7	65.5
	120	2.0	4.0	3.4	83.8
	150	+0.7	100.0	10.1	100.0
H_3PO_4	Room	0	0	+0.7	0.7
	100	+0.7	0	+0.7	0.7
	120	2.0	1.4	0	1.4
	150	3.4	2.7	7.4	2.0
HNO_2	Room	0	0	*	*
	100	+1.4	+2.0	*	*
	120	3.4	+1.3	*	*
	150	+1.4	+1.4	*	*

*See first paragraph, page 4

TABLE VI

Loss in strength when Dacron (Type I) is treated in different solutions and aged one month in solution at different temperatures

Acid	Temp. °F	Strength Loss % Acid Concentration (Normality)			
		0.1	1.0	2.0	5.0
H_2SO_4	Room	+0.7	+1.3	0	+0.7
	100	0.7	+0.7	0.7	+4.0
	120	2.0	+1.3	+0.7	0.7
	150	1.4	0.7	+0.9	2.8
HCl	Room	0.7	0	+1.3	0.7
	100	+0.7	+3.3	+0.7	5.4
	120	+0.7	+2.3	+0.7	21.0
	150	0.7	+0.4	27.8	95.2
HNO_3	Room	0.7	0	1.4	55.4
	100	+1.3	0	2.7	90.5
	120	+2.7	+0.7	6.8	100.0
	150	0.8	100.0	42.5	100.0
H_3PO_4	Room	0	1.4	0	0.7
	100	0	+1.3	0	0
	120	0	+2.7	+0.7	+1.3
	150	16.6	1.4	13.7	8.9
HNO_2	Room	0	+1.3	*	*
	100	+2.0	+1.3	*	*
	120	+1.3	+1.3	*	*
	150	+1.4	3.3	*	*

*See first paragraph, page 4.

TABLE VII

Loss in strength during ageing when Dacron (Type I) is treated in different solutions and aged in solution at different temperatures

Acid	Temp. °F	Conc. N	Strength Loss % Ageing Time	
			Two weeks	One month
H_2SO_3	Room	1.0	0	2.0
	Room	2.0	0	+2.7
	100	0.7	0.7	+2.7
	100	1.4	0.7	+2.0
	120	0.5	0	+1.3
	120	1.0	20.3	43.9
	150	0.3	+0.7	6.4
	150	0.5	91.2	98.7
H_2S	Room	0.2	0.7	0.7
	100	0.1	0.7	+2.7
	120	0.1	0.7	+0.7
	150	0.08	+0.7	2.0
HNO_2 Control	Room	1.0	0	+1.3
	100	1.0	0	+2.7
	120	1.0	1.4	+1.3
	150	1.0	3.4	5.2

TABLE VIII

Loss in strength during ageing when nylon is treated in H_2O and aged under different conditions at different temperatures.

	Strength Loss %			
	Ageing Time (Months)			
Ageing Conditions	1	2	4	6
In Solution at				
Room Temperature	1.0	1.5	+1.2	1.5
100°F	1.2	2.9	+1.2	2.0
120°F	1.0	2.9	0.7	0.9
150°F	5.4	10.0	12.5	13.5
Low Relative Humidity at				
Room Temperature	0.9	+1.2	12.3	18.9
100°F	+0.7	+2.7	15.2	17.1
120°F	0.7	0	7.1	7.4
150°F	1.2	4.9	31.0	45.9
High Relative Humidity at				
Room Temperature	+0.5	+1.2	0.7	+0.7
100°F	3.4	+0.2	0.2	2.0
120°F	7.6	+1.2	1.7	3.4
150°F	3.9	0.5	2.0	0.2

TABLE IX

Loss in strength during ageing when nylon is treated in H_2SO_4 solution and aged under different conditions and different temperatures

	Concentration of Solution N Ageing Time (Months)					Strength Loss % Ageing Time (Months)			
Ageing Conditions	**Initial**	**1**	**2**	**4**	**6**	**1**	**2**	**4**	**6**
In Solution at									
Room Temperature	0.056	0.056	0.051	0.049	0.049	4.4	3.5	2.9	5.7
100°F	0.023	0.027	0.024	0.021	0.022	3.7	4.9	9.3	17.0
120°F	0.017	0.011	0.011	0.010	0.099	2.9	3.6	14.0	39.9
150°F	0.021	0.016	0.013	0.009	0.0086	24.8	57.2	81.3	90.4
Low RH at									
Room Temperature	0.058	--	--	--	--	4.6	4.9	6.6	9.0
100°F	0.024	--	--	--	--	4.6	2.9	8.1	*
120°F	0.016	--	--	--	--	2.2	9.8	12.2	15.2
150°F	0.012	--	--	--	--	9.8	28.7	25.6	36.6
High RH at									
Room Temperature	0.058	--	--	--	--	5.1	6.1	8.1	9.0
100°F	0.024	--	--	--	--	20.8	24.3	28.7	21.6
120°F	0.016	--	--	--	--	4.6	3.1	2.7	8.3
150°F	0.021	--	--	--	--	3.7	2.2	7.8	20.6

*This result was not obtained because the sample was discarded by mistake at the end of the 4th month ageing period.

TABLE X

Loss in strength during ageing when nylon is treated in HCl solution and aged under different conditions at different temperatures.

Ageing Conditions	Initial	Concentration of Solution N Ageing Time (Months)				Strength Loss % Ageing Time (Months)			
		1	2	4	6	1	2	4	6
In Solution at									
Room Temperature	0.057	0.052	0.047	0.044	0.045	4.2	5.6	5.4	7.6
100°F	0.033	0.034	0.032	0.031	0.032	5.2	4.4	10.3	11.5
120°F	0.026	0.025	0.024	0.024	0.025	2.9	5.4	15.7	38.8
150°F	0.012	0.013	0.014	0.013	0.0086	4.4	6.1	9.8	16.7
Low RH at									
Room Temperature	0.054	--	--	--	--	2.0	7.6	5.1	9.0
100°F	0.033	--	--	--	--	1.4	10.5	12.5	18.6
120°F	0.027	--	--	--	--	8.5	33.6	44.7	75.4
150°F	0.012	--	--	--	--	7.7	26.2	33.9	36.6
High RH at									
Room Temperature	0.049	--	--	--	--	4.1	5.8	8.8	4.1
100°F	0.032	--	--	--	--	4.9	1.2	2.0	4.9
120°F	0.028	--	--	--	--	2.9	4.4	4.4	5.4
150°F	0.014	--	--	--	--	2.2	2.4	6.9	11.3

TABLE XI

Loss in strength during ageing when nylon is treated in HNO_3 solution and aged under different conditions at different temperatures

Ageing Conditions	Initial	Concentration of Solution N Ageing Time (Months)				Strength Loss % Ageing Time (Months)			
		1	2	4	6	1	2	4	6
In Solution at									
Room Temperature	0.051	0.051	0.046	0.046	0.051	7.6	14.2	15.0	19.4
100°F	0.035	0.035	0.035	0.033	0.033	9.6	17.9	31.9	64.4
120°F	0.016	0.015	0.015	0.014	0.014	5.7	13.5	22.1	42.3
150°F	0.013	0.019	0.015	0.017	0.016	17.4	36.6	72.7	86.5
Low RH at									
Room Temperature	0.034	--	--	--	--	10.0	14.2	11.8	13.3
100°F	0.025	--	--	--	--	12.7	13.2	18.7	21.9
120°F	0.016	--	--	--	--	10.8	16.2	20.4	33.2
150°F	0.010	--	--	--	--	18.9	33.1	41.8	41.5
High RH at									
Room Temperature	0.033	--	--	--	--	13.2	25.5	34.4	26.8
100°F	0.022	--	--	--	--	42.5	49.4	68.8	52.3
120°F	0.016	--	--	--	--	12.0	28.7	34.6	18.2
150°F	0.013	--	--	--	--	55.2	38.0	86.5	80.3

TABLE XII

Loss in strength during ageing when nylon is treated in H_3PO_4 solution and aged under different conditions at different temperatures

	Concentration of Solution N Ageing Time (Months)					Strength Loss % Ageing Time (Months)			
Ageing Conditions	Initial	1	2	4	6	1	2	4	6
In Solution at									
Room Temperature	0.108	0.108	0.096	0.092	0.093	1.2	2.5	3.2	4.2
100°F	0.055	0.052	0.051	0.055	0.055	2.9	2.7	6.4	7.6
120°F	0.011	0.010	0.009	0.008	0.008	1.0	2.2	5.4	9.0
150°F	0.012	0.018	0.014	0.015	0.015	8.1	9.8	16.5	28.3
Low RH at									
Room Temperature	0.114	--	--	--	--	1.2	5.2	3.7	5.4
100°F	0.069	--	--	--	--	2.7	7.3	13.3	10.0
120°F	0.034	--	--	--	--	1.4	14.7	12.0	24.0
150°F	0.009	--	--	--	--	7.6	16.2	29.7	40.7
High RH at									
Room Temperature	0.114	--	--	--	--	0.2	0	0.7	0.9
100°F	0.069	--	--	--	--	0.2	0	1.4	0.9
120°F	0.034	--	--	--	--	0.7	1.9	2.7	*
150°F	0.009	--	--	--	--	2.4	2.7	4.9	3.2

*This result was not obtained because the sample was discarded by mistake at the end of the 4th month ageing period

TABLE XIII

Loss in strength during ageing when nylon is treated in H_2SO_3 solution and aged under different conditions at different temperatures

Ageing Conditions	Initial	Concentration of Solution N Ageing Time (Months) 1	2	4	6	Strength Loss % Ageing Time (Months) 1	2	4	6
In Solution at									
Room Temperature	1.36	0.77	0.85	0.72	0.64	2.9	8.8	9.3	4.7
100°F	0.89	0.45	0.52	0.45	0.33	1.2	11.0	13.5	19.2
120°F	0.58	0.30	0.27	0.15	0.11	1.2	11.3	10.3	20.9
150°F	0.094	0.12	0.023	0.015	0.015	1.2	11.3	13.0	22.4
Low RH at									
Room Temperature	1.19	--	--	--	--	0.2	5.4	+0.7	0.2
100°F	0.86	--	--	--	--	0.7	2.2	6.1	11.3
120°F	0.58	--	--	--	--	1.4	8.8	4.7	11.0
150°F	0.097	--	--	--	--	8.8	27.7	34.9	36.1
High RH at									
Room Temperature	1.19	--	--	--	--	20.0	18.1	22.0	23.0
100°F	0.86	--	--	--	--	34.4	34.6	47.7	39.8
120°F	0.58	--	--	--	--	33.4	34.6	47.7	100.0
150°F	0.097	--	--	--	--	86.2	77.1	88.2	95.6

TABLE XIV

Loss in strength during ageing when nylon is treated in H_2S solution and aged under different conditions at different temperatures

Ageing Conditions	Initial	Concentration of Solution N Ageing Time (Months) 1	2	4	6	Strength Loss % Ageing Time (Months) 1	2	4	6
In Solution at									
Room Temperature	0.18	--	--	--	--	+0.7	0.7	+1.2	0
100°F	0.14	--	--	--	--	+0.7	0.9	+0.5	1.7
120°F	0.11	--	--	--	--	+0.7	3.9	0	+9.8
150°F	0.08	--	--	--	--	0.7	0	2.0	4.4
Low RH at									
Room Temperature	0.18	--	--	--	--	4.7	0.5	+0.2	+0.2
100°F	0.14	--	--	--	--	1.5	+3.7	1.7	4.2
120°F	0.11	--	--	--	--	3.4	1.9	4.2	2.9
150°F	0.08	--	--	--	--	14.7	22.1	23.0	28.5
High RH at									
Room Temperature	0.18	--	--	--	--	0.2	0	0	0.9
100°F	0.14	--	--	--	--	+0.5	+1.2	+2.0	+0.5
120°F	0.11	--	--	--	--	+1.2	0.5	+0.5	2.2
150°F	0.08	--	--	--	--	0.9	16.9	10.6	7.1

TABLE XV

Loss in Strength during ageing when nylon is treated in HNO_2 solution and aged under different conditions at different temperatures

Ageing Conditions	Concentration of Solution N Ageing Time (Months)					Strength Loss % Ageing Time (Months)			
	Initial	1	2	4	6	1	2	4	6
In Solution at									
Room Temperature	0.65	0.46	0.46	0.43	0.42	14.7	10.3	19.1	25.0
100°F	0.40	0.26	0.26	0.23	0.23	11.3	10.0	16.9	17.9
120°F	0.30	0.22	0.22	0.22	0.22	11.1	18.6	36.1	32.4
150°F	0.22	0.22	0.21	0.015	0.011	2.9	4.4	6.3	10.0
Low RH at									
Room Temperature	1.0	--	--	--	--	0.7	1.7	0	3.2
100°F	1.0	--	--	--	--	1.0	5.8	4.2	12.0
120°F	1.0	--	--	--	--	11.0	28.5	69.0	67.0
150°F	1.0	--	--	--	--	6.1	19.2	19.2	30.4
High RH at									
Room Temperature	1.0	--	--	--	--	8.1	15.9	11.5	2.9
100°F	1.0	--	--	--	--	10.3	1.7	4.9	5.2
120°F	1.0	--	--	--	--	4.9	28.7	100.0	100.0
150°F	1.0	--	--	--	--	20.8	41.0	57.2	42.8

TABLE XVI

Loss in strength during ageing when nylon is treated in HNO_2 Control solution and aged under different conditions at different temperatures

	Strength Loss % Ageing Time (Months)			
Ageing Conditions	1	2	4	6
In Solution at				
Room Temperature	1.0	0.9	0.7	2.0
100°F	3.4	4.1	7.6	9.3
120°F	2.9	8.1	14.2	65.1
150°F	4.9	67.3	74.7	85.3
Low RH at				
Room Temperature	0	6.3	+2.0	3.7
100°F	7.3	6.4	0.2	13.0
120°F	5.9	16.9	27.8	25.0
150°F	5.7	20.8	19.4	31.2
High RH at				
Room Temperature	0.7	0.5	0.7	3.7
100°F	2.4	3.4	5.1	3.2
120°F	2.2	2.4	7.1	5.9
150°F	34.1	54.1	70.0	60.9

TABLE XVII

Loss in strength during ageing when Dacron (Type II) is treated in H_2O and aged under different conditions at different temperatures

Ageing Conditions	Strength Loss % Ageing Time (Months) 1	 2	 4	 6
In Solution at				
Room Temperature	4.2	2.5	6.9	+2.7
100°F	+3.2	0	7.7	+4.7
120°F	17.0	1.7	11.1	+2.7
150°F	13.6	3.0	17.8	+0.2
Low RH at				
Room Temperature	0.5	+1.5	4.4	1.5
100°F	+2.0	0.4	7.4	1.2
120°F	+2.2	+0.8	10.1	12.4
150°F	+1.0	0.8	12.6	9.9
High RH at				
Room Temperature	3.2	4.4	+1.2	+3.9
100°F	7.4	1.9	4.0	+4.9
120°F	2.7	4.4	1.2	+3.2
150°F	8,4	0.9	4.7	6.2

TABLE XVIII

Loss in strength during ageing when Dacron (Type II) is treated in H_2SO_4 solution and aged under different conditions at different temperatures

Ageing Conditions	Concentration of Solution N					Strength Loss %			
		Ageing Time (Months)				Ageing Time (Months)			
	Initial	1	2	4	6	1	2	4	6
In Solution at									
Room Temperature	5.045	5.61	5.21	5.28	*	+0.2	3.3	+1.5	+0.5
100°F	5.045	4.90	5.29	5.67	*	1.7	5.2	1.7	0.2
120°F	5.045	4.85	5.11	5.23	*	4.1	7.4	6.6	14.4
150°F	5.045	4.77	5.21	5.71	*	4.6	14.4	20.5	24.8
Low RH at									
Room Temperature	2.14	--	--	--	--	5.9	9.9	+2.5	5.1
100°F	2.14	--	--	--	--	26.4	34.1	77.2	63.3
120°F	0.056	--	--	--	--	9.9	30.6	6.4	43.3
150°F	0.056	--	--	--	--	34.4	50.4	62.4	100.0
High RH at									
Room Temperature	2.14	--	--	--	--	1.7	8.4	1.0	0
100°F	2.14	--	--	--	--	+2.0	7.6	0	+1.0
120°F	0.056	--	--	--	--	0.7	10.8	3.2	9.2
150°F	0.056	--	--	--	--	5.4	11.6	21.5	24.0

*The normality of the solution at the 6th month period is not listed because the solution was discarded by mistake before titration

TABLE XIX

Loss of strength during ageing when Dacron (Type II) is treated in HCl solution and aged under different conditions at different temperatures

		Concentration of Solution N Ageing Time (Months)				Strength Loss % Ageing Time (Months)			
Ageing Conditions	Initial	1	2	4	6	1	2	4	6
In Solution at									
Room Temperature	4.98	4.77	4.88	4.69	*	8.2	7.4	0.2	11.6
100°F	5.18	4.72	4.66	4.73	*	9.1	22.5	**	**
120°F	4.98	4.60	4.56	4.77	*	15.0	24.7	33.1	87.8
150°F	2.49	2.36	2.44	2.52	*	38.6	30.8	68.0	100.0
Low RH at									
Room Temperature	4.98	--	--	--	--	29.9	16.8	10.9	34.4
100°F	4.98	--	--	--	--	31.6	18.8	12.1	26.7
120°F	4.98	--	--	--	--	34.6	20.0	19.0	32.4
150°F	4.98	--	--	--	--	25.4	24.2	18.8	33.6
High RH at									
Room Temperature	4.98	--	--	--	--	2.0	13.3	16.3	27.2
100°F	4.98	--	--	--	--	17.8	39.6	57.0	73.7
120°F	4.98	--	--	--	--	11.1	24.7	63.9	92.0
150°F	4.98	--	--	--	--	83.7	88.3	83.6	100.0

*The normality of the solution at the 6th month period is not listed because the solution was discarded by mistake before titration.

**This result was not obtained because the sample was discarded by mistake before its breaking strength was determined.

TABLE XX

Loss in strength during ageing when Dacron (Type II) is treated in HNO_3 solution and aged under different conditions at different temperatures

Ageing Conditions	Initial	Concentration of Solution N Ageing Time (Months) 1	2	4	6	Strength Loss % Ageing Time (Months) 1	2	4	6
In Solution at									
Room Temperature	2.81	2.58	2.73	2.64	*	9.2	21.7	2.7	23.0
100°F	2.40	2.31	2.98	2.47	*	15.6	39.6	44.8	57.4
120°F	2.30	2.18	2.51	2.30	*	13.1	21.5	31.4	81.4
150°F	1.002	0.92	1.10	0.98	*	16.8	14.6	58.9	87.8
Low RH at									
Room Temperature	2.48	--	--	--	--	18.3	17.8	11.9	17.6
100°F	2.21	--	--	--	--	21.0	24.2	20.8	20.2
120°F	2.21	--	--	--	--	19.3	21.2	20.8	25.9
150°F	2.21	--	--	--	--	23.0	13.8	12.9	6.7
High RH at									
Room Temperature	2.49	--	--	--	--	7.4	13.6	26.0	40.3
100°F	2.11	--	--	--	--	17.3	23.7	49.0	51.0
120°F	2.11	--	--	--	--	13.8	31.1	60.6	71.5
150°F	2.11	--	--	--	--	84.9	76.9	80.9	100.0

*The normality of the solution at the 6th month period is not listed because the solution was discarded by mistake before titration.

TABLE XXI

Loss in strength during ageing when Dacron (Type II) is treated in H_3PO_4 solution and aged under different conditions at different temperatures

Ageing Conditions	Concentration of Solution N Ageing Time (Months)					Strength Loss % Ageing Time (Months)			
	Initial	1	2	4	6	1	2	4	6
In Solution at									
Room Temperature	4.92	4.92	4.78	4.95	*	+0.7	6.1	0.9	+3.4
100°F	4.92	4.88	4.98	5.42	*	3.2	2.8	14.9	+3.9
120°F	4.92	4.84	5.08	5.46	*	+1.9	0.9	14.4	+1.2
150°F	1.98	1.54	2.23	3.20	*	0.7	0.9	16.3	10.9
Low RH at									
Room Temperature	4.92	--	--	--	--	1.7	9.9	8.6	0.2
100°F	4.92	--	--	--	--	1.0	+1.2	1.2	1.7
120°F	4.92	--	--	--	--	+3.2	6.9	29.4	42.8
150°F	0.69	--	--	--	--	4.5	6.6	10.9	20.7
High RH at									
Room Temperature	4.92	--	--	--	--	1.4	+0.4	1.7	0.2
100°F	4.92	--	--	--	--	3.2	+0.2	2.7	2.5
120°F	4.92	--	--	--	--	6.4	+3.2	+1.0	+1.5
150°F	0.70	--	--	--	--	6.1	8.6	3.5	11.6

*The normality of the solution at the 6th month period is not listed because the solution was discarded by mistake before titrating.

TABLE XXII

Loss of strength during ageing when Dacron (Type II) is treated in H_2SO_3 solution and aged under different conditions at different temperatures

Ageing Conditions	Initial	Concentration of Solution N, Ageing Time (Months) 1	2	4	6	Strength Loss %, Ageing Time (Months) 1	2	4	6
In Solution at									
Room Temperature	1.2	0.74	0.66	0.58	*	2.9	1.0	1.2	+4.9
100°F	0.9	0.53	0.47	0.32	*	+1.7	1.5	+0.1	+4.9
120°F	0.6	0.31	0.27	0.17	*	1.4	+3.7	1.2	+3.4
150°F	0.1	0.05	0.04	0.03	*	1.4	6.9	3.9	+0.4
Low RH at									
Room Temperature	1.19	--	--	--	--	12.6	12.8	5.0	14.4
100°F	0.86	--	--	--	--	10.1	9.6	17.6	32.9
120°F	0.58	--	--	--	--	13.8	14.6	47.0	26.7
150°F	0.097	--	--	--	--	6.1	9.6	3.7	27.9
High RH at									
Room Temperature	1.19	--	--	--	--	3.7	+0.2	+3.2	+3.2
100°F	0.86	--	--	--	--	4.7	+1.2	2.5	0.7
120°F	0.58	--	--	--	--	9.1	+0.4	1.7	+0.2
150°F	0.097	--	--	--	--	16.0	12.3	19.3	17.0

*The normality of the solution at the 6th month period is not listed because the solution was discarded by mistake before titration.

TABLE XXIII

Loss in strength during ageing when Dacron (Type II) is treated in H_2S solution and aged under different conditions at different temperatures

Ageing Conditions	Initial	Concentration of Solution N Ageing Time (Months) 1	2	4	6	Strength Loss % Ageing Time (Months) 1	2	4	6
In Solution at									
Room Temperature	0.18	--	--	--	--	3.5	14.3	3.7	2.5
100°F	0.14	--	--	--	--	+ 0.2	12.1	0.7	+0.7
120°F	0.11	--	--	--	--	+ 3.0	10.1	3.7	7.7
150°F	0.08	--	--	--	--	+ 5.2	12.6	3.2	4.5
Low RH at									
Room Temperature	0.18	--	--	--	--	2.0	11.1	5.9	3.4
100°F	0.14	--	--	--	--	1.2	17.3	11.4	7.4
120°F	0.11	--	--	--	--	2.5	23.0	6.4	51.5
150°F	0.08	--	--	--	--	12.4	15.8	9.7	5.9
High RH at									
Room Temperature	0.18	--	--	--	--	2.2	1.7	+2.0	+0.7
100°F	0.14	--	--	--	--	1.9	2.9	0	3.7
120°F	0.11	--	--	--	--	+4.4	+0.2	+1.2	+6.7
150°F	0.08	--	--	--	--	4.9	8.1	2.5	0.7

TABLE XXIV

Loss in strength during ageing when Dacron (Type II) is treated in HNO_2 solution and aged under different conditions at different temperatures

Ageing Conditions	Initial	Concentration of Solution N Ageing Time (Months) 1	2	4	6	Strength Loss % Ageing Time (Months) 1	2	4	6
In Solution at									
Room Temperature	1.0	0.74	0.67	0.64	*	8.9	2.7	7.0	+3.9
100°F	1.0	0.71	0.57	0.60	*	5.1	+0.9	10.9	+2.9
120°F	1.0	0.67	0.57	0.60	*	3.9	0.4	12.9	5.2
150°F	1.0	0.64	0.50	0.47	*	11.6	3.4	13.6	9.4
Low RH at									
Room Temperature	1.0	--	--	--	--	6.4	4.9	2.7	4.9
100°F	1.0	--	--	--	--	6.6	7.1	5.9	0.2
120°F	0.5	--	--	--	--	7.1	5.9	7.4	10.4
150°F	0.2	--	--	--	--	8.1	8.9	13.4	6.9
High RH at									
Room Temperature	1.0	--	--	--	---	0.9	1.2	+0.7	+1.2
100°F	1.0	--	--	--	--	5.4	2.2	3.0	2.2
120°F	0.5	--	--	--	--	+2.4	11.9	1.0	+0.5
150°F	0.2	--	--	--	--	+0.2	+1.0	1.7	+2.9

*The normality of the solution at the 6th month period was not listed because the solution was discarded by mistake before titration.

TABLE XXV

Loss in strength during ageing when Dacron (Type II) is treated in HNO_2 Control solution and aged under different conditions at different temperatures

	Strength Loss % Ageing Time (Months)			
Ageing Conditions	1	2	4	6
In Solution at				
Room Temperature	2.7	1.5	5.4	+3.2
100°F	2.9	5.7	9.7	+5.0
120°F	9.9	+2.0	7.7	+1.2
150°F	9.9	3.2	16.3	13.9
Low RH at				
Room Temperature	6.4	4.5	9.6	5.9
100°F	7.9	5.4	9.9	7.9
120°F	2.2	5.4	6.9	11.4
150°F	+6.9	2.7	6.4	5.9
High RH at				
Room Temperature	3.4	1.0	5.0	+3.5
100°F	0.9	3.2	7.7	1.2
120°F	3.4	3.4	6.1	+0.5
150°F	3.9	9.1	16.6	11.4

TABLE XXVI

Loss in strength during ageing when Dacron (Type I) is treated in H_2O and solutions of H_2SO_4 and HCl and aged in solution at different temperatures

Ageing Conditions	Concentration of Solution N					Strength Loss %			
		Ageing Time (Months)				Ageing Time (Months)			
	Initial	1	2	4	6	1	2	4	6
H_2O at									
Room Temperature	--	--	--	--	--	+2.9	0.2	2.3	0.2
100°F	--	--	--	--	--	1.8	+1.8	1.8	+0.7
120°F	--	--	--	--	--	+0.5	1.0	2.3	0.2
150°F	--	--	--	--	--	2.9	+2.1	0.8	7.1
H_2SO_4 at									
Room Temperature	5.05	5.99	5.39	5.11	5.11	4.7	10.0	17.2	8.2
100°F	5.05	5.38	5.09	5.67	5.11	11.9	4.2	+0.5	11.9
120°F	5.05	5.50	5.22	5.52	5.79	21.9	4.2	6.6	8.4
150°F	5.05	5.48	5.16	5.29	5.11	6.6	8.9	15.5	18.2
HCl at									
Room Temperature	4.98	4.80	4.62	4.58	4.73	7.7	5.5	10.6	18.2
100°F	4.98	5.07	4.96	4.67	4.84	15.6	25.0	46.7	65.4
120°F	4.98	4.78	4.60	4.64	4.84	20.1	32.7	47.8	68.3
150°F	2.32	3.45	2.93	2.99	2.99	43.5	96.0	100.0	100.0

TABLE XXVII

Loss in strength during ageing when Dacron (Type I) is treated in solutions of HNO_3, H_3PO_4 and H_2SO_3 and aged in solution at different temperatures

	Concentration of Solution N Ageing Time (Months)					Strength Loss % Ageing Time (Months)			
Ageing Conditions	Initial	1	2	4	6	1	2	4	6
HNO_3 at									
Room Temperature	2.60	2.38	2.64	2.73	2.65	4.5	6.3	17.6	36.1
100°F	2.16	2.04	2.04	2.20	2.34	17.2	21.3	39.0	40.9
120°F	2.16	2.32	2.10	2.18	2.31	14.8	27.9	44.8	54.0
150°F	1.07	0.98	0.97	0.90	1.03	16.1	26.1	49.0	61.0
H_3PO_4 at									
Room Temperature	4.92	5.02	4.85	4.72	5.11	2.9	5.5	6.3	7.1
100°F	4.92	5.49	4.83	4.73	5.08	1.3	4.2	4.5	9.8
120°F	4.92	4.90	4.86	4.73	4.92	5.5	0.2	2.9	10.3
150°F	2.16	1.92	2.01	1.99	1.95	+1.3	0.8	6.6	5.8
H_2SO_3 at									
Room Temperature	1.36	0.77	0.85	0.80	0.73	3.2	+1.5	4.2	2.9
100°F	0.89	0.45	0.52	0.19	0.14	1.8	5.2	0.8	2.6
120°F	0.58	0.30	0.30	0.27	0.22	0.5	+4.2	+6.0	7.6
150°F	0.094	0.12	0.02	0.02	0.021	1.6	0.7	4.0	6.5

TABLE XXVIII

Loss in strength during ageing when Dacron (Type I) is treated in solutions of H_2S, HNO_2, and HNO_2 Control and aged in solution at different temperatures

Ageing Conditions	Initial	Concentration of Solution N Ageing Time (Months)				Strength Loss % Ageing Time (Months)			
		1	2	4	6	1	2	4	6
H_2S at									
Room Temperature	0.18	--	--	--	--	0.8	3.6	0.8	4.5
100°F	0.14	--	--	--	--	+2.4	0	+2.4	+0.2
120°F	0.11	--	--	--	--	2.4	0	0	9.8
150°F	0.08	--	--	--	--	10.3	3.6	1.3	10.8
HNO_2 at									
Room Temperature	1.0	0.80	0.80	0.82	0.78	0.5	1.0	2.9	+0.2
100°F	1.0	0.93	0.93	0.67	0.67	3.4	2.1	+1.3	11.0
120°F	1.0	0.58	0.58	0.53	0.53	6.1	3.1	3.0	7.9
150°F	1.08	1.06	1.06	0.90	0.57	+2.4	+1.6	2.4	7.1
HNO_2 Control at									
Room Temperature	1.0	--	--	--	--	2.9	+2.1	1.8	9.2
100°F	1.0	--	--	--	--	4.7	5.5	5.3	4.5
120°F	1.0	--	--	--	--	1.0	8.1	+0.8	4.5
150°F	1.0	--	--	--	--	3.2	4.2	20.8	17.9

TABLE XXIX

Loss in strength when nylon is treated in different solutions and exposed to light in Fade-Ometer

		Strength Loss % Exposure Time (Hours)			
Acid	Conc. N	10	20	40	80
Water	-	29.2	44.0	63.9	75.4
H_2SO_4	0.1	42.8	53.0	67.8	79.1
H_2SO_4	1.0	56.3	72.2	76.2	83.0
HCl	0.1	65.6	74.4	77.9	96.6
HCl	1.0	79.6	90.2	92.9	100.0
HNO_3	0.1	70.3	73.5	72.5	85.3
HNO_3	1.0	80.8	78.1	86.0	97.1
H_3PO_4	0.1	53.8	63.1	72.7	91.4
H_3PO_4	1.0	40.0	51.6	71.0	81.0
H_2SO_3	1.0	32.9	51.4	67.0	82.8
HNO_2	1.0	34.4	35.6	46.4	68.5
H_2S	0.1	35.1	37.8	53.3	77.4
HNO_2 Control*					

*Since only 12 samples could be run in the Fade-Ometer simultaneously, the HNO_2 Control sample was omitted. This was the most logical one to omit because it is probable that the loss of strength for the HNO_2 Control would fall near, or perhaps between, the values obtained with the water and HNO_2 samples.

TABLE XXX

Loss in strength when Dacron (Type II) is treated in different solutions and exposed to light in Fade-Ometer

Acid	Conc. N	Strength Loss % Exposure Time (Hours) 40	80	160	320
H_2O	-	13.4	12.1	17.0	14.6
H_2SO_4	1.0	49.5	37.6	72.0	100.0
H_2SO_4	5.0	51.5	68.3	100.0	100.0
HCl	1.0	11.6	21.0	57.1	26.7
HCl	5.0	12.6	19.3	29.4	24.8
HNO_3	1.0	9.4	16.8	32.6	21.5
HNO_3	5.0	16.3	18.3	26.4	21.0
H_3PO_4	1.0	9.7	10.1	11.1	16.3
H_3PO_4	5.0	9.4	11.1	19.5	16.8
H_2SO_3	1.0	17.6	18.3	13.4	15.8
HNO_2	1.0	17.1	22.0	27.9	24.5
H_2S	0.1	16.6	14.6	16.8	12.9
HNO_2 Control*					

*Since only 12 samples could be run in the Fade-Ometer simultaneously, the HNO_2 Control sample was omitted. This was the most logical one to omit because it is probable that the loss of strength for the HNO_2 Control would fall near, or perhaps between, the values obtained with the water and HNO_2 samples.

TABLE XXXI

Loss in strength of nylon and Dacron fabrics resulting from exposure to the vapors of sulfurous, nitrous, and hydrosulfuric acids at different temperatures for one month at high relative humidity

Acid	Initial Conc. N	Temp. °F	Strength Loss	
			Nylon	Dacron
H_2SO_3	1.8	80	10	0
	1.8	110	20	0
	1.8	150	29	0
	0.2	80	2	0
	0.2	110	4	0
	0.2	150	5	0
HNO_2	1.0	80	80	0
	1.0	110	98	0
	1.0	150	100	3
	0.1	80	7	0
	0.1	110	10	0
	0.1	150	20	0
H_2S	0.1	80	0	0
	0.1	110	0	0
	0.1	150	0	0

TABLE XXXII

Relationship between fluorescence of nylon under ultraviolet light and conditions of treatment; type of acid, temperature, and strength loss

	No. of observation in each group		% of observation in each group	
Acid	Fluoresces noticeably different from control	Fluoresces similar to control	Fluoresces noticeably different from control	Fluoresces similar to control
H_2O	10	37	21	79
H_2SO_4	20	27	43	57
HCl	17	30	36	64
HNO_3	17	28	37	63
H_3PO_4	12	35	25	75
H_2SO_3	13	37	26	74
H_2S	14	32	30	70
HNO_2	37	8	82	18
HNO_2 Control	15	34	30	70
Temperature				
Room	16	91	15	85
100°F	22	83	21	79
120°F	32	75	30	70
150°F	84	22	79	21
Strength Loss				
0 - 5%	32	146	18	82
5 - 15%	40	78	34	66
15 - 25%	24	23	51	49
25 - 35%	21	10	67	33
35 - 45%	14	4	78	22
45 - 100%	24	8	75	25

TABLE XXXIII

Relationship between fluorescence of nylon under visible light and conditions of treatment; type of acid, temperature and strength loss

	No. of observations in each group		% of observation in each group	
Acid	Appears noticeably different from control	Appears similar to control	Appears noticeably different from control	Appears similar to control
H_2O	5	38	12	88
H_2SO_4	6	37	14	86
HCl	7	34	17	83
HNO_3	9	35	20	80
H_3PO_4	5	38	12	88
H_2SO_3	8	36	18	82
H_2S	16	31	34	66
HNO_2	30	16	65	35
HNO_2 Control	10	37	21	79
Temperature				
Room	5	77	6	94
100°F	9	70	11	89
120°F	9	72	11	89
150°F	37	41	47	53
Strength Loss:				
0 - 5%	22	151	13	87
5 - 15%	20	104	17	83
15 - 25%	16	31	34	66
25 - 35%	12	19	39	61
35 - 45%	7	11	39	61
45 - 100%	20	12	63	37

TABLE XXXIV

Relationship between fluorescence of Dacron (Type II) under ultraviolet light and conditions of treatment; type of acid, temperature and strength loss

Acid	No. of observations in each group		% of observations in each group	
	Fluoresces* different from control	Fluoresces similar to control	Fluoresces* different from control	Fluoresces similar to control
H_2O	2	42	5	95
H_2SO_4	2	45	4	96
HCl	2	46	4	96
HNO_3	28	22	56	44
H_3PO_4	5	47	10	90
H_2SO_3	1	43	2	98
H_2S	2	50	4	96
HNO_2	11	41	21	79
HNO_2 Control	2	50	4	96
Temperature				
Room	13	93	12	88
100°F	14	90	13	87
120°F	13	92	12	88
150°F	17	88	16	84
Strength Loss				
0 - 5%	15	166	8	92
5 - 15%	17	113	13	87
15 - 25%	6	33	15	85
25 - 35%	5	16	24	76
35 - 45%	3	3	50	50
45 - 100%	10	26	28	72

*Only slight differences in fluorescence observed

TABLE XXXV

Relationship between fluorescence of Dacron (Type II) under visible light conditions of treatment; type of acid, temperature, and strength loss

	No. of observations in each group		% of observation in each group	
Acid	Appears* different from control	Appears similar to control	Appears* different from control	Appears similar to control
H_2O	27	17	61	39
H_2SO_4	27	21	56	44
HCl	29	19	60	40
HNO_3	27	21	56	44
H_3PO_4	29	20	59	41
H_2SO_3	26	14	65	35
H_2S	26	22	54	44
HNO_2	28	20	58	42
HNO_2 Control	27	21	56	44
Temperature				
Room	61	45	57	43
100°F	60	46	56	44
120°F	62	44	58	42
150°F	61	45	57	43
Strength Loss				
0 - 5%	109	69	61	39
5 - 15%	77	52	60	40
15 - 25%	26	15	63	37
25 - 35%	13	9	59	41
35 - 45%	2	4	33	67
45 - 100%	12	23	34	66

*Only slight visual differences observed

APPENDIX II
FIGURES

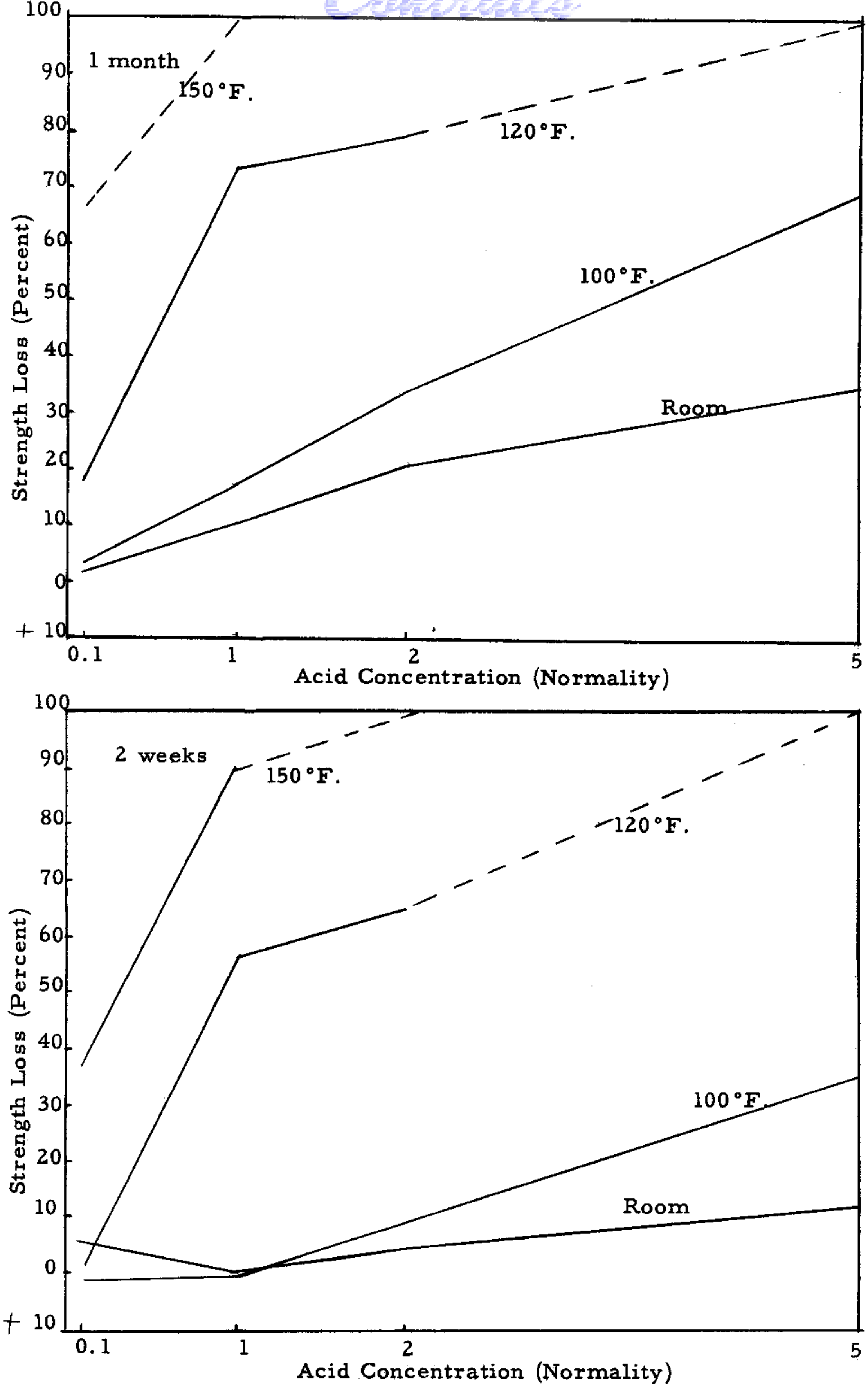


Figure 1 Loss in Strength vs. Acid Concentration when nylon is treated in H_2SO_4 and aged in solution for periods of 2 weeks and 1 month at different temperatures.

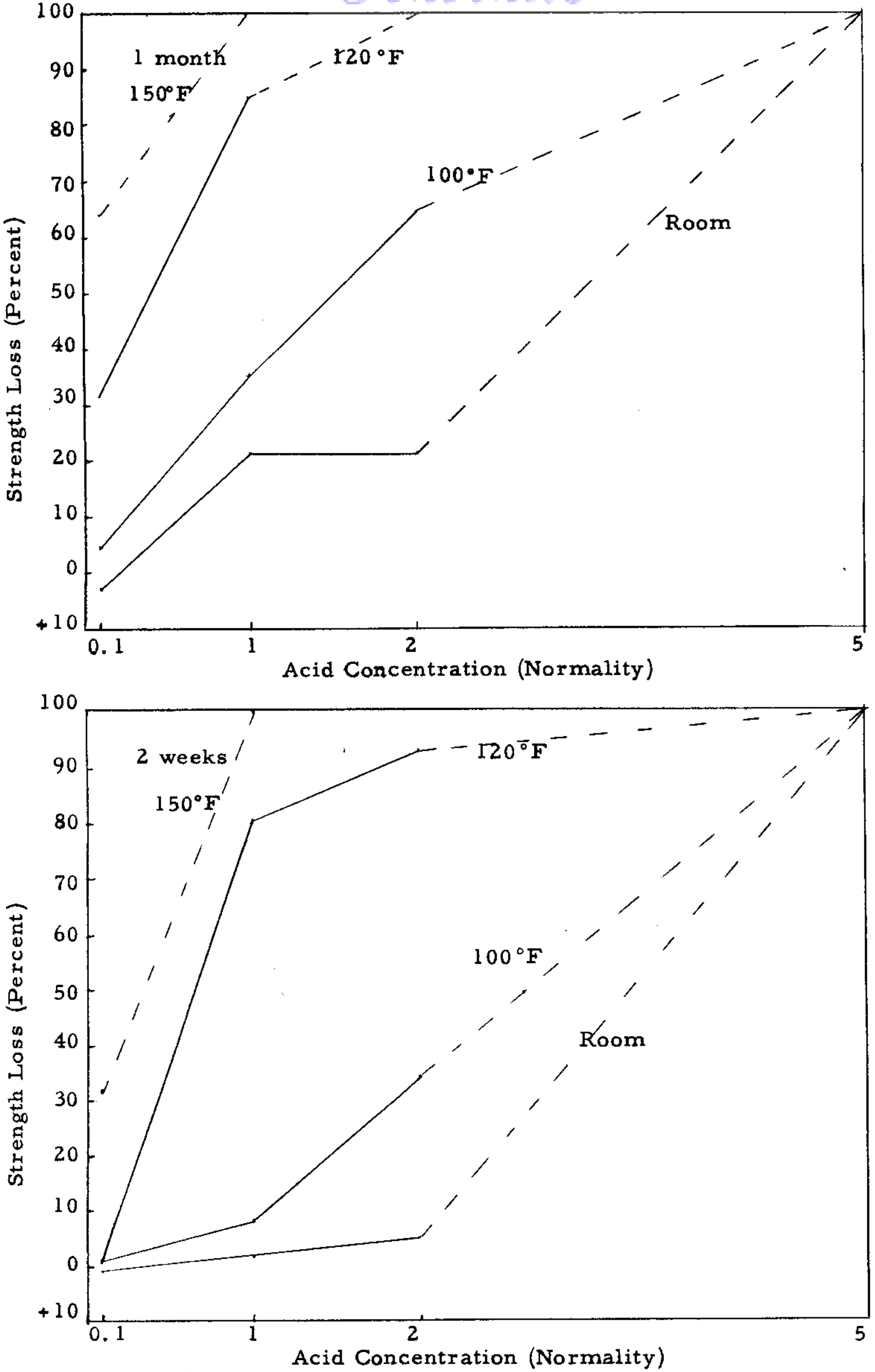


Figure 2 Loss in Strength vs. Acid Concentration when nylon is treated in HCl and aged in solution for periods of 2 weeks and 1 month at different temperatures.

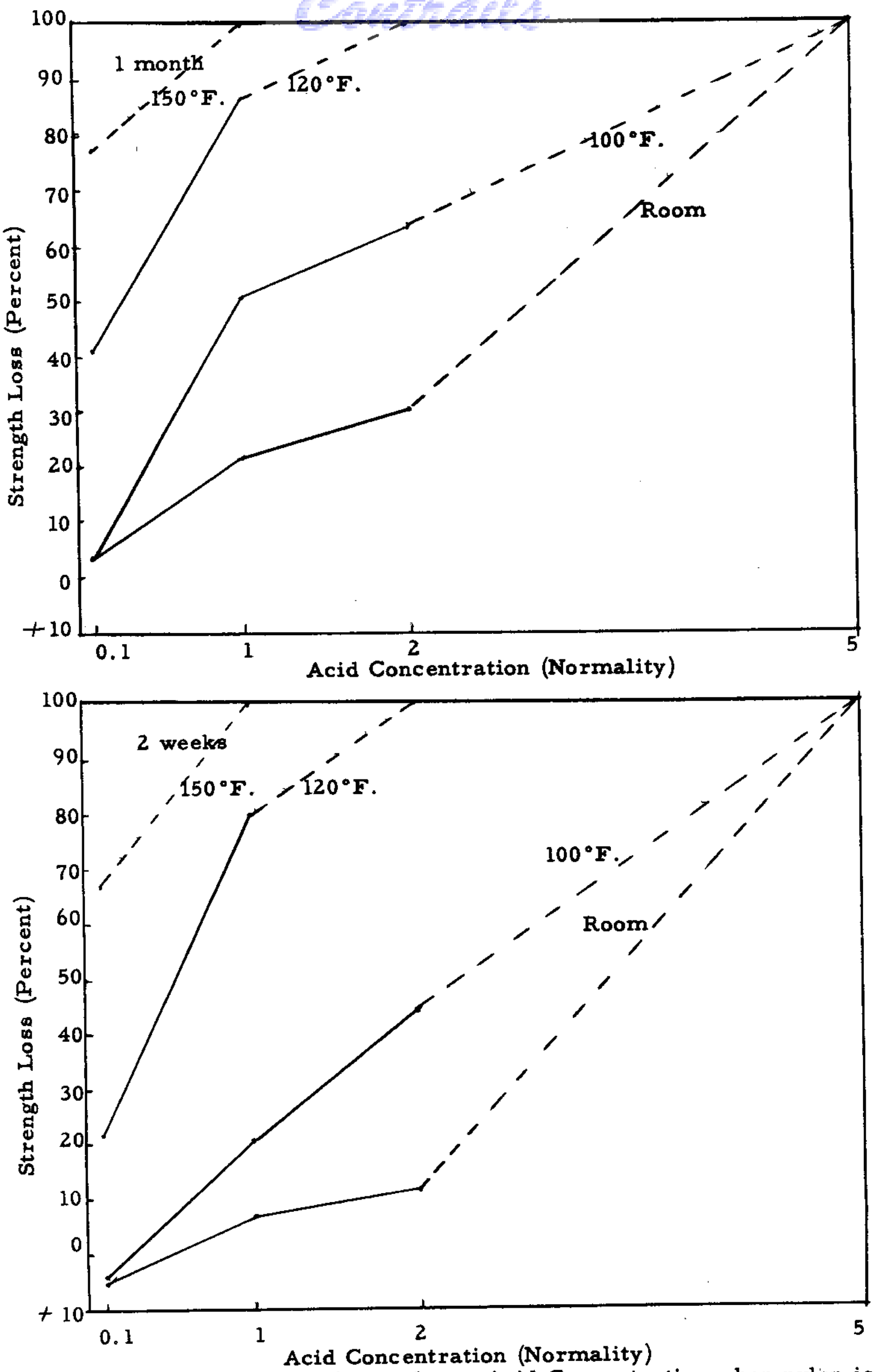


Figure 3 Loss in Strength vs. Acid Concentration when nylon is treated in HNO_3 and aged in solution for periods of 2 weeks and 1 month at different temperatures.

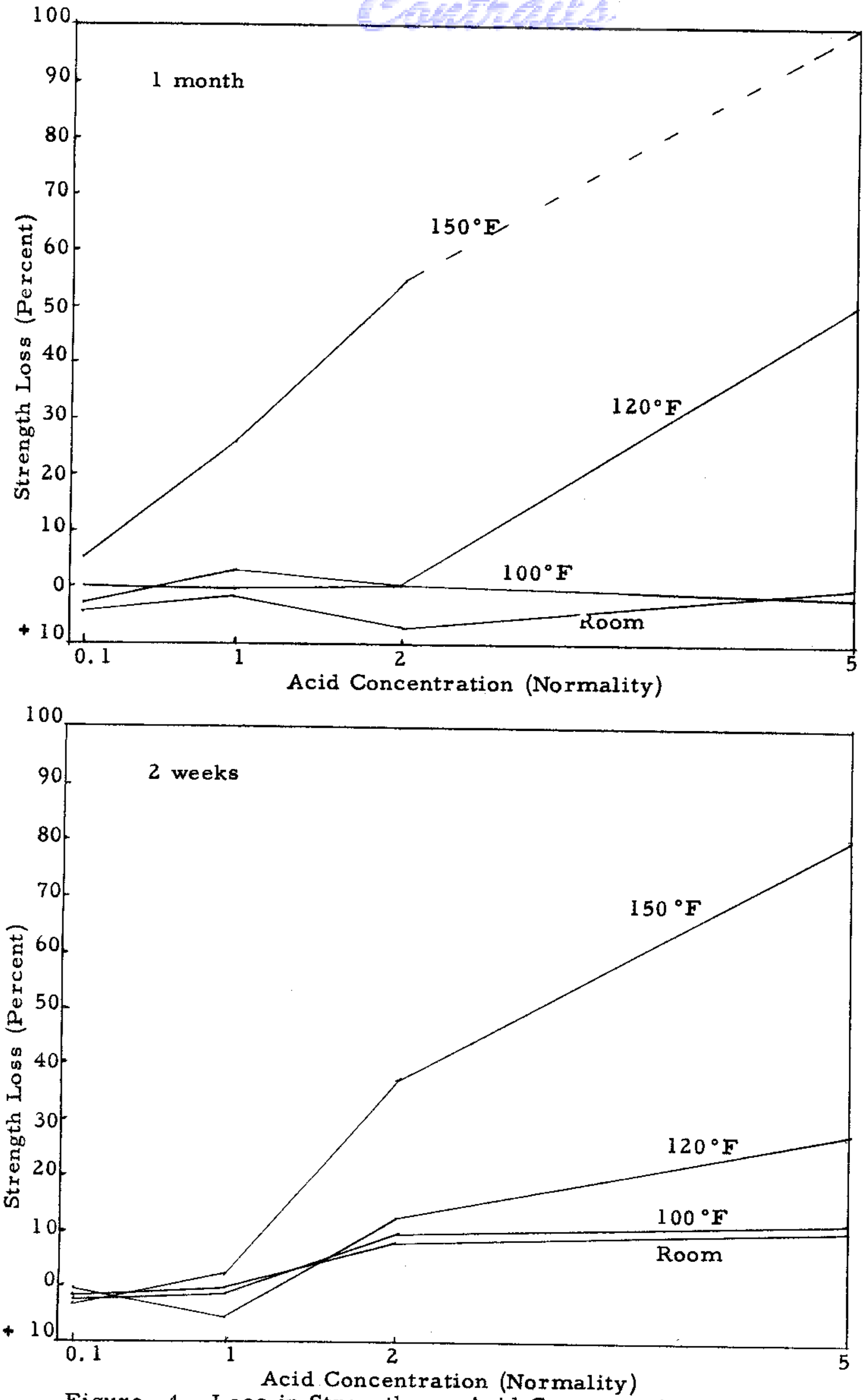


Figure 4 Loss in Strength vs. Acid Concentration when nylon is treated in H_3PO_4 and aged in solution for periods of 2 weeks and 1 month at different temperatures.

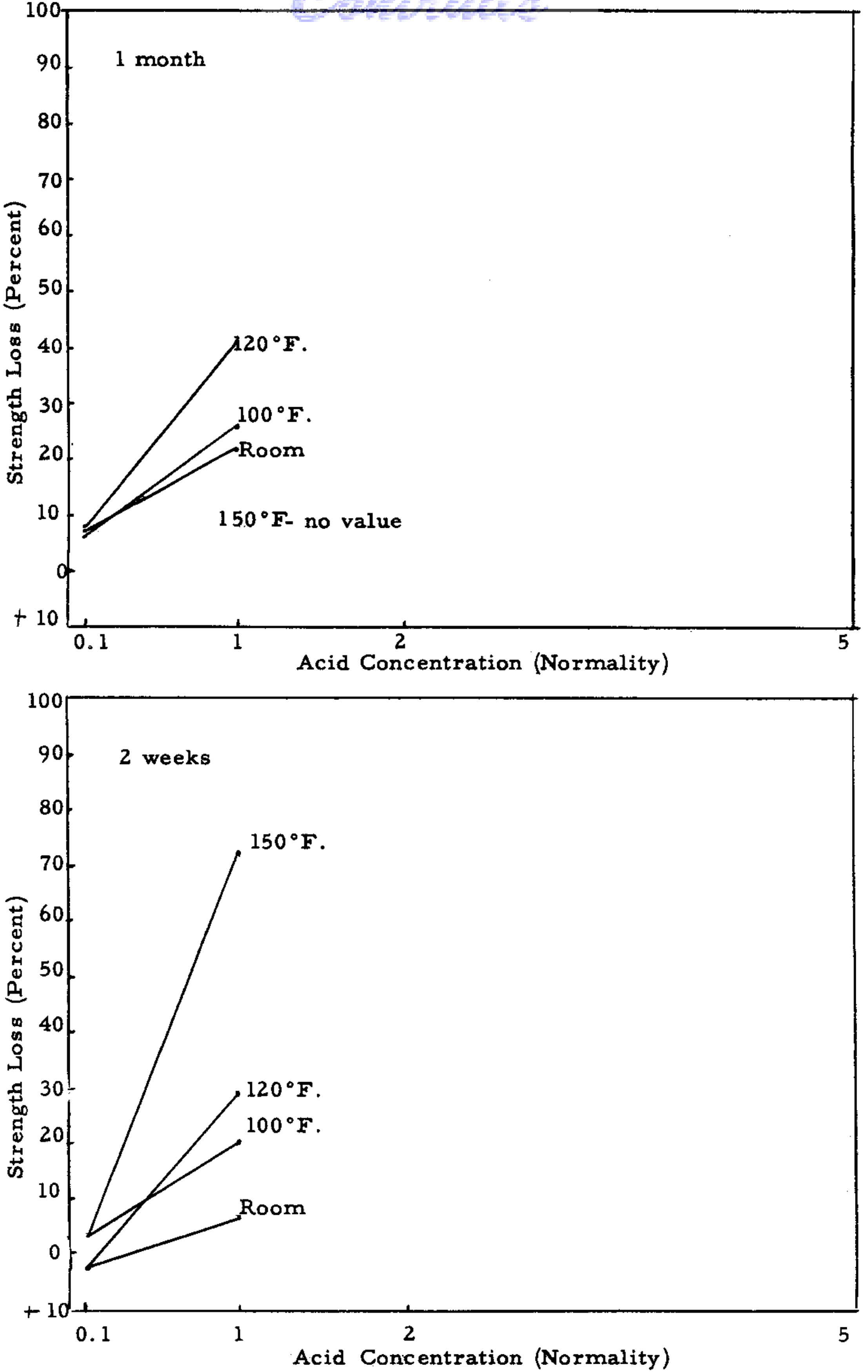


Figure 5 Loss in Strength vs. Acid Concentration when nylon is treated in HNO_2 and aged in solution for periods of 2 weeks and 1 month at different temperatures.

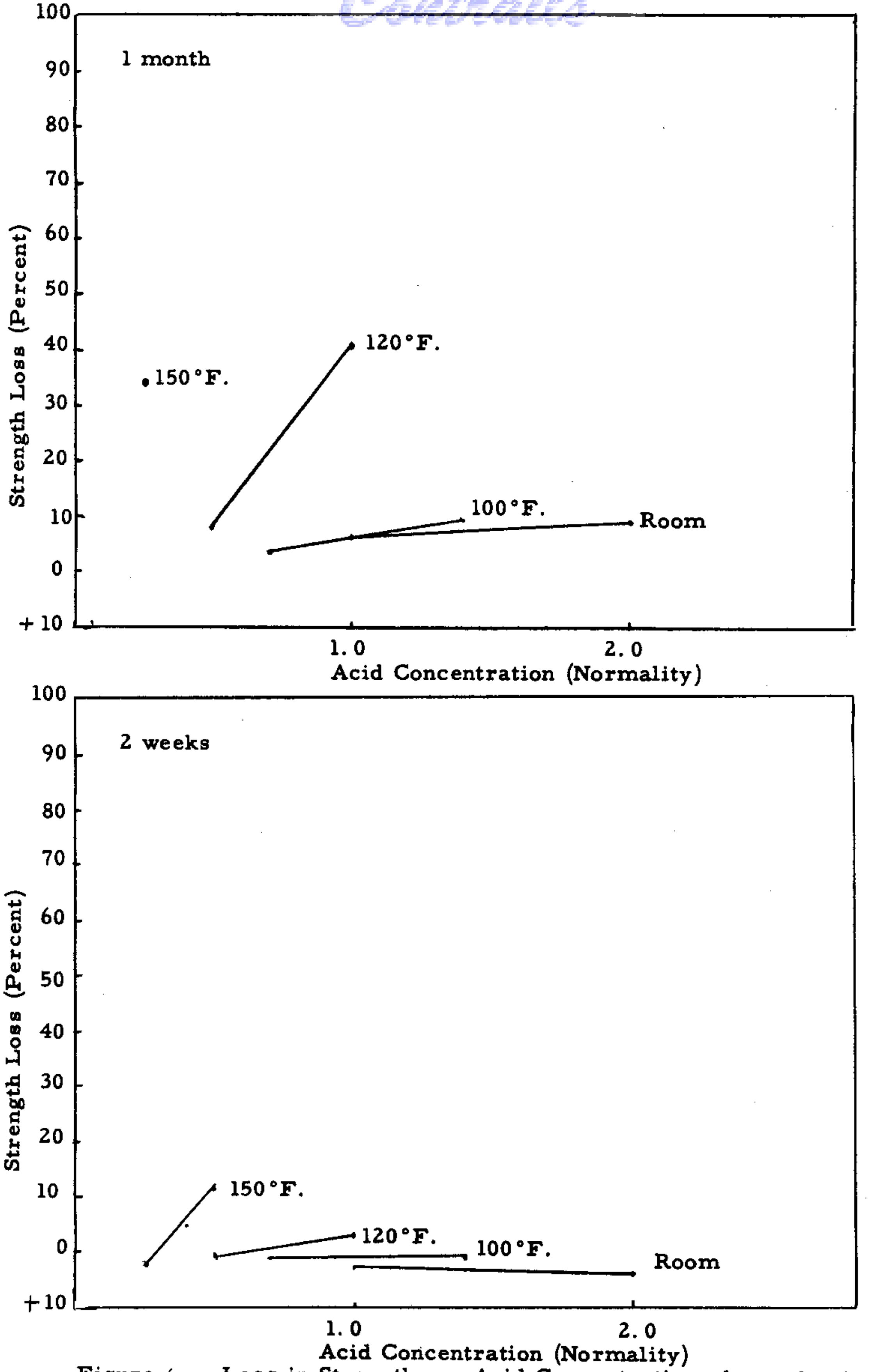
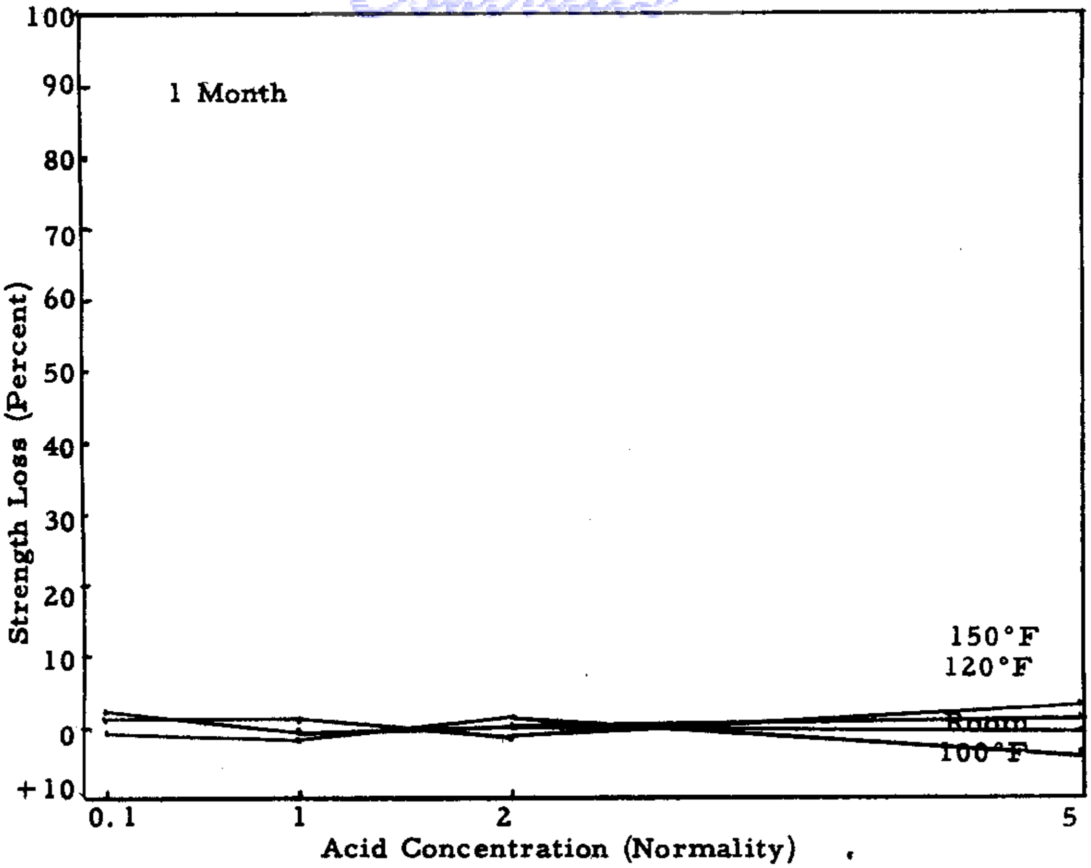


Figure 6 Loss in Strength vs. Acid Concentration when nylon is treated in H_2SO_3 and aged in solution for periods of 2 weeks and 1 month at different temperatures.



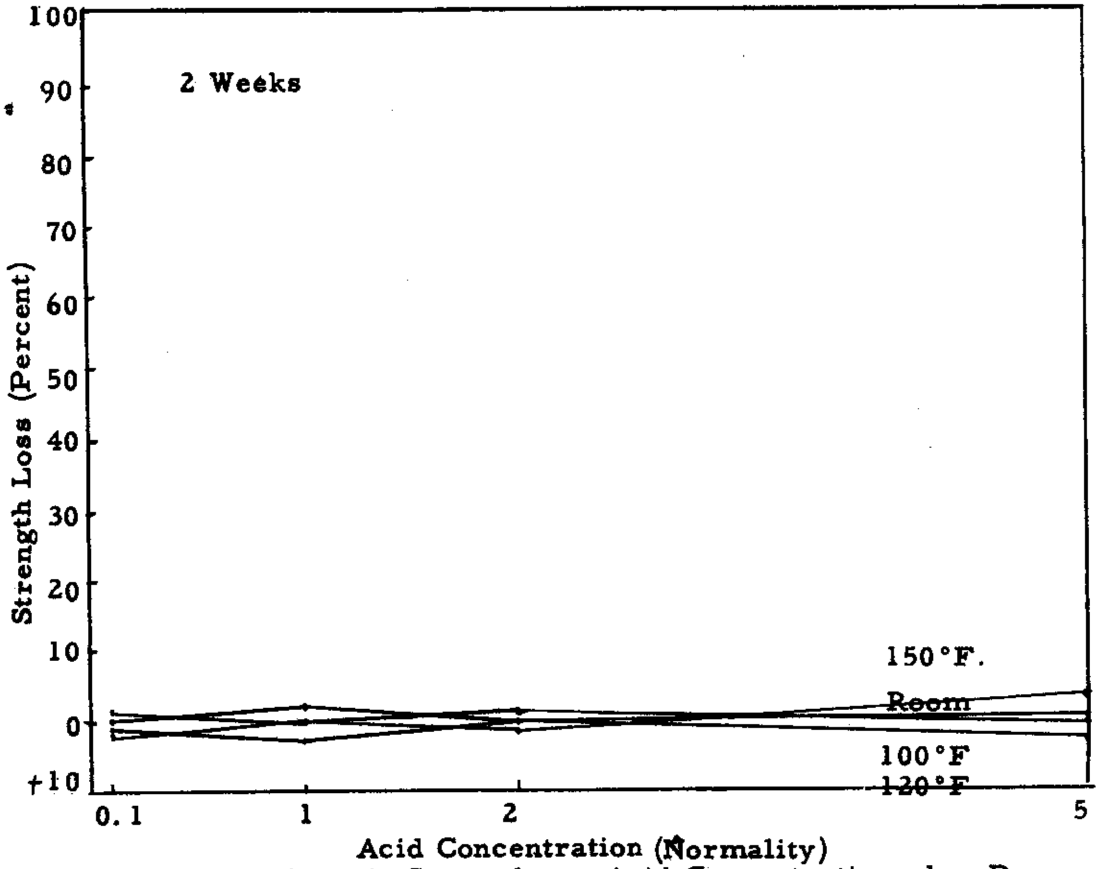


Figure 7 Loss in Strength vs. Acid Concentration when Dacron(Type I and II) is treated in H_2SO_4 and aged in solution for periods of 2 weeks and 1 month at different temperatures.

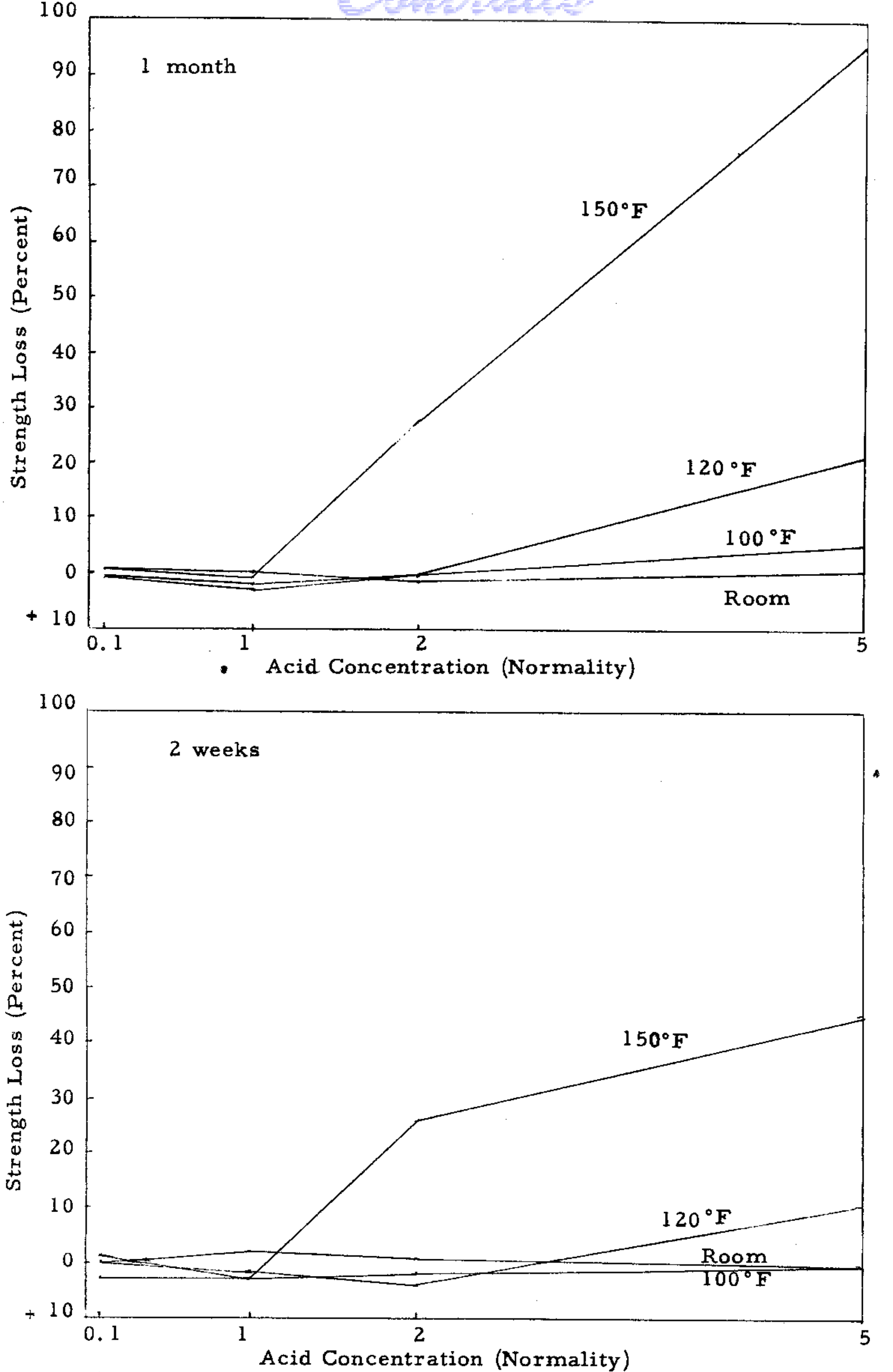


Figure 8. Loss in Strength vs. Acid Concentration when Dacron (Type I) is treated in HCl and aged in solution for periods of 2 weeks and 1 month at different temperatures.

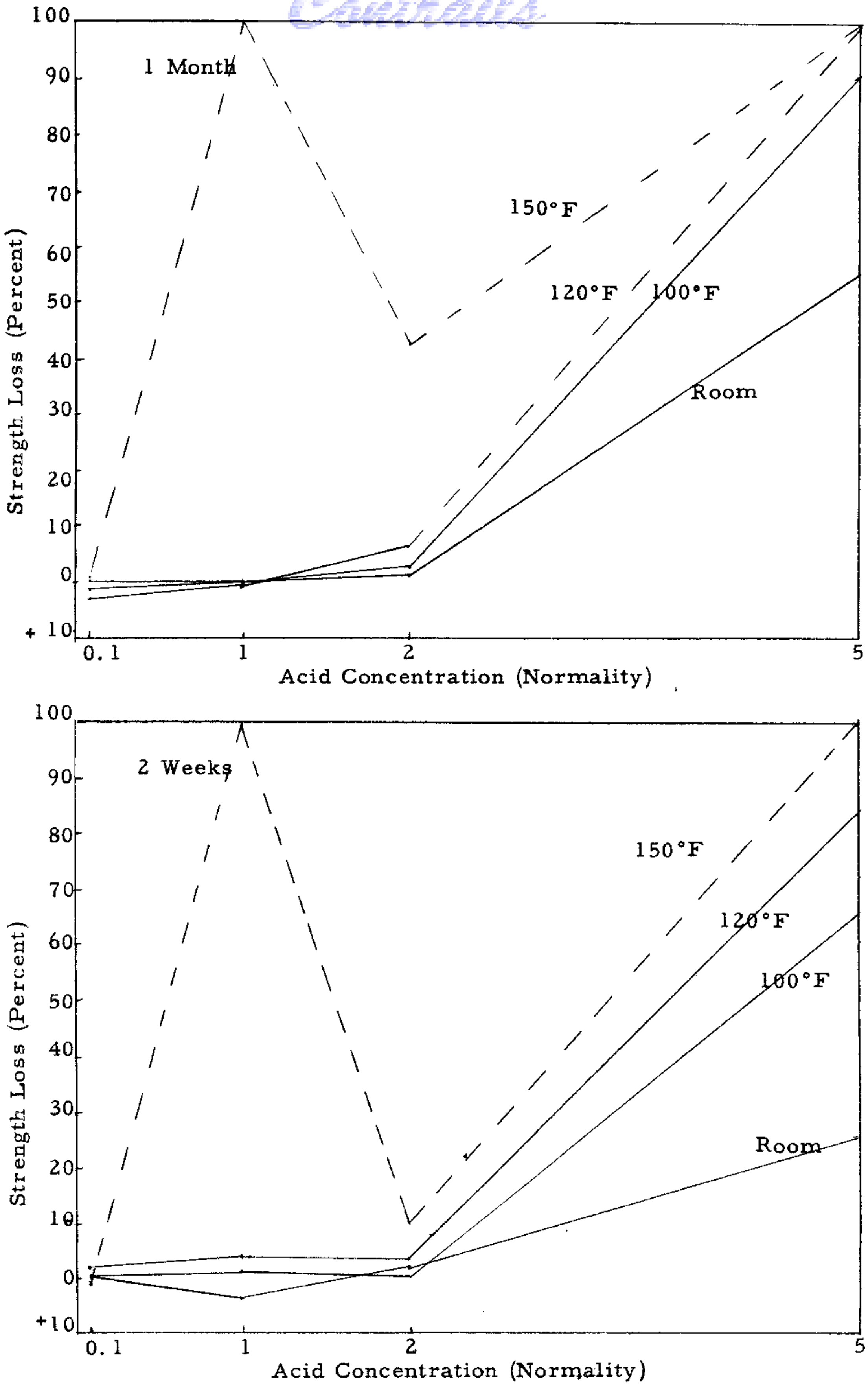


Figure 9 Loss in Strength vs. Acid Concentration when Dacron Type I and II) is treated in HNO_3 and aged in solution for periods of 2 weeks and 1 month at different temperatures.

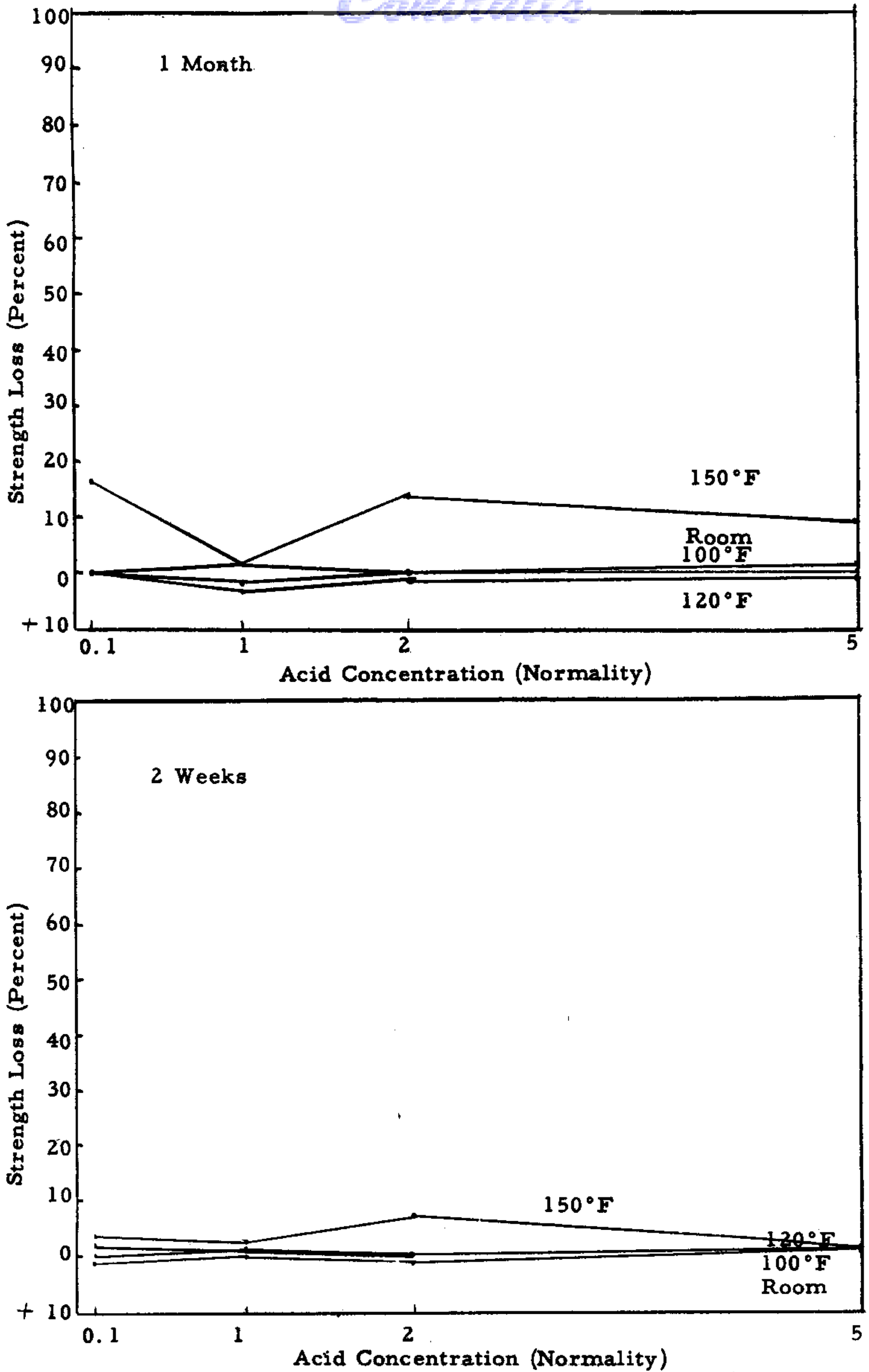
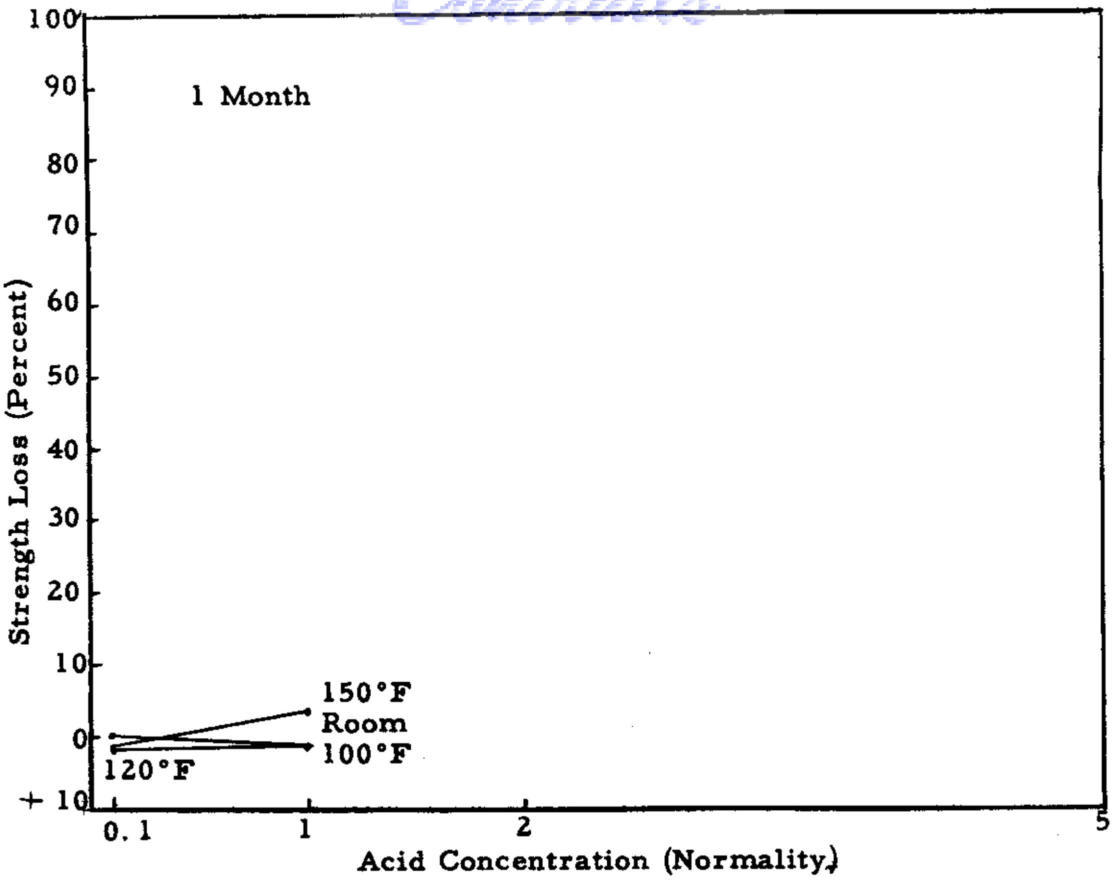


Figure 10 Loss in Strength vs. Acid Concentration when Dacron (Type I) is treated in H_3PO_4 and aged in solution for periods of 2 weeks and 1 month at different temperatures.



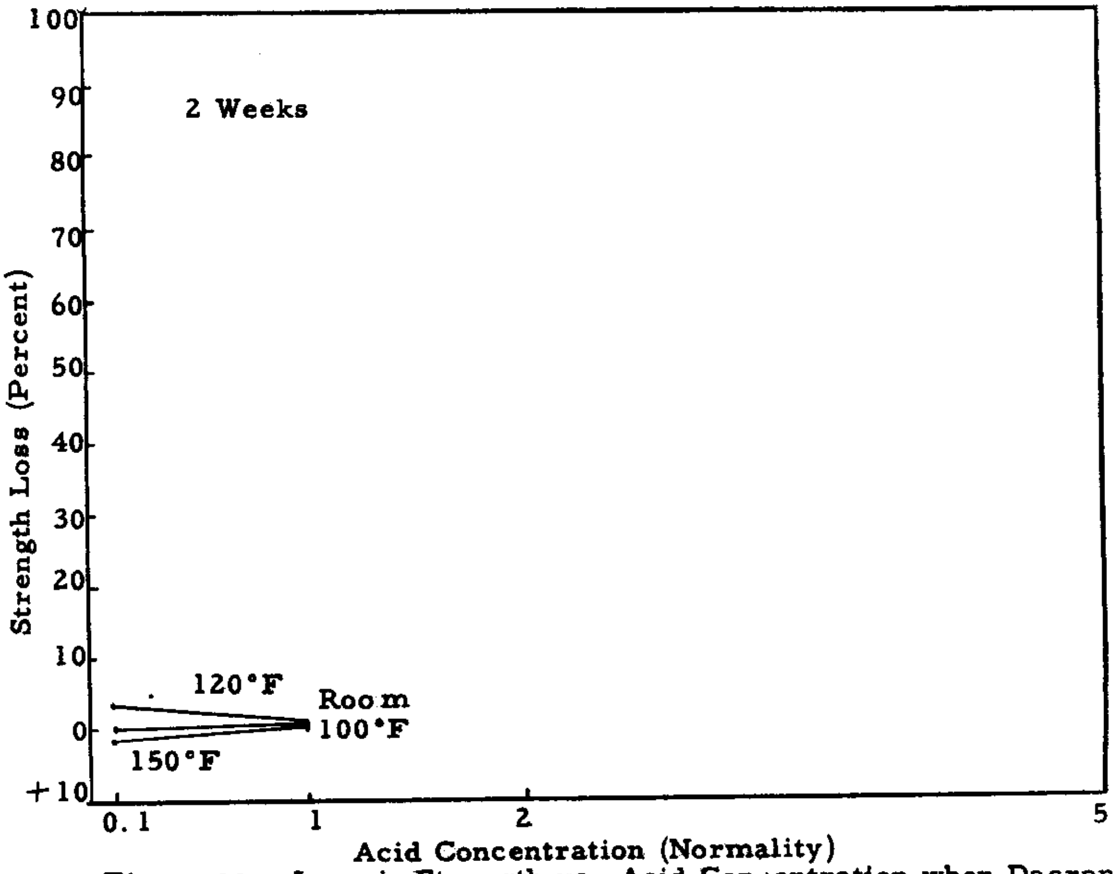


Figure 11 Loss in Strength vs. Acid Concentration when Dacron (Type I) is treated in HNO_2 and aged in solution for periods of 2 weeks and 1 month at different temperatures.

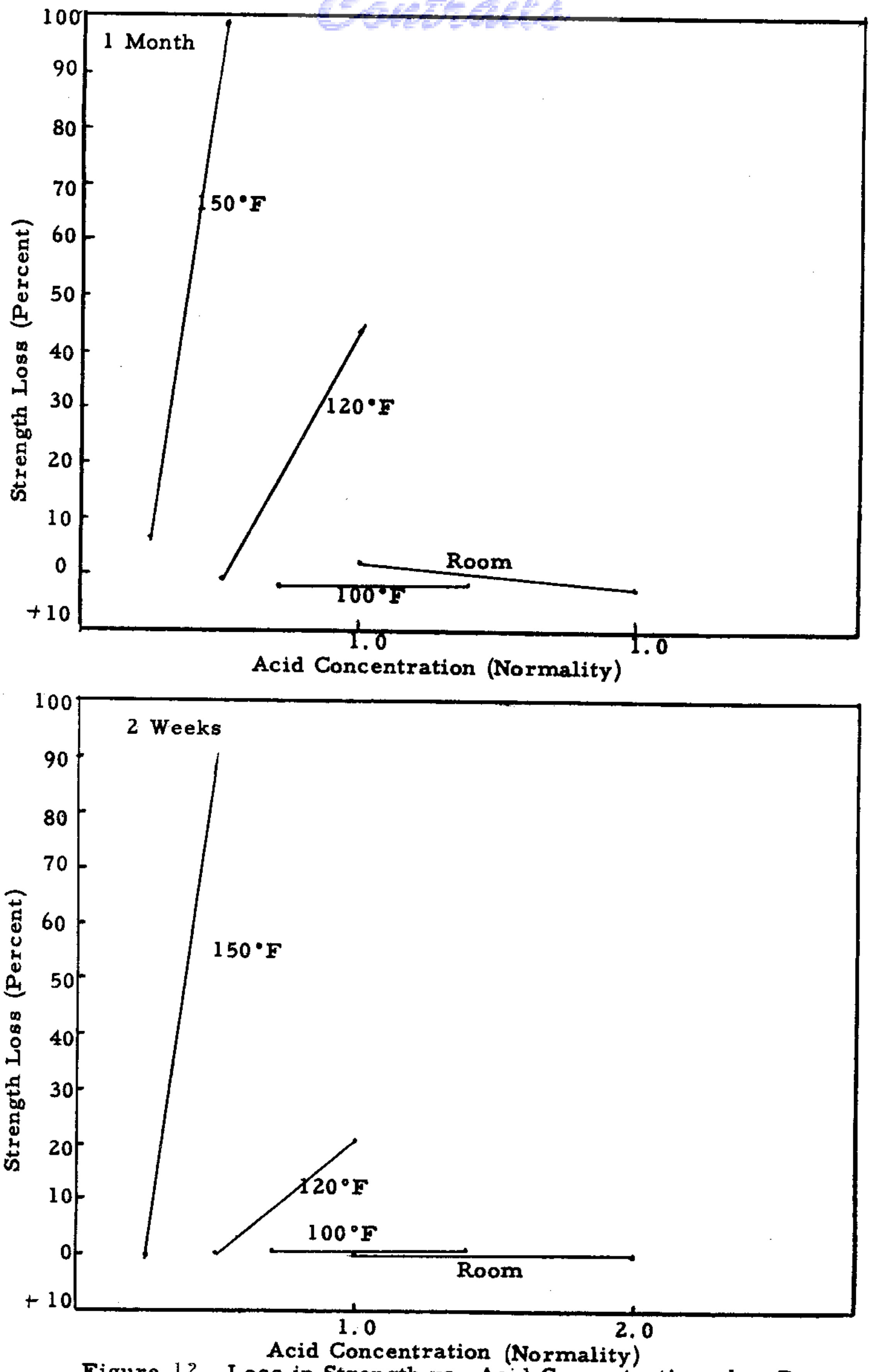


Figure 12 Loss in Strength vs. Acid Concentration when Dacron (Type I) is treated in H_2SO_3 and aged in solution for periods of 2 weeks and 1 month at different temperatures.

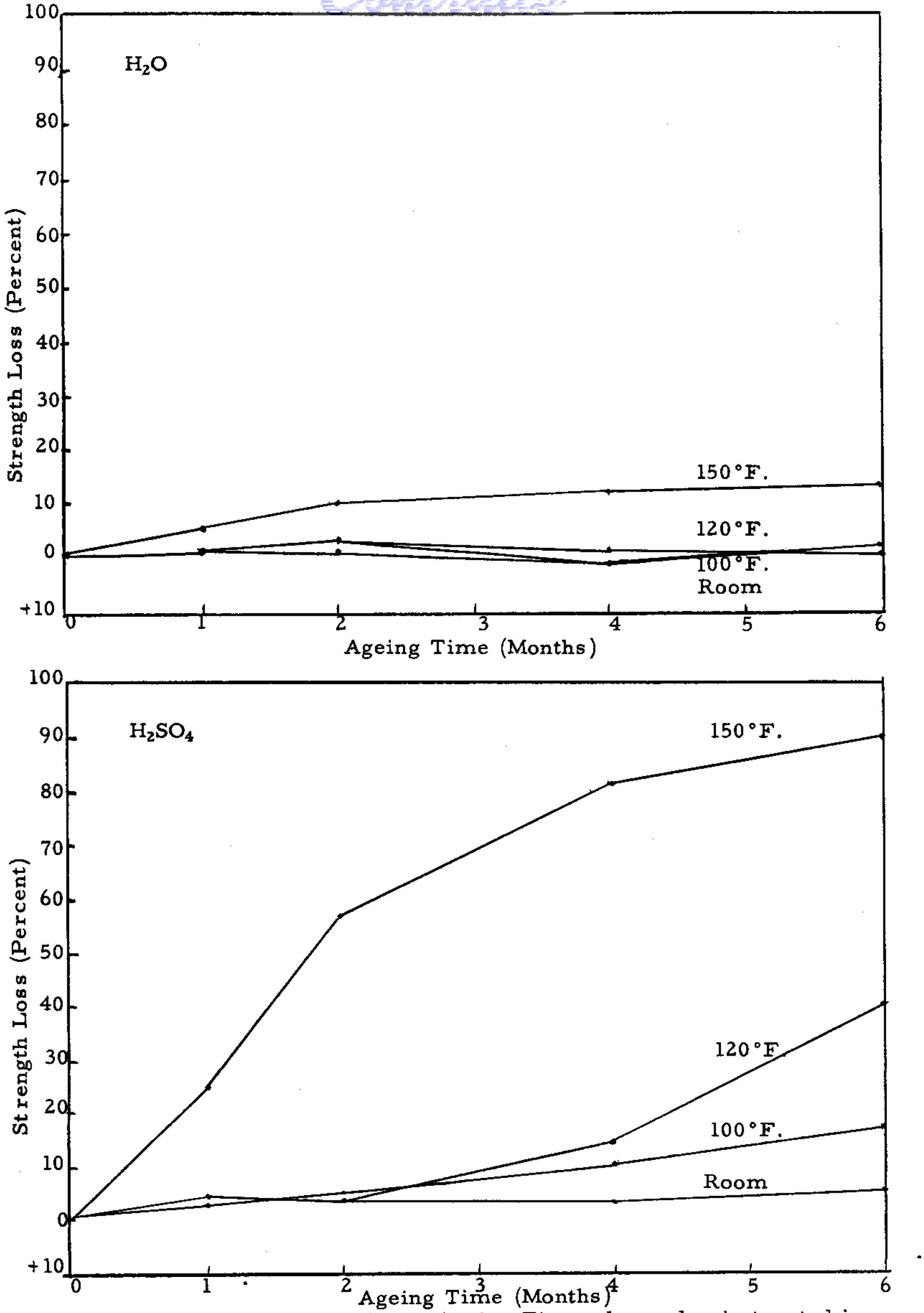


Figure 13 Loss in Strength vs. Ageing Time when nylon is treated in H_2O and H_2SO_4 and aged in solution at different temperatures.

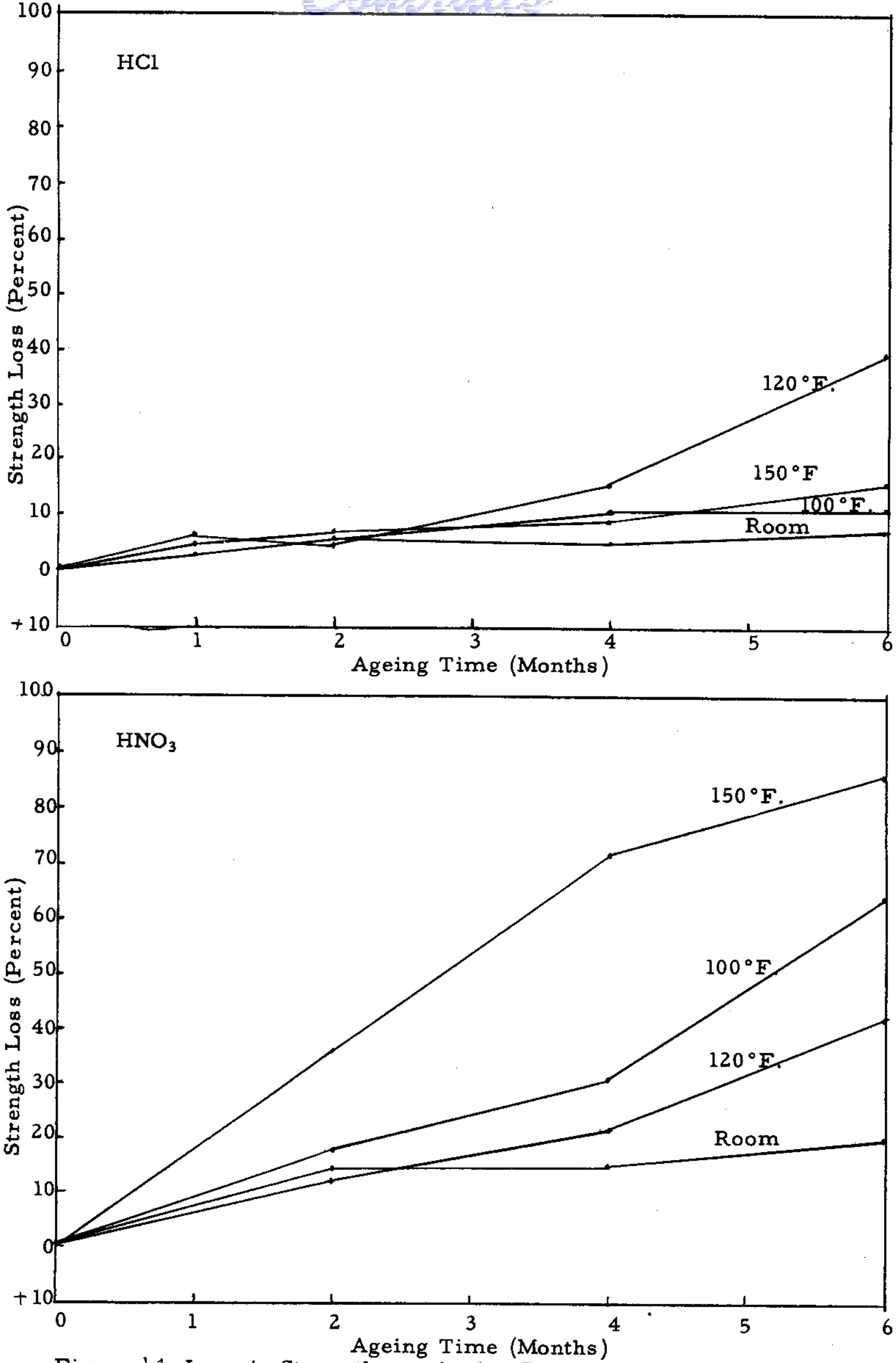


Figure 14 Loss in Strength vs. Ageing Time when nylon is treated in HCl and HNO$_3$ and aged in solution at different temperatures.

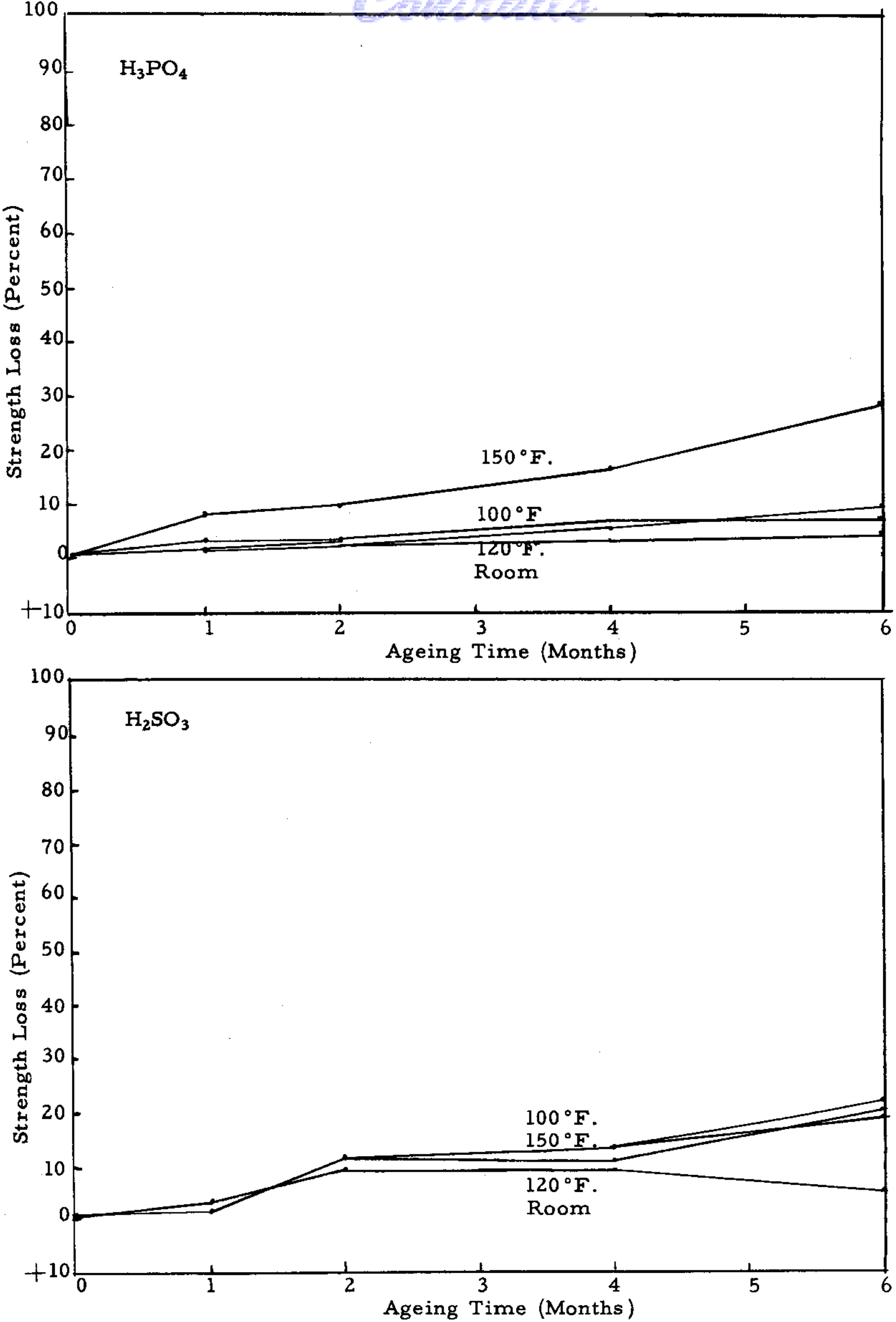


Figure 15 Loss in Strength vs. Ageing Time when nylon is treated in H_3PO_4 and H_2SO_3 and aged in solution at different temperatures.

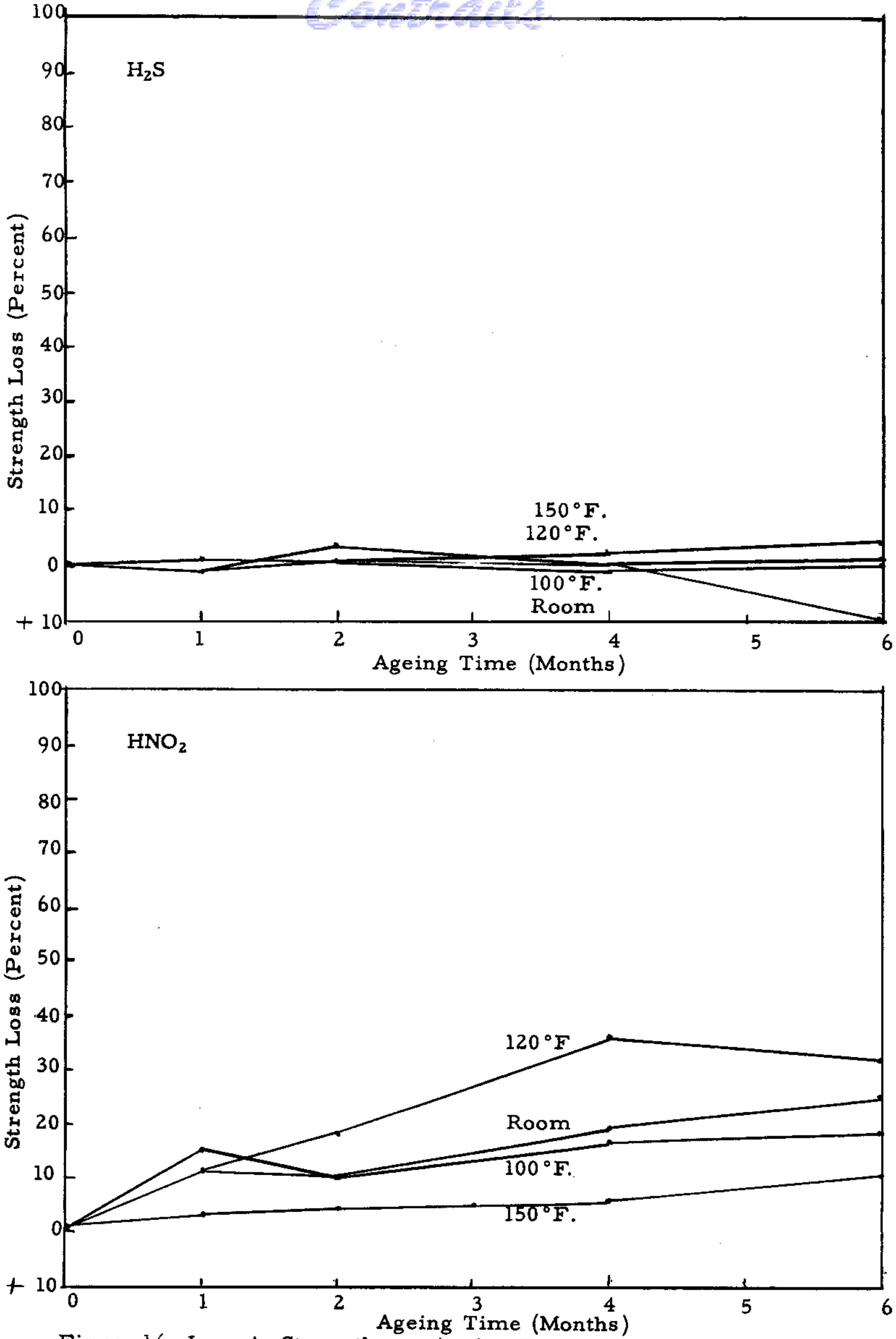


Figure 16 Loss in Strength vs. Ageing Time when nylon is treated in H_2S and HNO_2 and aged in solution at different temperatures.

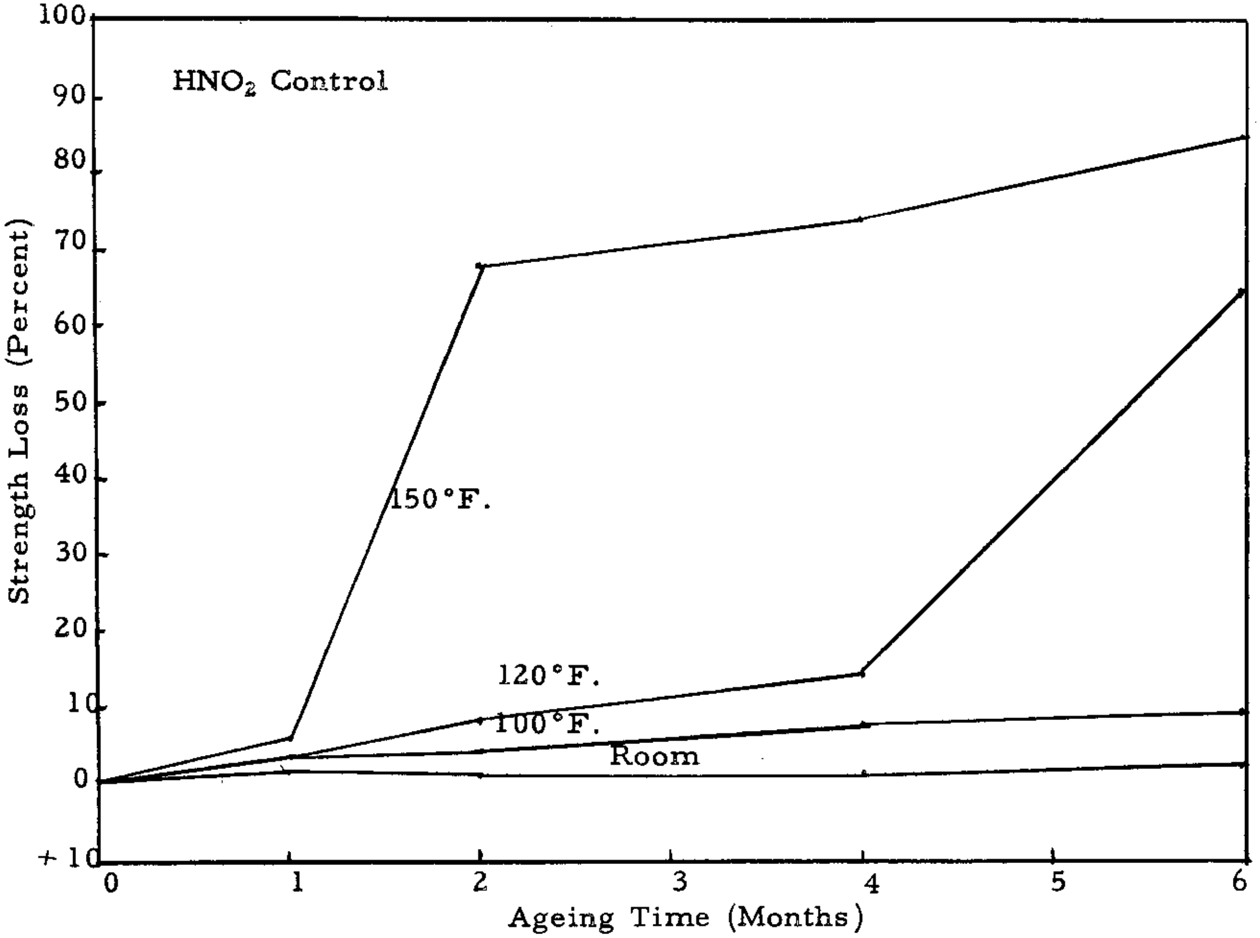


Figure 17 Loss in Strength vs. Ageing Time when nylon is treated in HNO_2 Control and aged in solution at different temperatures.

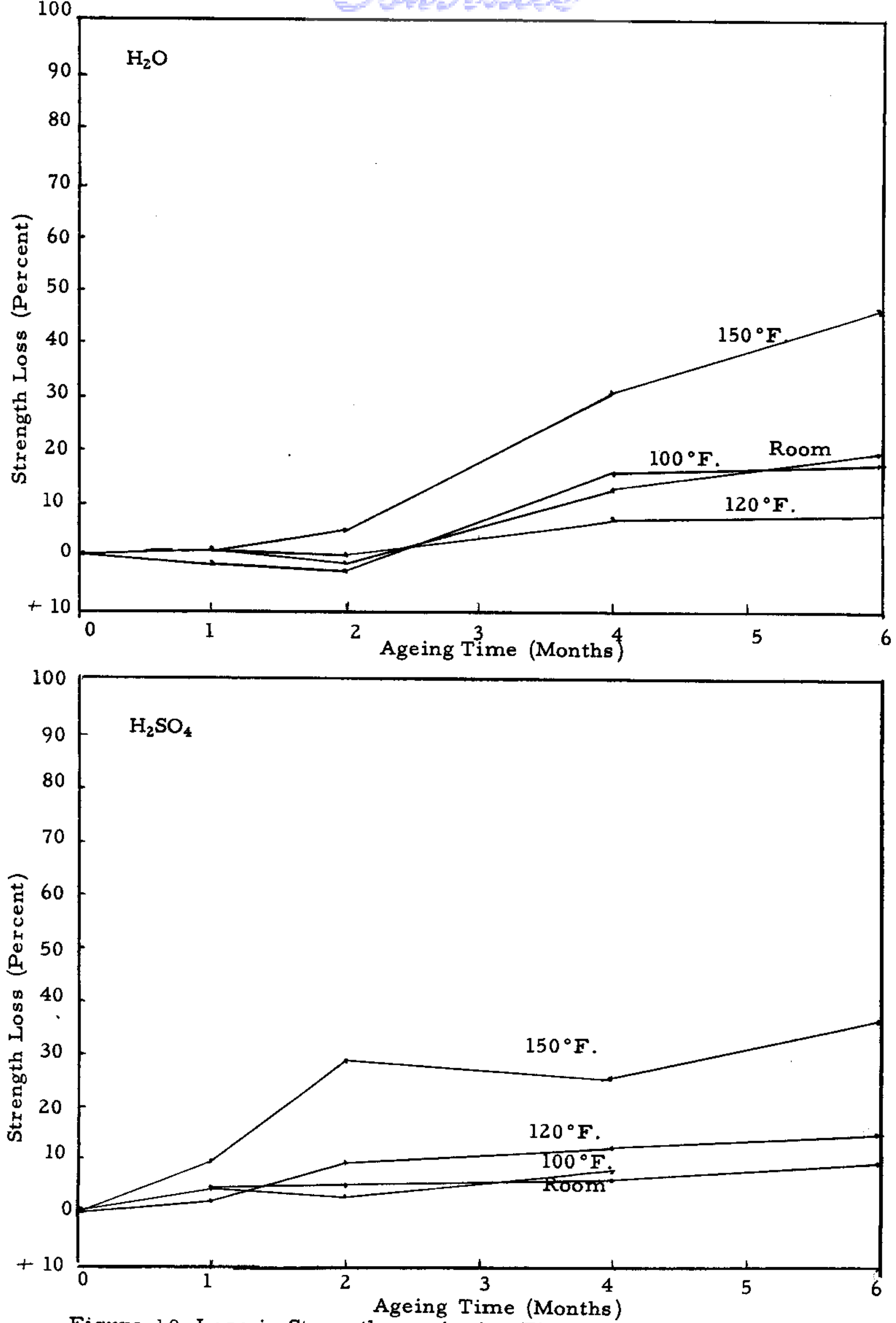


Figure 18 Loss in Strength vs. Ageing Time when nylon is treated in H_2O and H_2SO_4 and aged at low relative humidity at different temperatures.

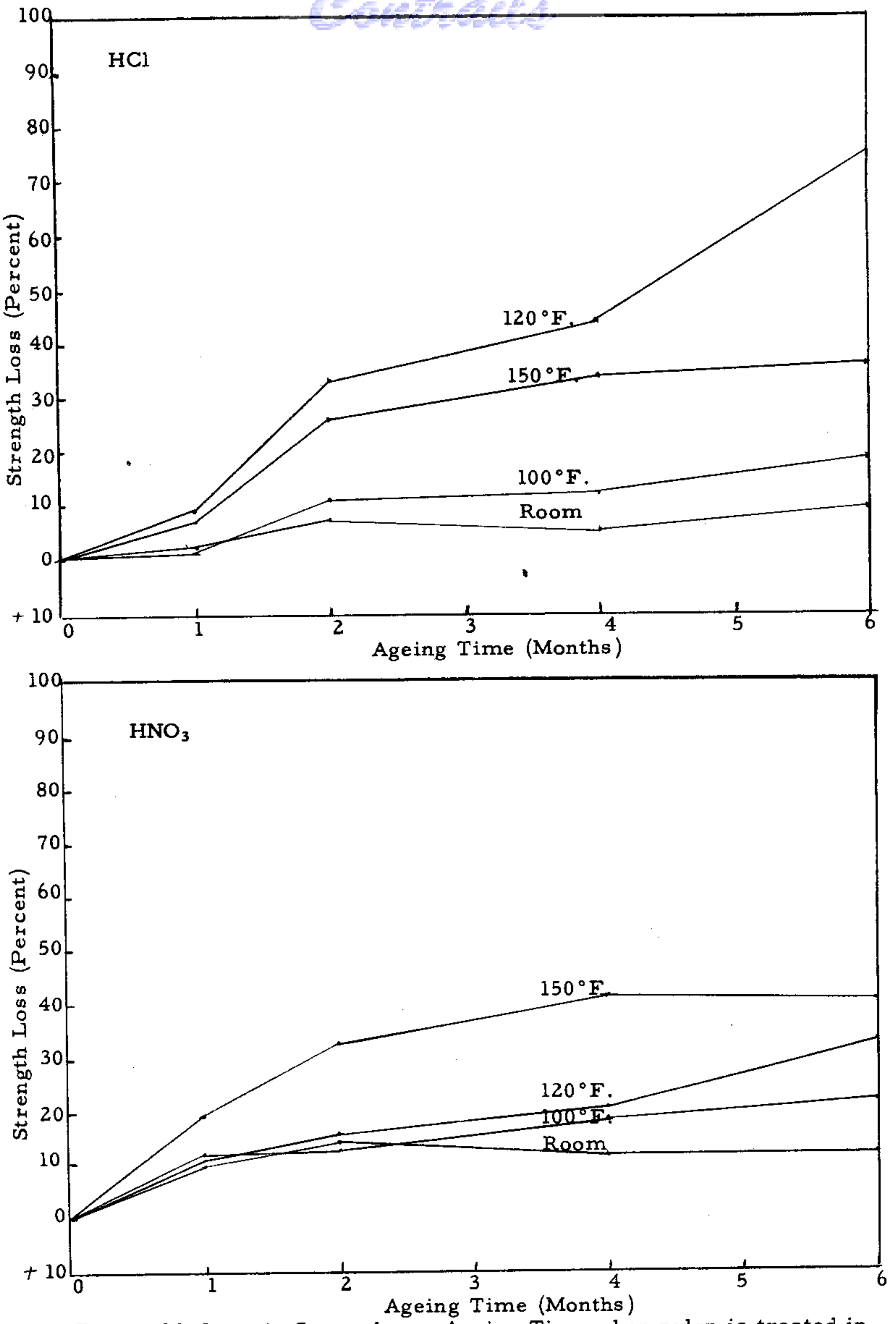
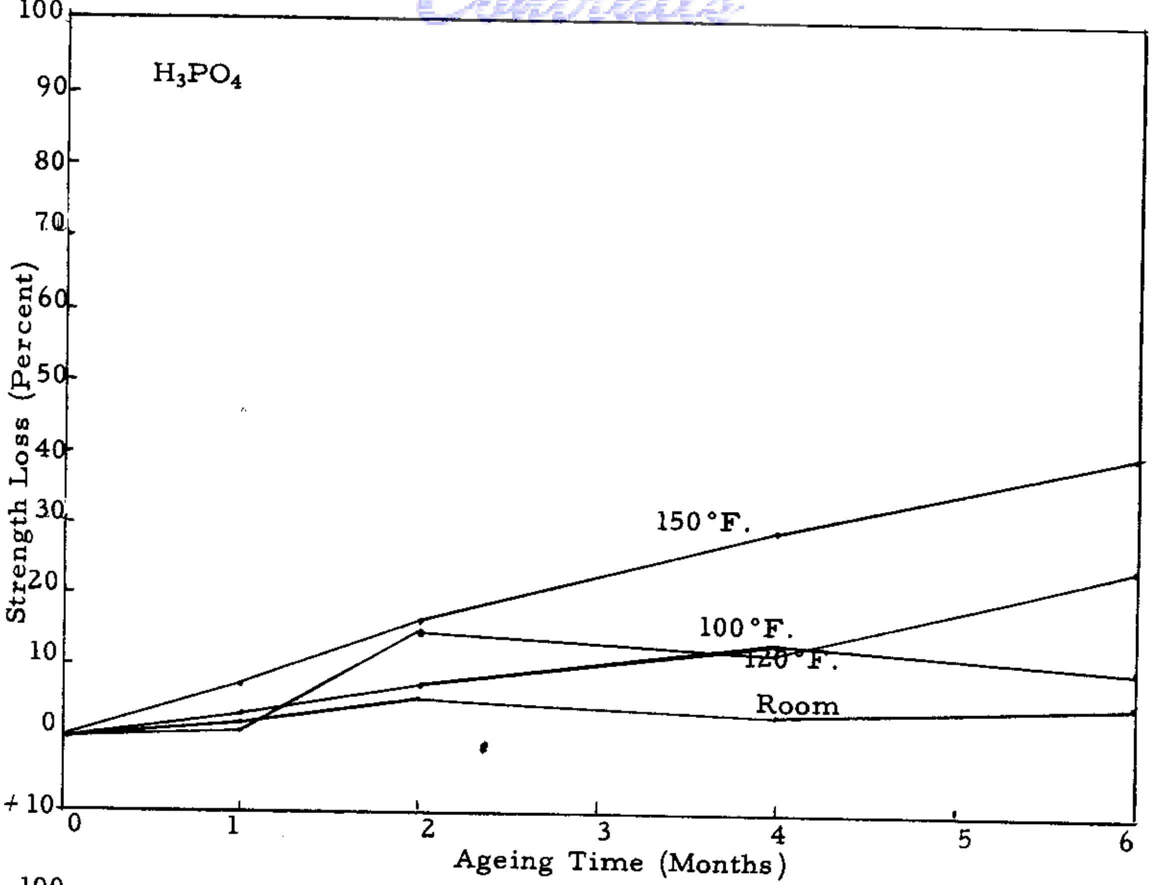


Figure 19. Loss in Strength vs. Ageing Time when nylon is treated in HCl and HNO_3 and aged at low relative humidity at different temperatures.



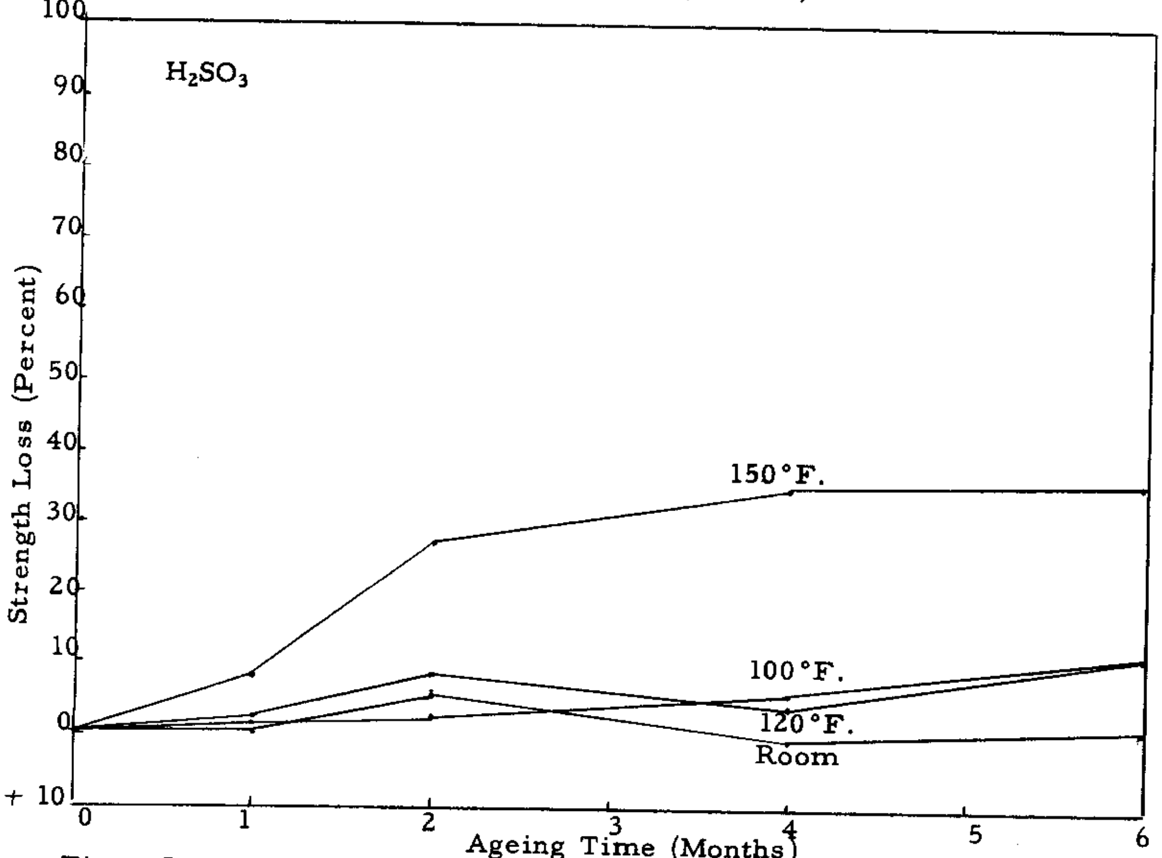


Figure 20. Loss in Strength vs. Ageing Time when nylon is treated in H_3PO_4 and H_2SO_3 and aged at low relative humidity at different temperatures.

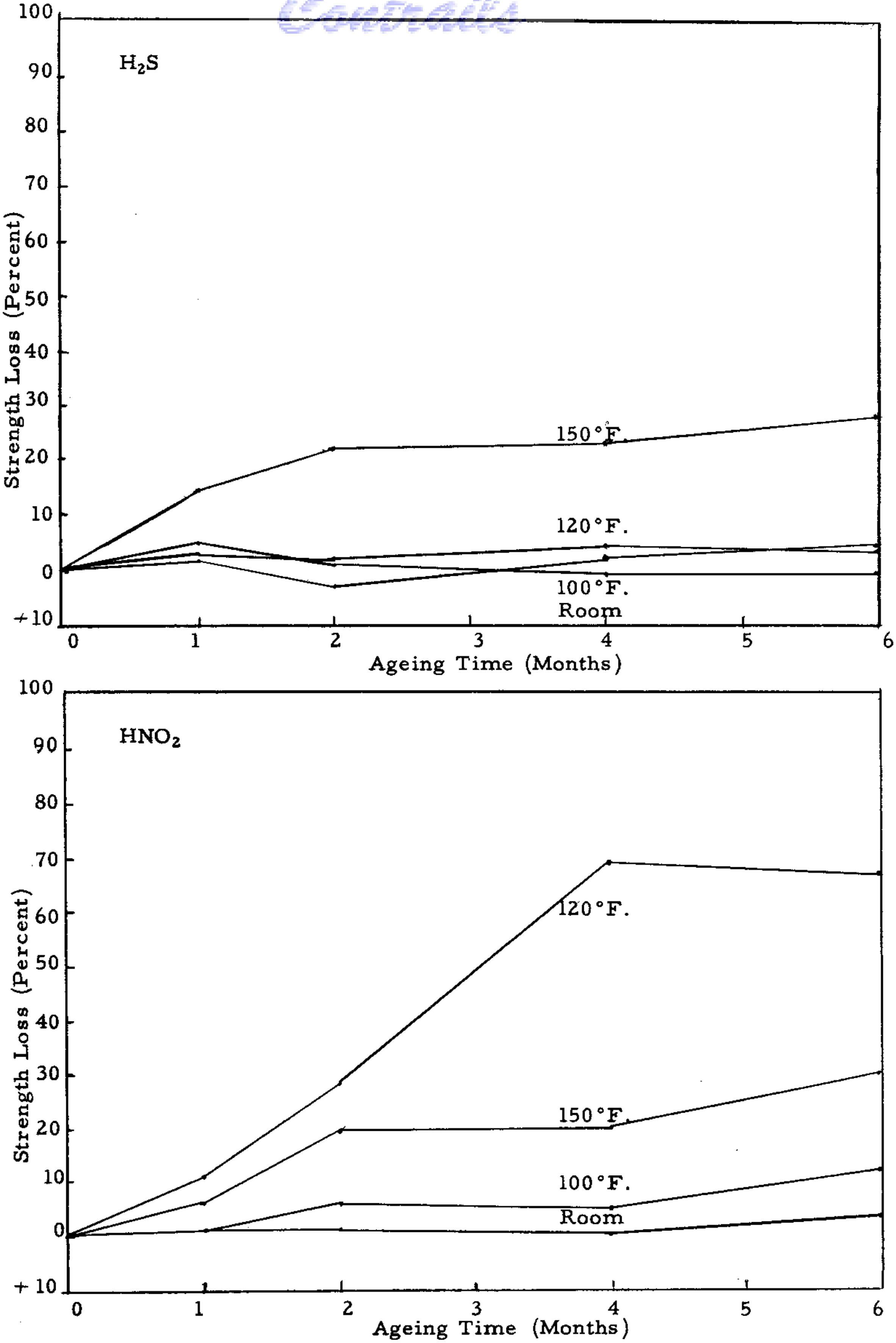


Figure 21. Loss in Strength vs. Ageing Time when nylon is treated in H_2S and HNO_2 and aged at low relative humidity at different temperatures.

different temperatures.

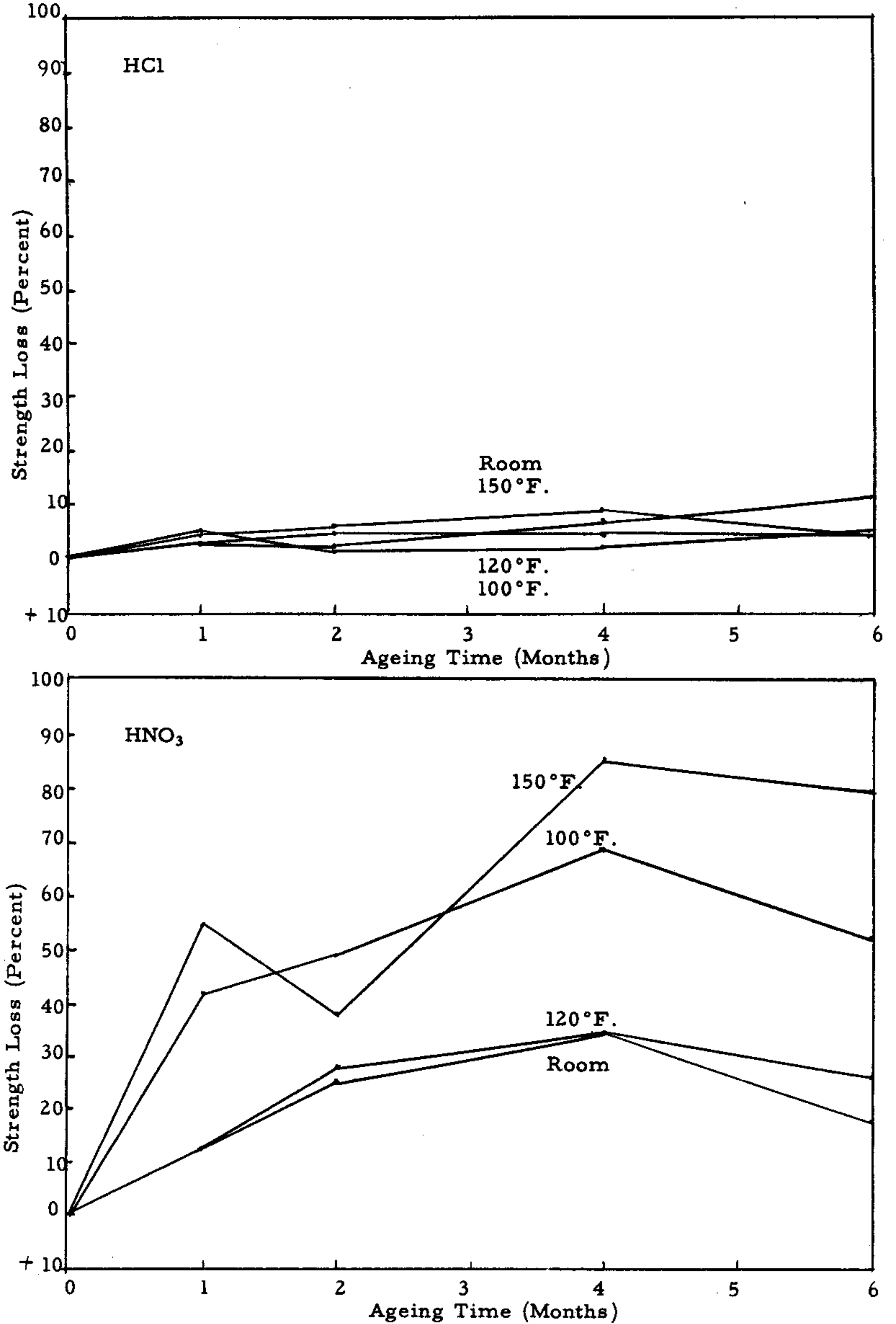


Figure 24. Loss in Strength vs. Ageing Time when nylon is treated in HCl and HNO_3 and aged at high relative humidity at different temperatures.

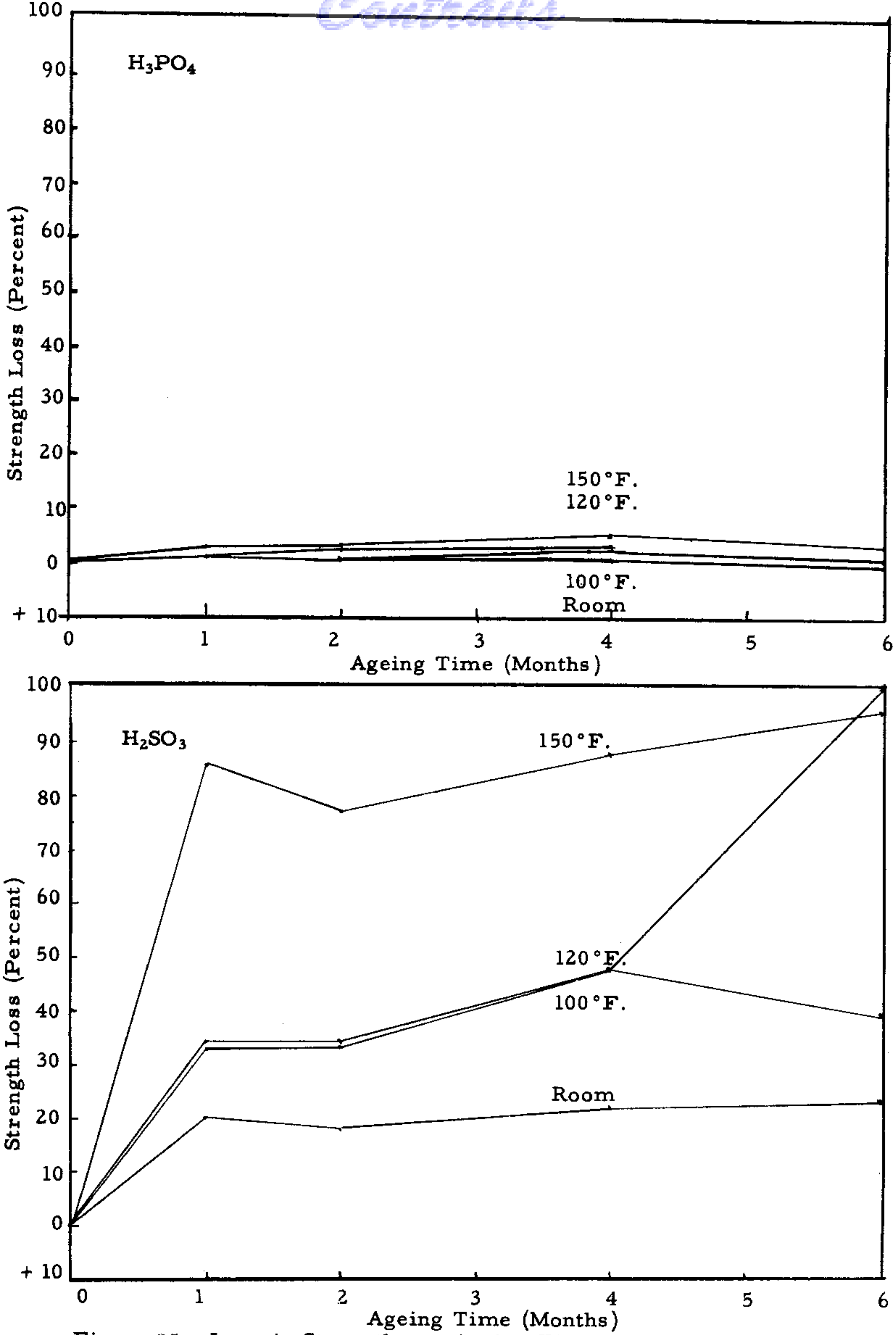


Figure 25. Loss in Strength vs. Ageing Time when nylon is treated in H_3PO_4 and H_2SO_3 and aged at high relative humidity at different temperatures.

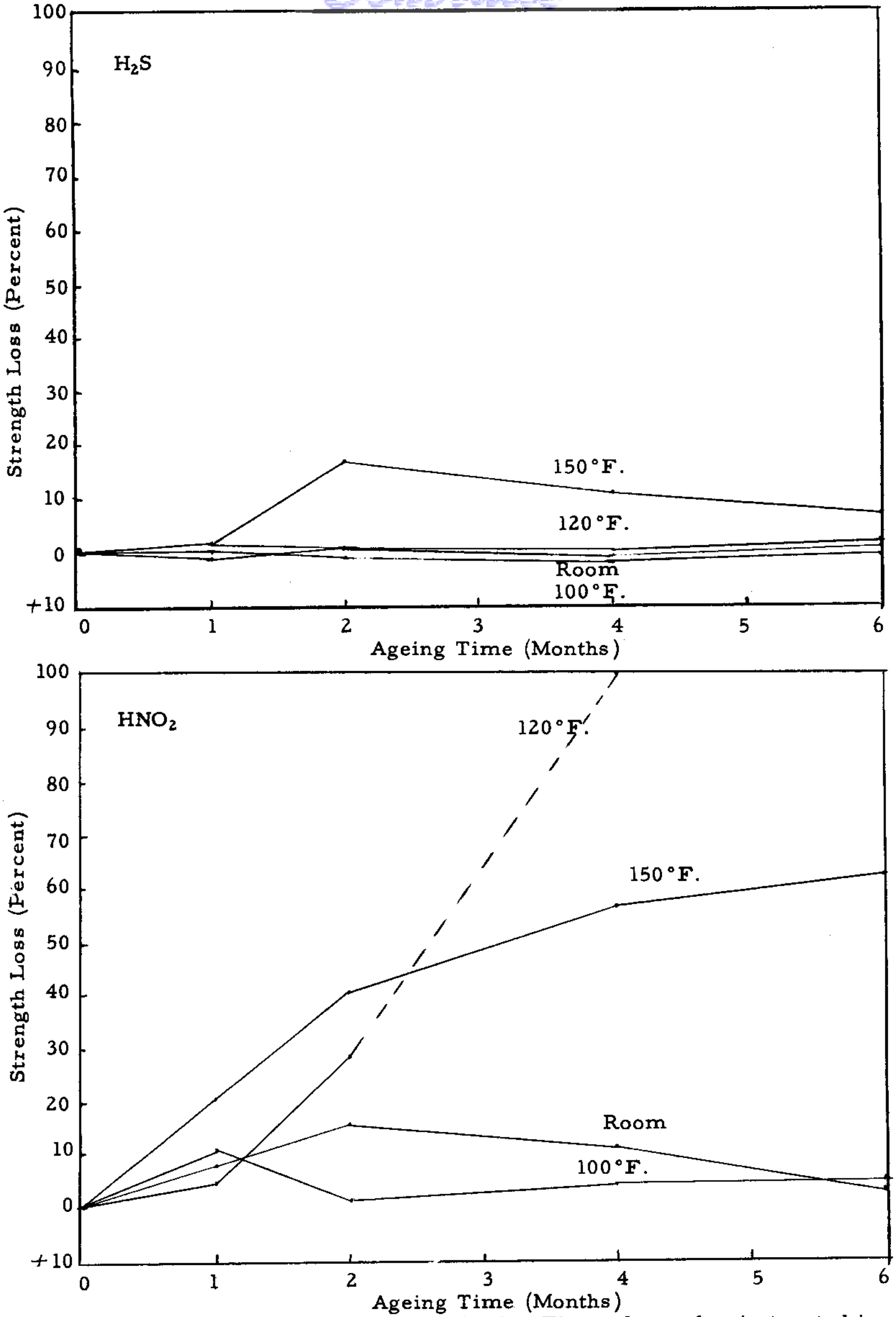


Figure 26 Loss in Strength vs. Ageing Time when nylon is treated in H_2S and HNO_2 and aged at high relative humidity at different temperatures.

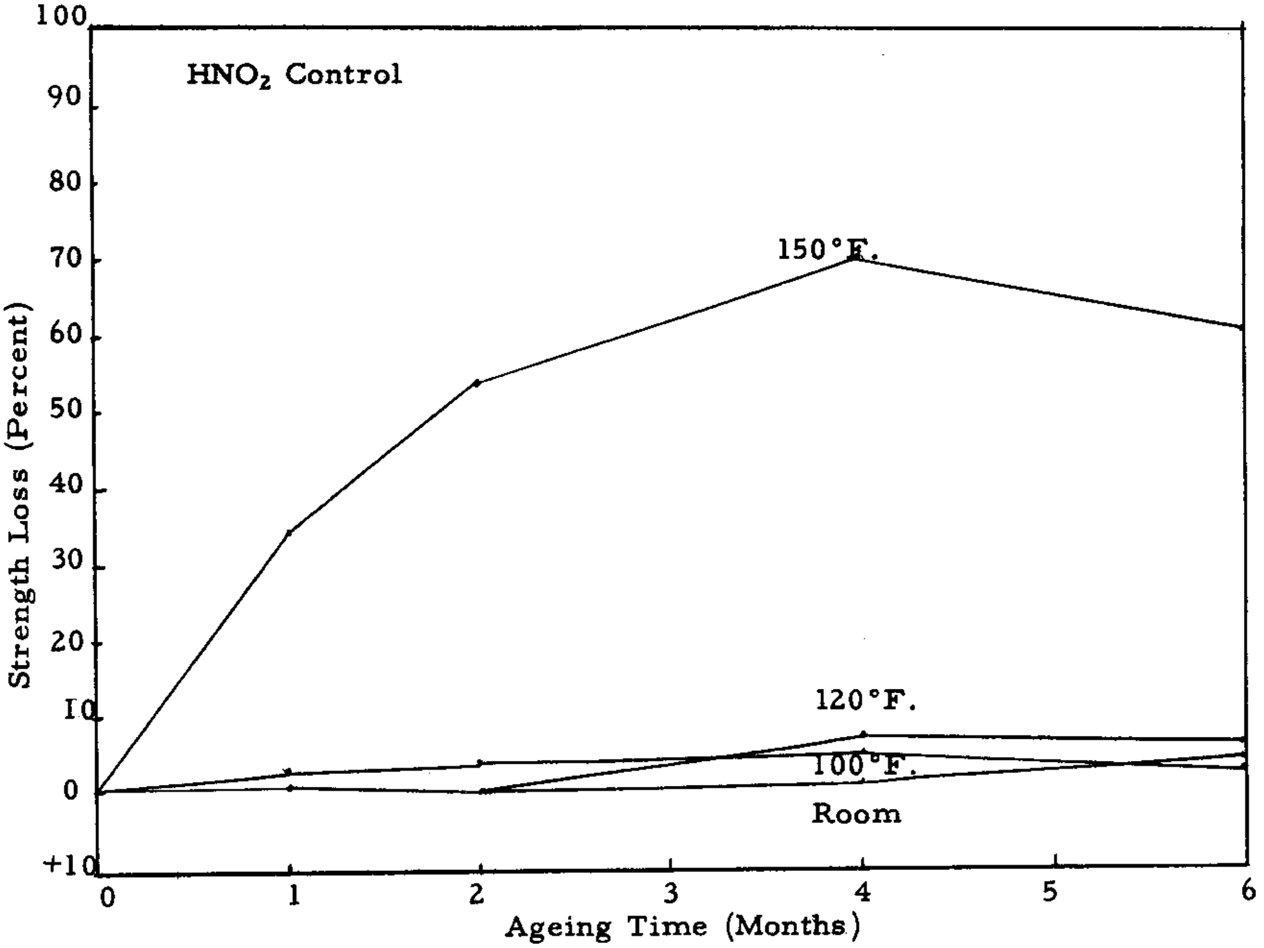


Figure 27. Loss in Strength vs. Ageing Time when nylon is treated in HNO_2 Control and aged at high relative humidity at different temperatures.

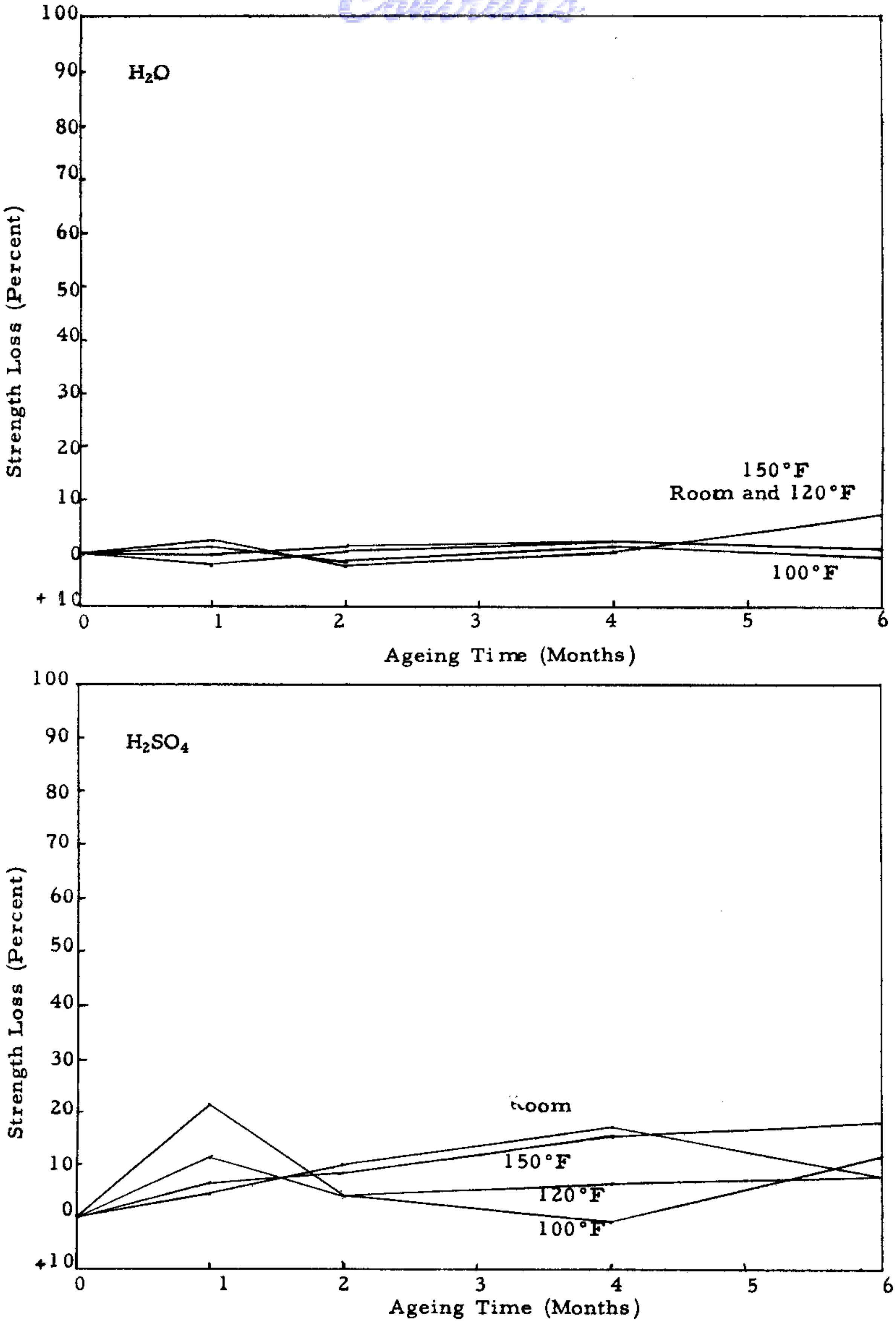
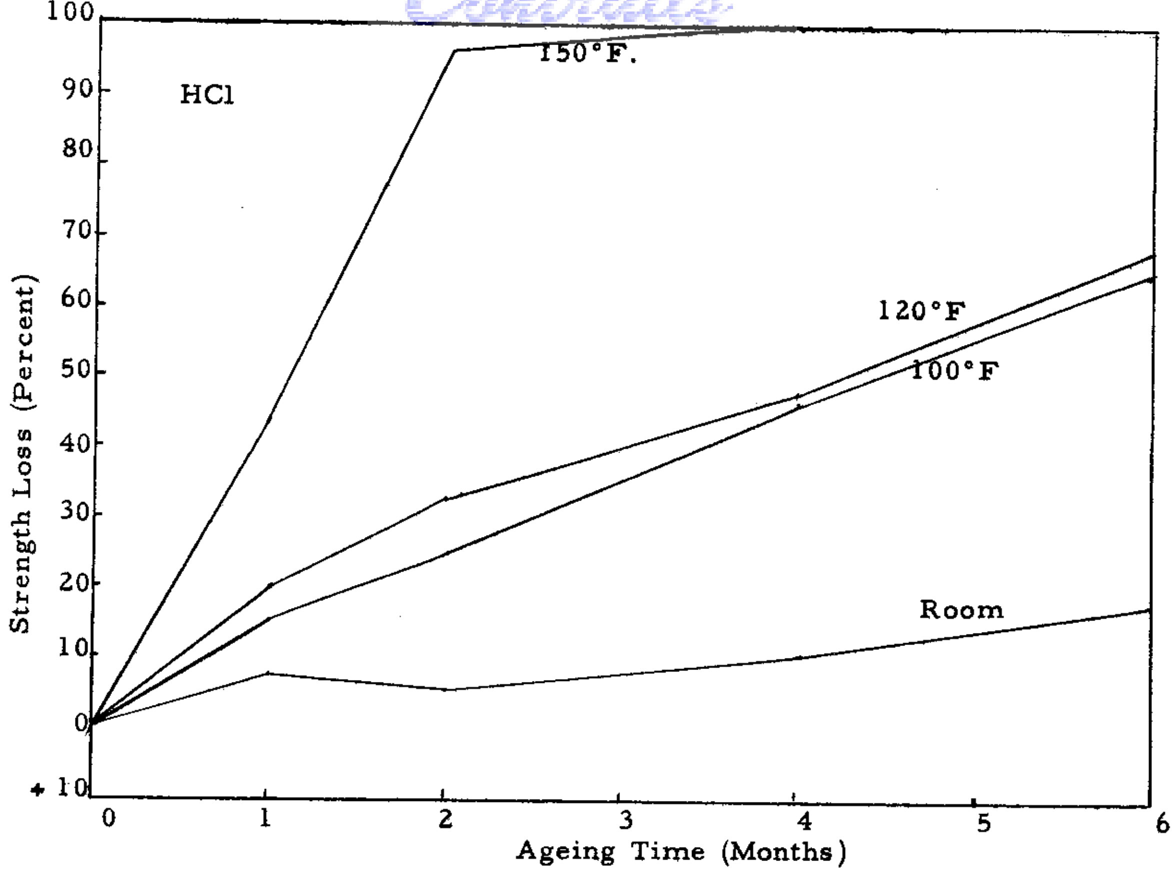


Figure 28. Loss in Strength vs. Ageing Time when Dacron (Type I) is treated in H_2O and H_2SO_4 and aged in solution at different temperatures.



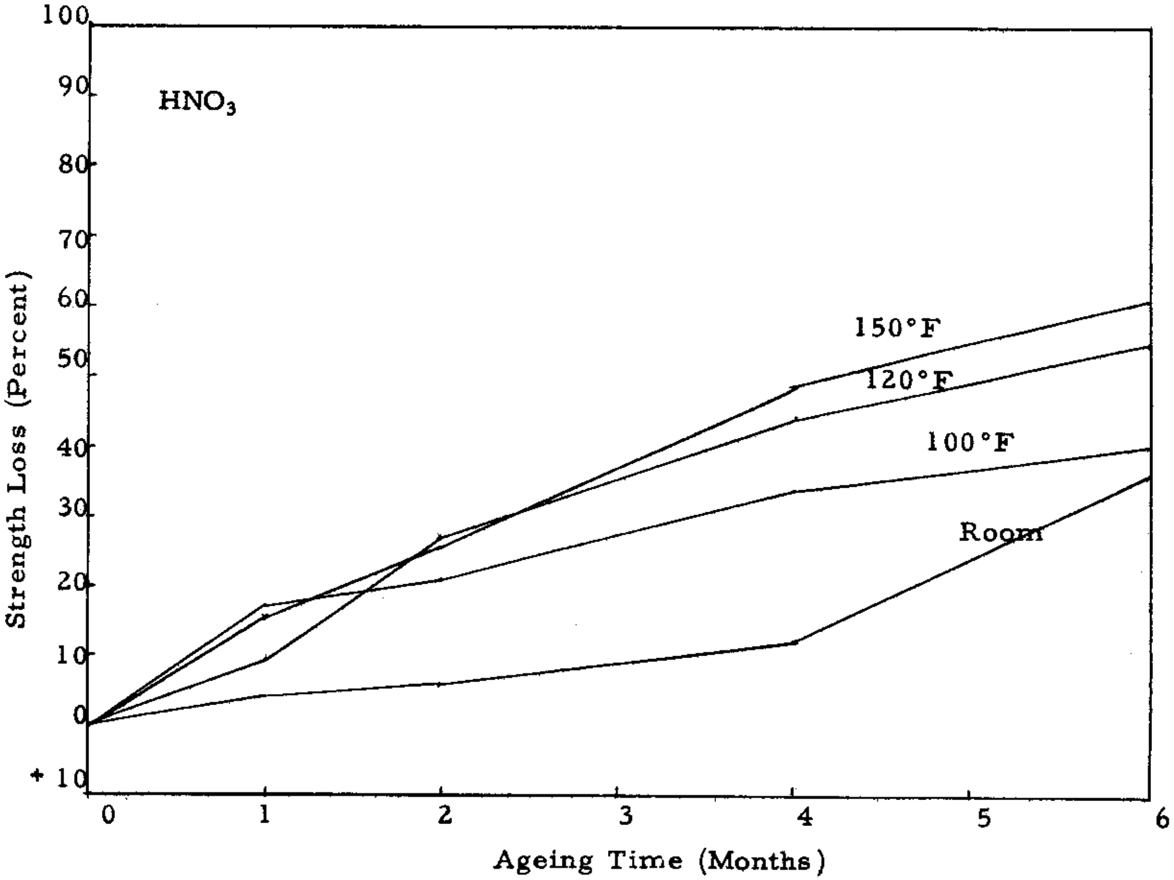


Figure 29 Loss in Strength vs. Ageing Time when Dacron (Type I) is treated in HCl and HNO_3 and aged in solution at different temperatures.

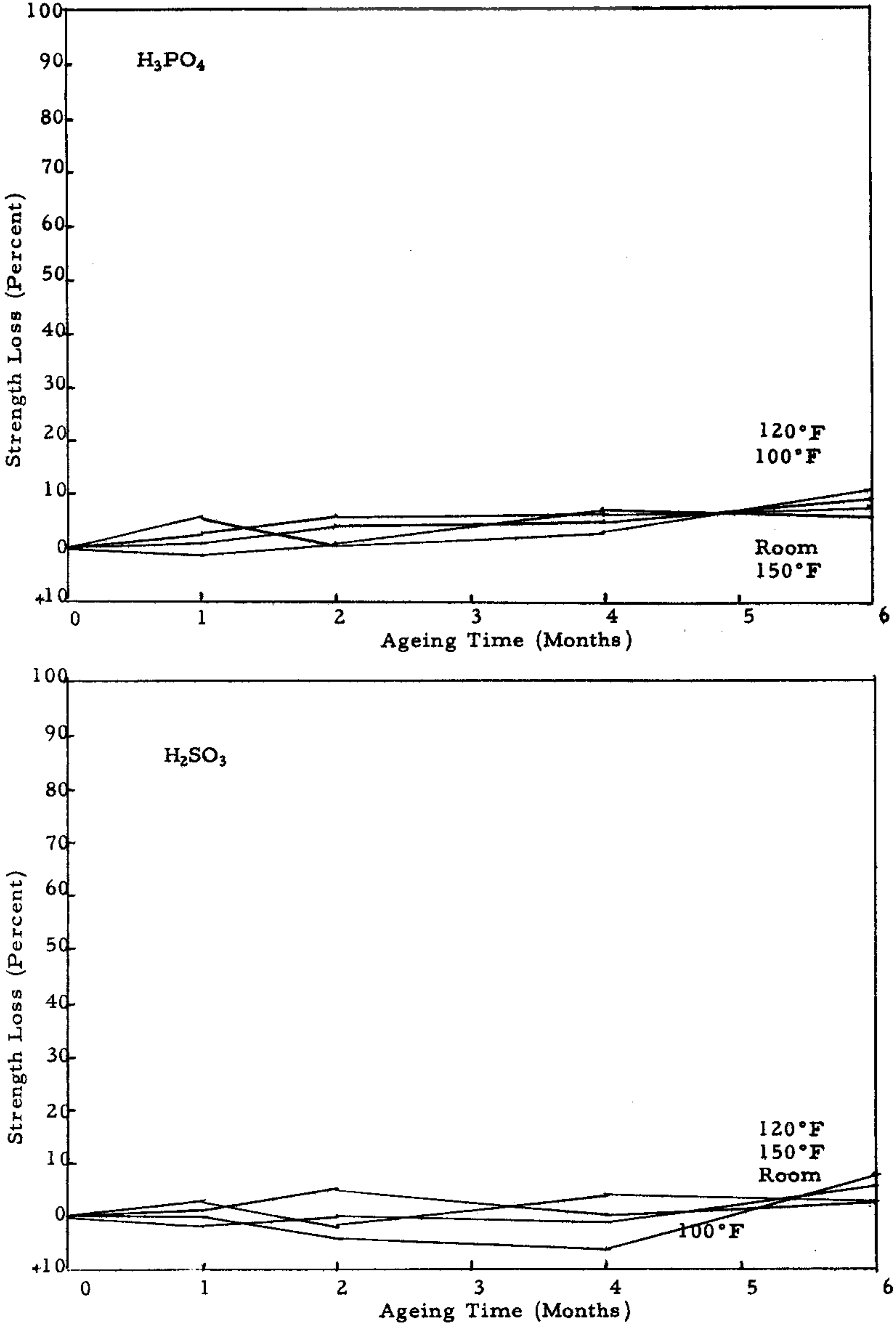
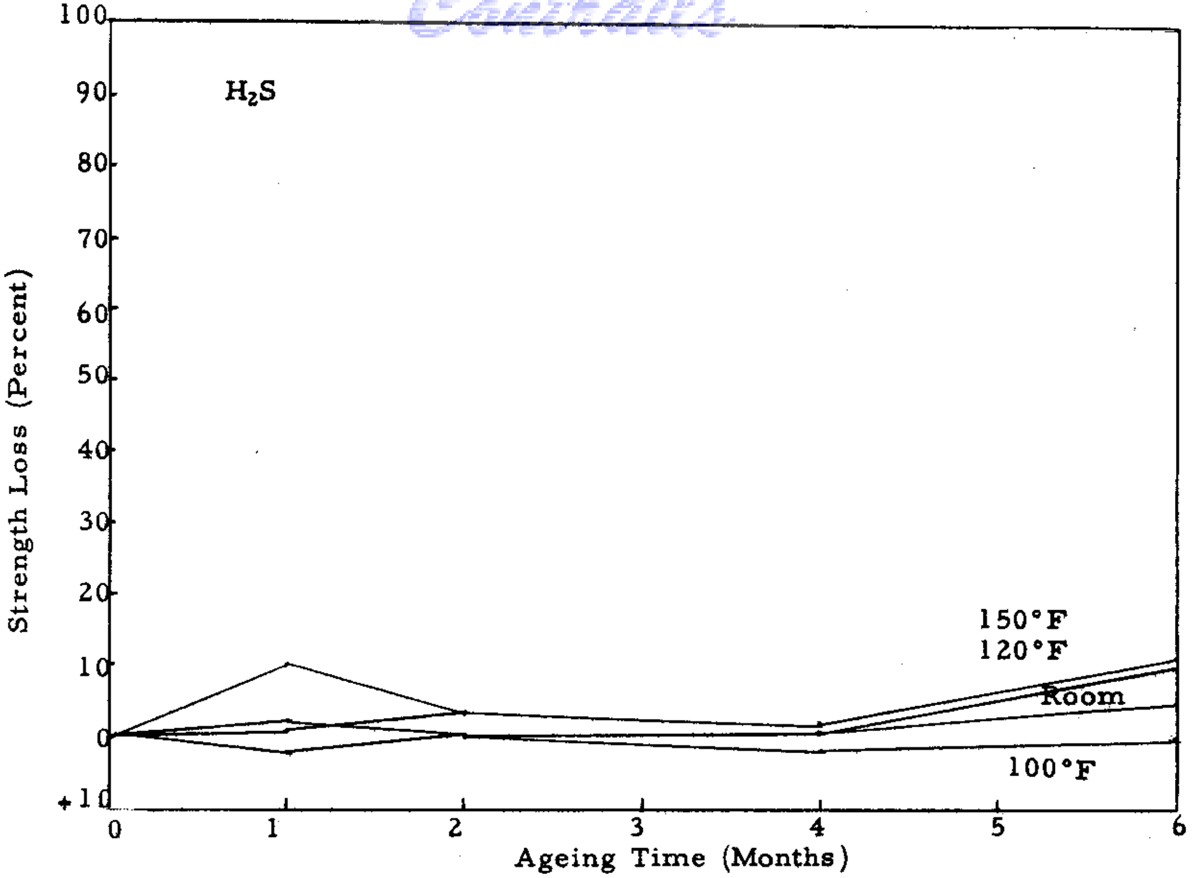


Figure 30. Loss in Strength vs. Ageing Time when Dacron (Type I) is treated in H_3PO_4 and H_2SO_3 and aged in solution at different temperatures.



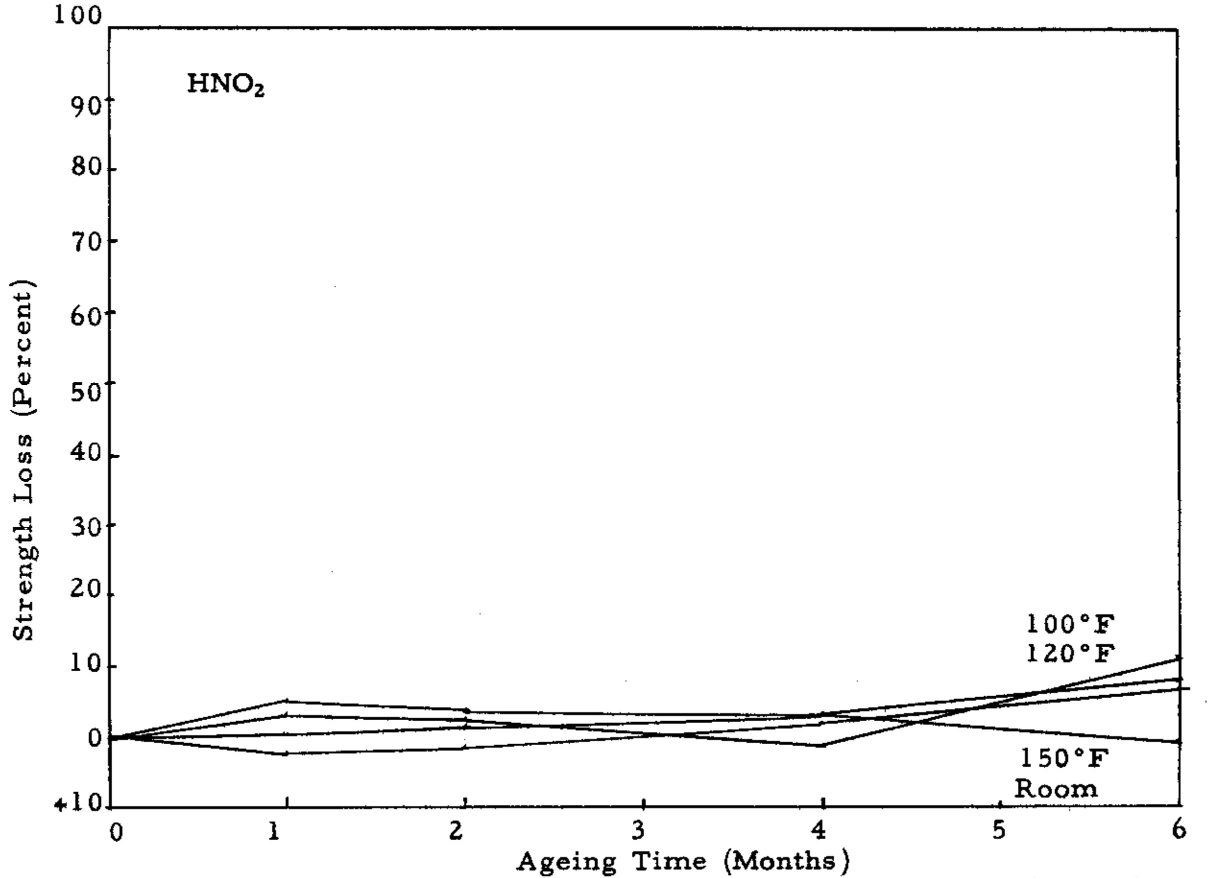


Figure 31. Loss in Strength vs. Ageing Time when Dacron (Type I) is treated in H_2S and HNO_2 and aged in solution at different temperatures.

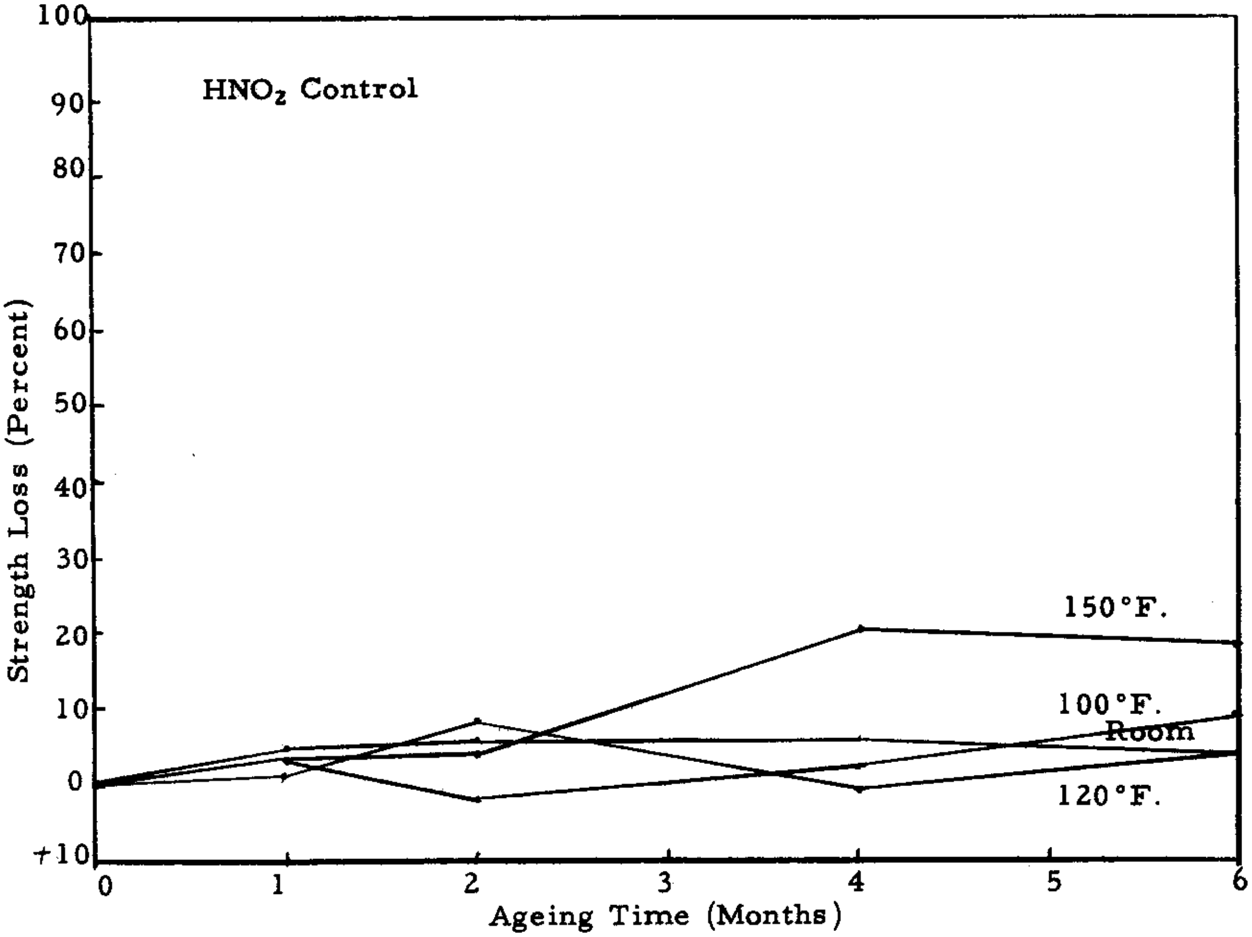


Figure 32. Loss in Strength vs. Ageing Time when Dacron (Type I) is treated in HNO_2 Control and aged in solution at different temperatures.

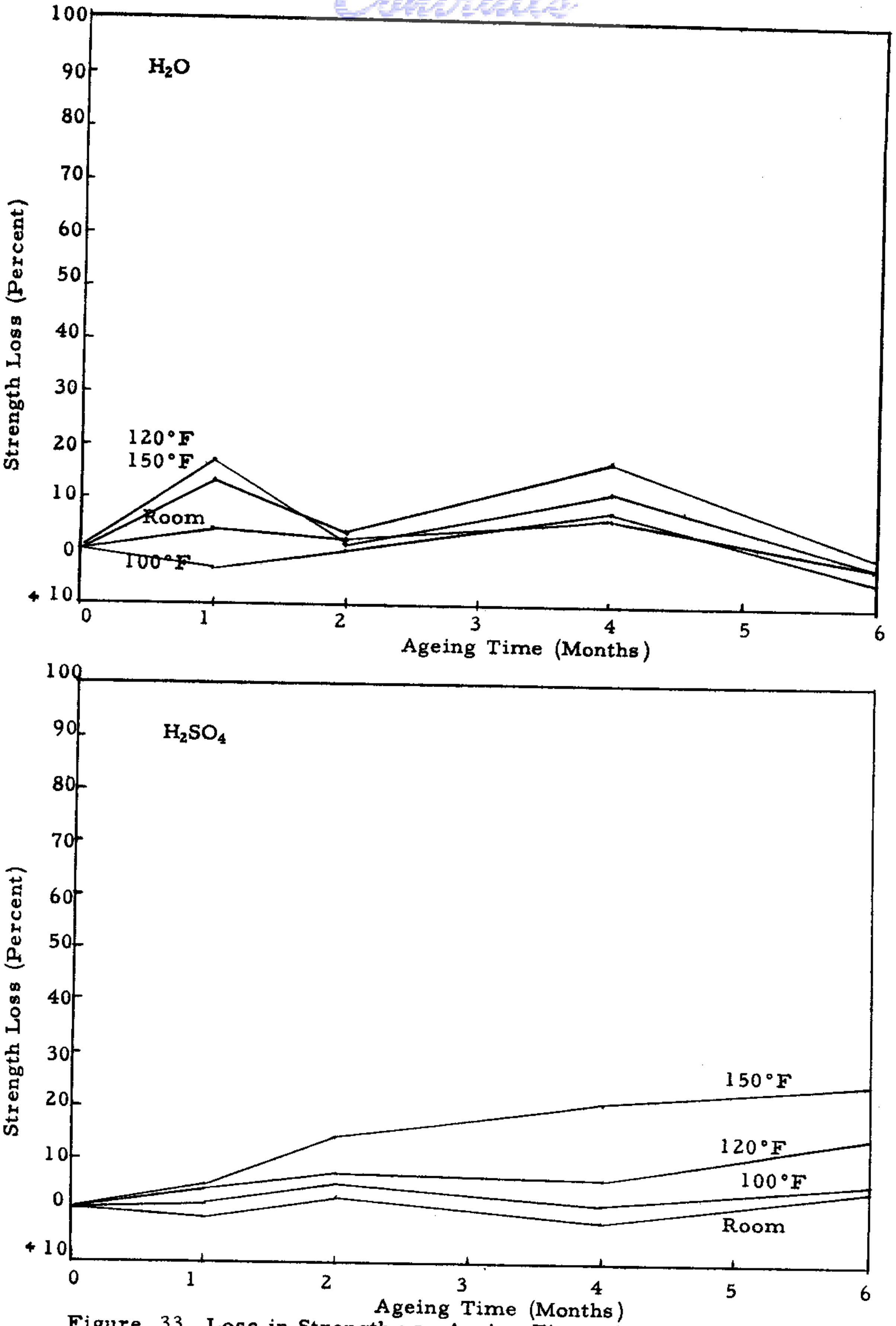
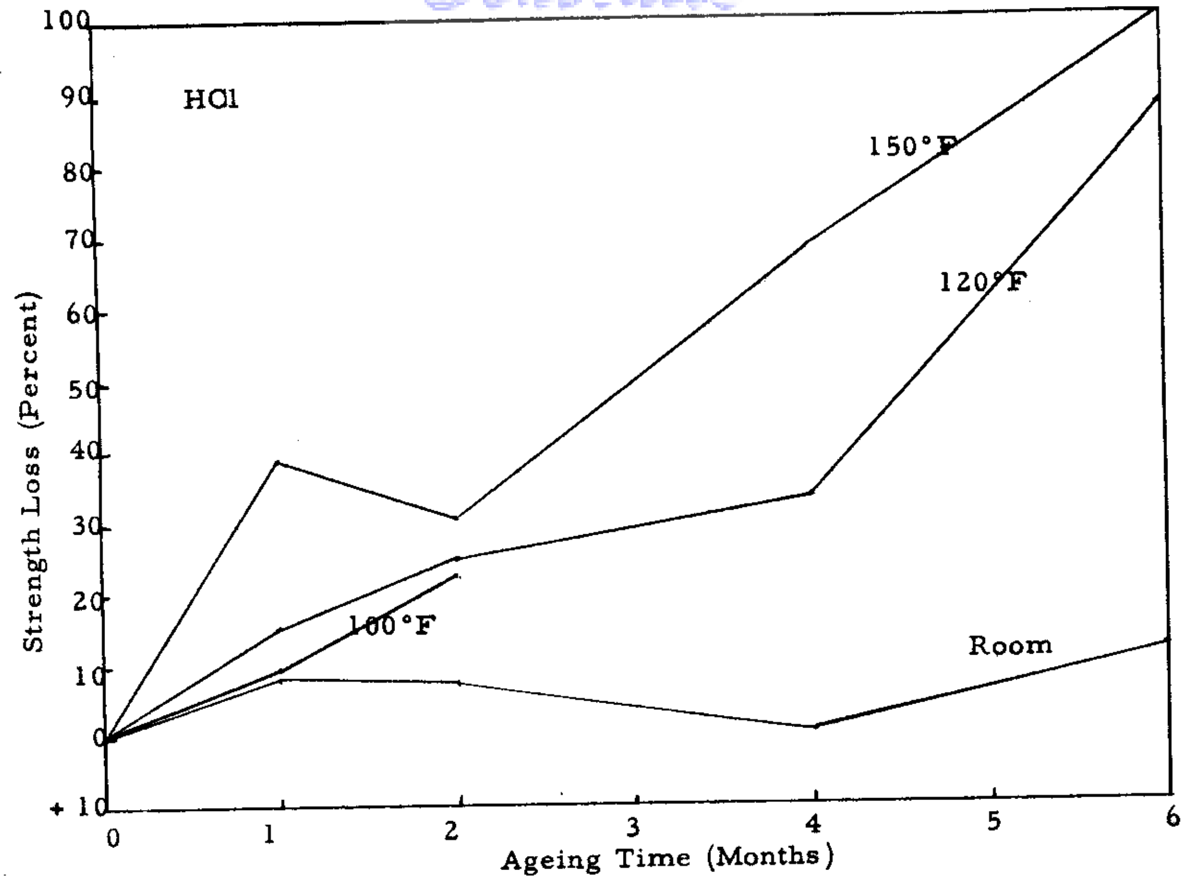


Figure 33. Loss in Strength vs. Ageing Time when Dacron (Type II) is treated in H_2O and H_2SO_4 and aged in solution at different temperatures.



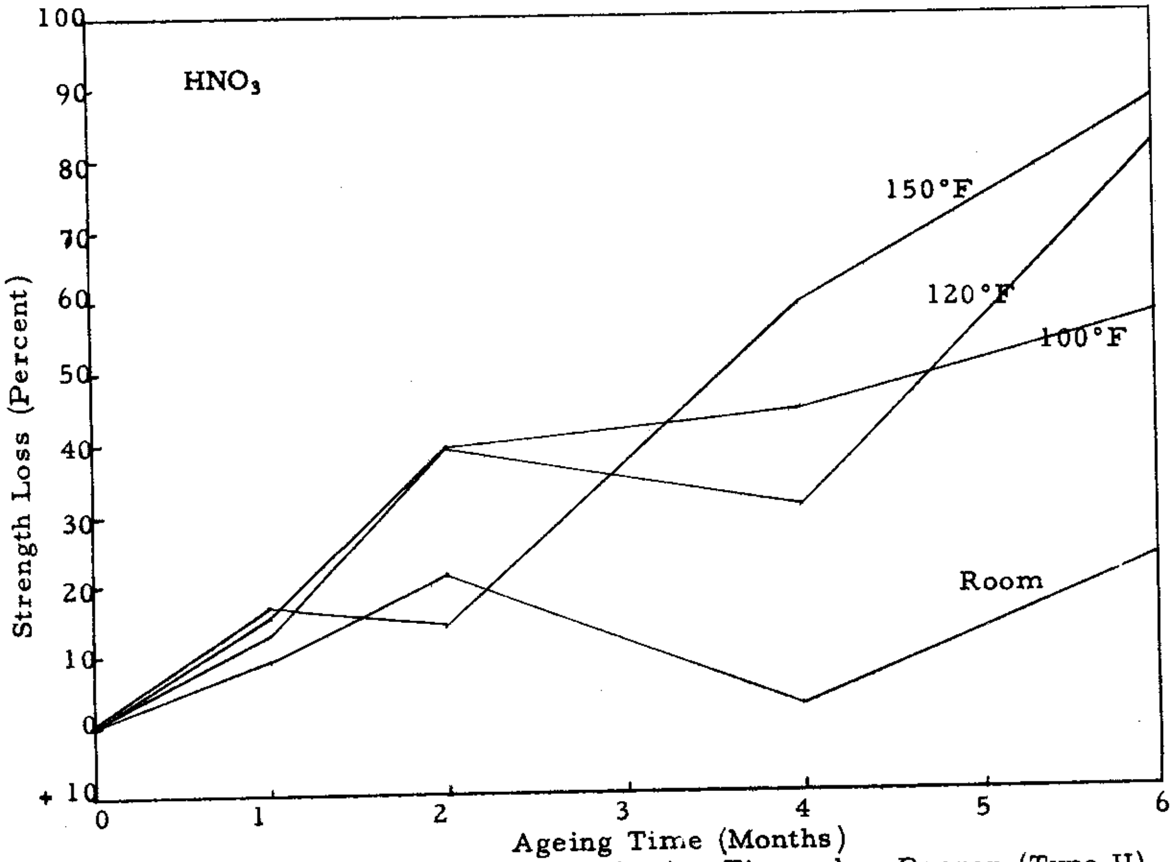


Figure 34. Loss in Strength vs. Ageing Time when Dacron (Type II) is treated in HCl and HNO$_3$ and aged in solution at different temperatures.

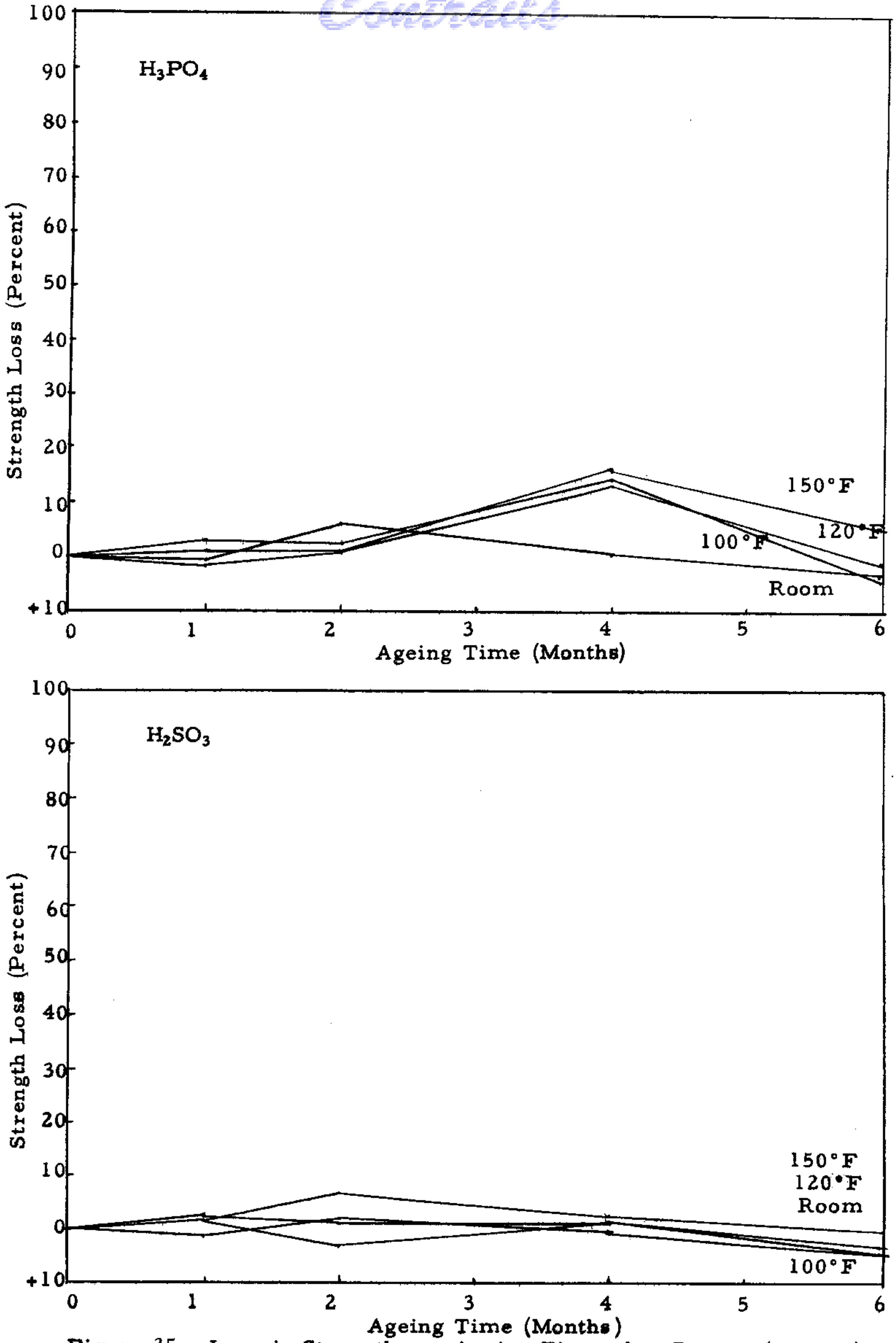


Figure 35. Loss in Strength vs. Ageing Time when Dacron (Type II) is treated in H_3PO_4 and H_2SO_3 and aged in solution at different temperatures.

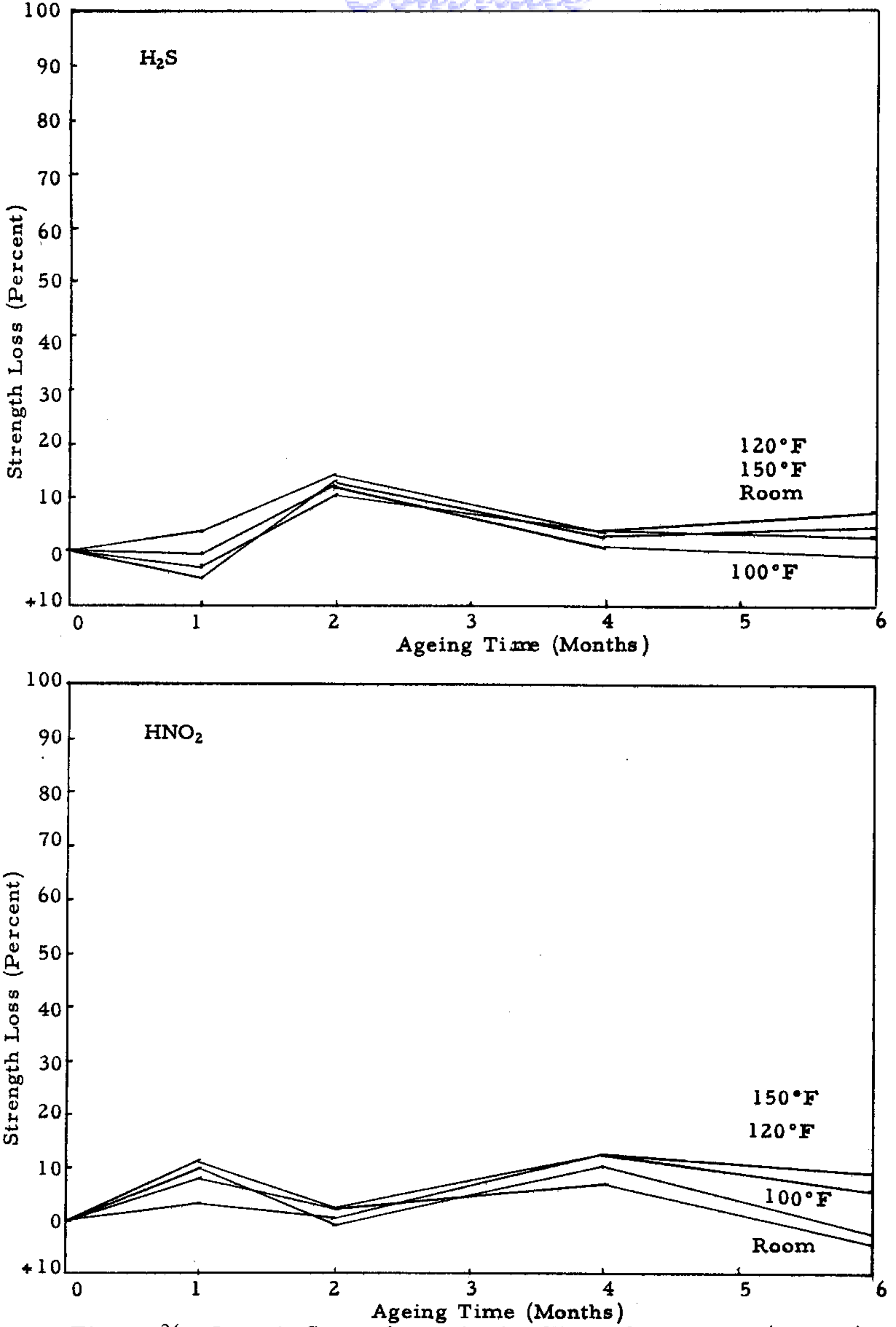


Figure 36. Loss in Strength vs. Ageing Time when Dacron (Type II) is treated in H_2S and HNO_2 and aged in solution at different temperature.

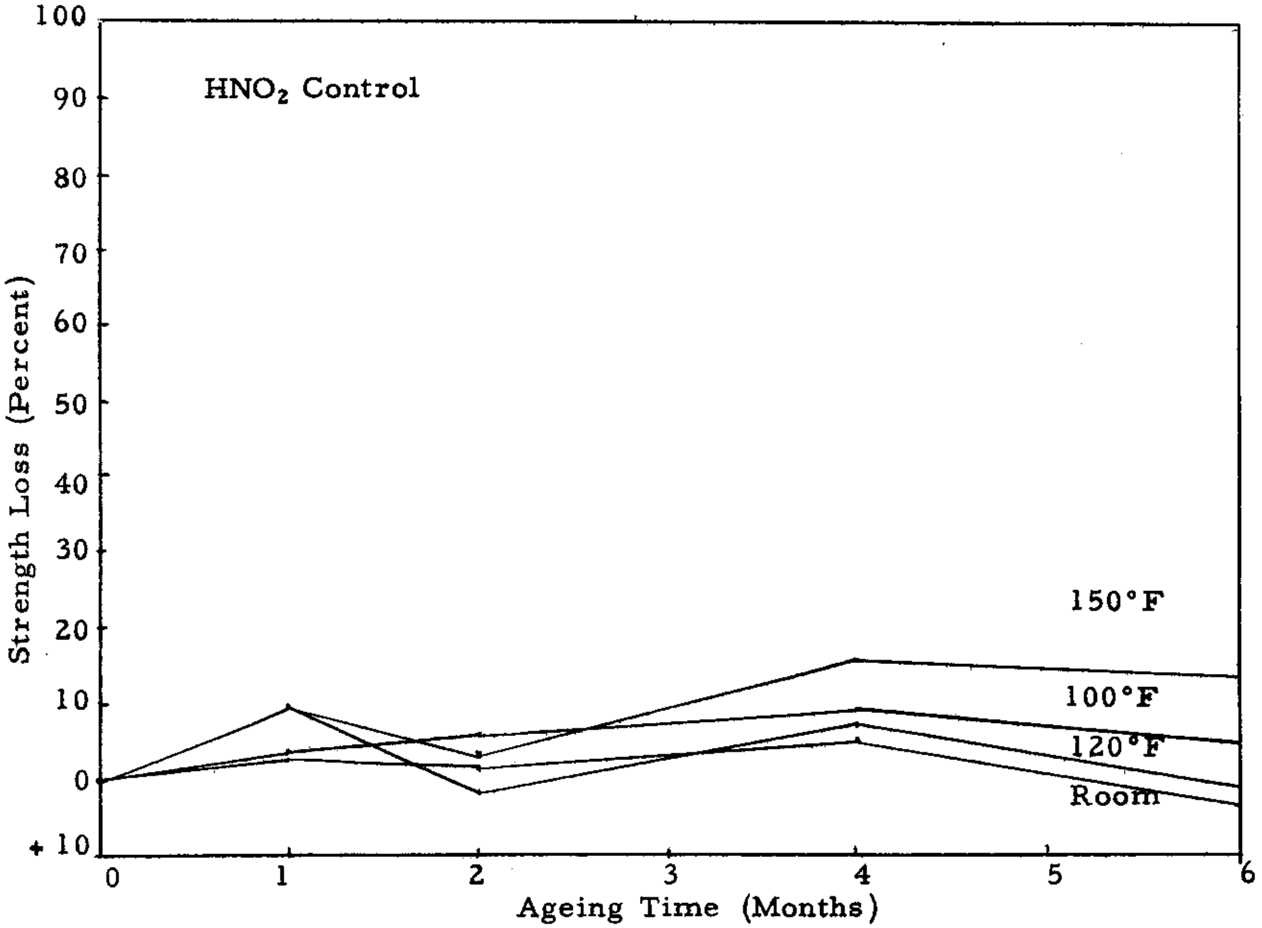
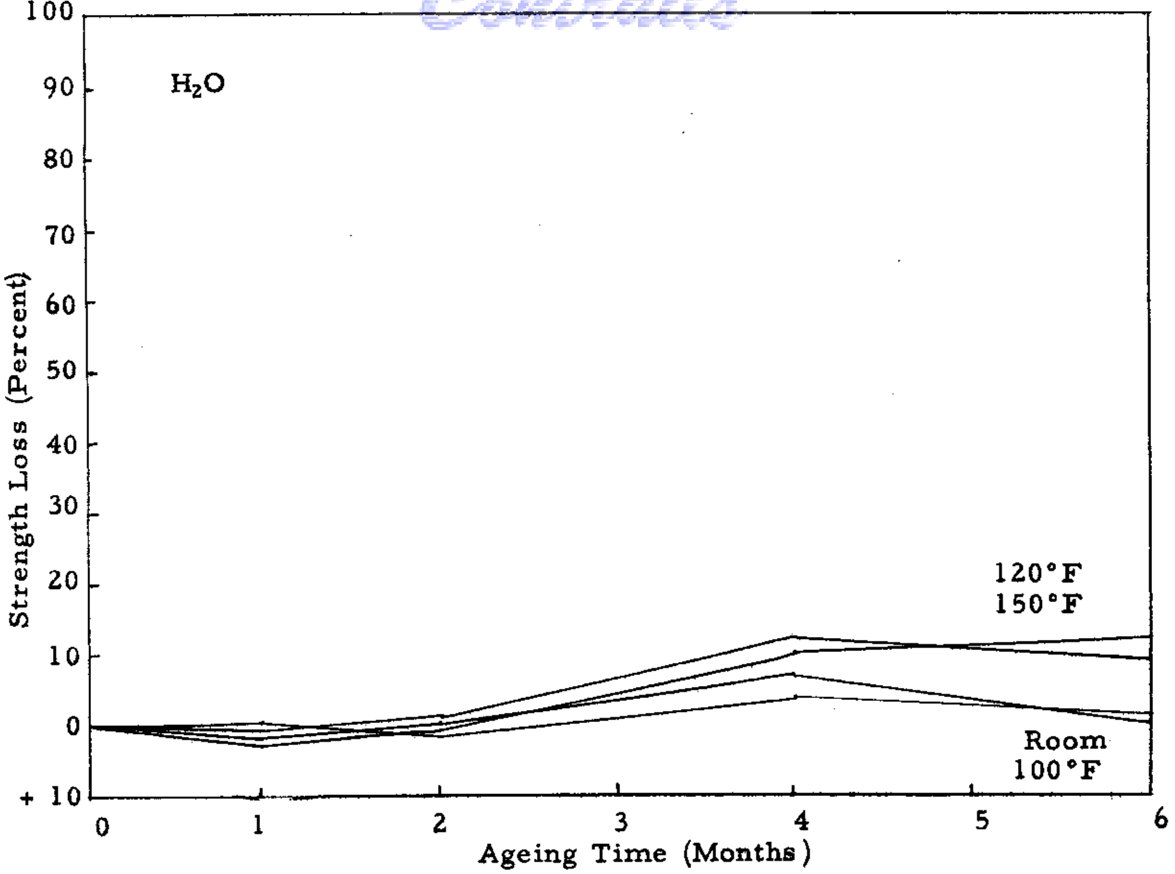


Figure 37. Loss in Strength vs. Ageing Time when Dacron (Type II) is treated in HNO_2 Control and aged in solution at different temperatures.



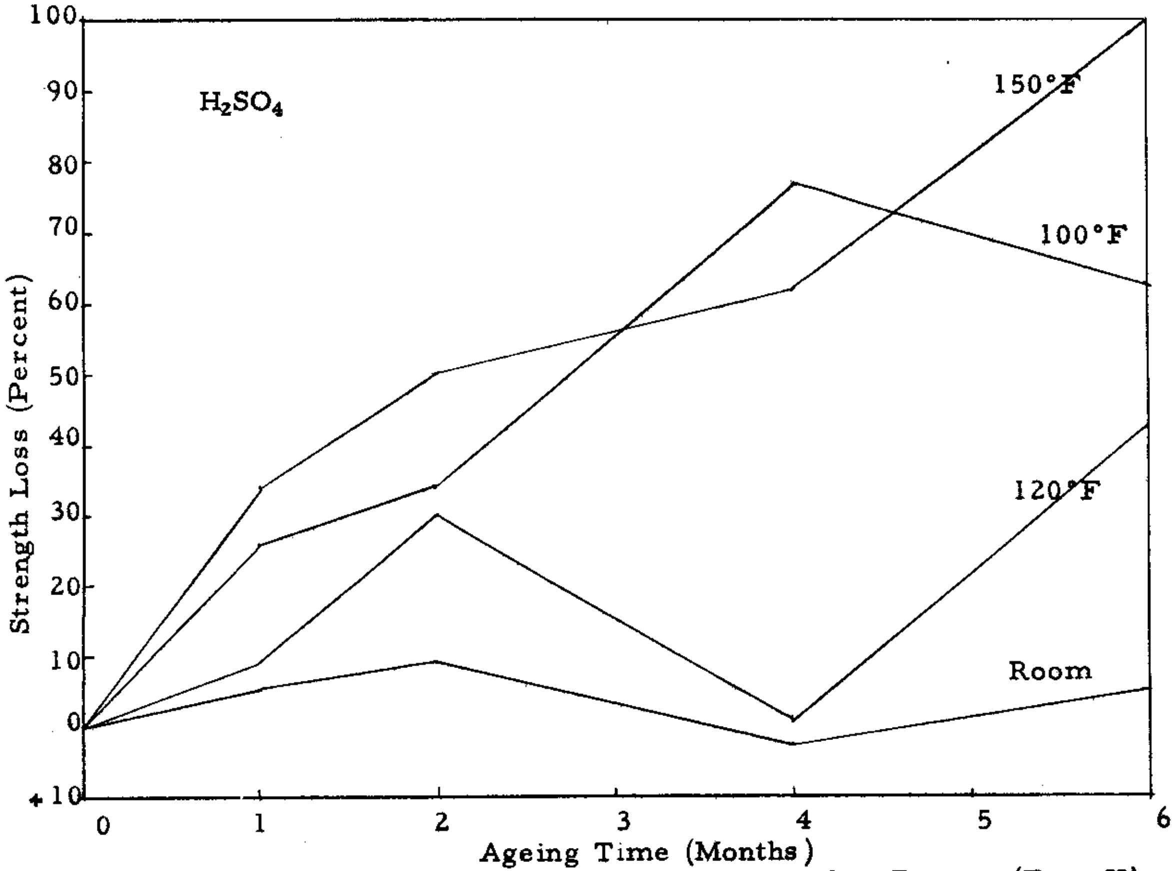


Figure 38. Loss in Strength vs. Ageing Time when Dacron (Type II) is treated in H_2O and H_2SO_4 and aged at low relative humidity at different temperatures.

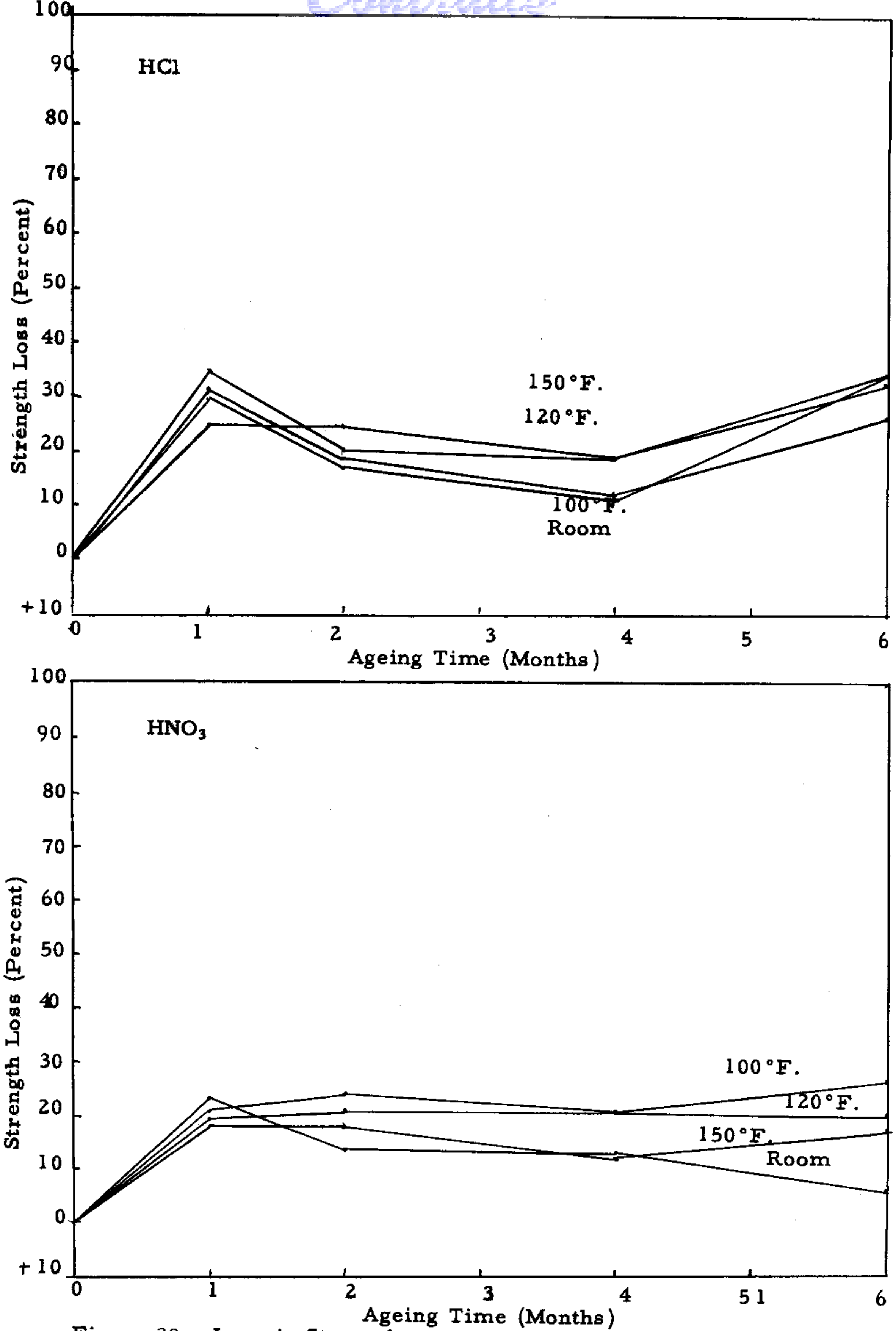
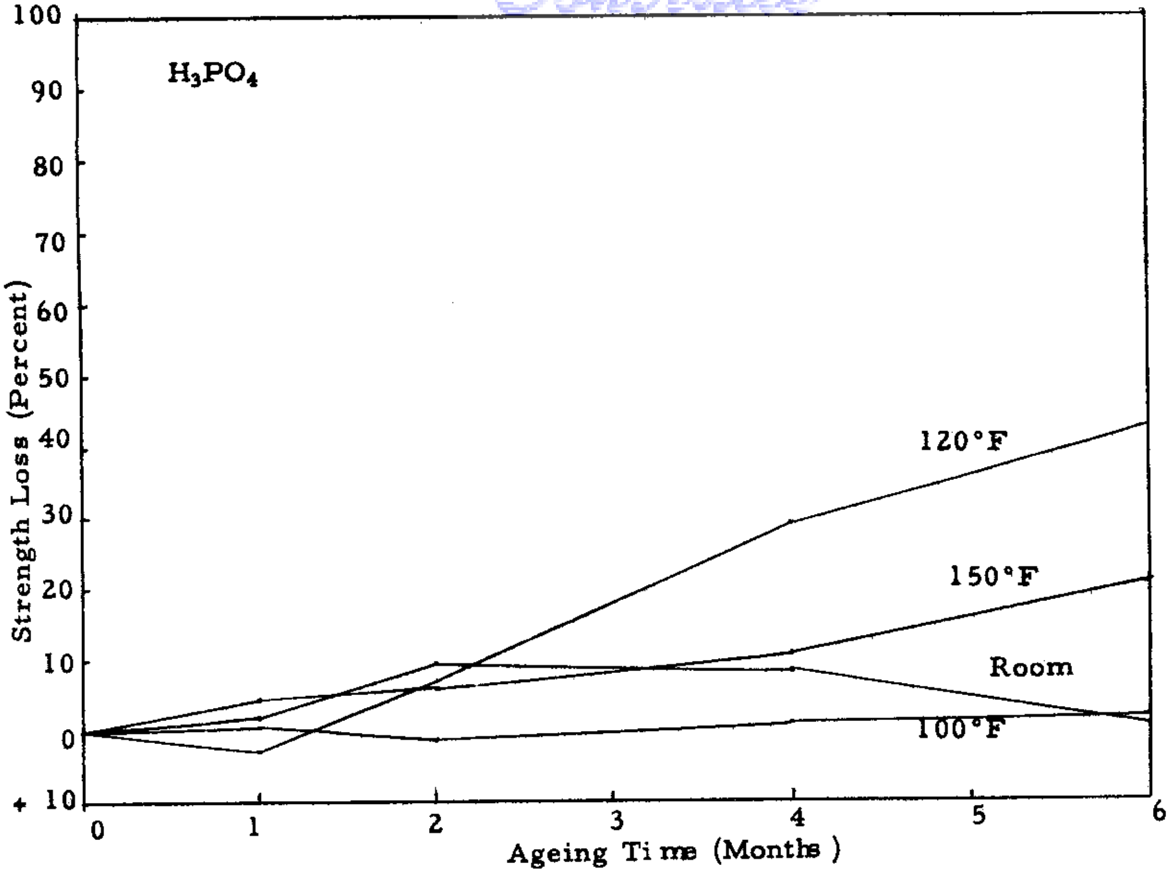


Figure 39. Loss in Strength vs. Ageing Time when Dacron (Type II) is treated in HCl and HNO$_3$ and aged at low relative humidity at different temperatures.



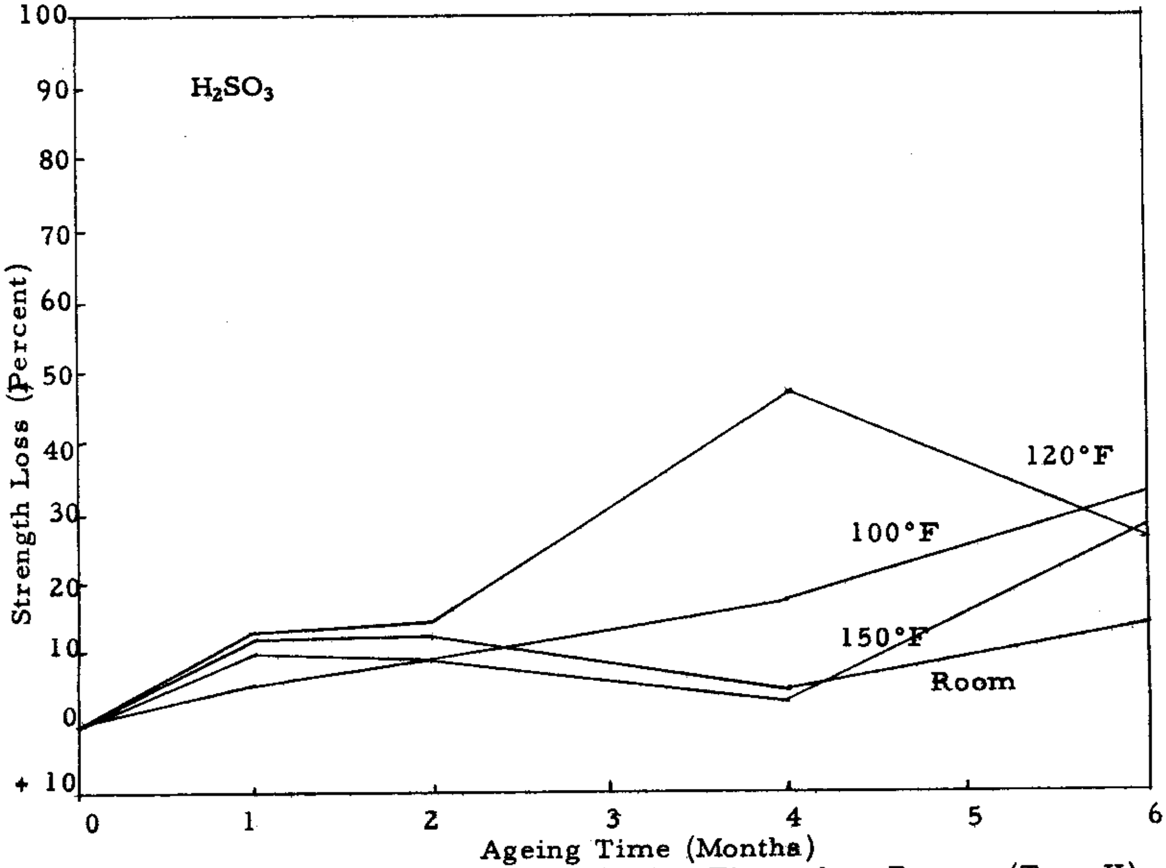


Figure 40. Loss in Strength vs. Ageing Time when Dacron (Type II) is treated in H_3PO_4 and H_2SO_3 and aged at low relative humidity at different temperatures.

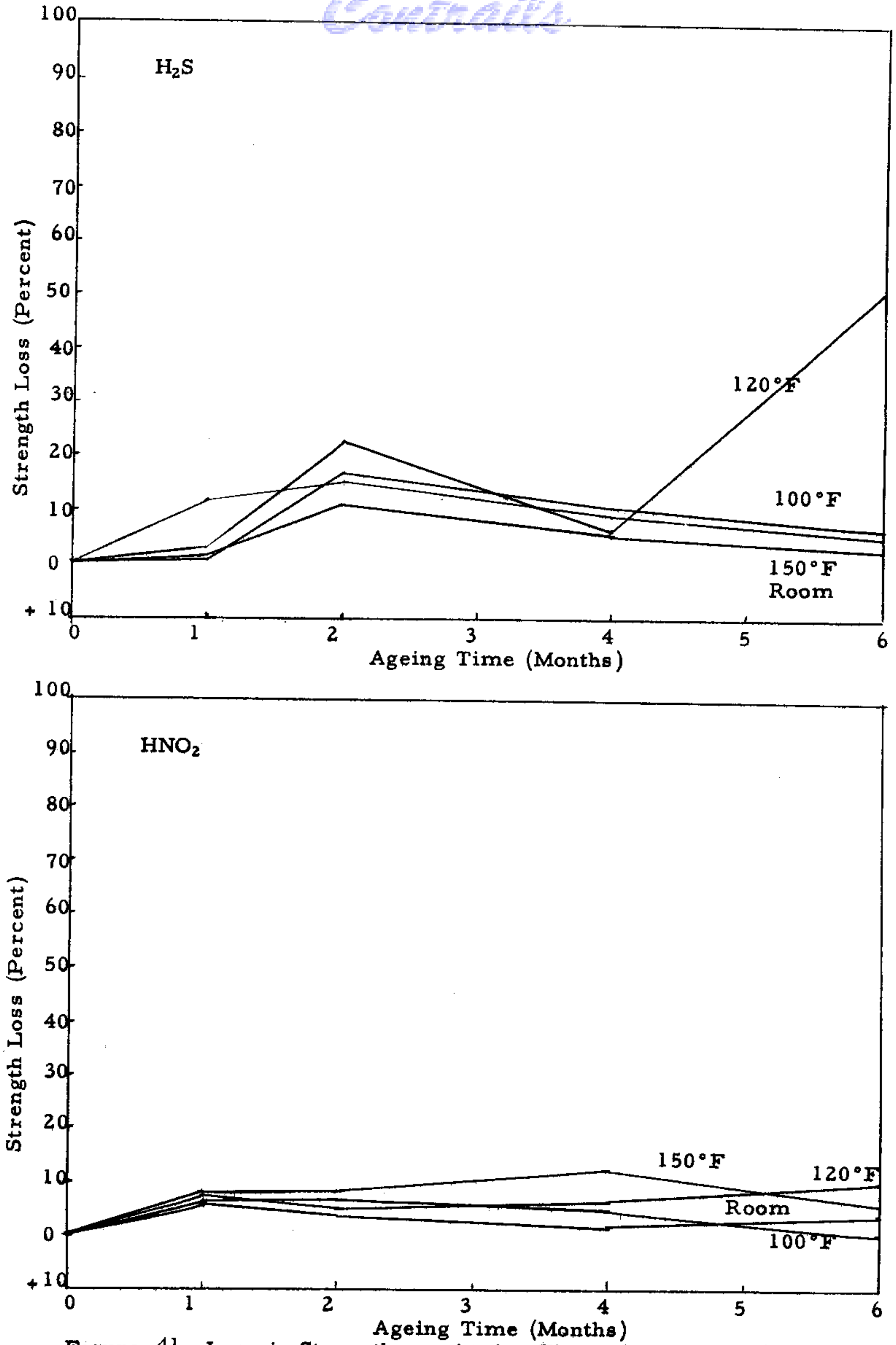


Figure 41. Loss in Strength vs. Ageing Time when Dacron (Type II) is treated in H_2S and HNO_2 and aged at low relative humidity at different temperatures.

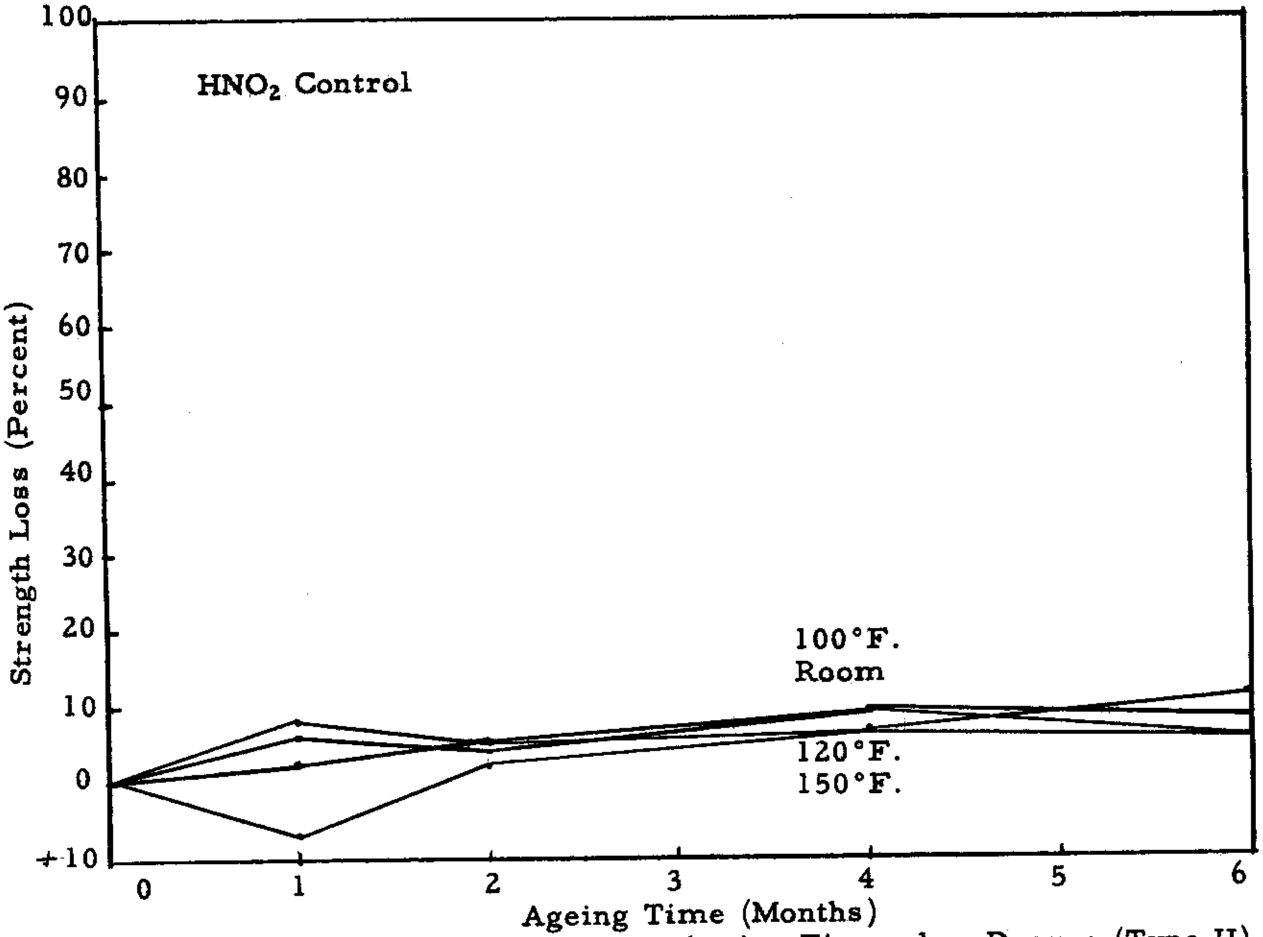


Figure 42. Loss in Strength vs. Ageing Time when Dacron (Type II) is treated in HNO$_2$ Control and aged at low relative humidity at different temperatures.

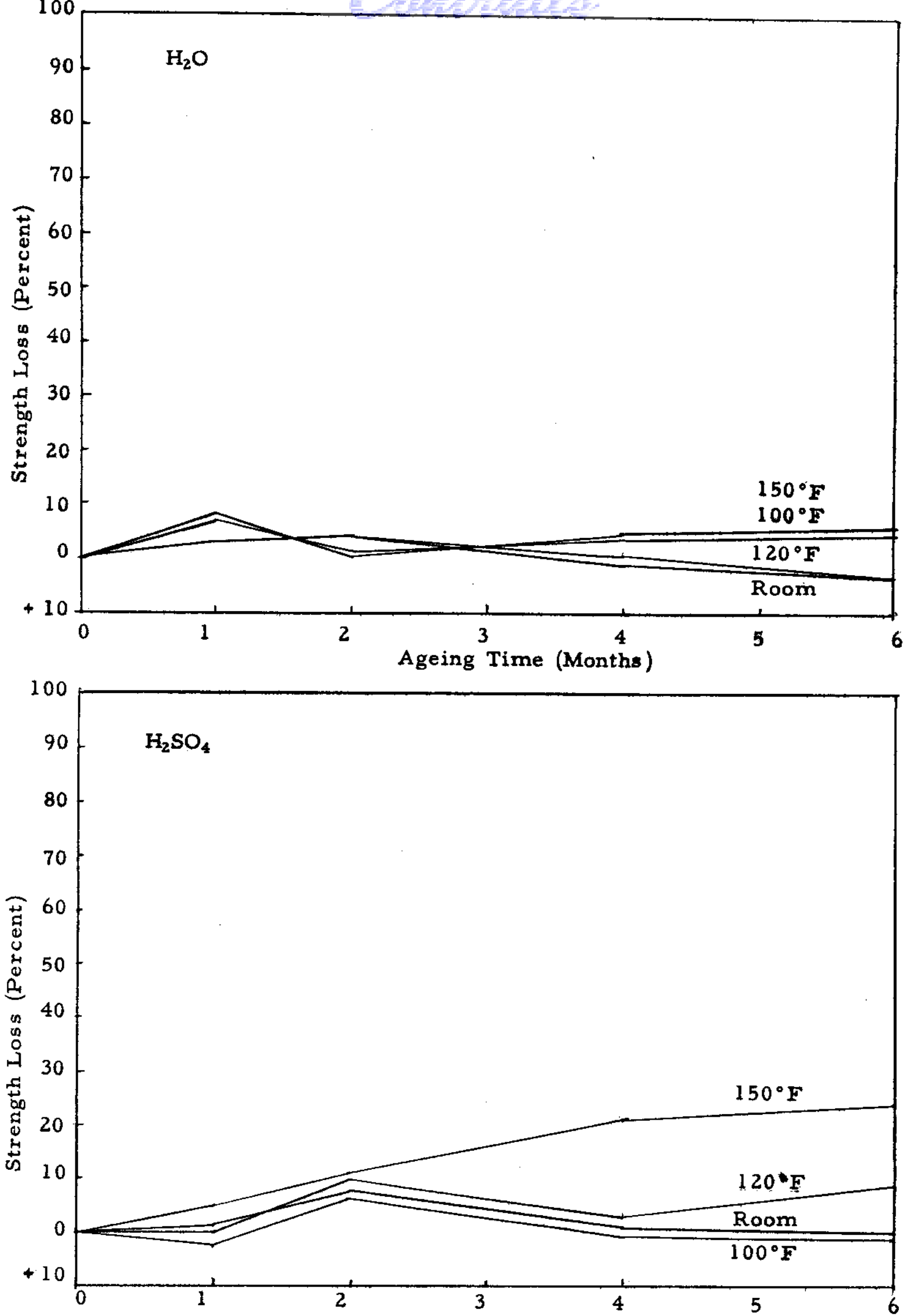


Figure 43. Loss in Strength vs. Ageing Time when Dacron (Type II) is treated in H_2O and H_2SO_4 and aged at high relative humidity at different temperatures.

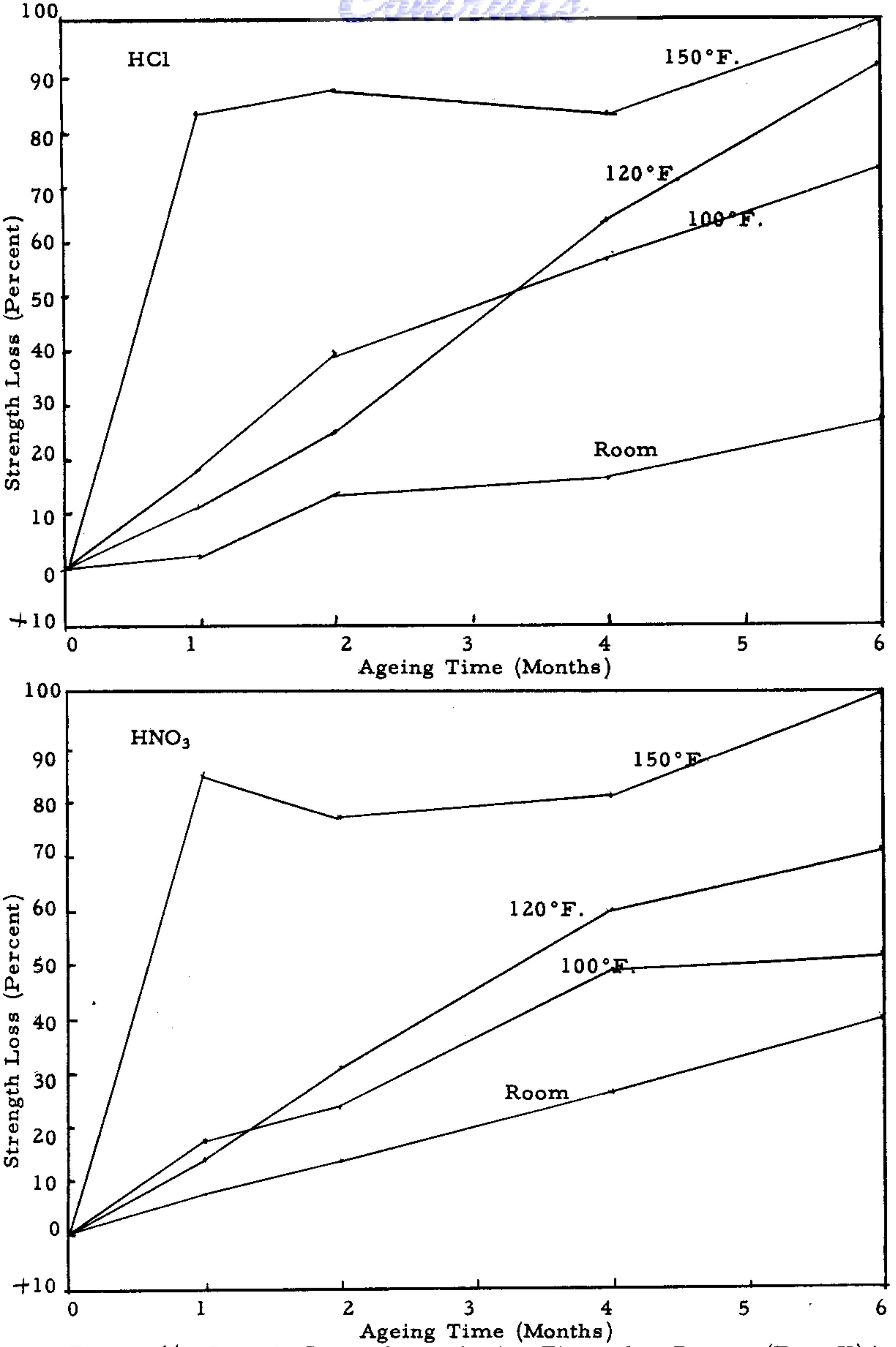


Figure 44. Loss in Strength vs. Ageing Time when Dacron (Type II) is treated in HCl and HNO$_3$ and aged at high relative humidity at different temperatures.

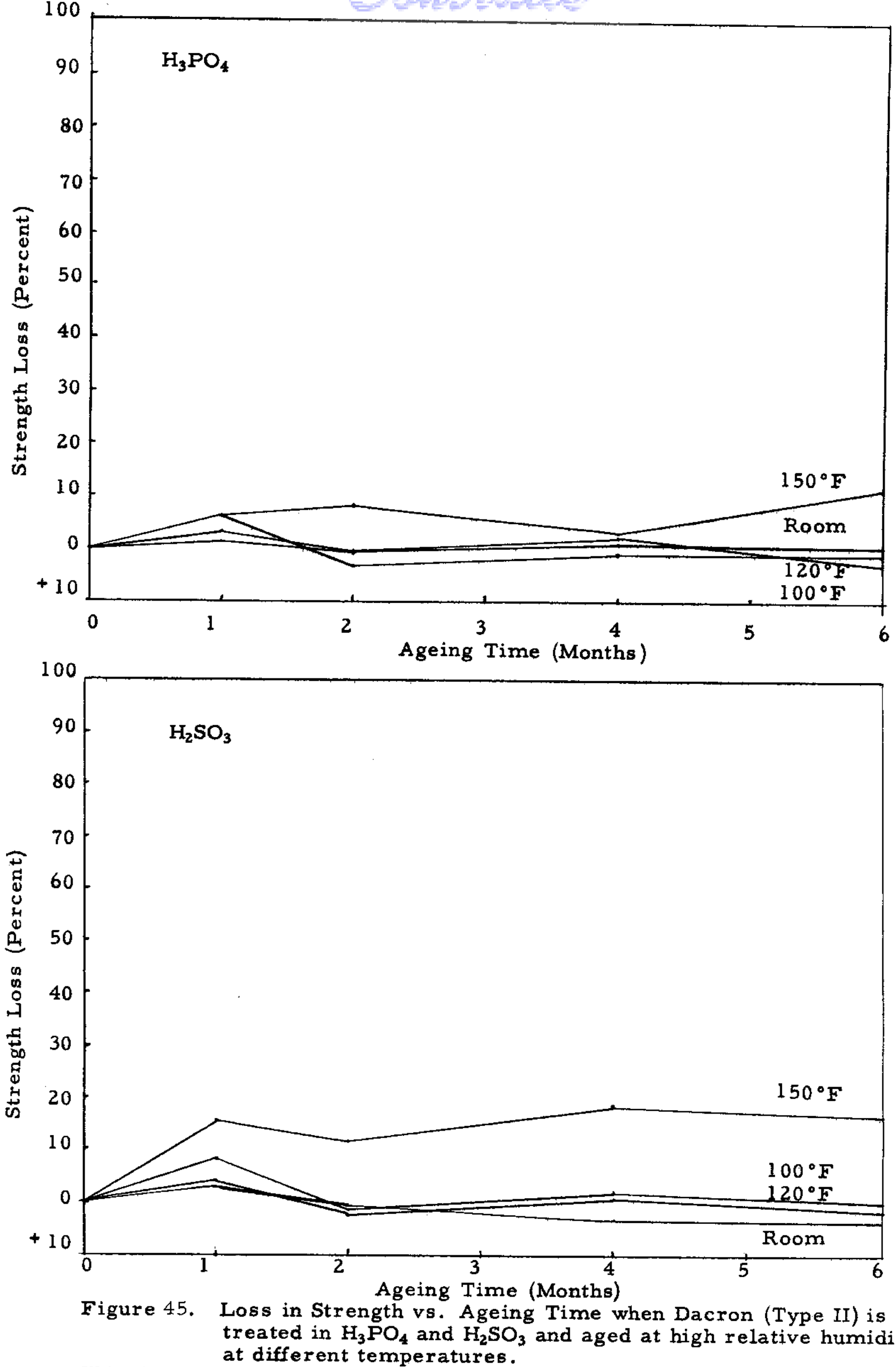


Figure 45. Loss in Strength vs. Ageing Time when Dacron (Type II) is treated in H_3PO_4 and H_2SO_3 and aged at high relative humidity at different temperatures.

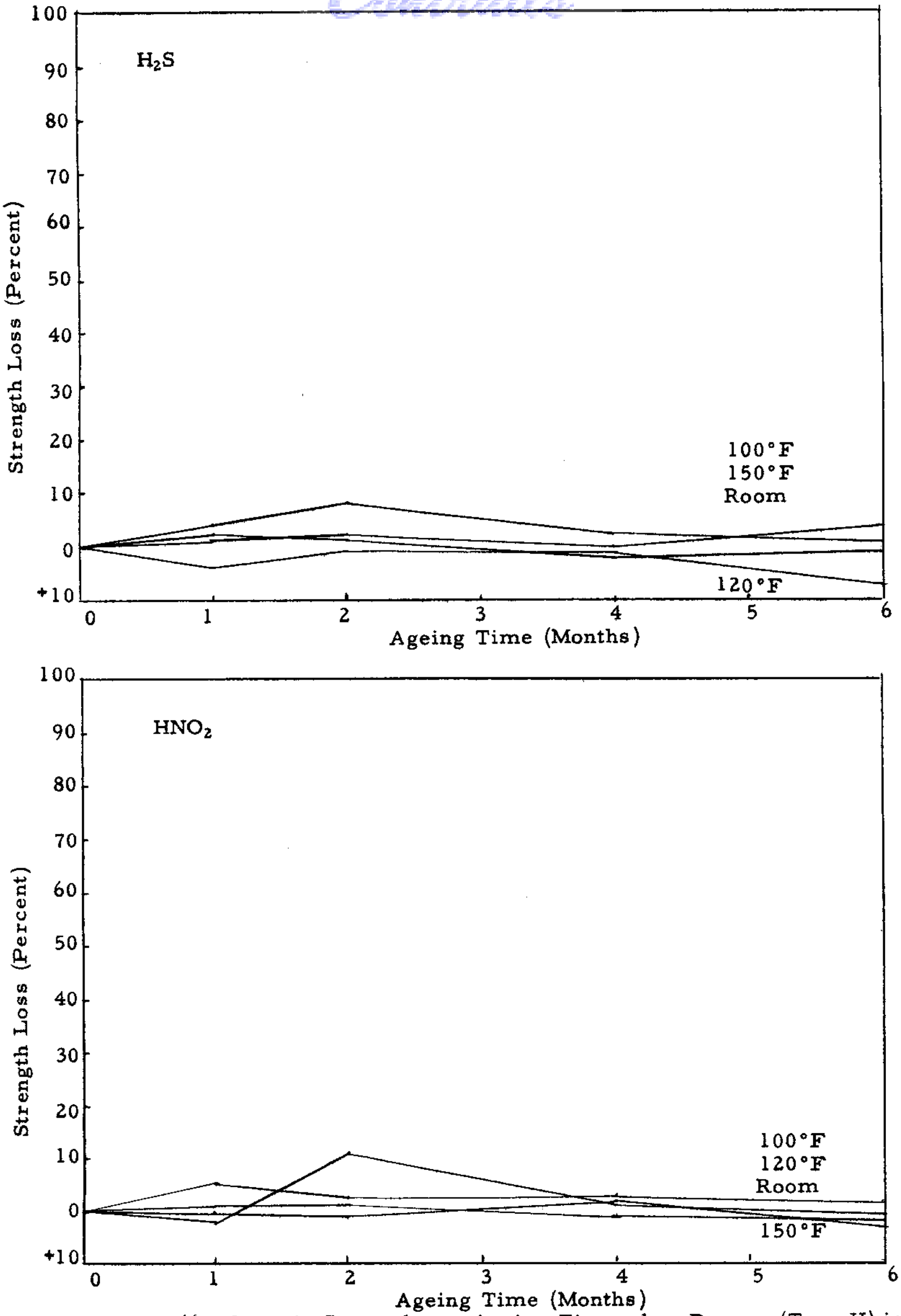


Figure 46. Loss in Strength vs. Ageing Time when Dacron (Type II) is treated in H_2S and HNO_2 and aged at high relative humidity at different temperatures.

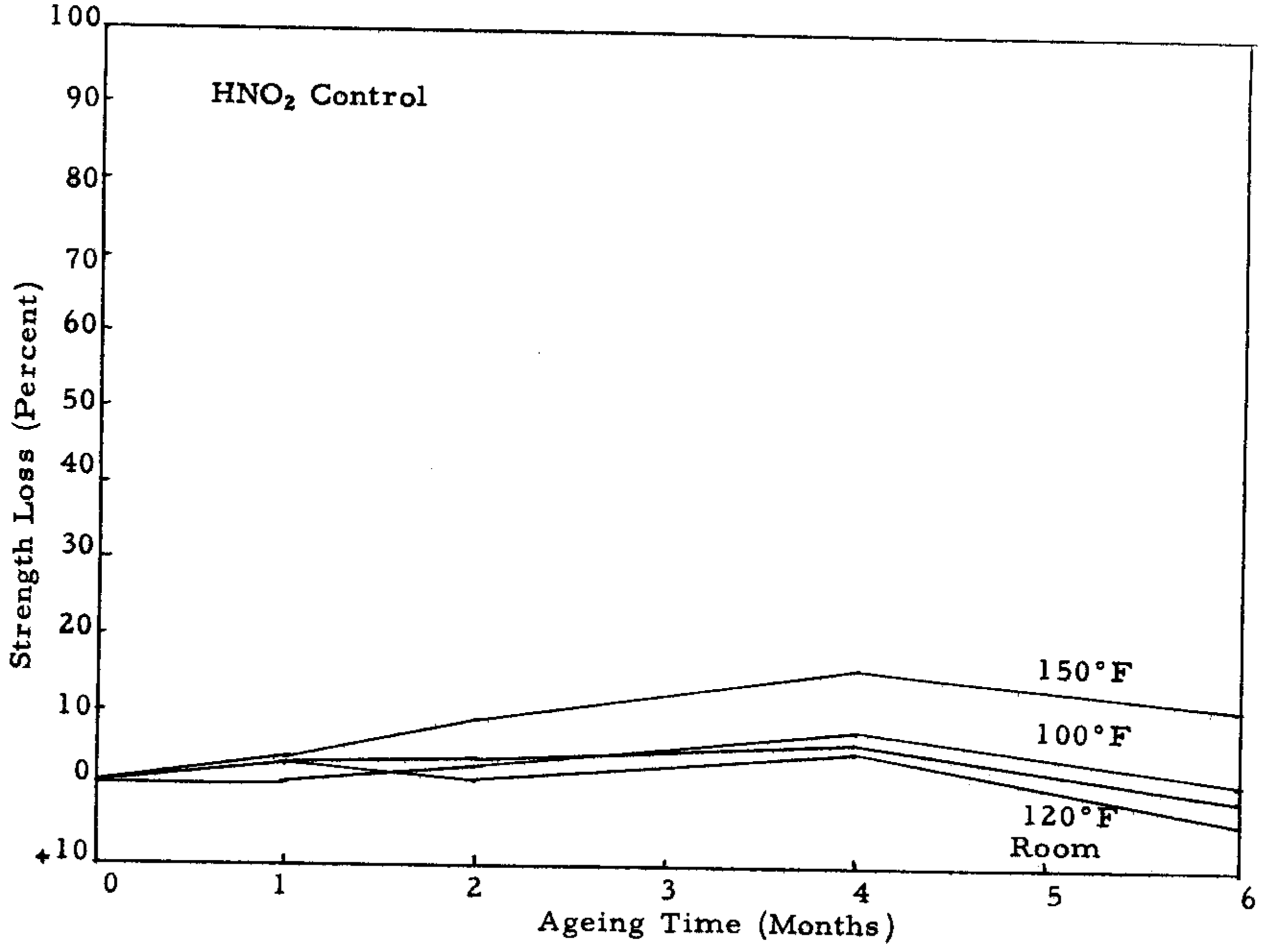


Figure 47. Loss in Strength vs. Ageing Time when Dacron (Type II) is treated in HNO_2 Control and aged at high relative humidity at different temperatures.

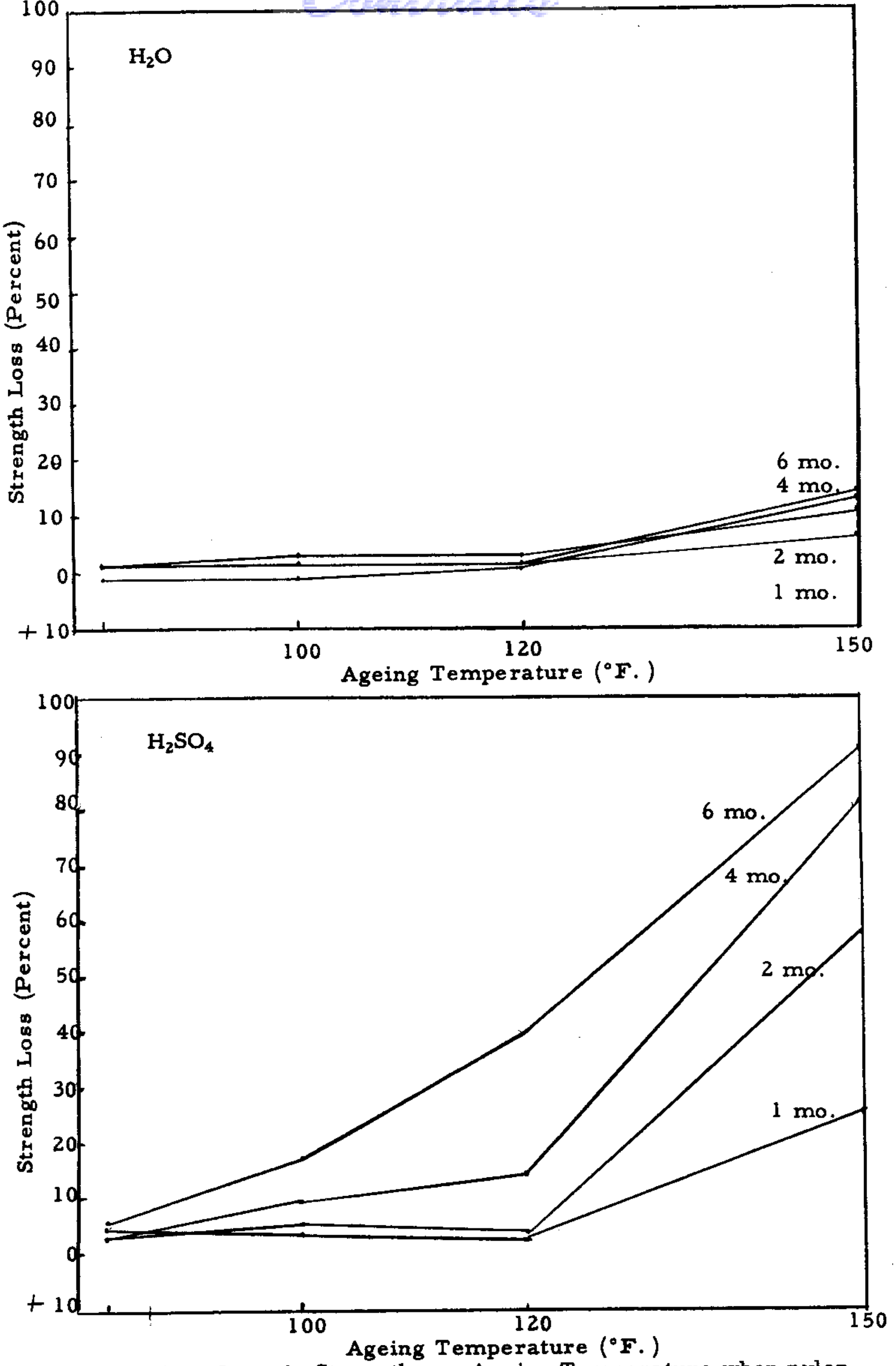


Figure 48. Loss in Strength vs. Ageing Temperature when nylon is treated in H_2O and H_2SO_4 and aged in solution for different periods of time.

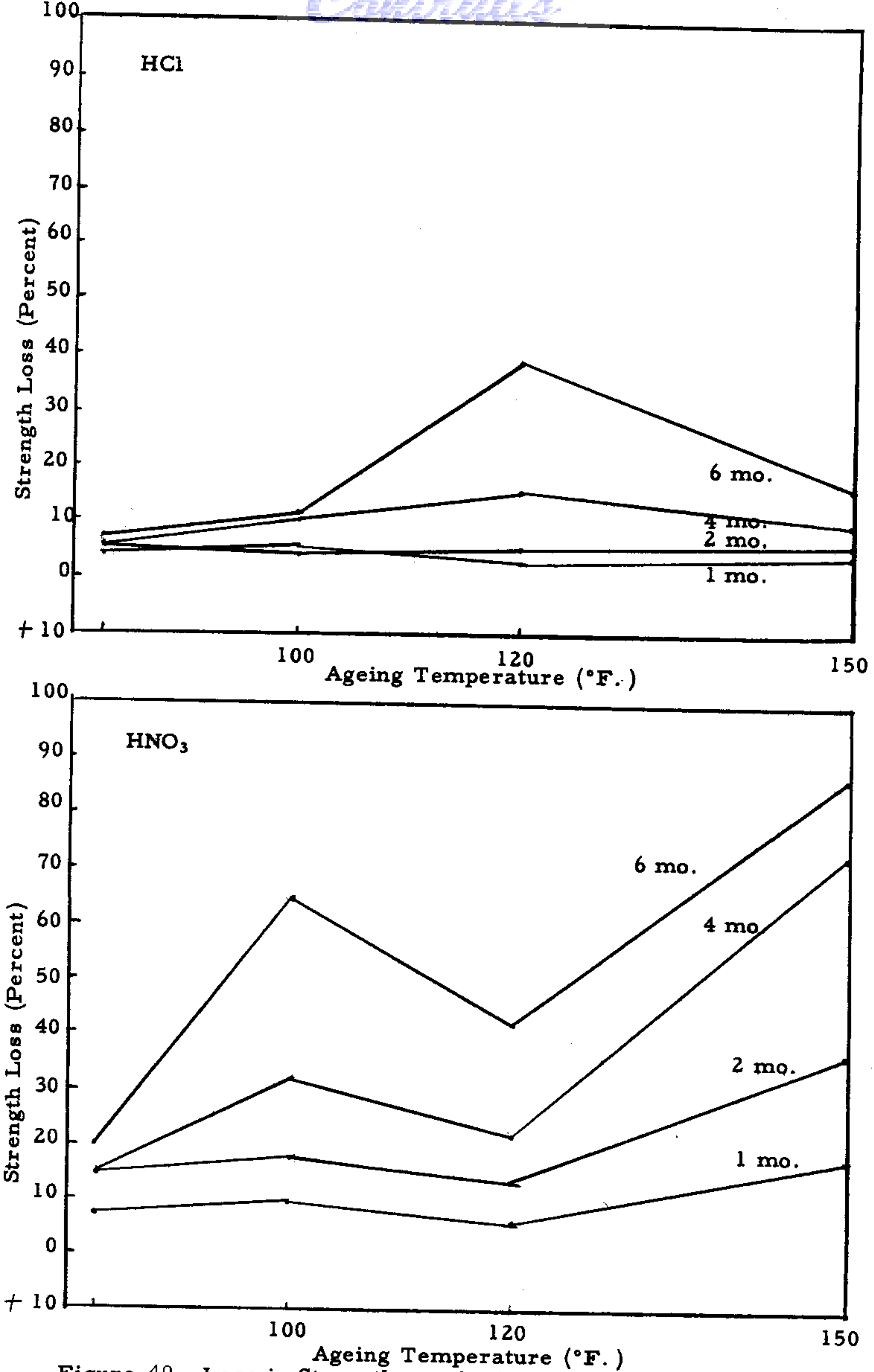
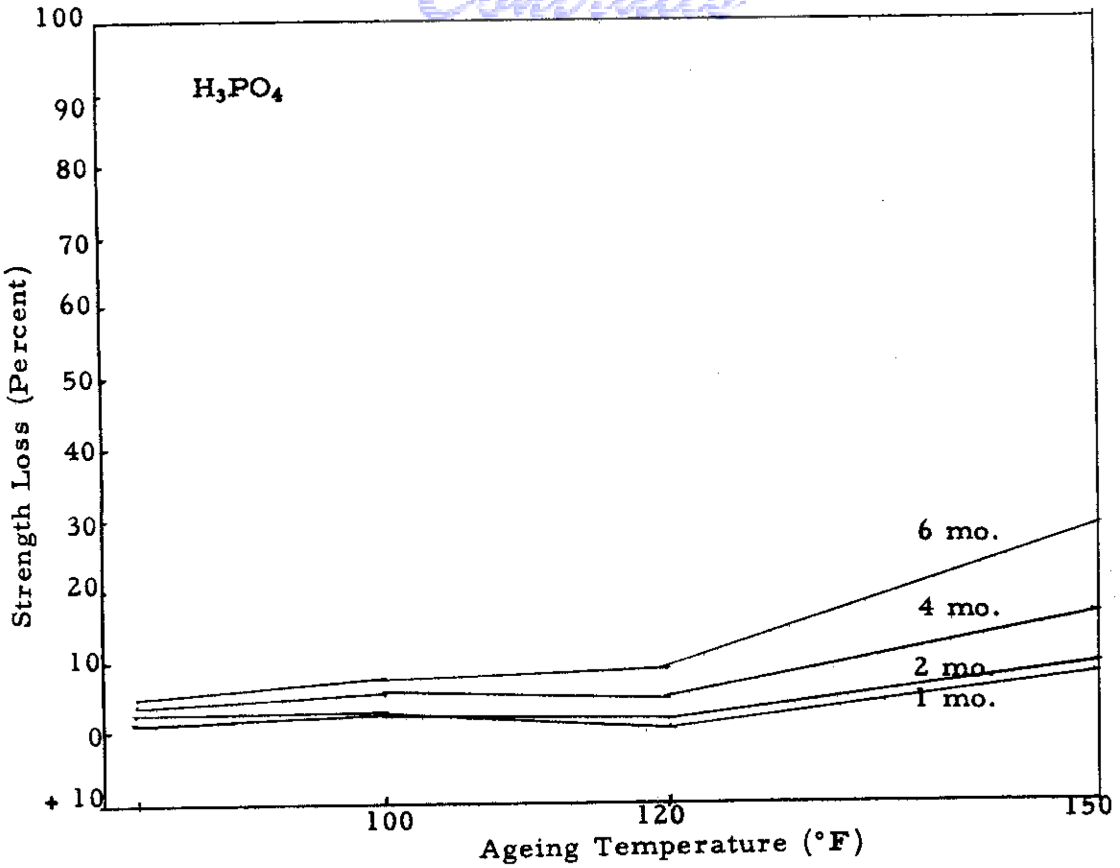


Figure 49. Loss in Strength vs. Ageing Temperature when nylon is treated in HCl and HNO_3 and aged in solution for different periods of time.



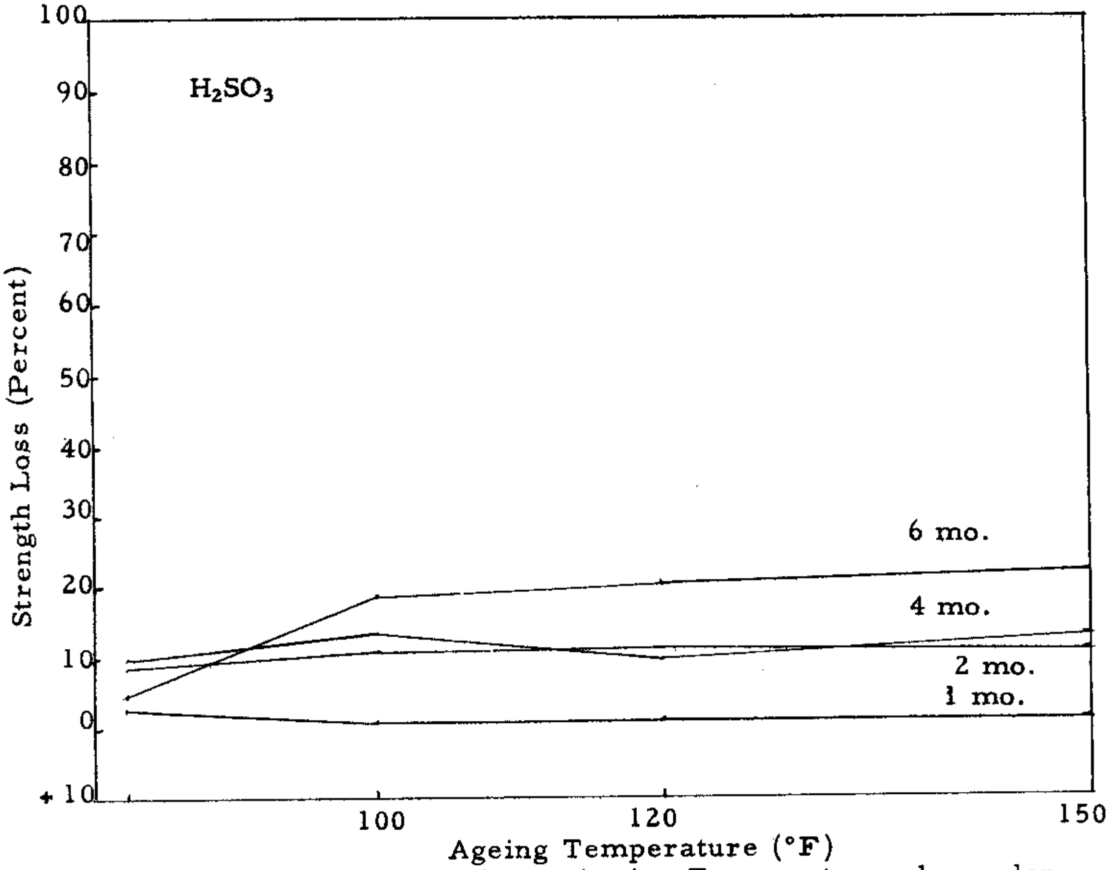
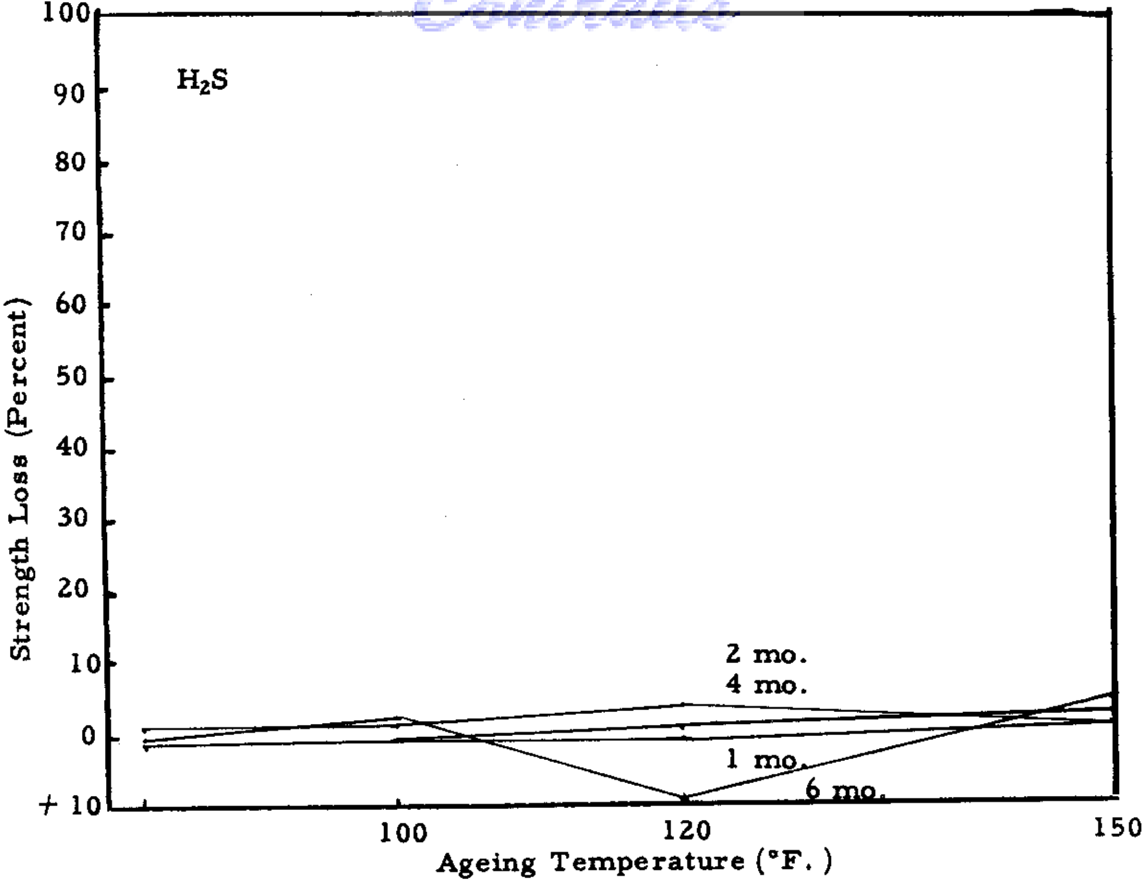


Figure 50. Loss in Strength vs. Ageing Temperature when nylon is treated in H_3PO_4 and H_2SO_3 and aged in solution for different periods of time.



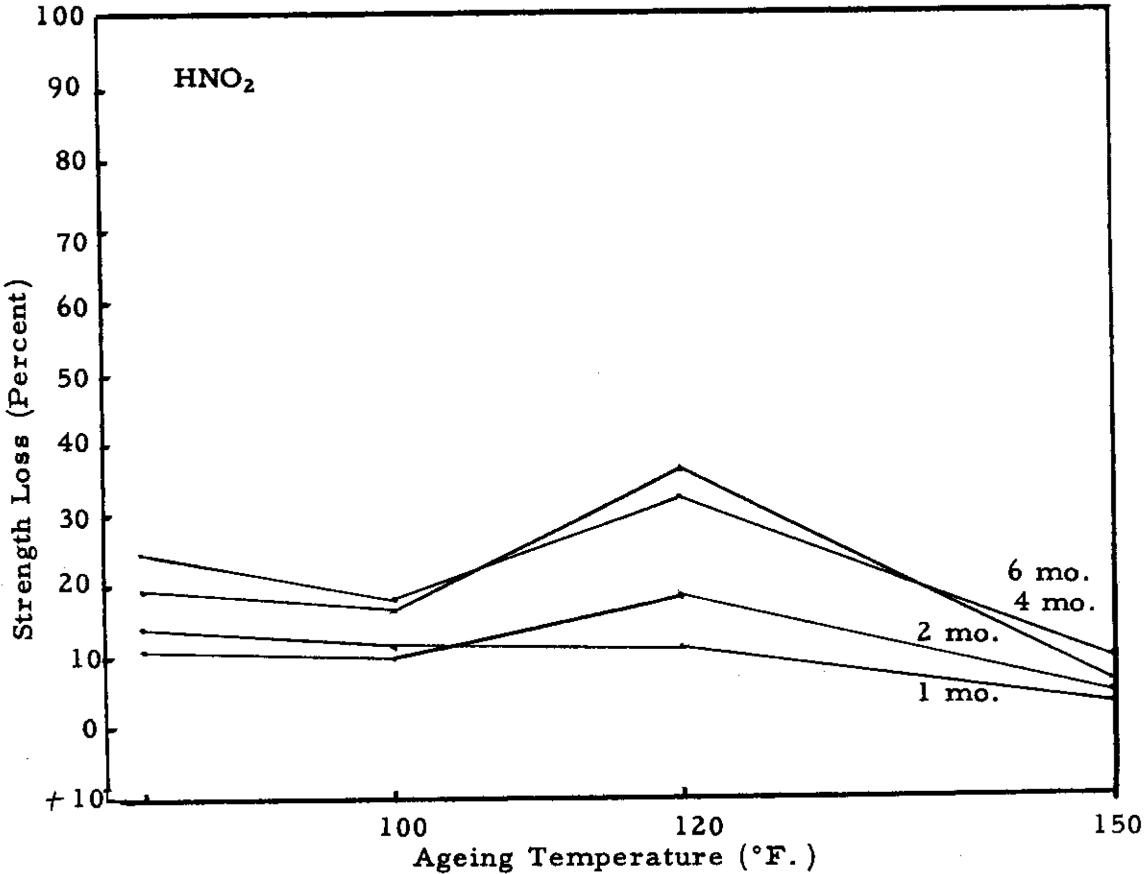


Figure 51. Loss in Strength vs. Ageing Temperature when nylon is treated in H_2S and HNO_2 and aged in solution for different periods of time.

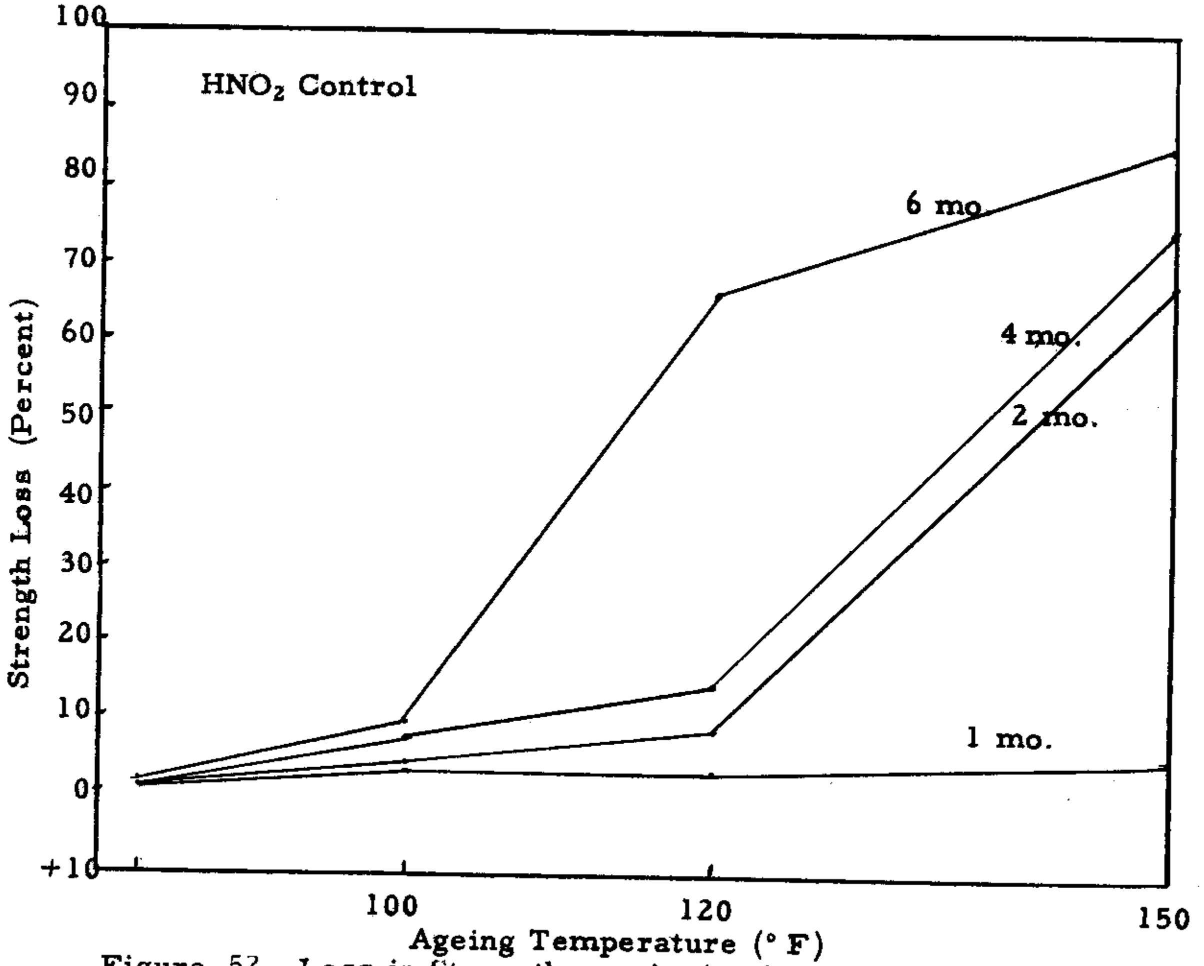
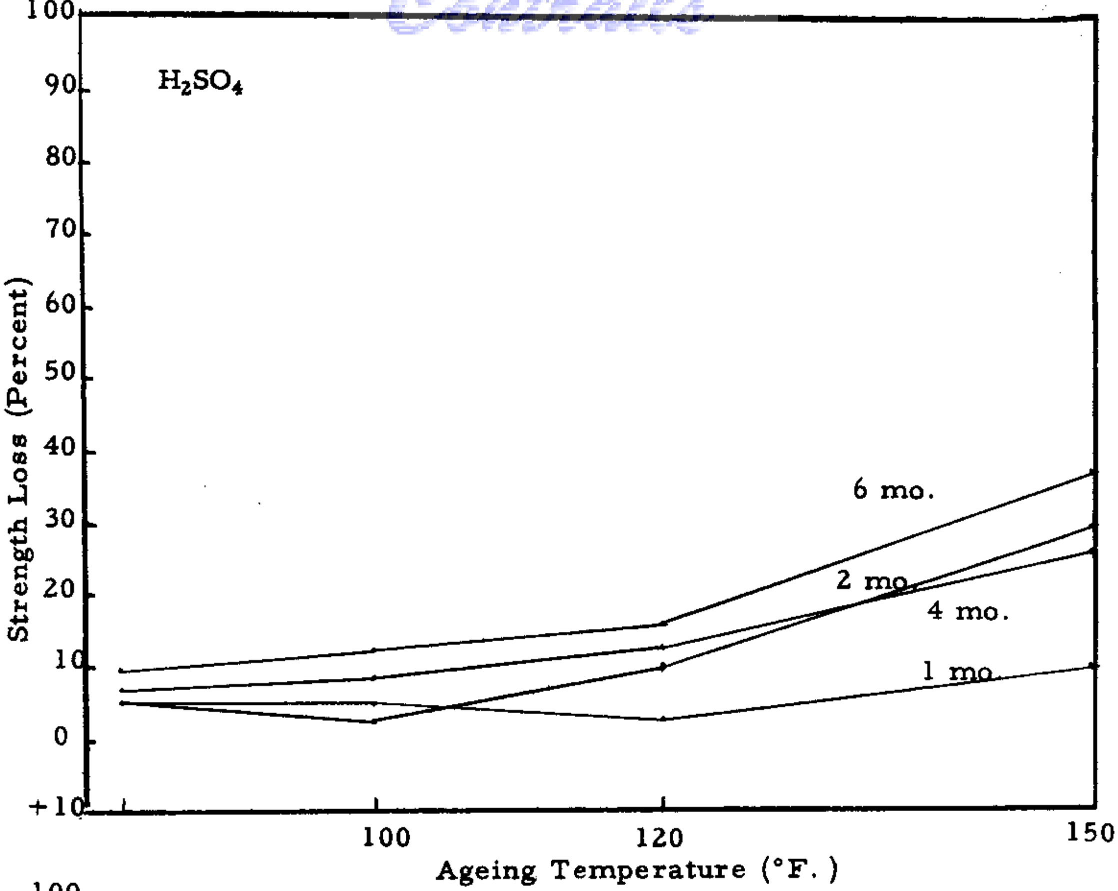


Figure 52. Loss in Strength vs. Ageing Temperature when nylon is treated in HNO_2 Control and aged in solution for different periods of time



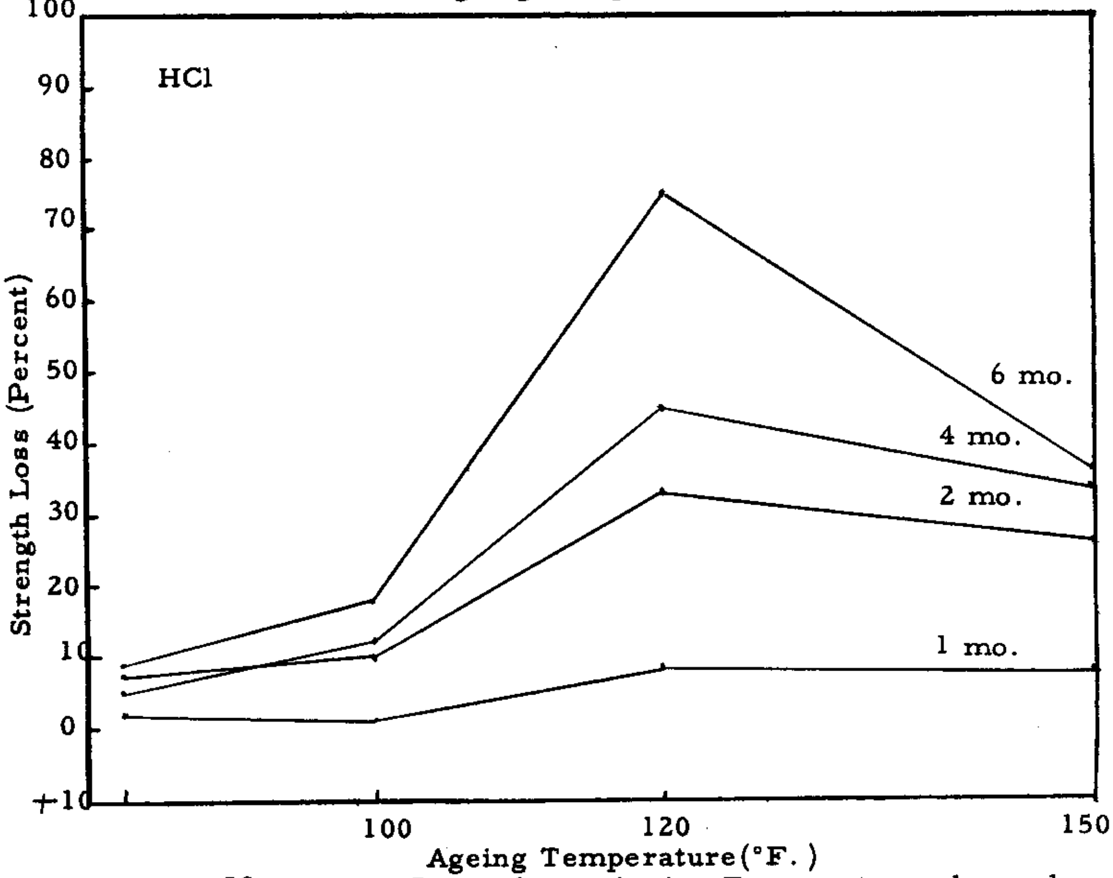


Figure 53. Loss in Strength vs. Ageing Temperature when nylon is treated in H$_2$SO$_4$ and HCl and aged at low relative humidity for different periods of time.

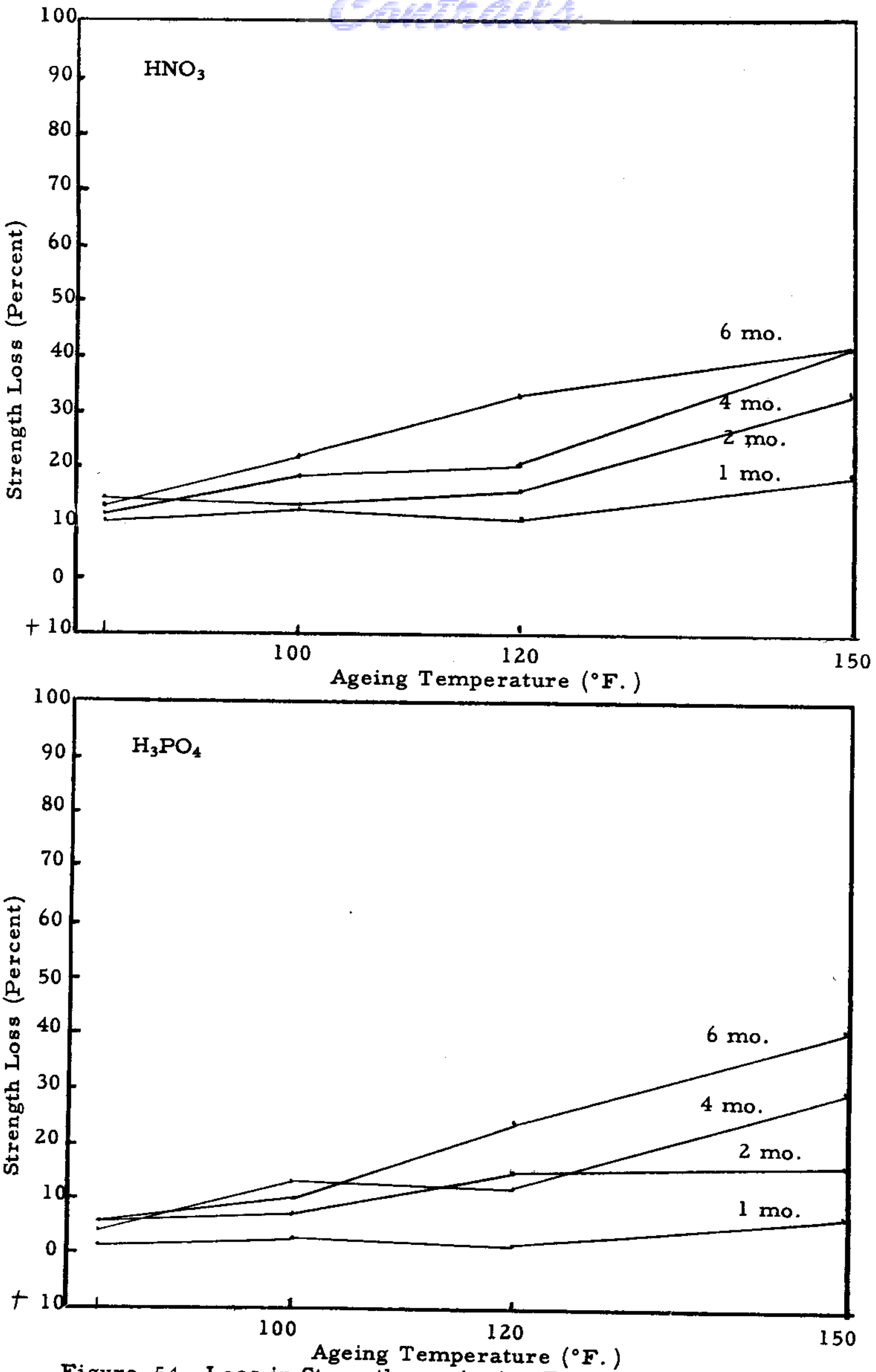


Figure 54. Loss in Strength vs. Ageing Temperature when nylon is treated in HNO_3 and H_3PO_4 and aged at low relative humidity for different periods of time.

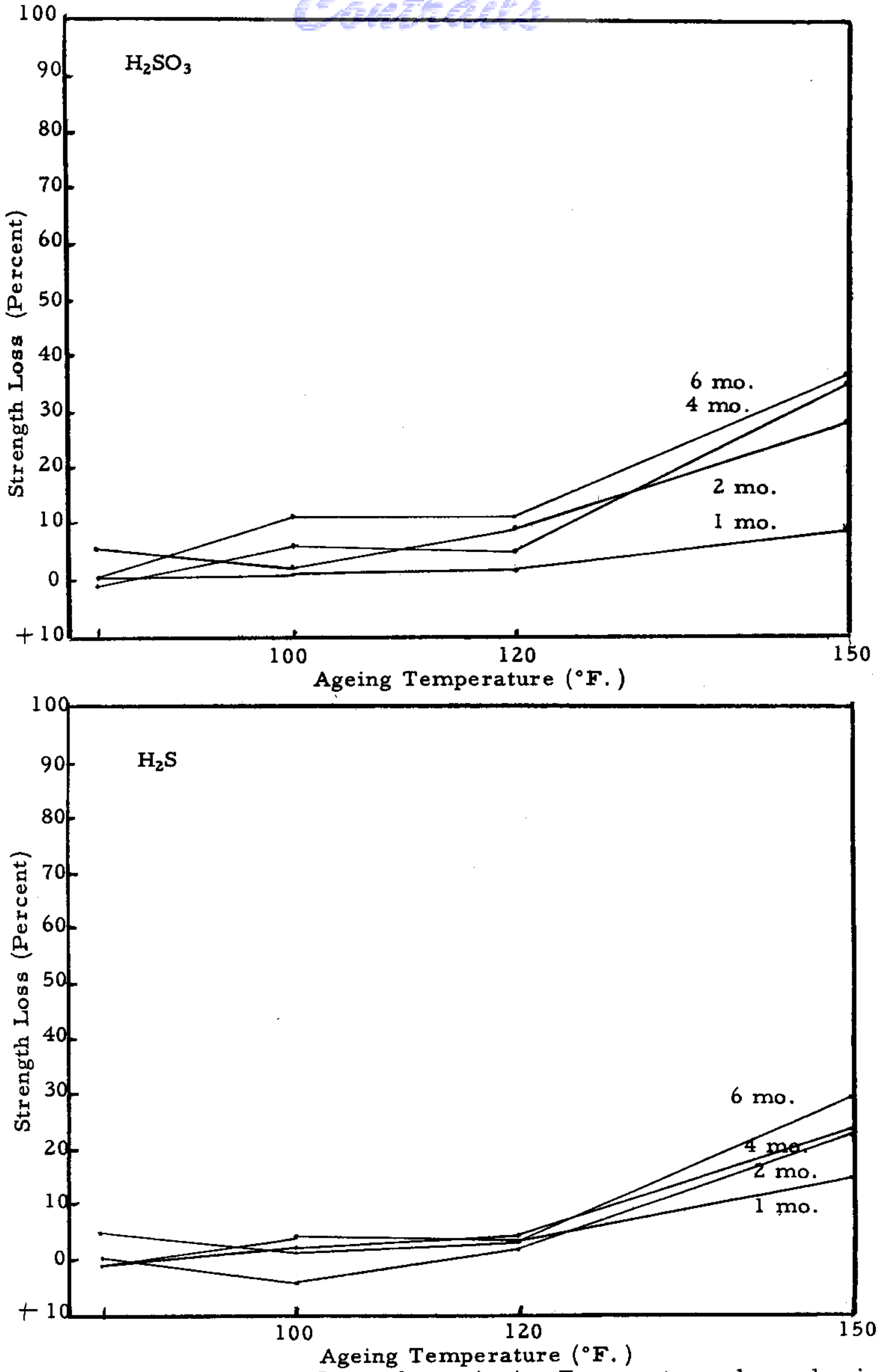


Figure 55. Loss in Strength vs. Ageing Temperature when nylon is treated in H_2SO_3 and H_2S and aged at low relative humidity for different periods of time.

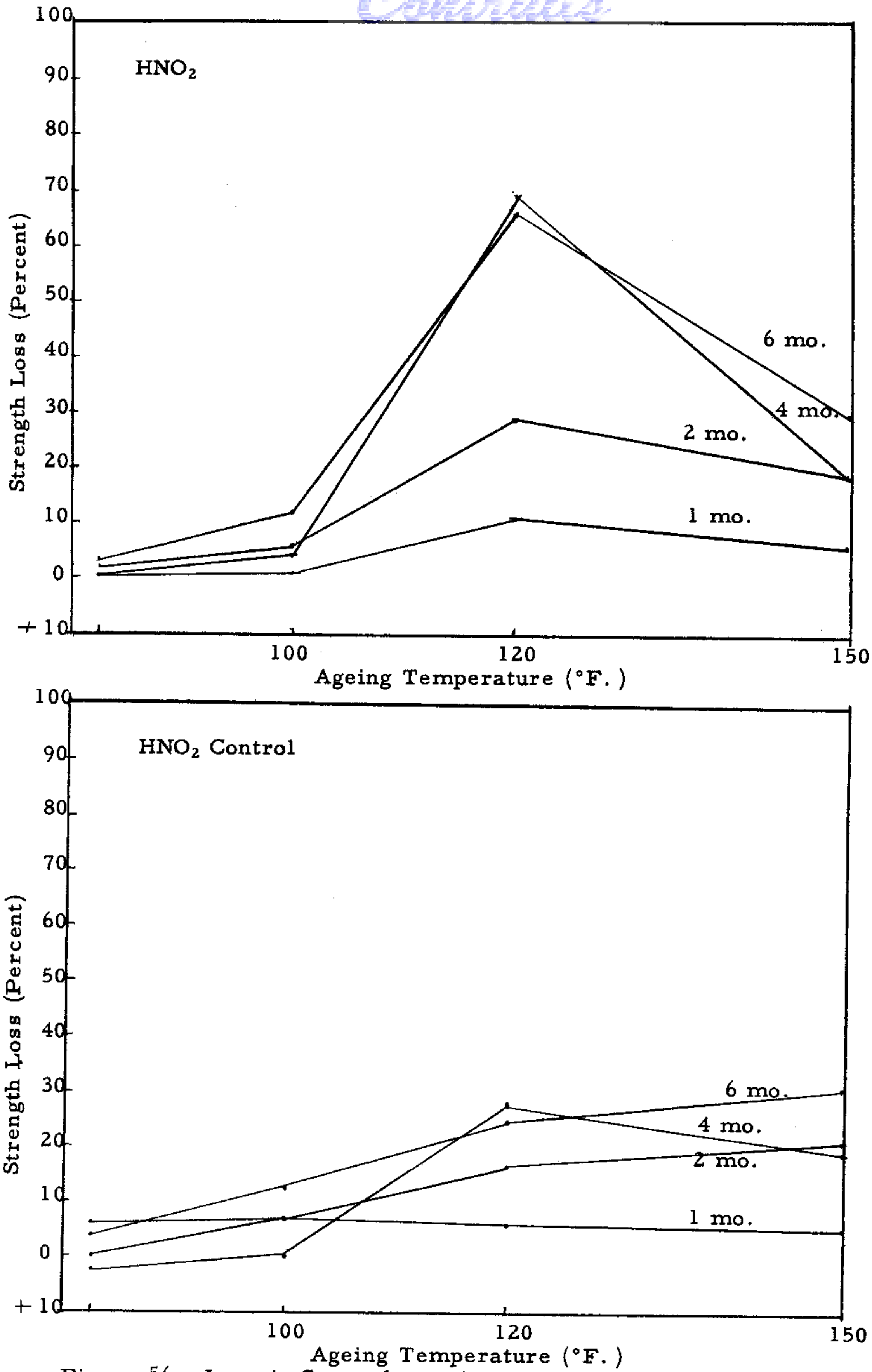


Figure 56. Loss in Strength vs. Ageing Temperature when nylon is treated in HNO_2 and HNO_2 Control and aged at low relative humidity for different periods of time.

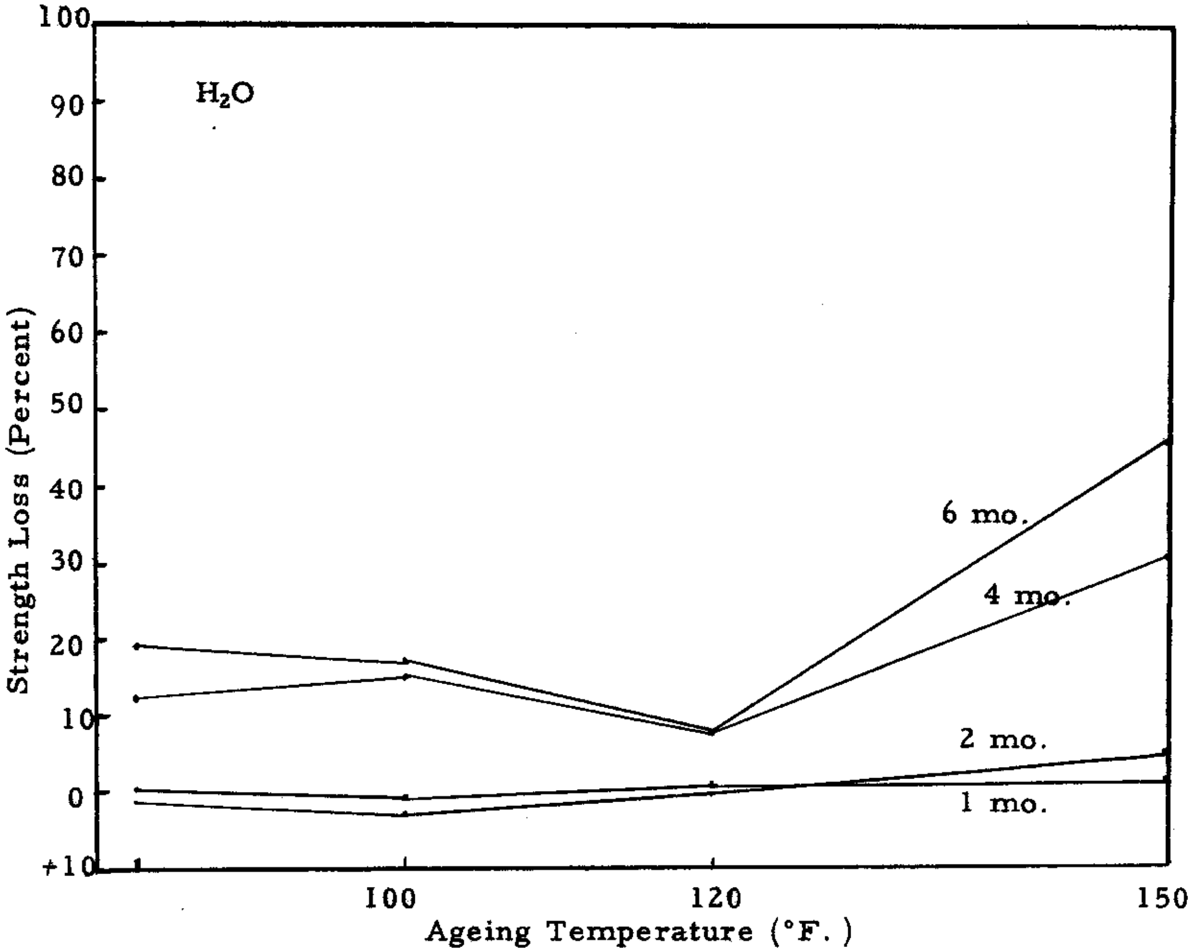


Figure 57. Loss in Strength vs. Ageing Temperature when nylon is treated in H_2O and aged at low relative humidity for different periods of time.

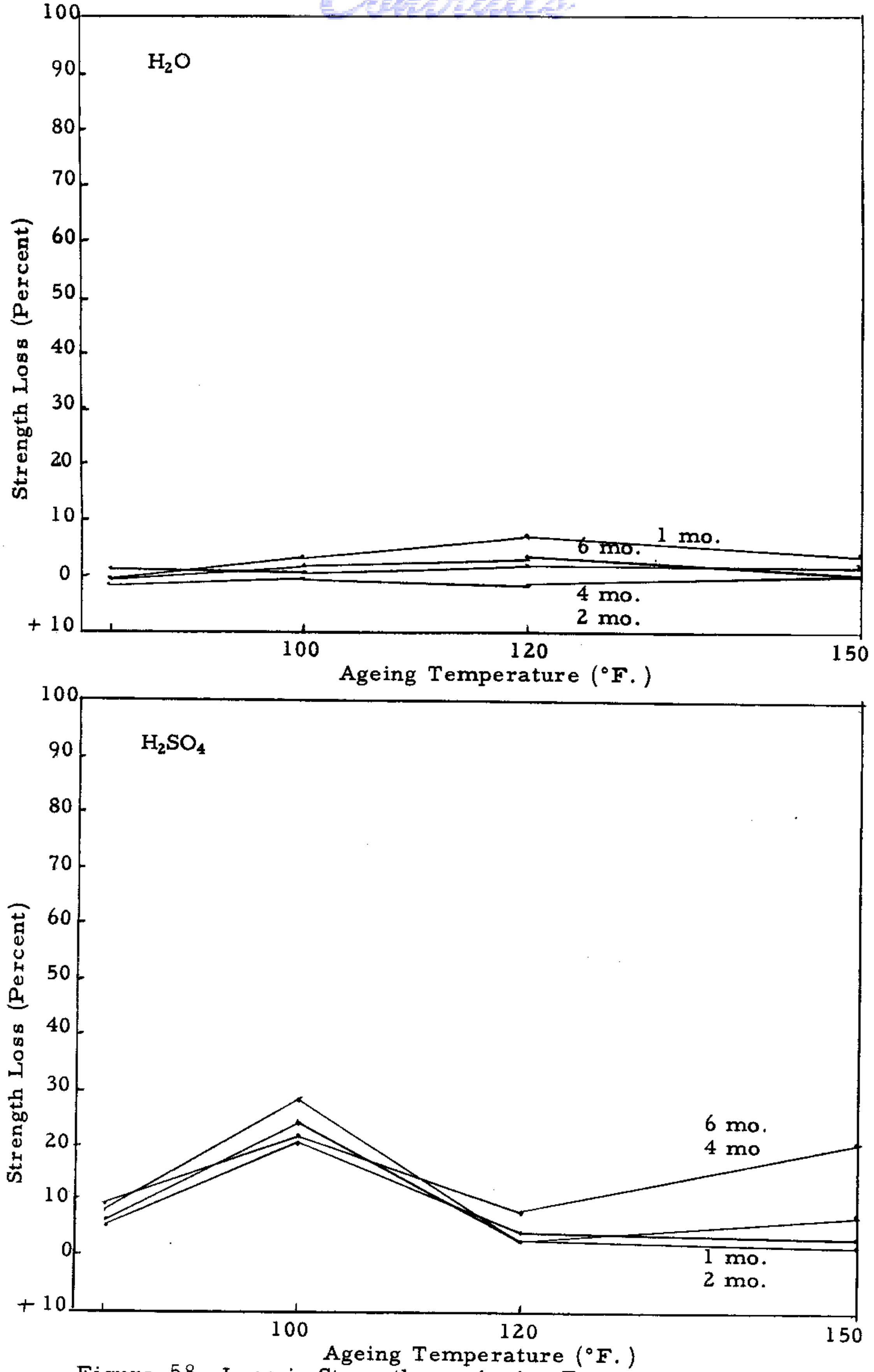


Figure 58. Loss in Strength vs. Ageing Temperature when nylon is treated in H_2O and H_2SO_4 and aged at high relative humidity for different periods of time.

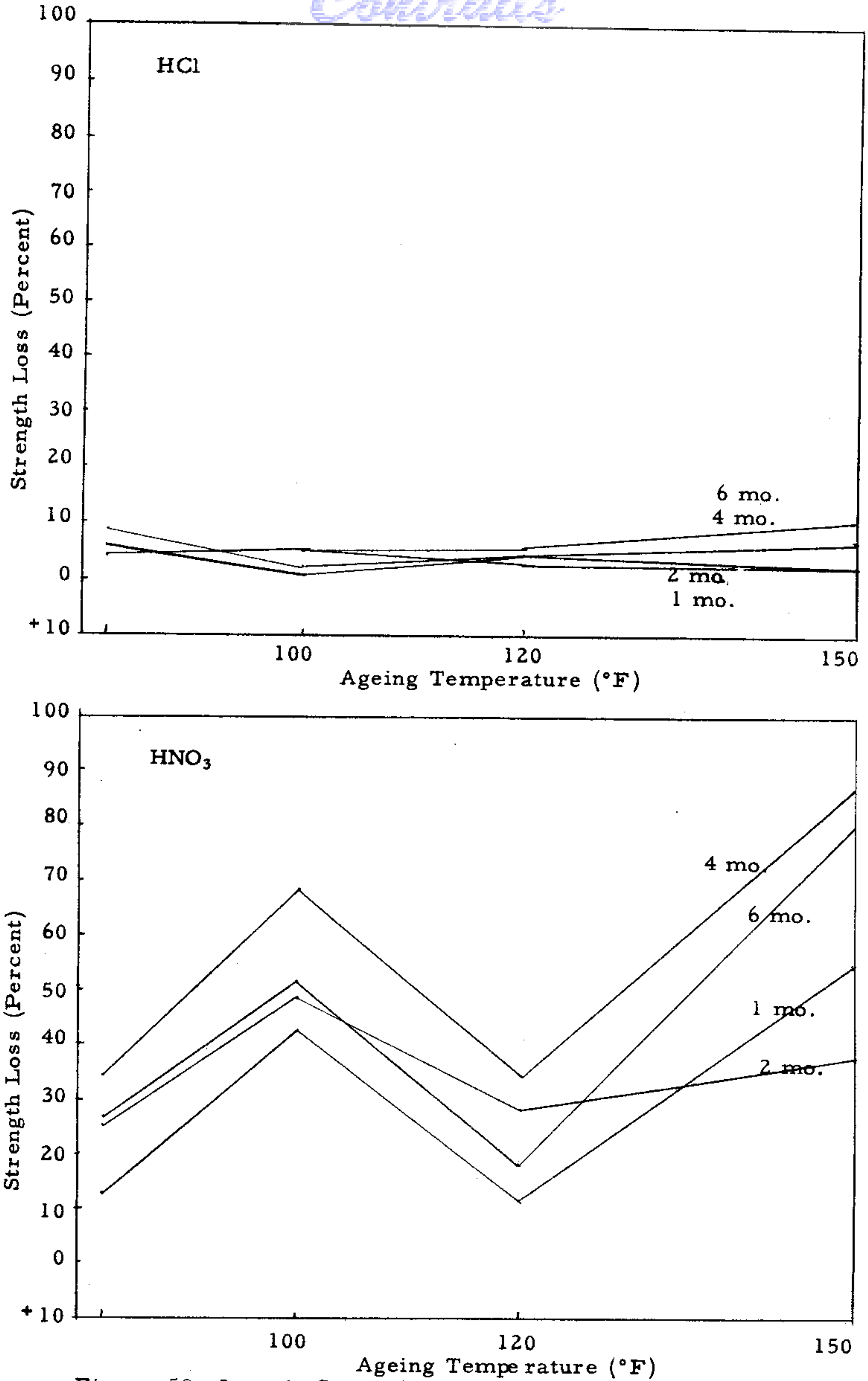
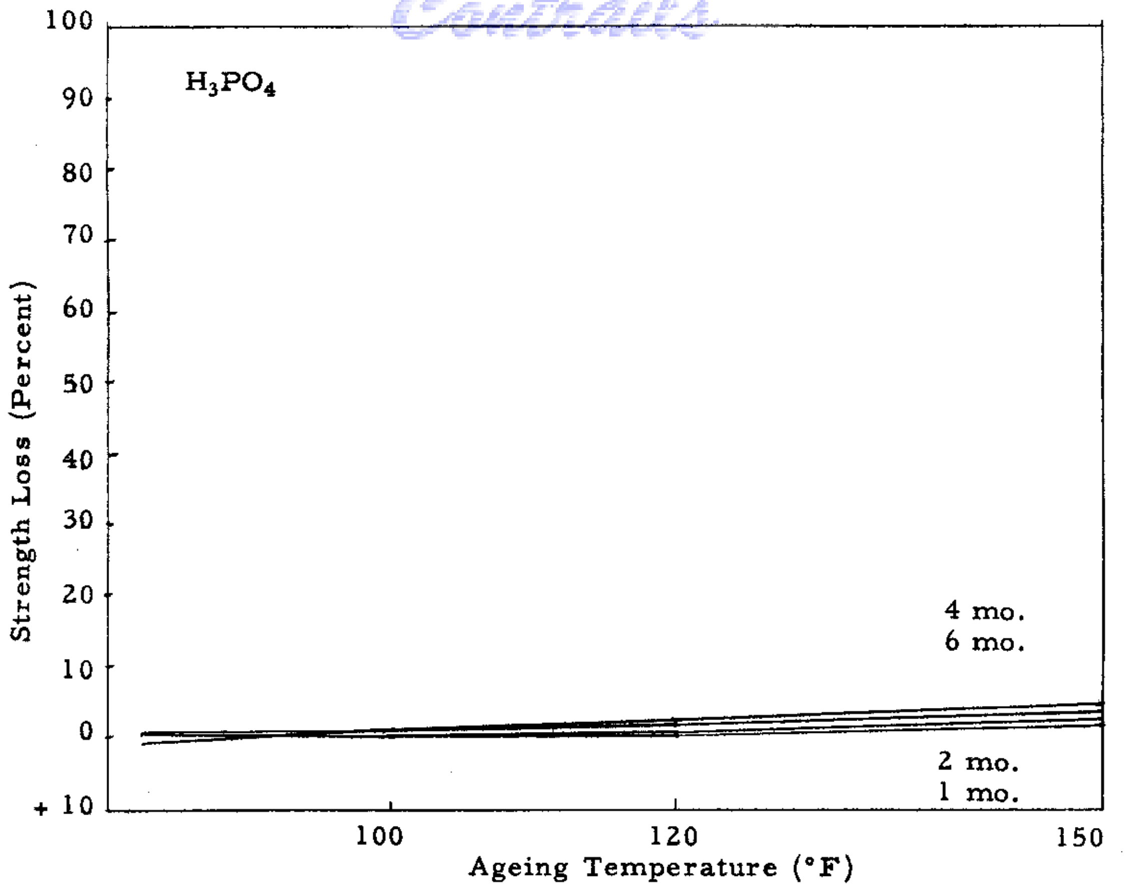


Figure 59. Loss in Strength vs. Ageing Temperature when nylon is treated in HCl and HNO_3 and aged at high relative humidity for different periods of time.



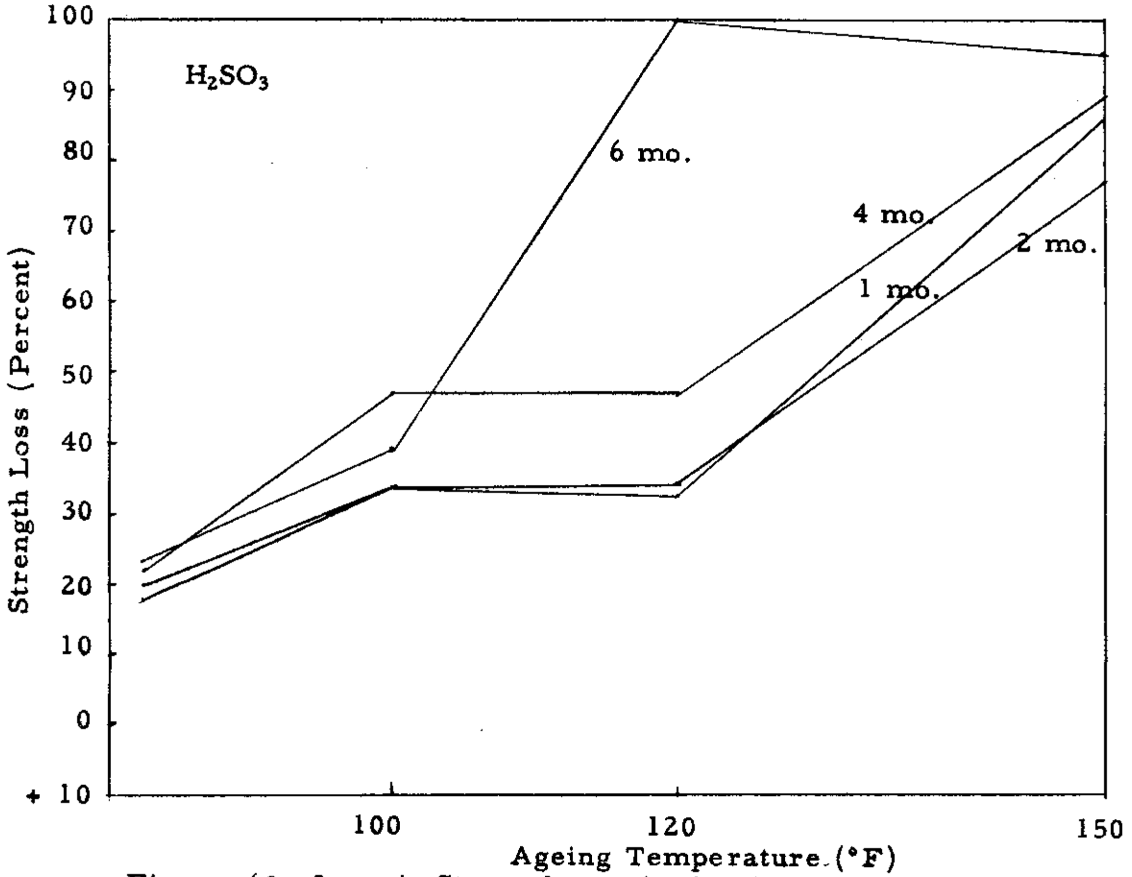


Figure 60. Loss in Strength vs. Ageing Temperature when nylon is treated in H_3PO_4 and H_2SO_3 and aged at high relative humidity for different periods of time.

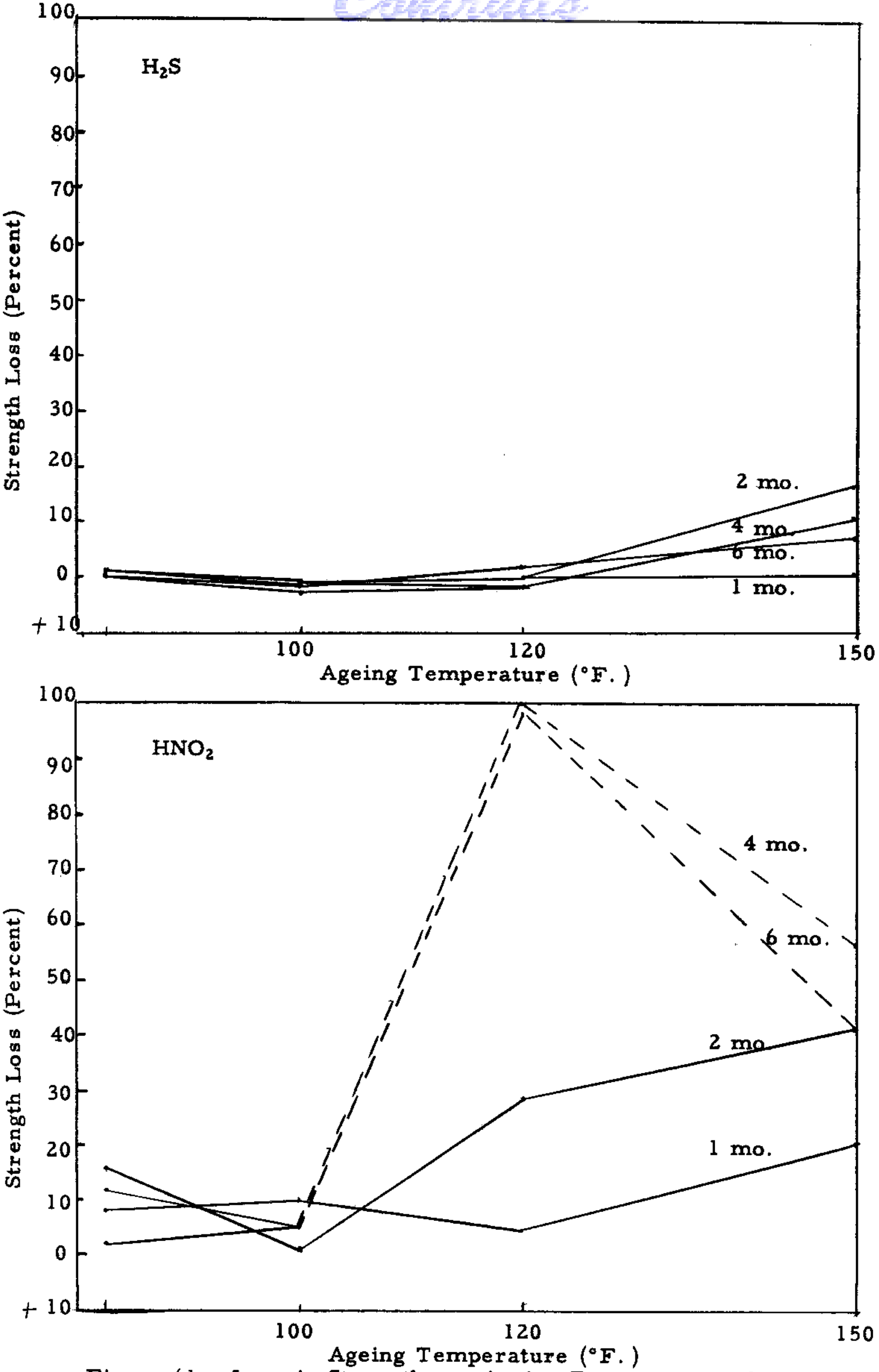


Figure 61. Loss in Strength vs. Ageing Temperature when nylon is treated in H_2S and HNO_2 and aged at high relative humidity for different periods of time.

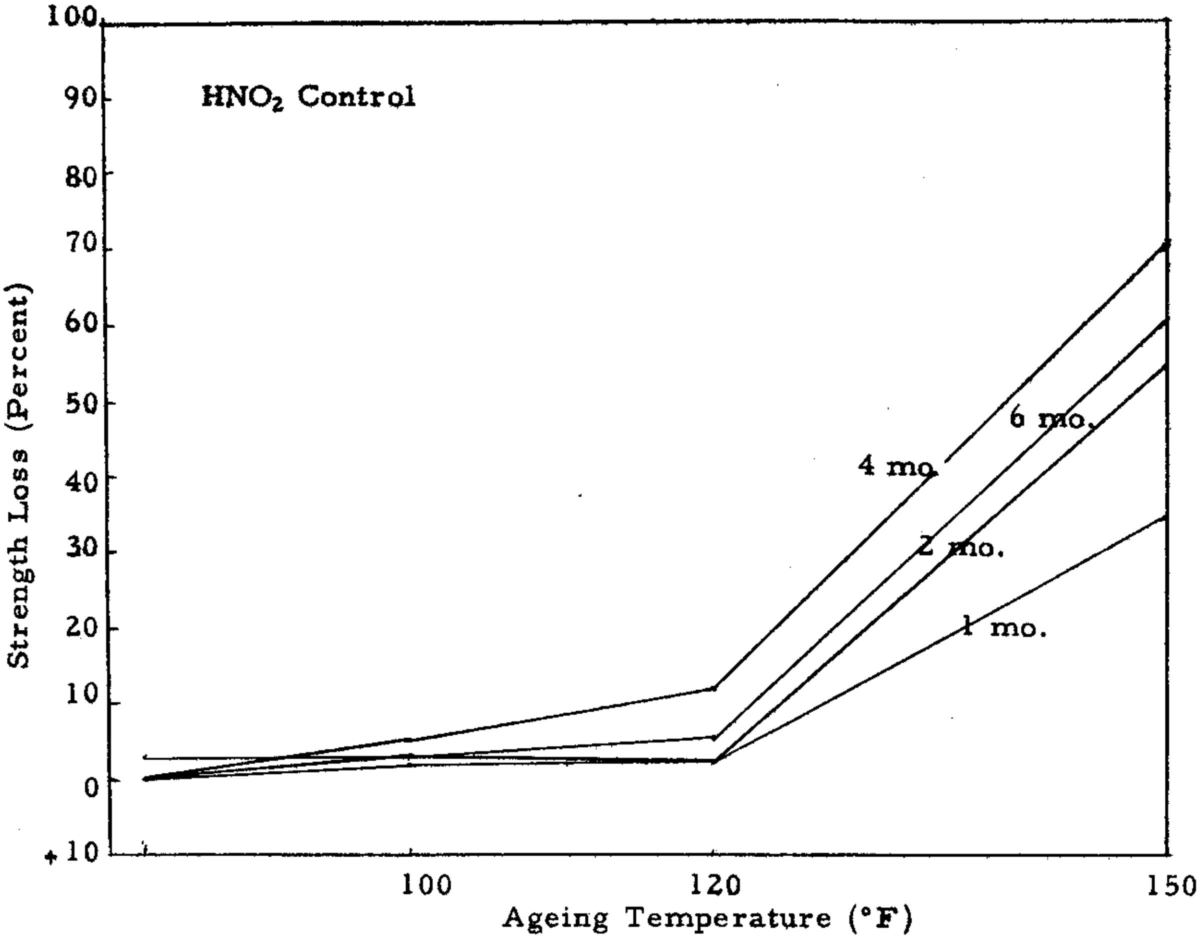


Figure 62. Loss in Strength vs. Ageing Temperature when nylon is treated in HNO_2 Control and aged at high relative humidity for different periods of time.

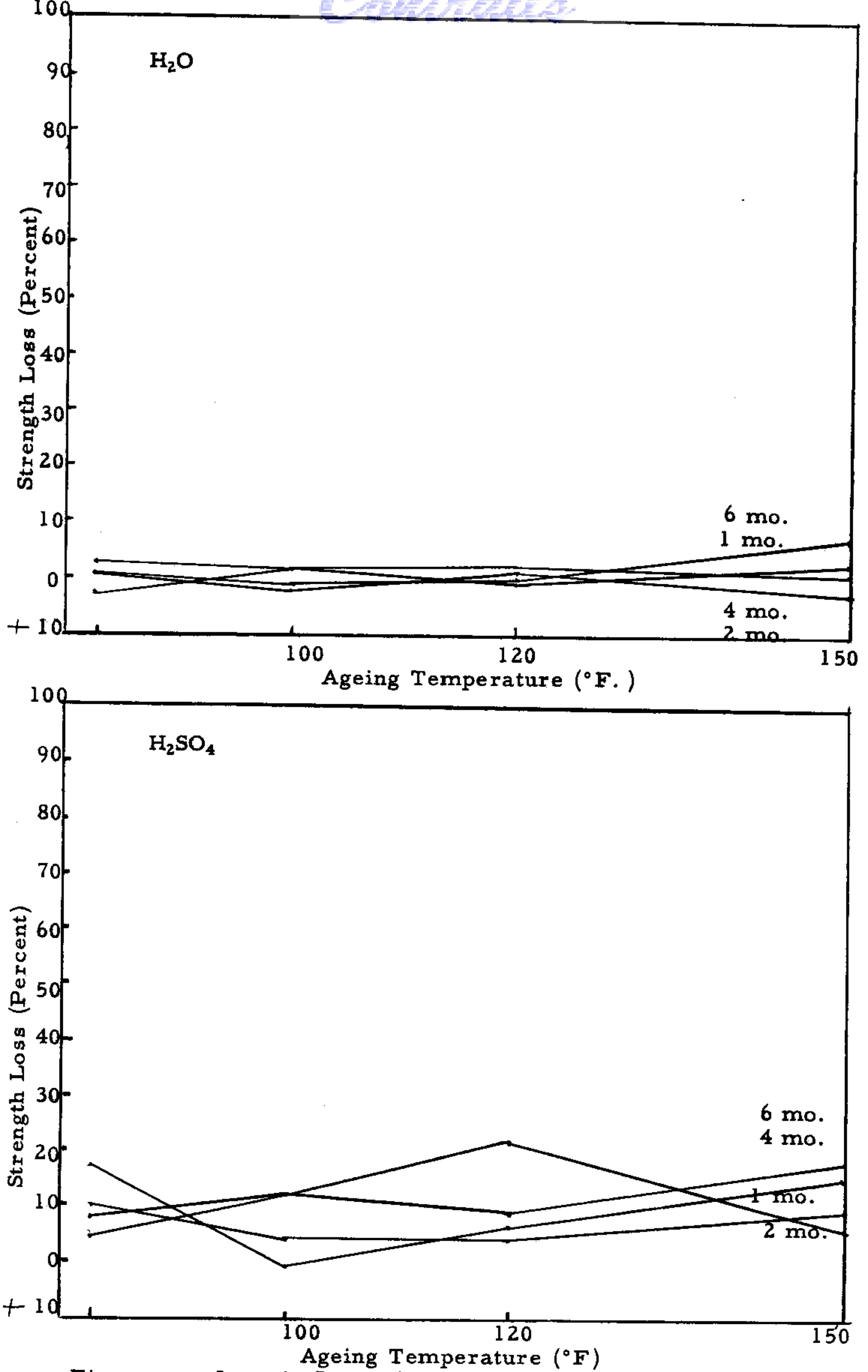


Figure 63. Loss in Strength vs. Ageing Temperature when Dacron (Type I) is treated in H_2O and H_2SO_4 and aged in solution for different periods of time.

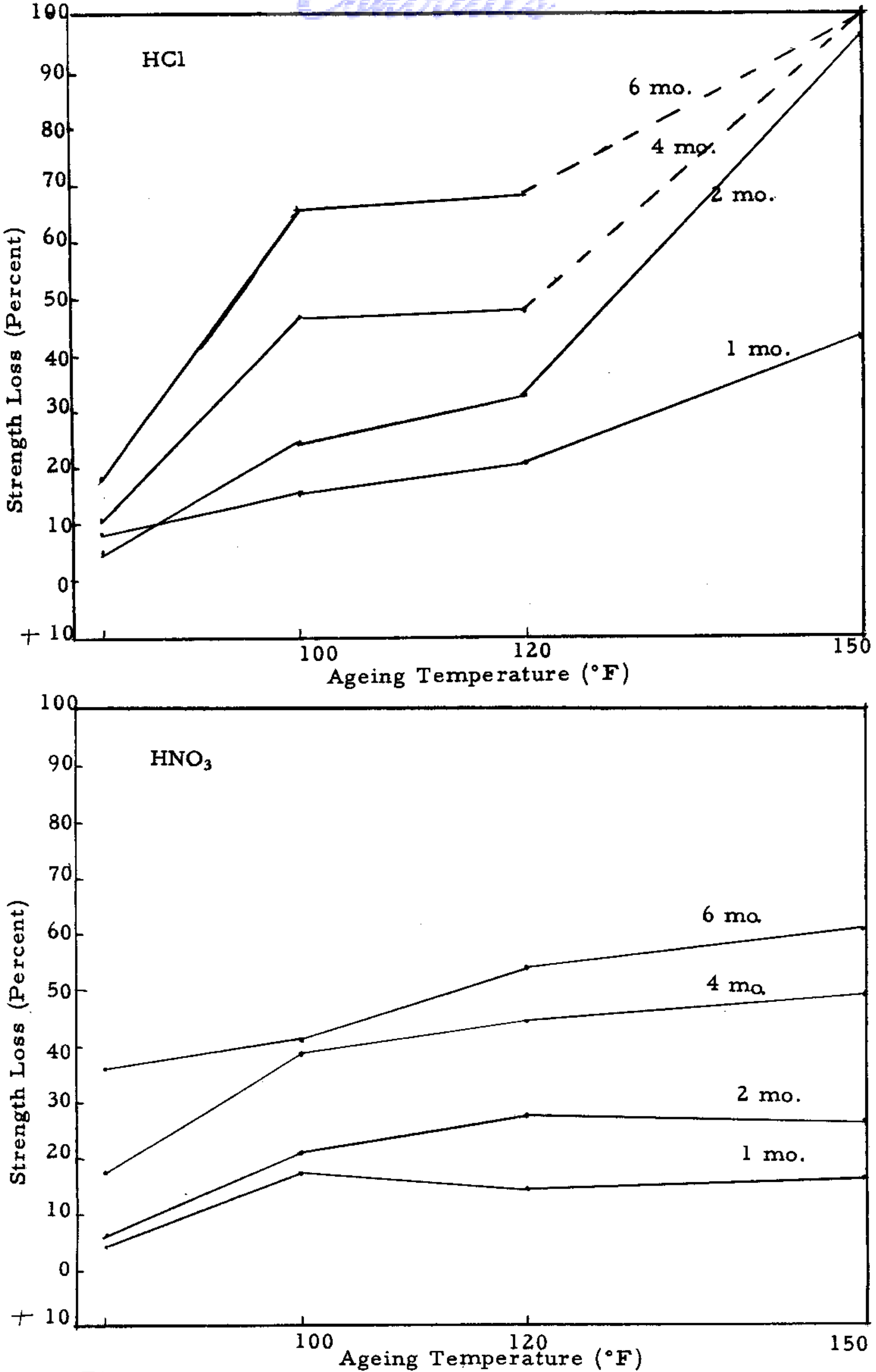


Figure 64. Loss in Strength vs. Ageing Temperature when Dacron (Type I) is treated in HCl and HNO_3 and aged in solution for different periods of time.

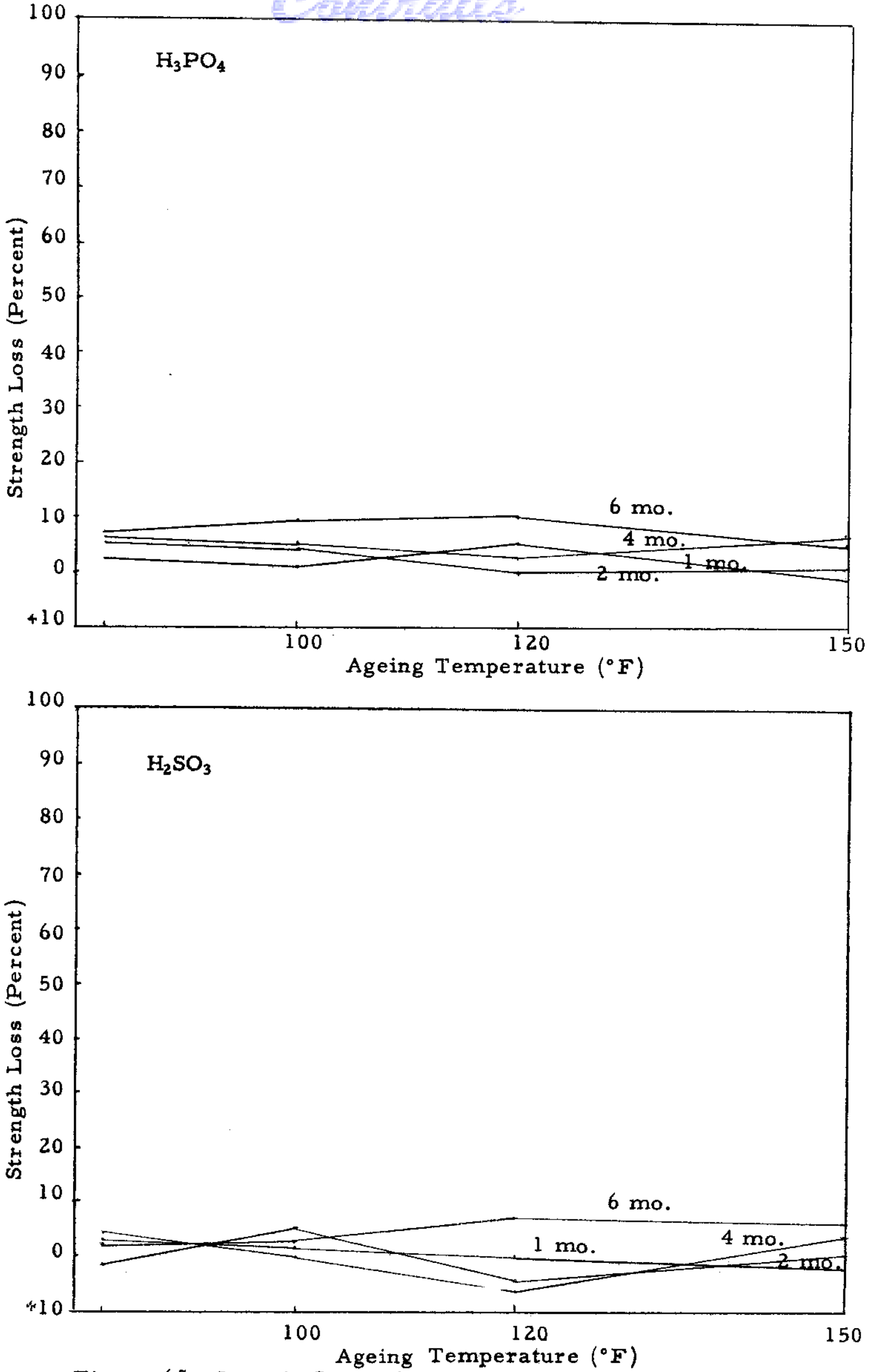
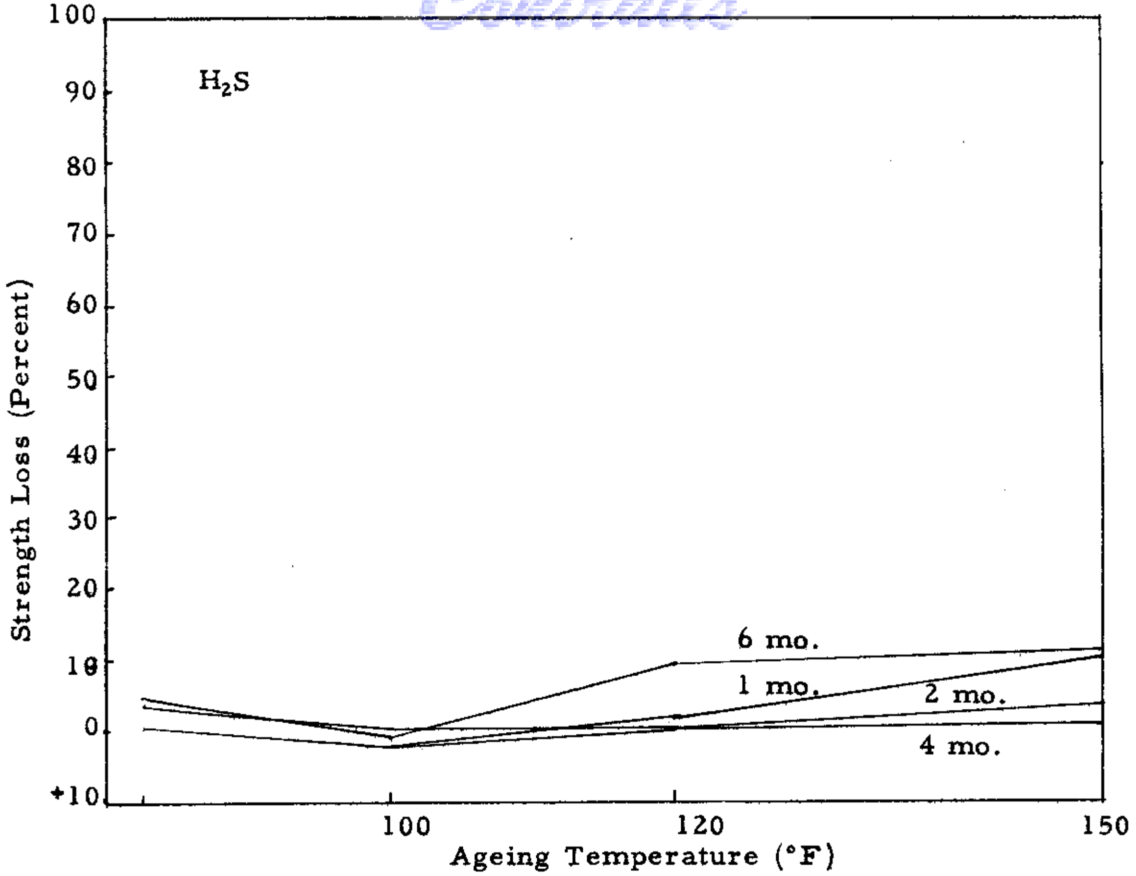


Figure 65. Loss in Strength vs. Ageing Temperature when Dacron (Type I) is treated in H_3PO_4 and H_2SO_3 and aged in solution for different periods of time.



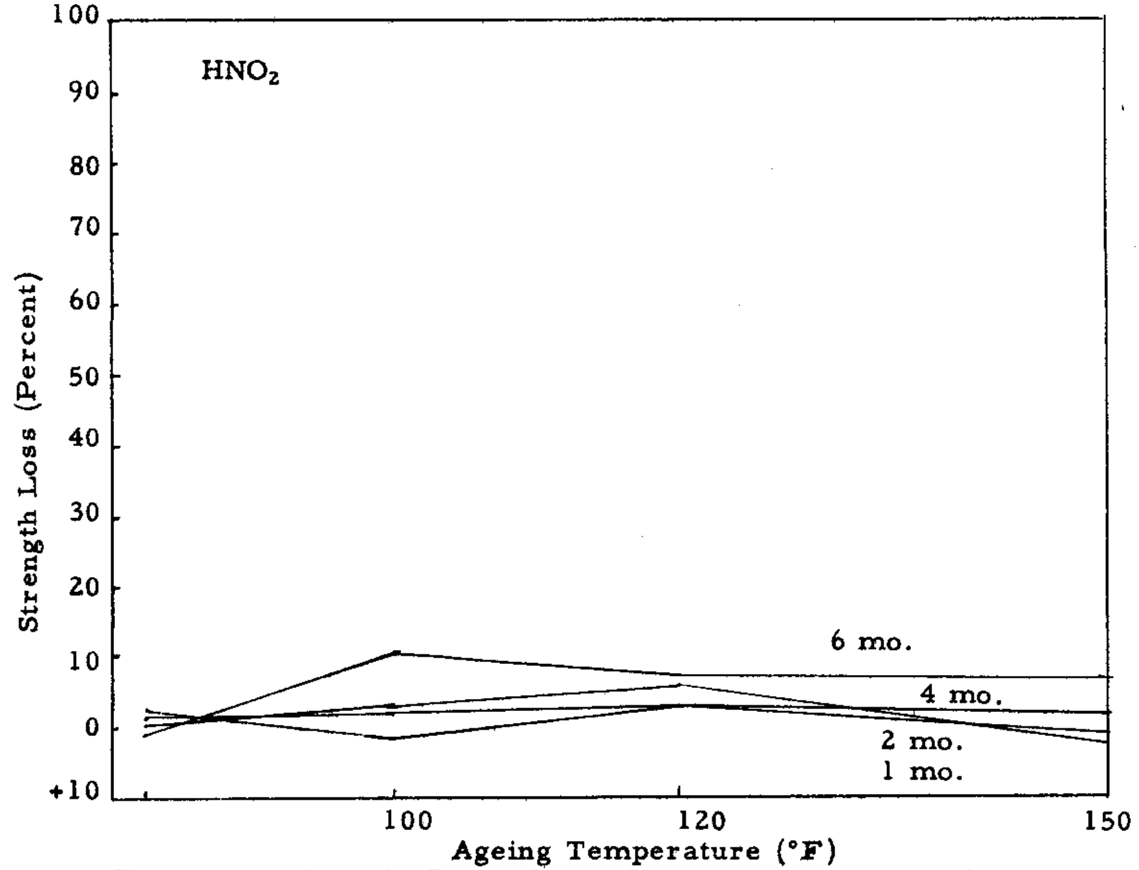


Figure 66. Loss in Strength vs. Ageing Temperature when Dacron (Type I) is treated in H_2S and HNO_2 and aged in solution for different periods of time.

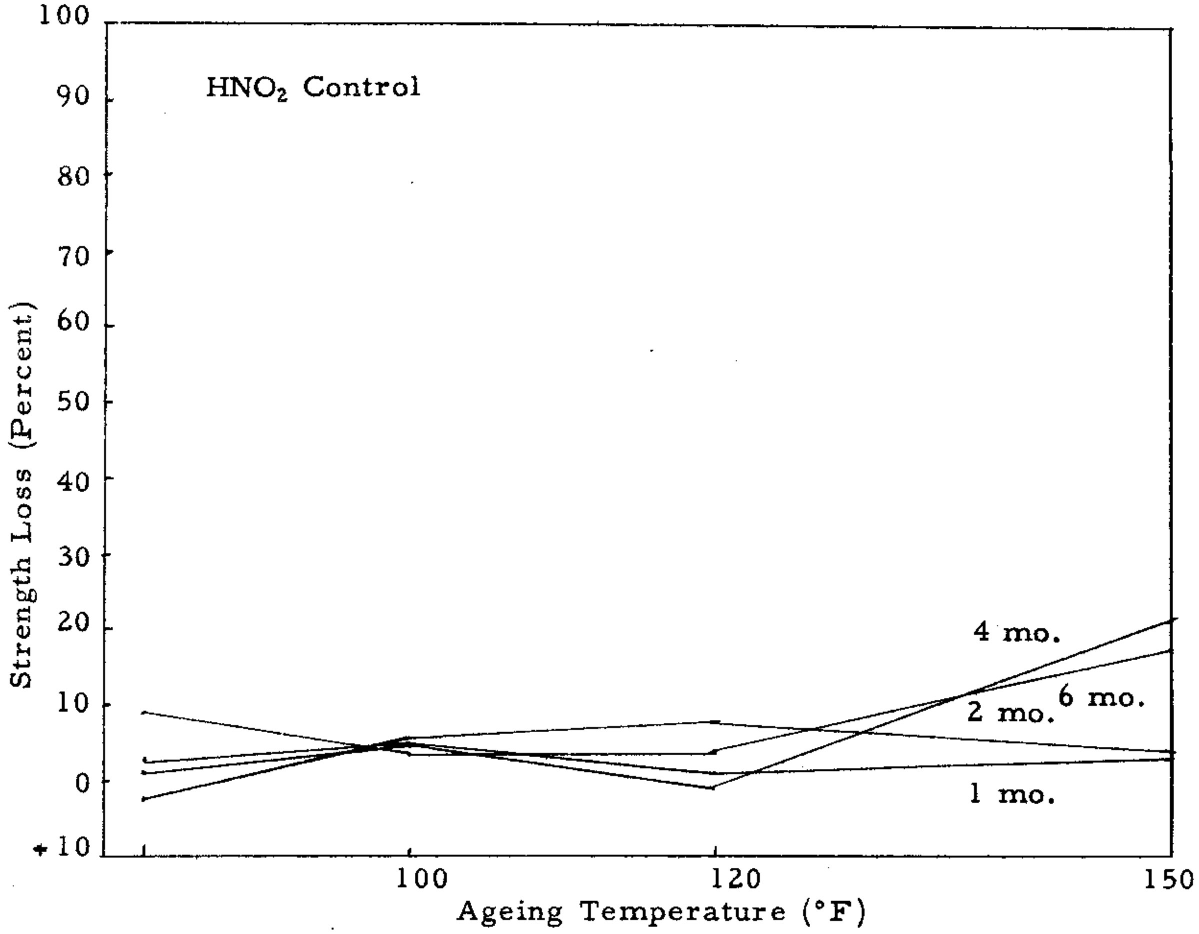


Figure 67. Loss in Strength vs. Ageing Temperature when Dacron (Type I) is treated in HNO_2 and aged in solution for different periods of time.

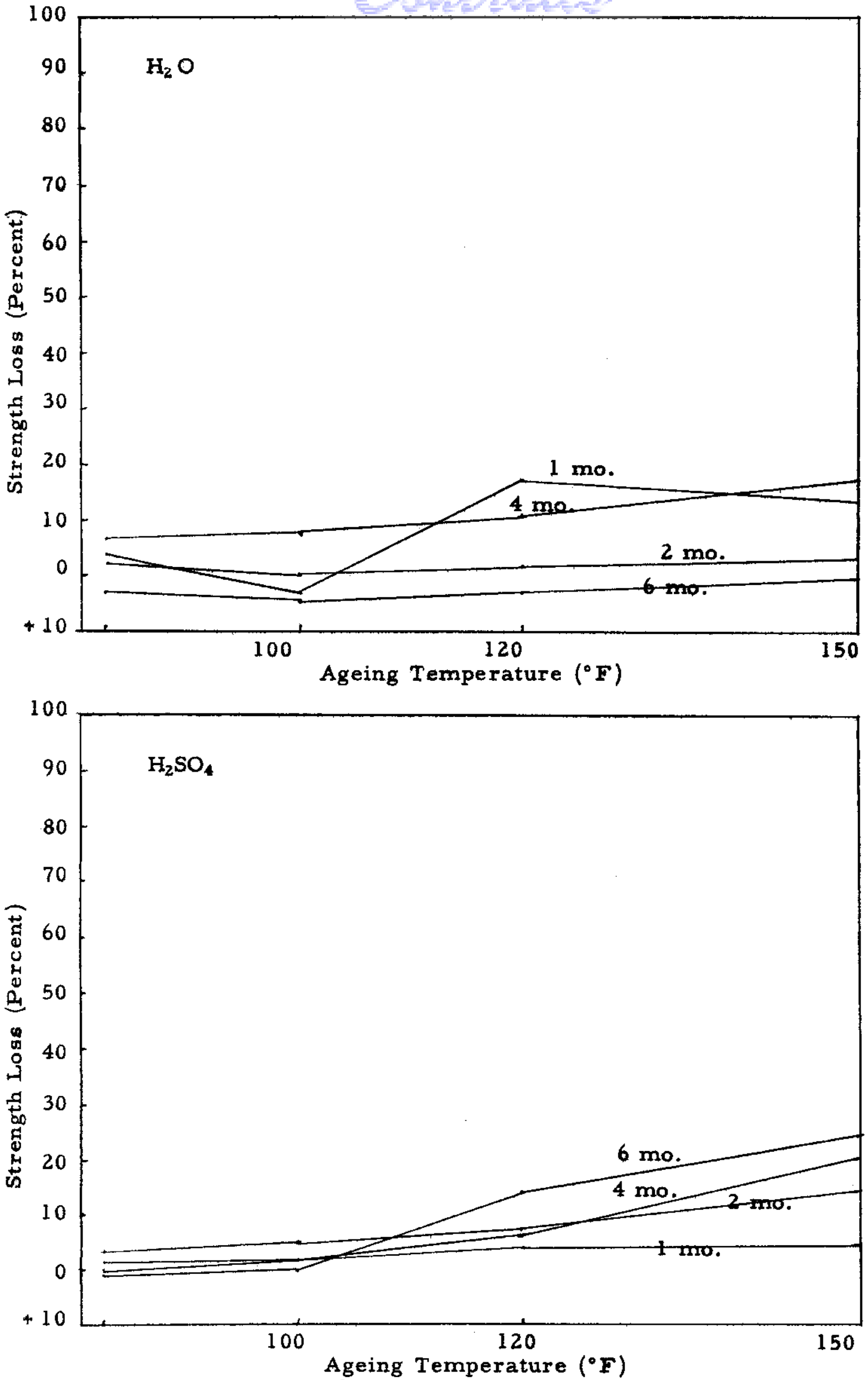


Figure 68. Loss in Strength vs. Ageing Temperature when Dacron (Type II) is treated in H_2O and H_2SO_4 and aged in solution for different periods of time.

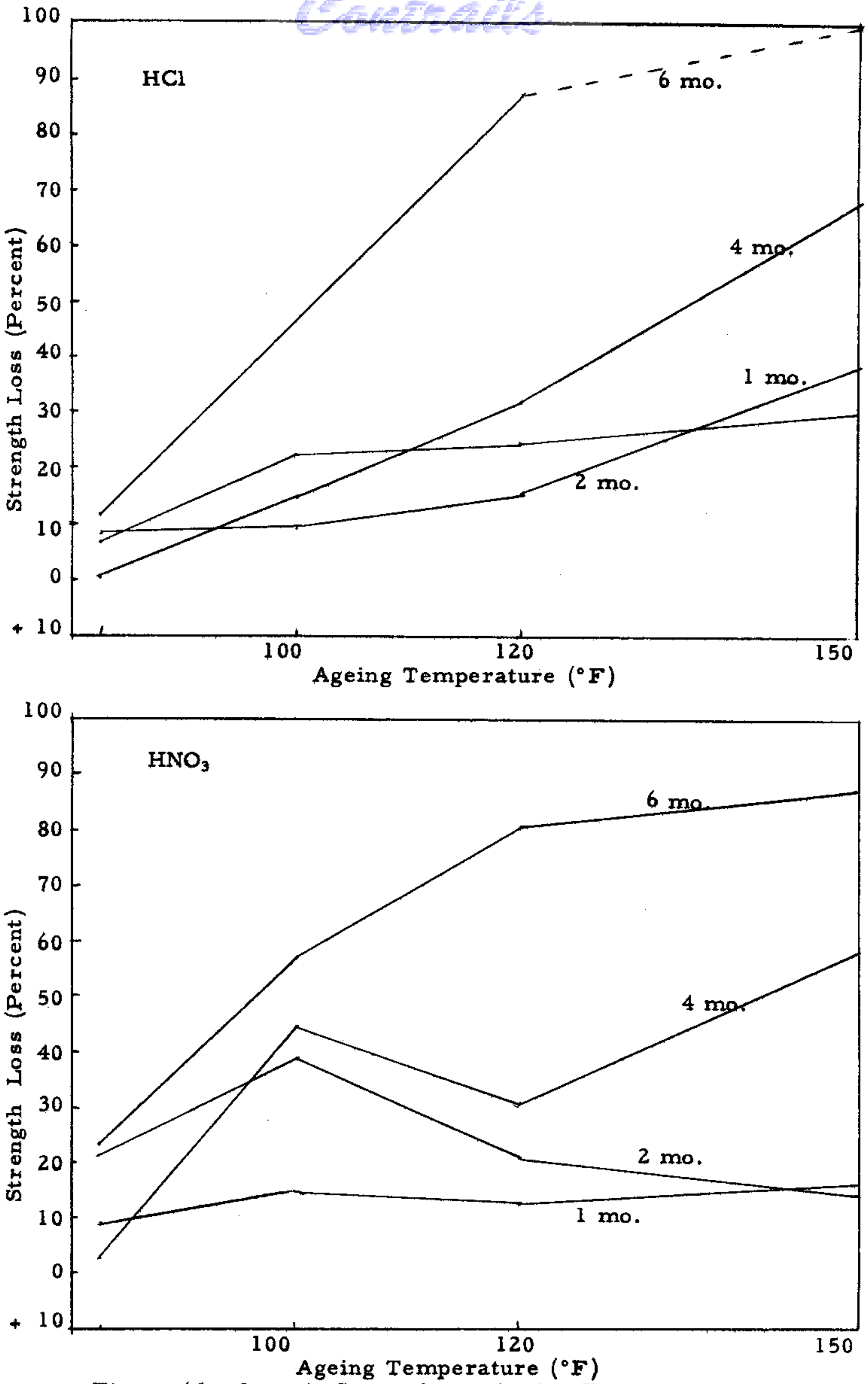


Figure 69. Loss in Strength vs. Ageing Temperature when Dacron (Type II) is treated in HCl and HNO_3 and aged in solution for different periods of time.

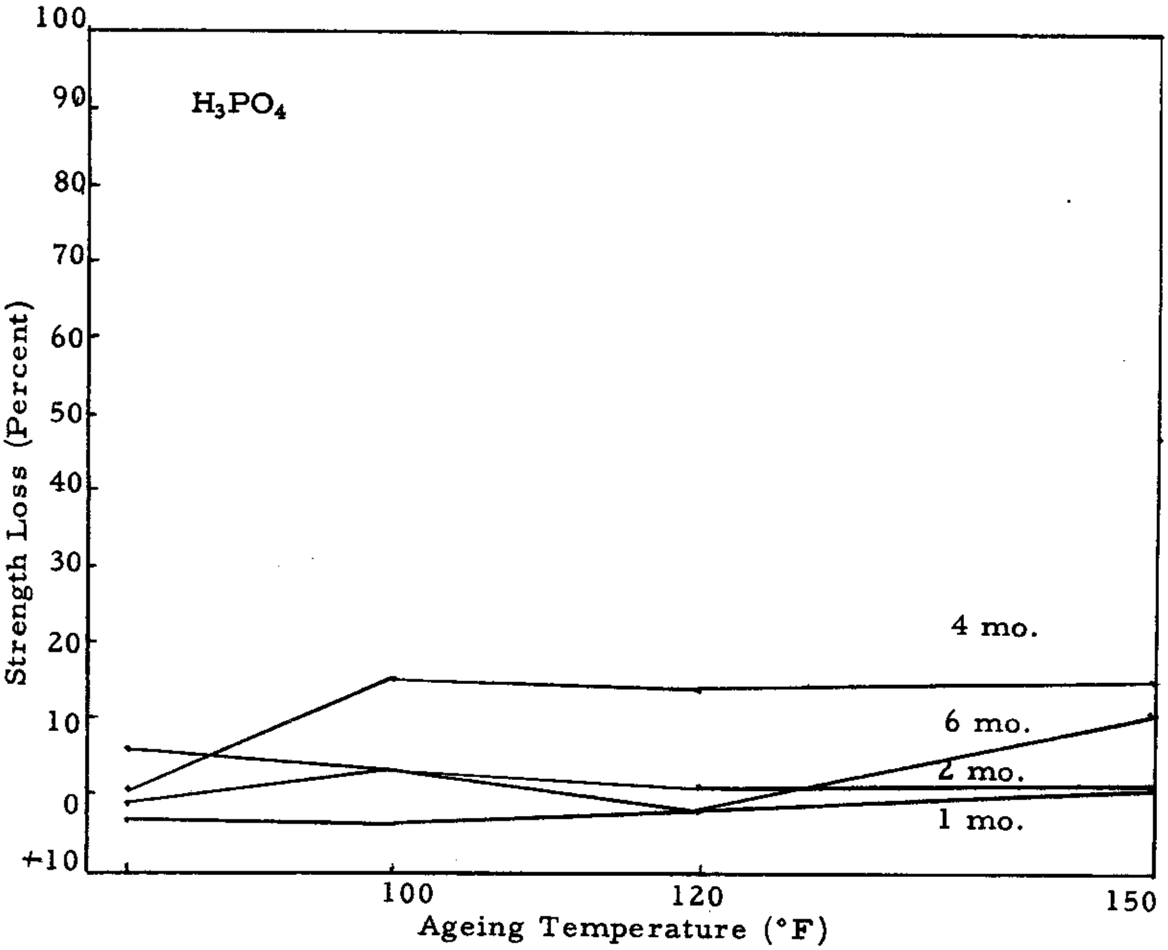
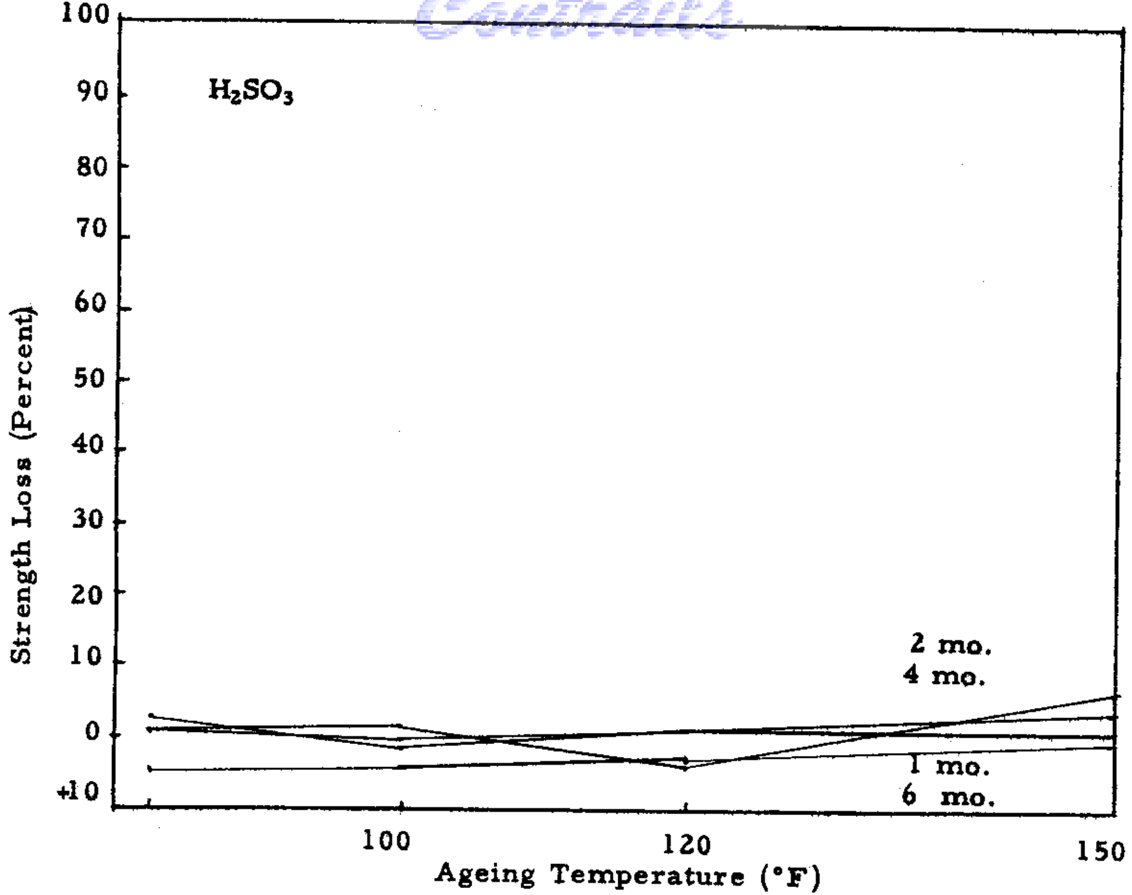


Figure 70. Loss in Strength vs. Ageing Temperature when Dacron (Type II) is treated in H_3PO_4 and aged in solution for different periods of time.



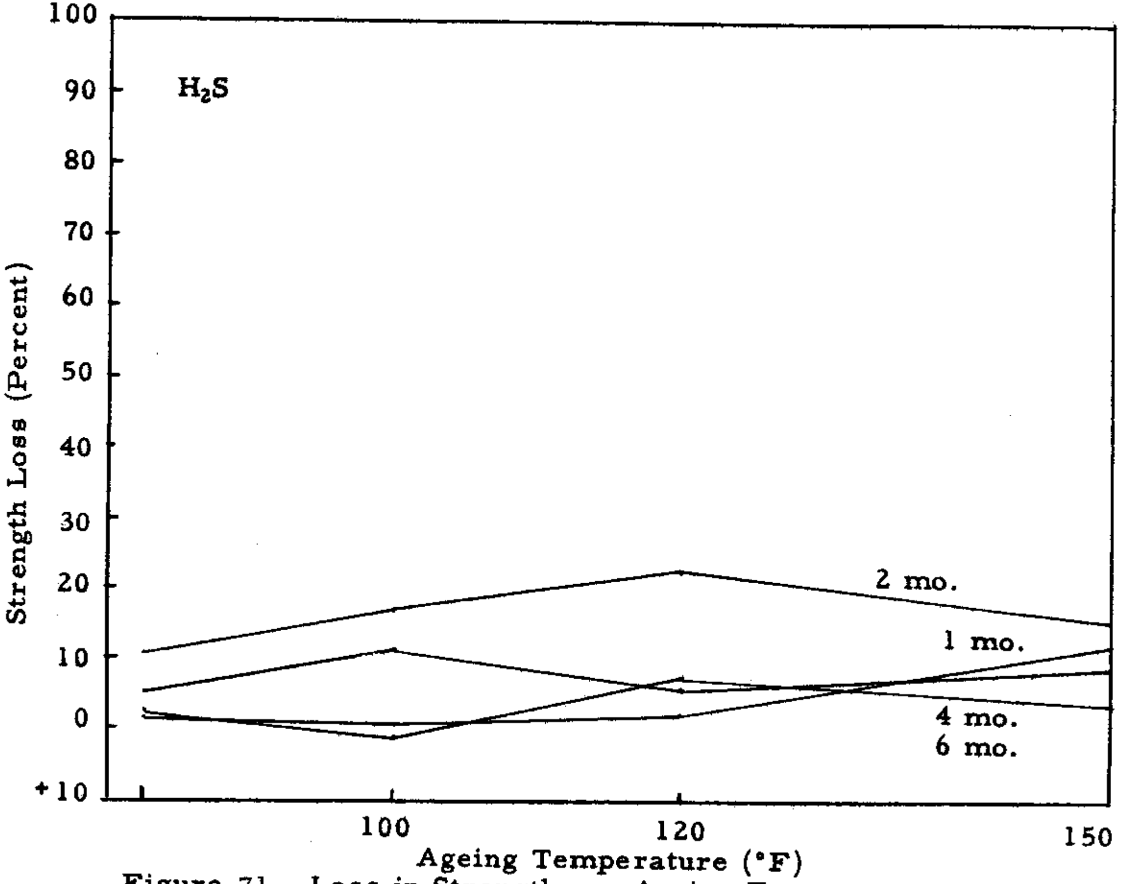


Figure 71. Loss in Strength vs. Ageing Temperature when Dacron (Type II) is treated in H_2SO_3 and H_2S and aged in solution for different periods of time.

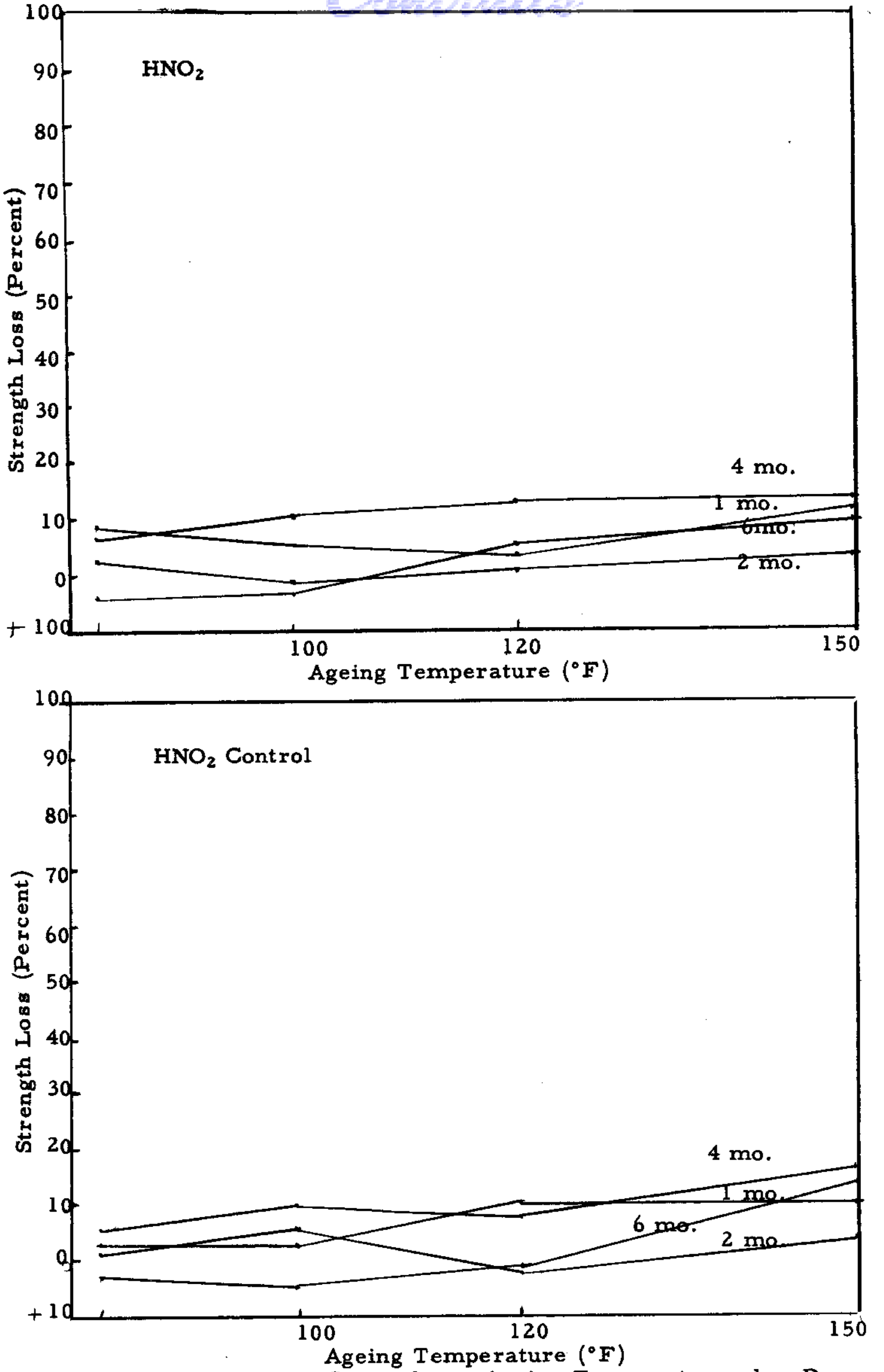


Figure 72. Loss in Strength vs. Ageing Temperature when Dacron (Type II) is treated in HNO$_2$ and HNO$_2$ Control and aged in solution for different periods of time.

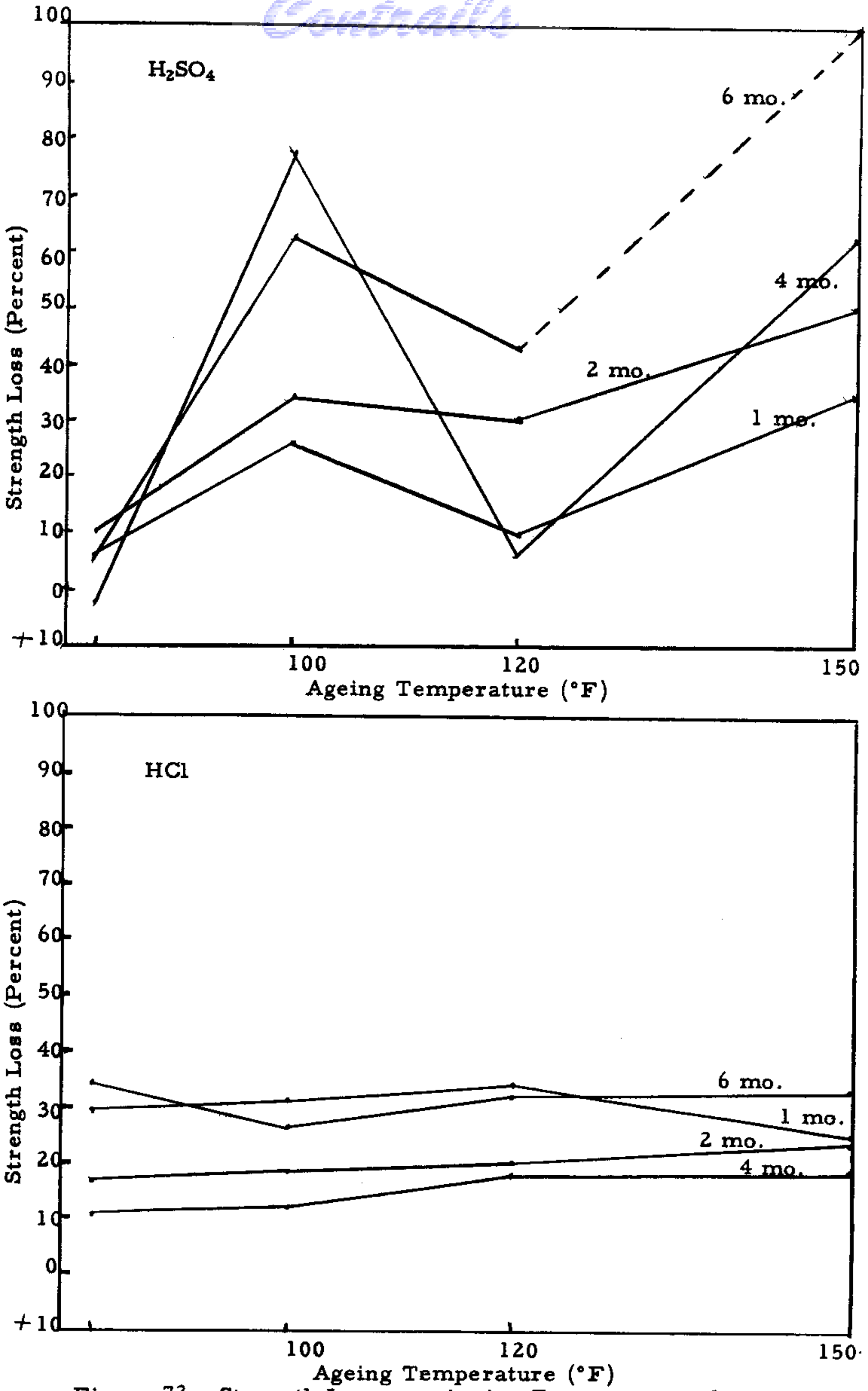


Figure 73. Strength Loss vs. Ageing Temperature when Dacron (Type II) is treated in H_2SO_4 and HCl and aged at low relative humidity for different periods of time.

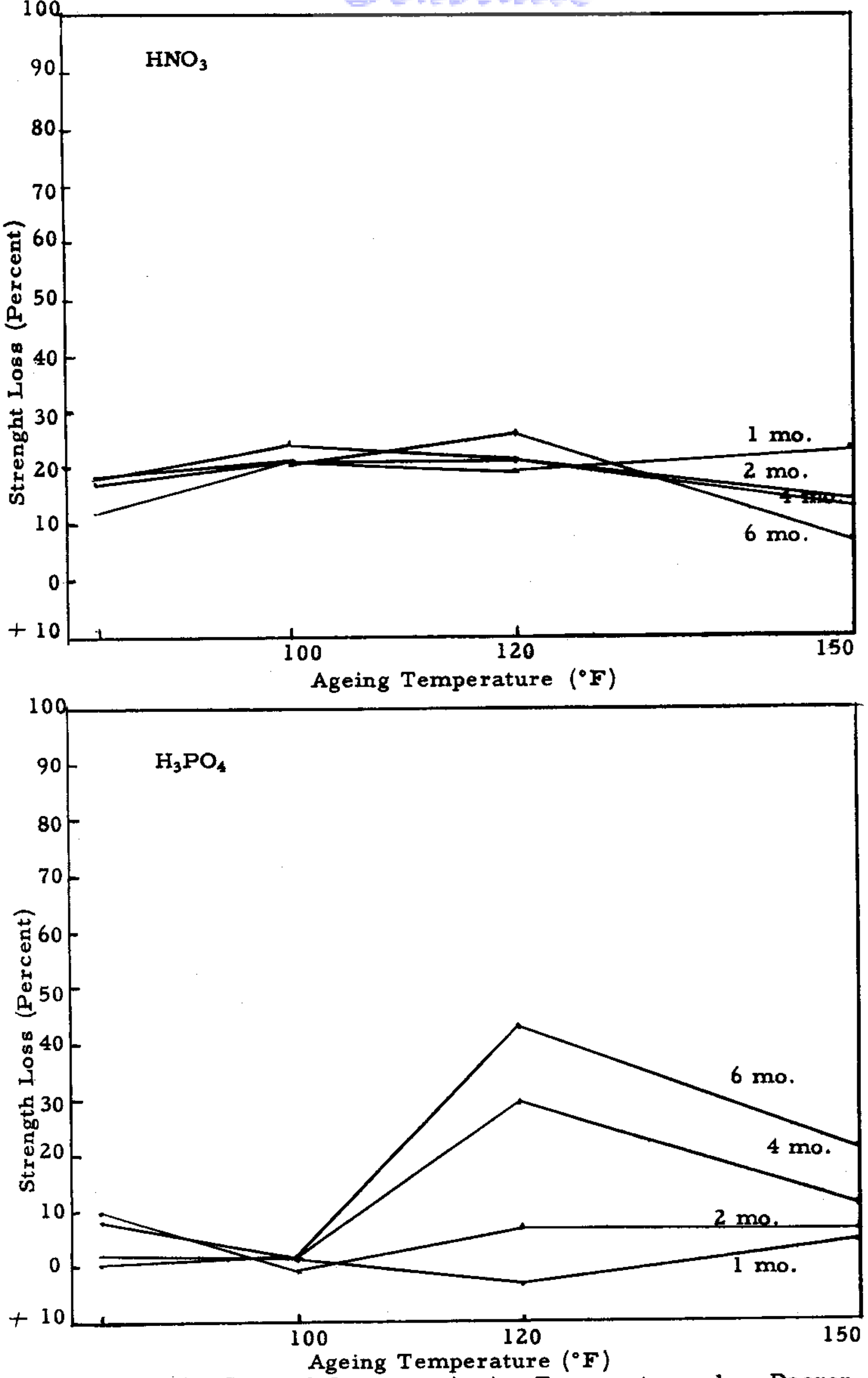
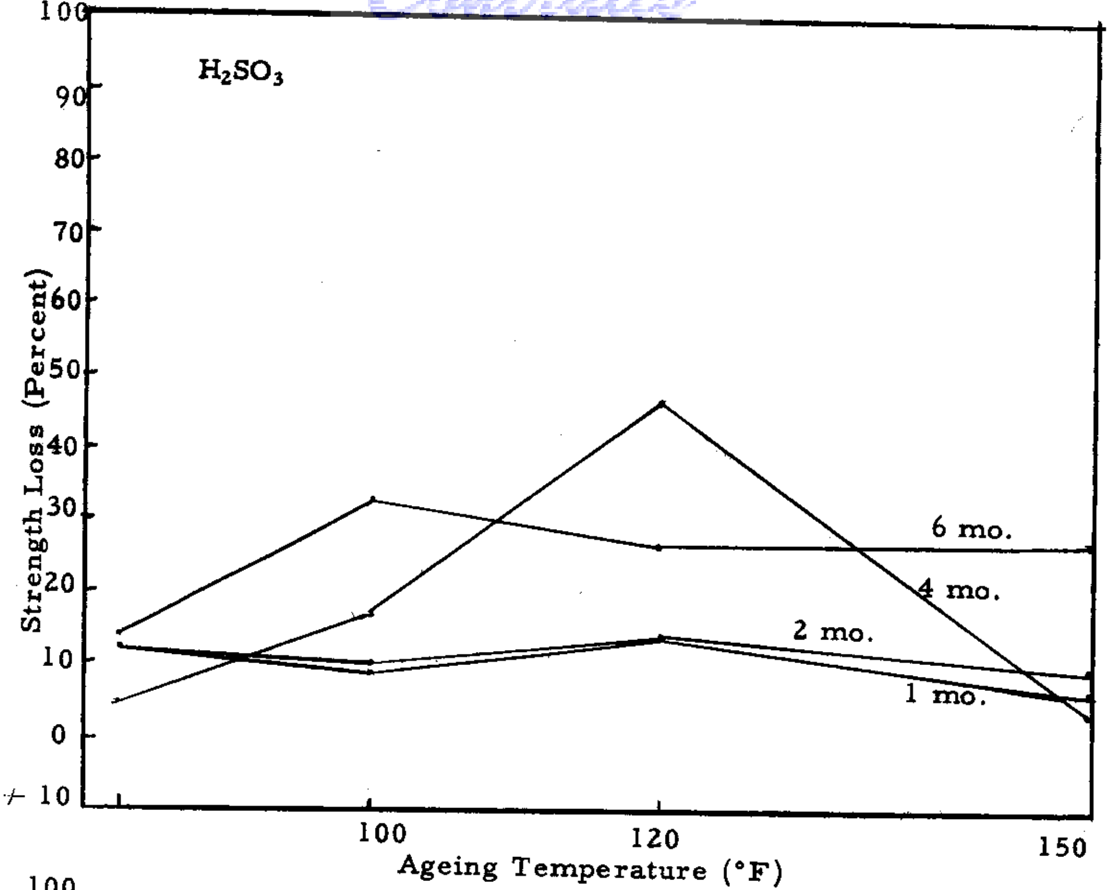


Figure 74. Strength Loss vs. Ageing Temperature when Dacron (Type II) is treated in HNO$_3$ and H$_3$PO$_4$ and aged at low relative humidity for different periods of time.



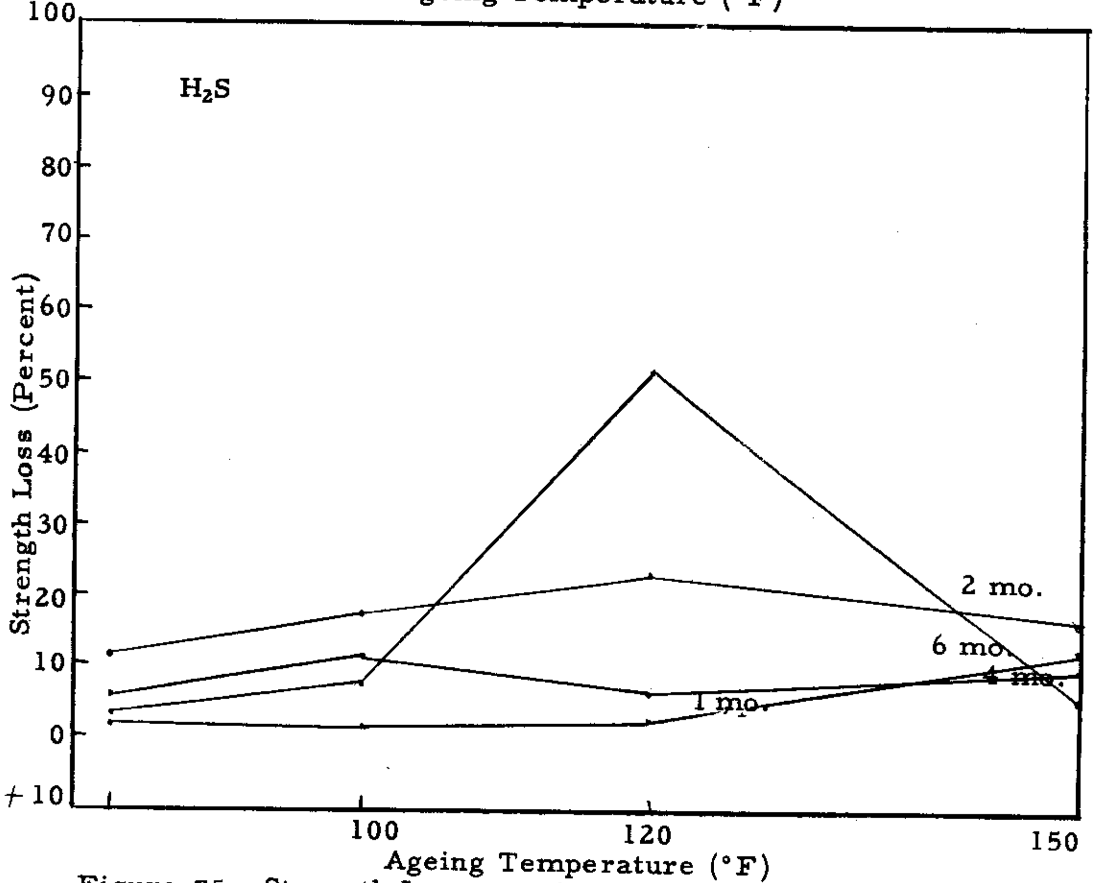


Figure 75. Strength Loss vs. Ageing Temperature when Dacron (Type II) is treated in H_2SO_3 and H_2S and aged at low relative humidity for different periods of time.

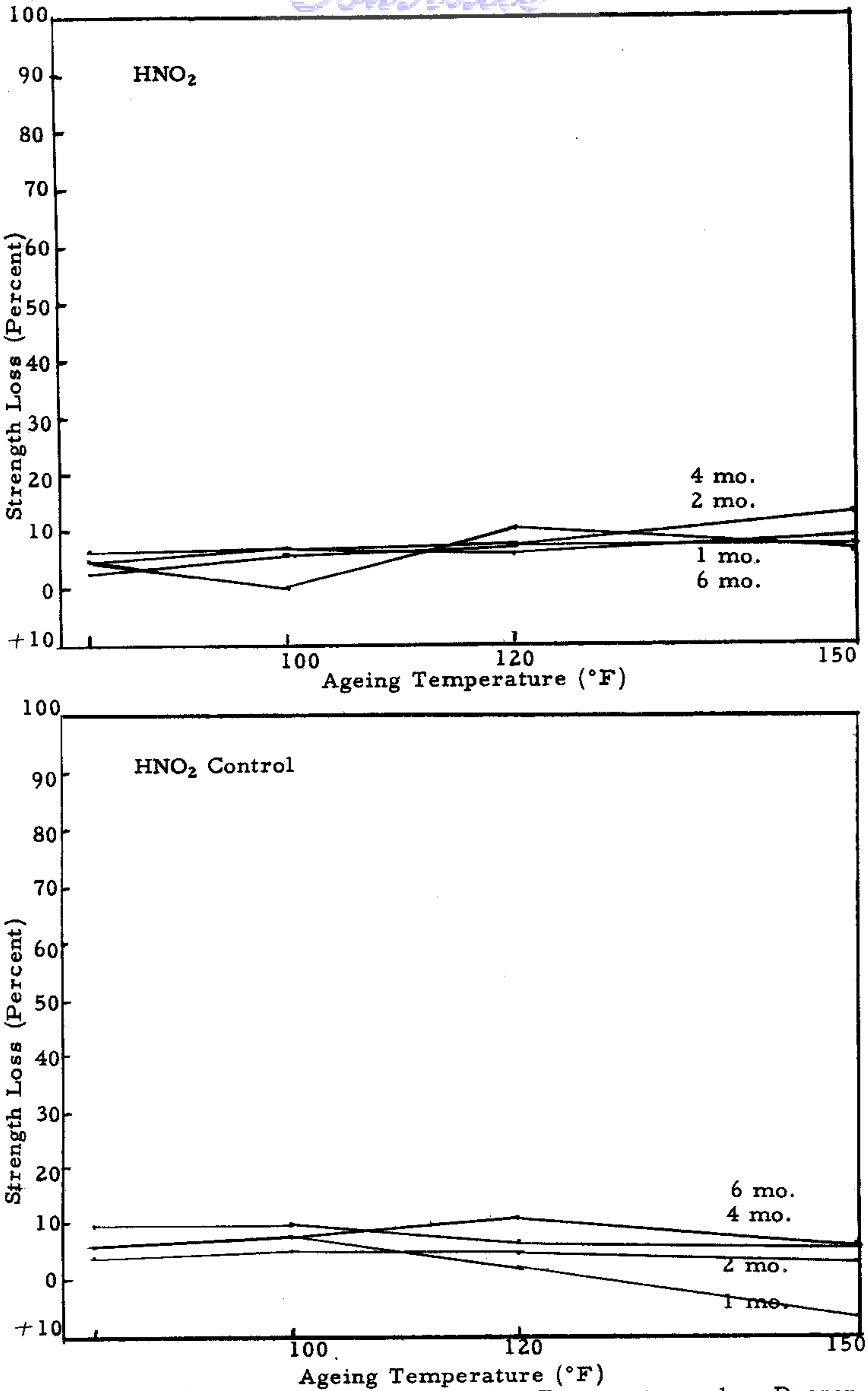


Figure 76. Strength Loss vs. Ageing Temperature when Dacron (Type II) is treated in HNO_2 and HNO_2 Control and aged at low relative humidity for different periods of time.

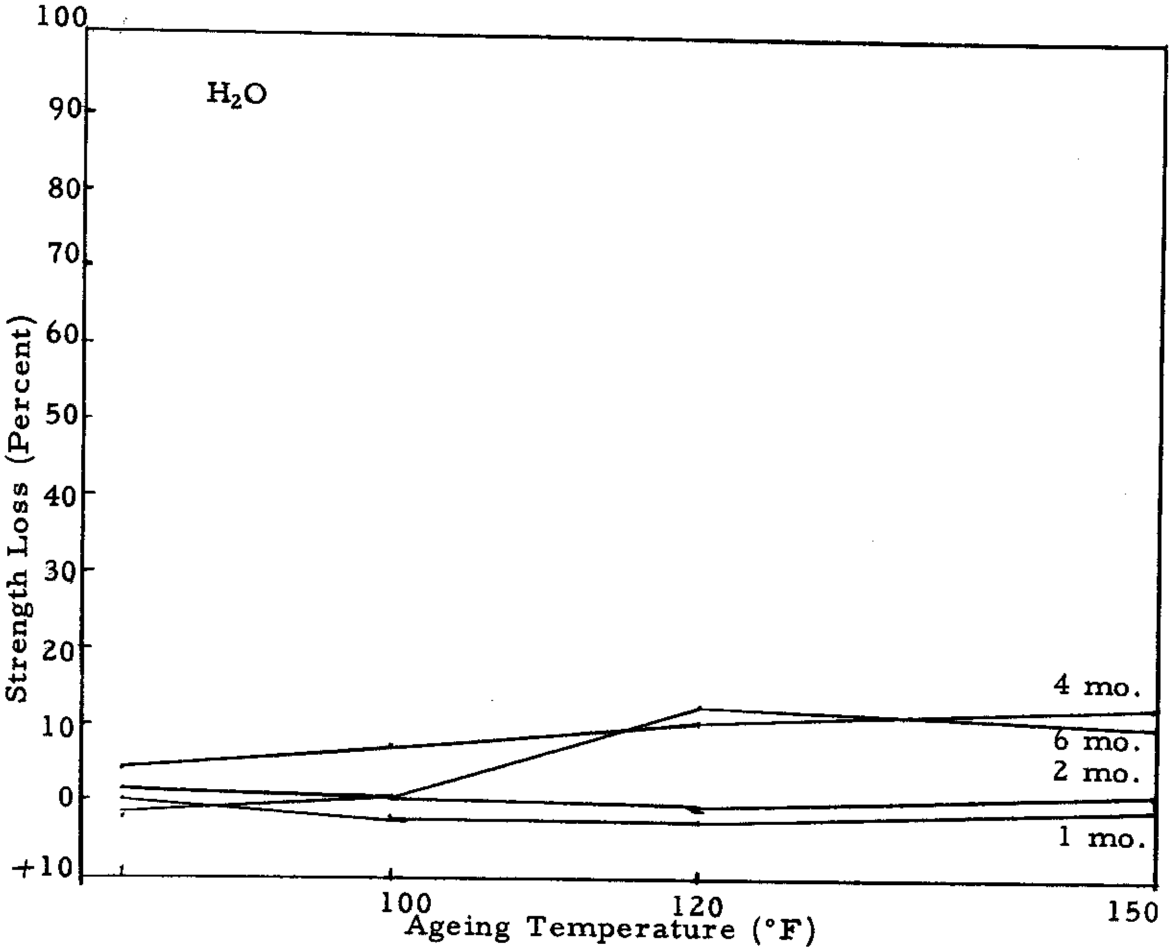


Figure 77. Strength Loss vs. Ageing Temperature when Dacron (Type II) is treated in H_2O and aged at low relative humidity for different periods of time.

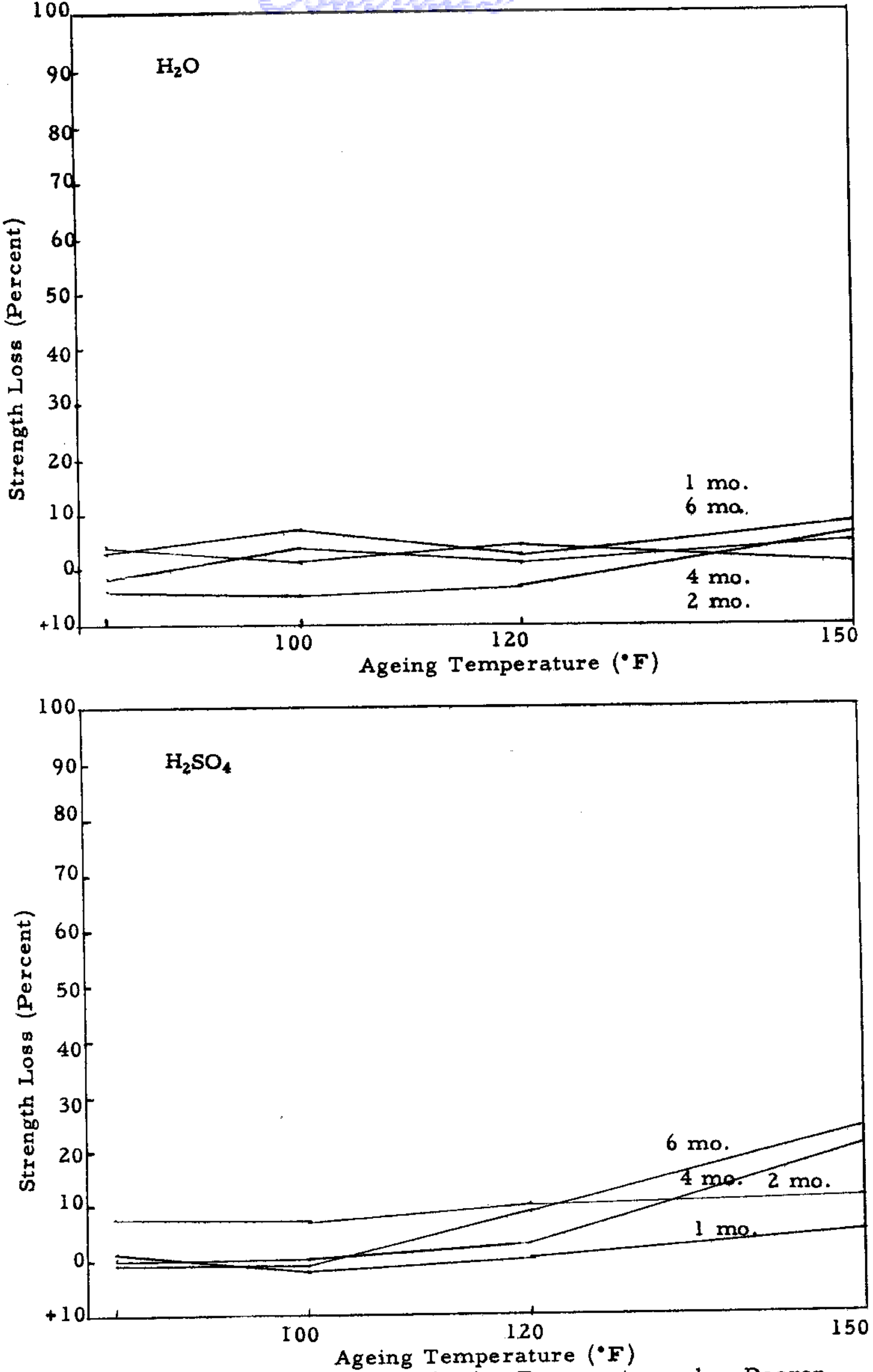


Figure 78. Strength Loss vs. Ageing Temperature when Dacron (Type II) is treated in H_2O and H_2SO_4 and aged at high relative humidity for different periods of time.

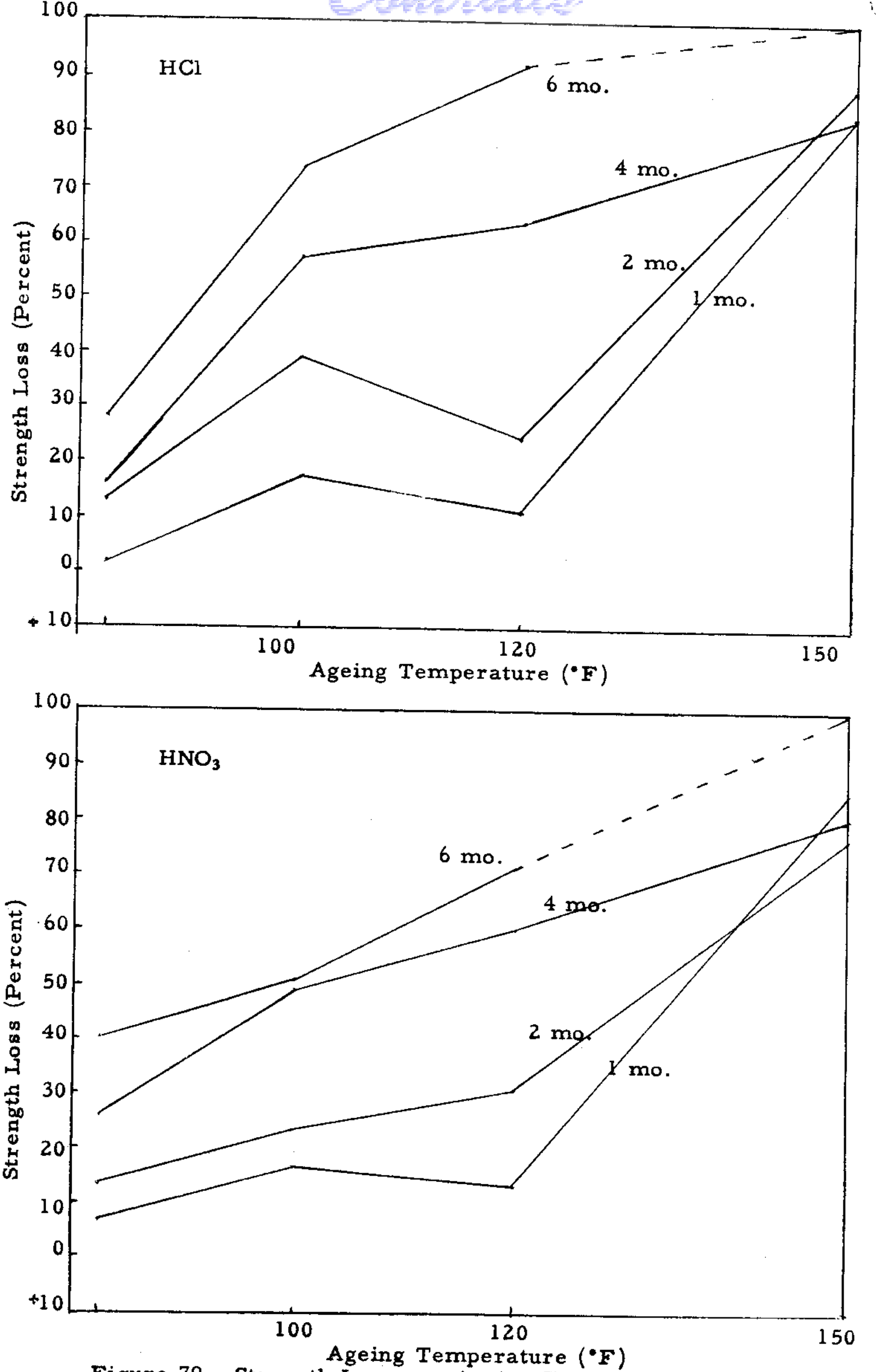
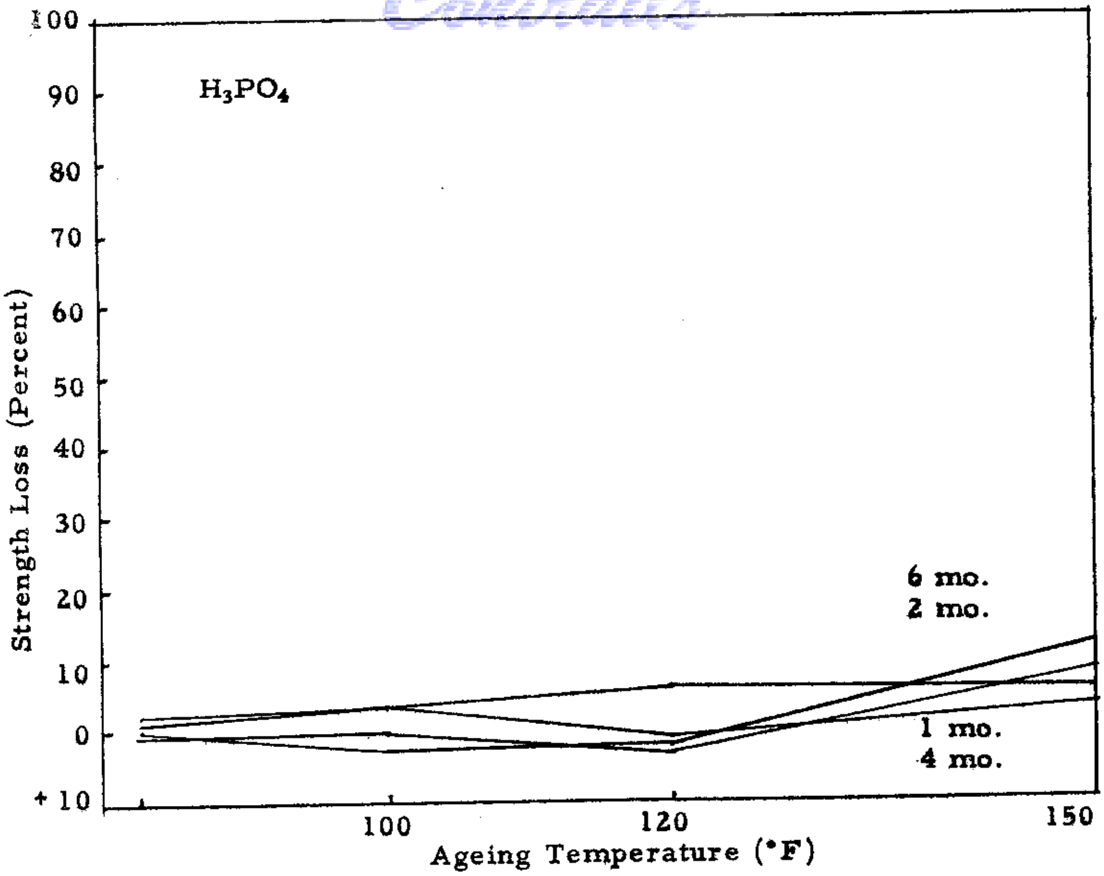


Figure 79. Strength Loss vs. Ageing Temperature when Dacron (Type II) is treated in HCl and HNO_3 and aged at high relative humidity for different periods of time.



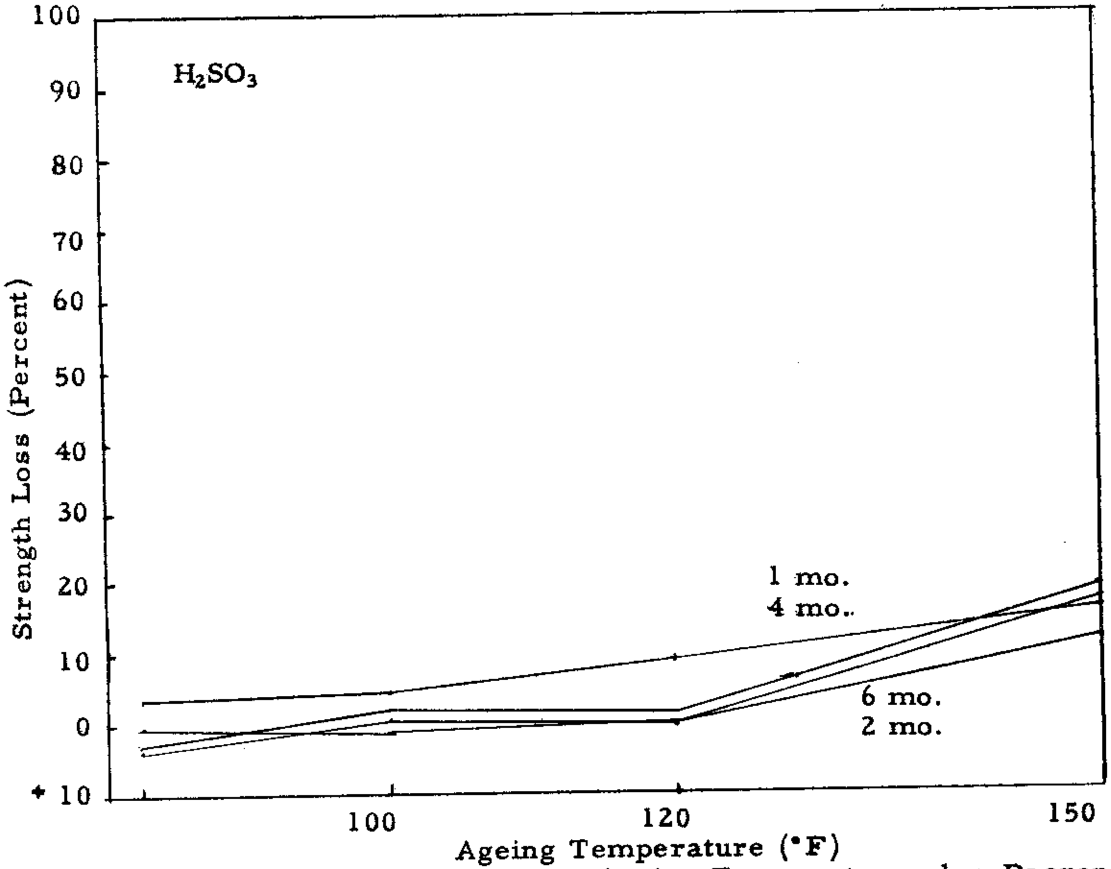


Figure 80. Strength Loss vs. Ageing Temperature when Dacron (Type II) is treated in H_3PO_4 and H_2SO_3 and aged at high relative humidity for different periods of time.

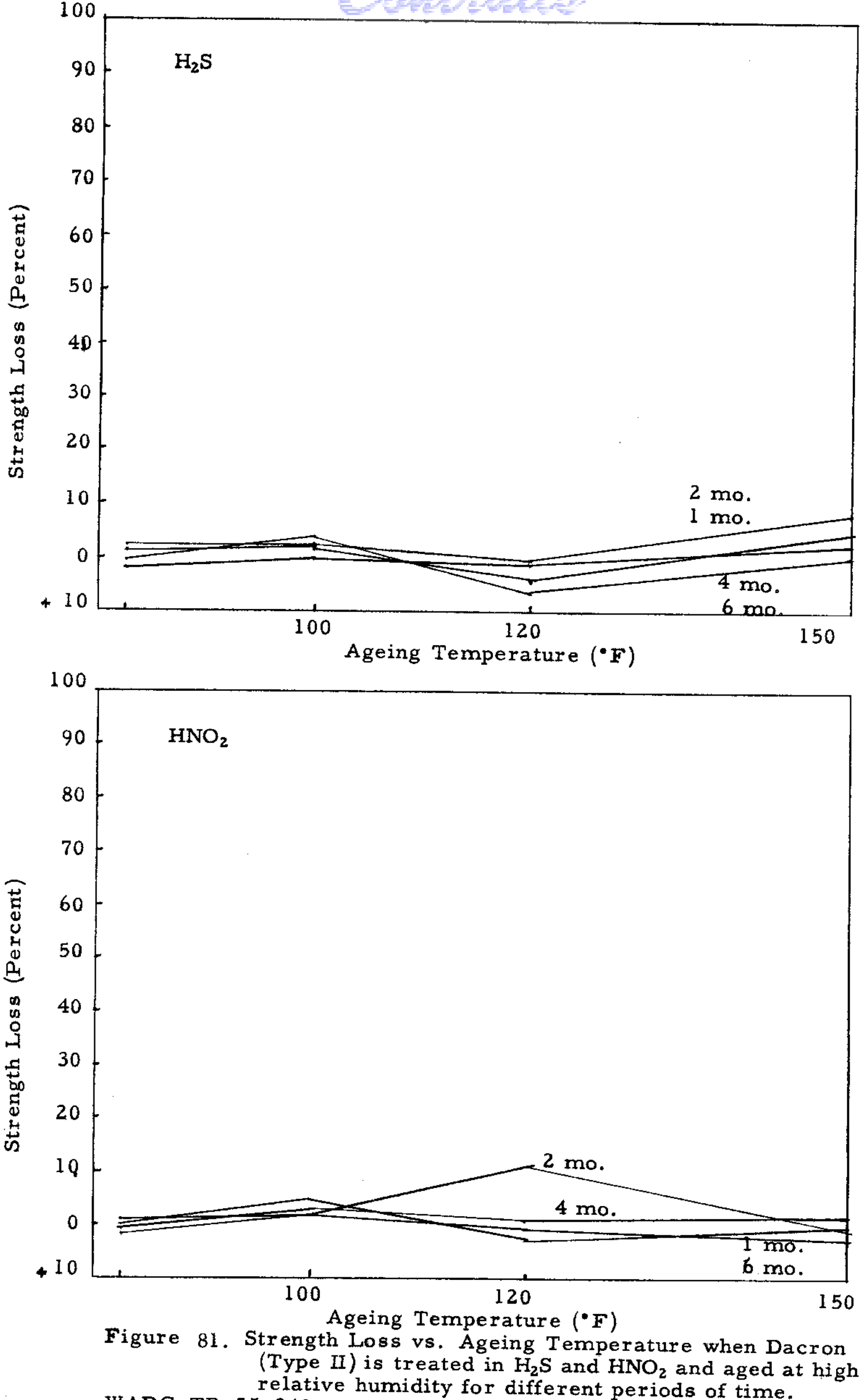


Figure 81. Strength Loss vs. Ageing Temperature when Dacron (Type II) is treated in H_2S and HNO_2 and aged at high relative humidity for different periods of time.

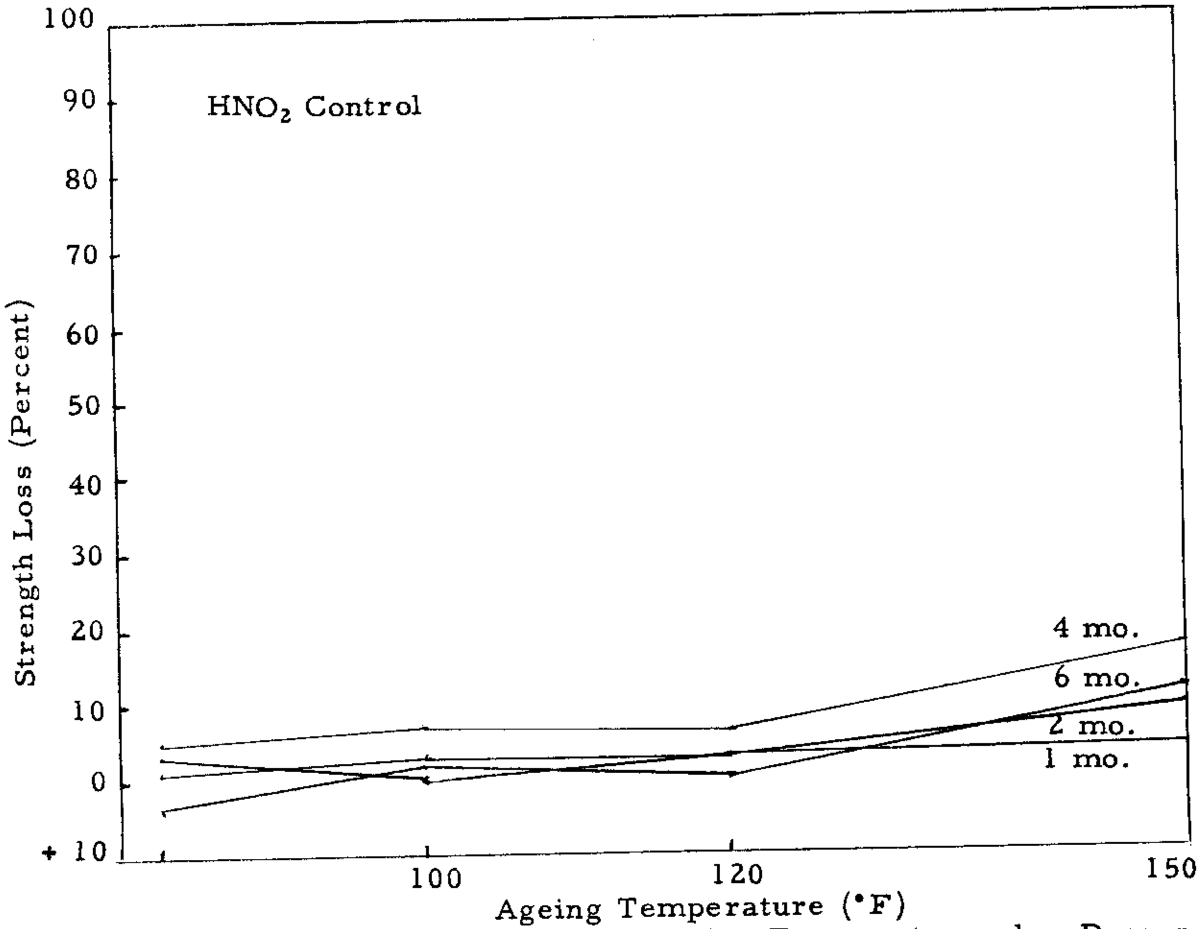


Figure 82. Strength Loss vs. Ageing Temperature when Dacron (Type II) is treated in HNO$_2$ Control and aged at high relative humidity for different periods of time.

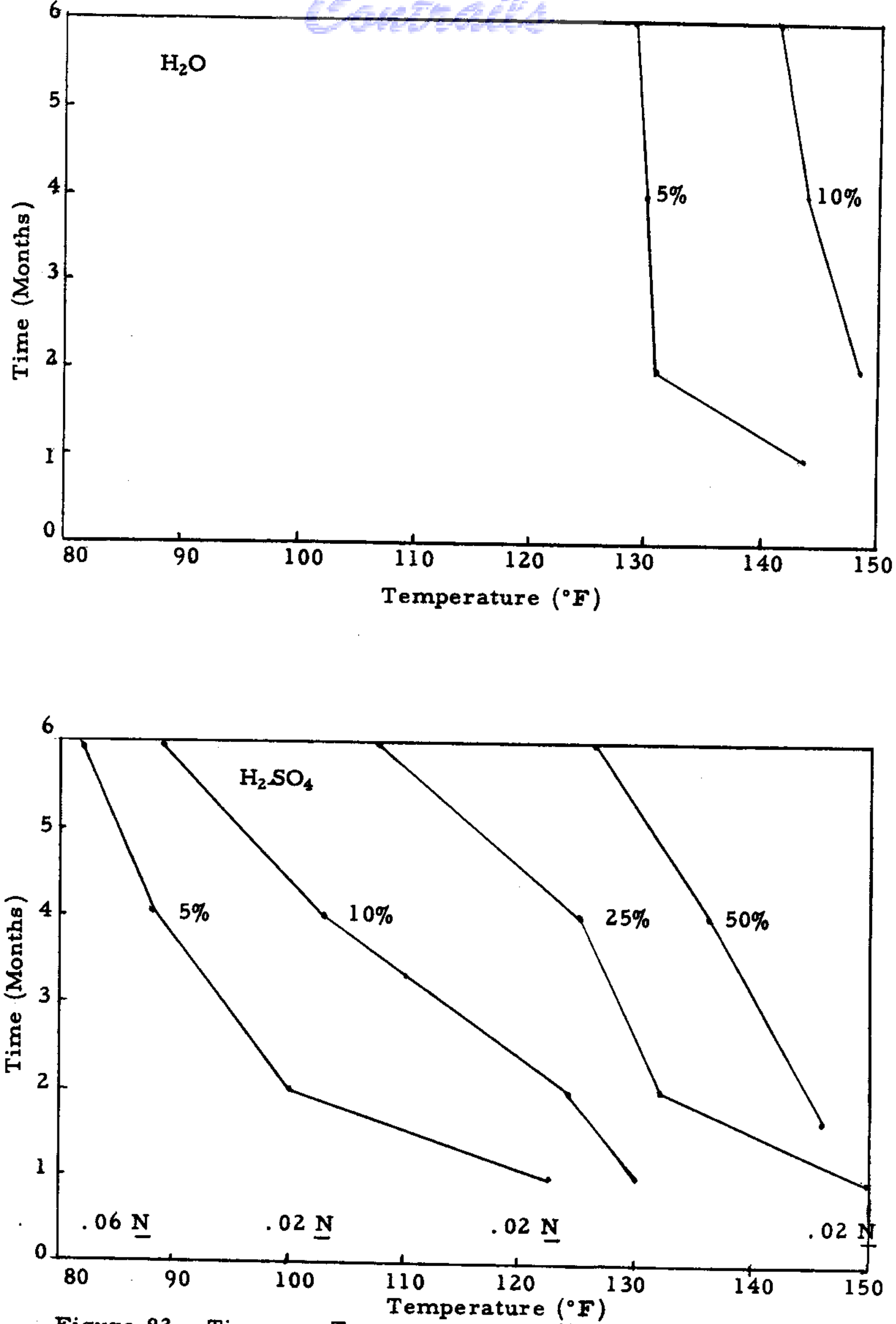
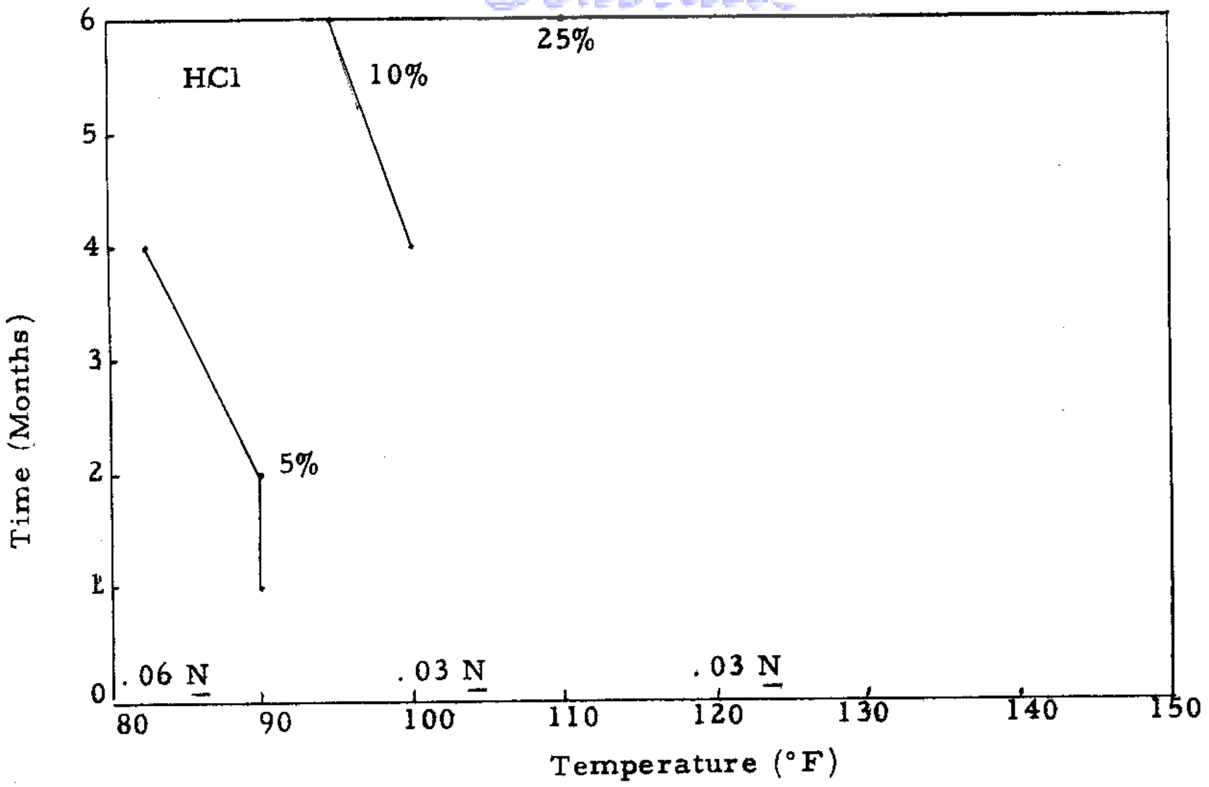


Figure 83. Time vs. Temperature to Effect Specific Strength Losses when nylon is treated in H_2O and H_2SO_4 and aged in solution; initial concentration of H_2SO_4 used at each temperature condition is shown.



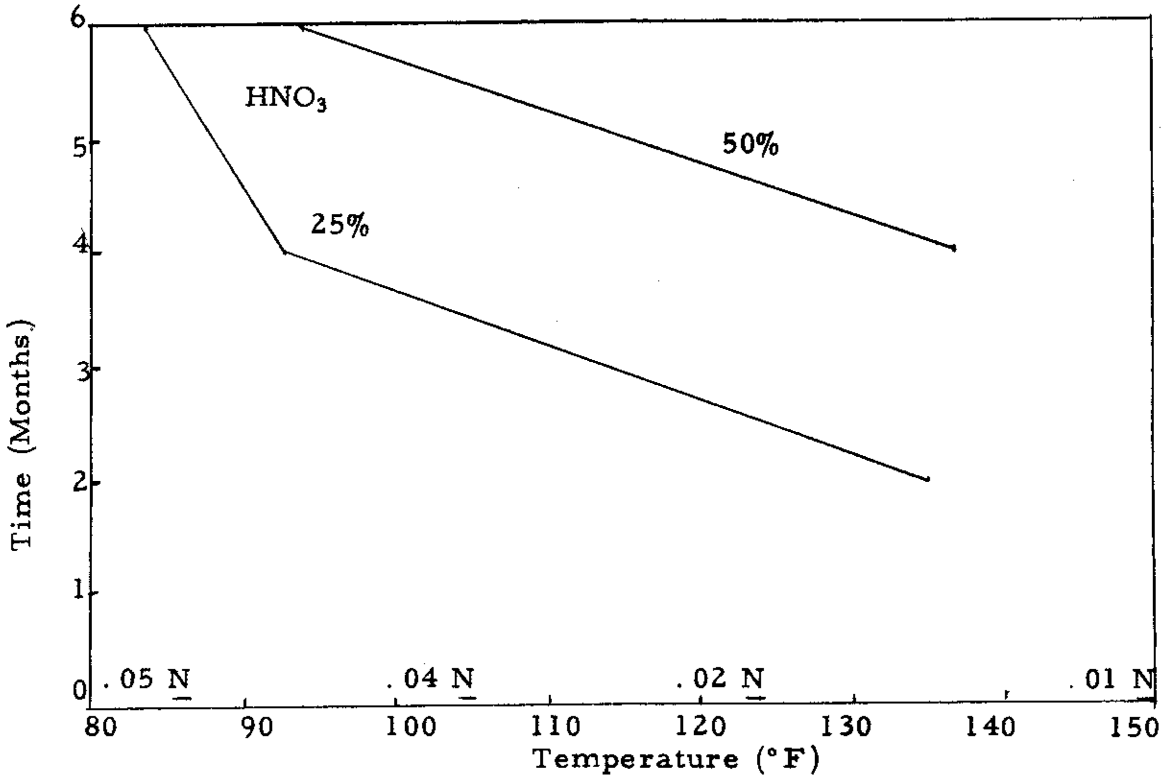
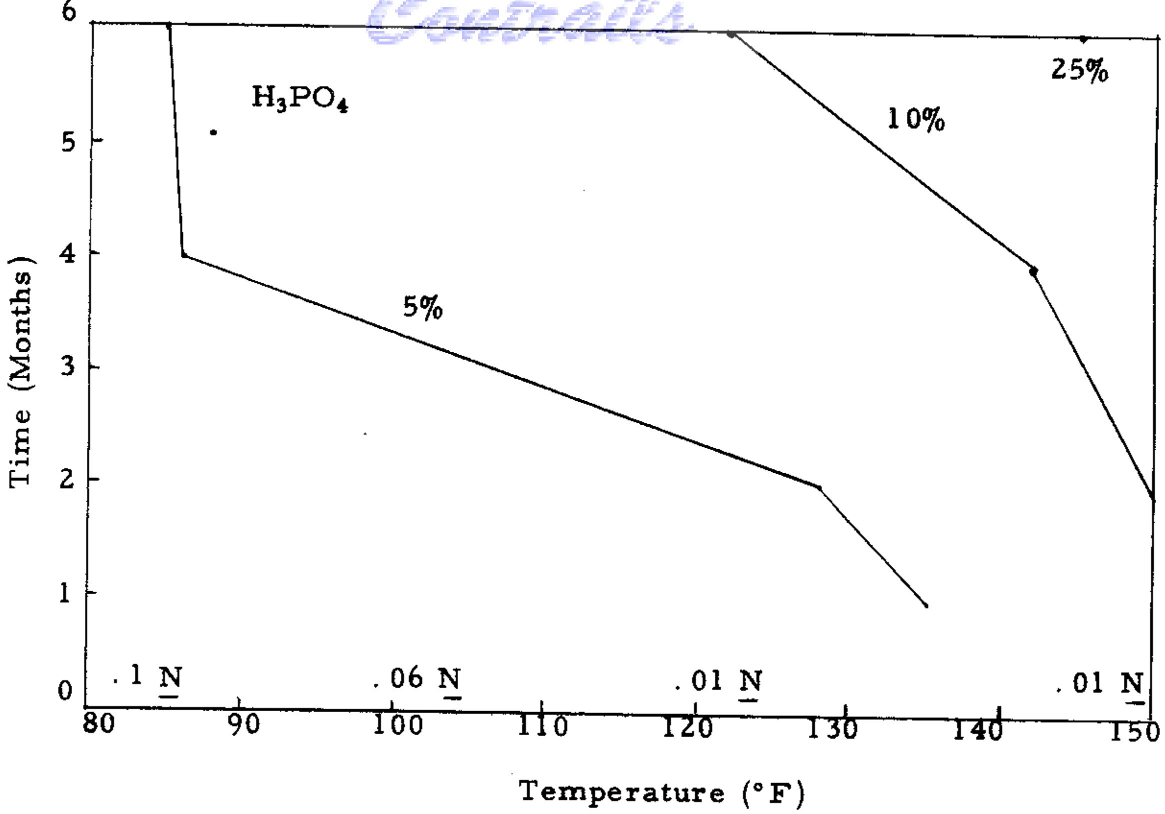


Figure 84. Time vs. Temperature to Effect Specific Strength Losses when nylon is treated in HCl and HNO_3 and aged in solution; initial concentration of acid used at each temperature condition is shown.



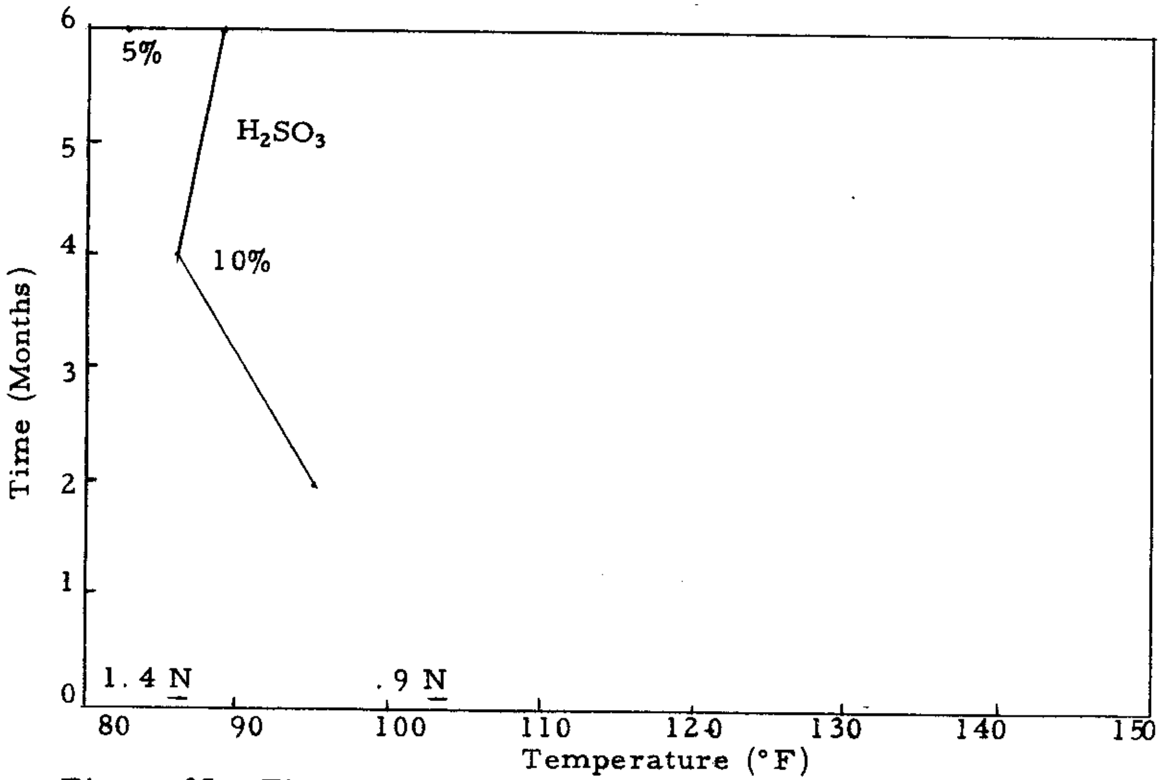


Figure 85. Time vs. Temperature to Effect Specific Strength Losses when nylon is treated in H_3PO_4 and H_2SO_3 and aged in solution; initial concentration of acid used at each temperature condition is shown.

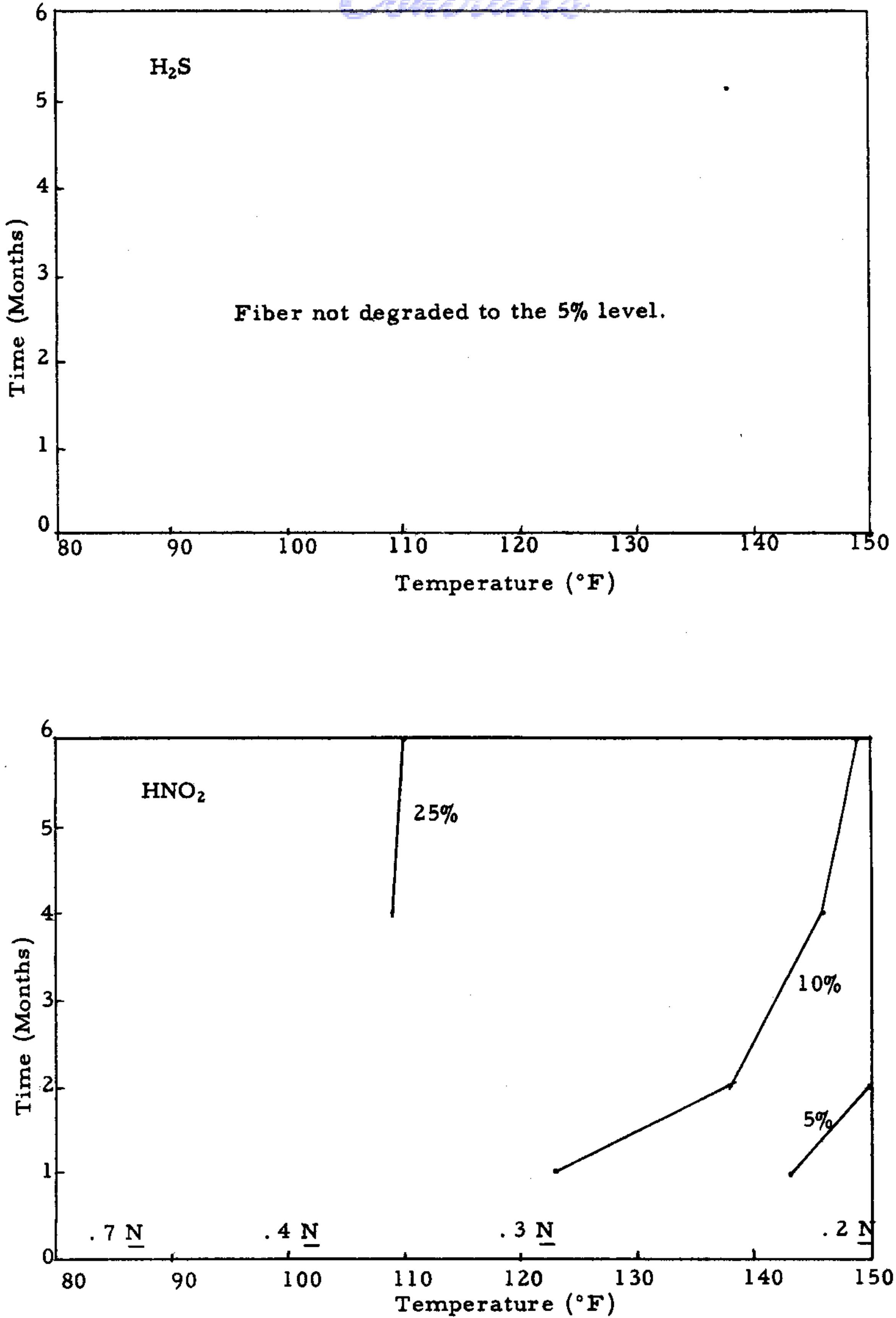


Figure 86. Time vs. Temperature to Effect Specific Strength Losses when nylon is treated in H_2S and HNO_2 and aged in solution; initial concentration of acid used at each temperature condition is shown.

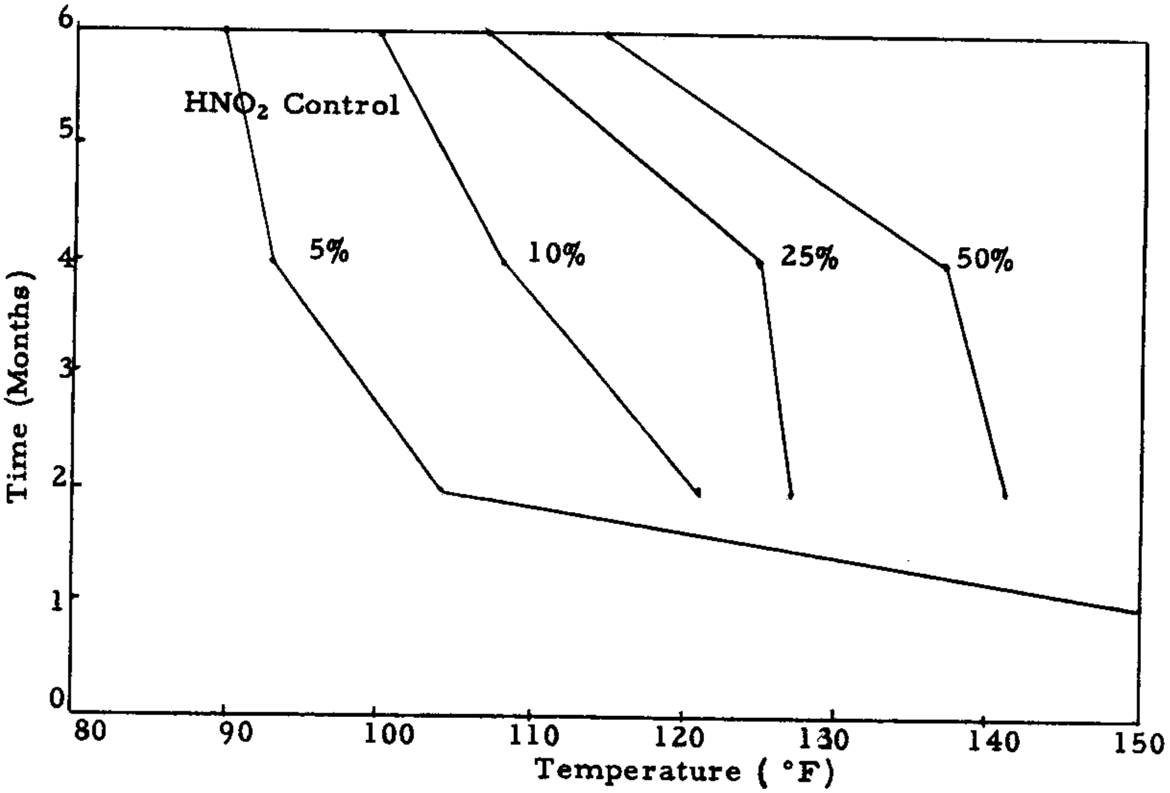
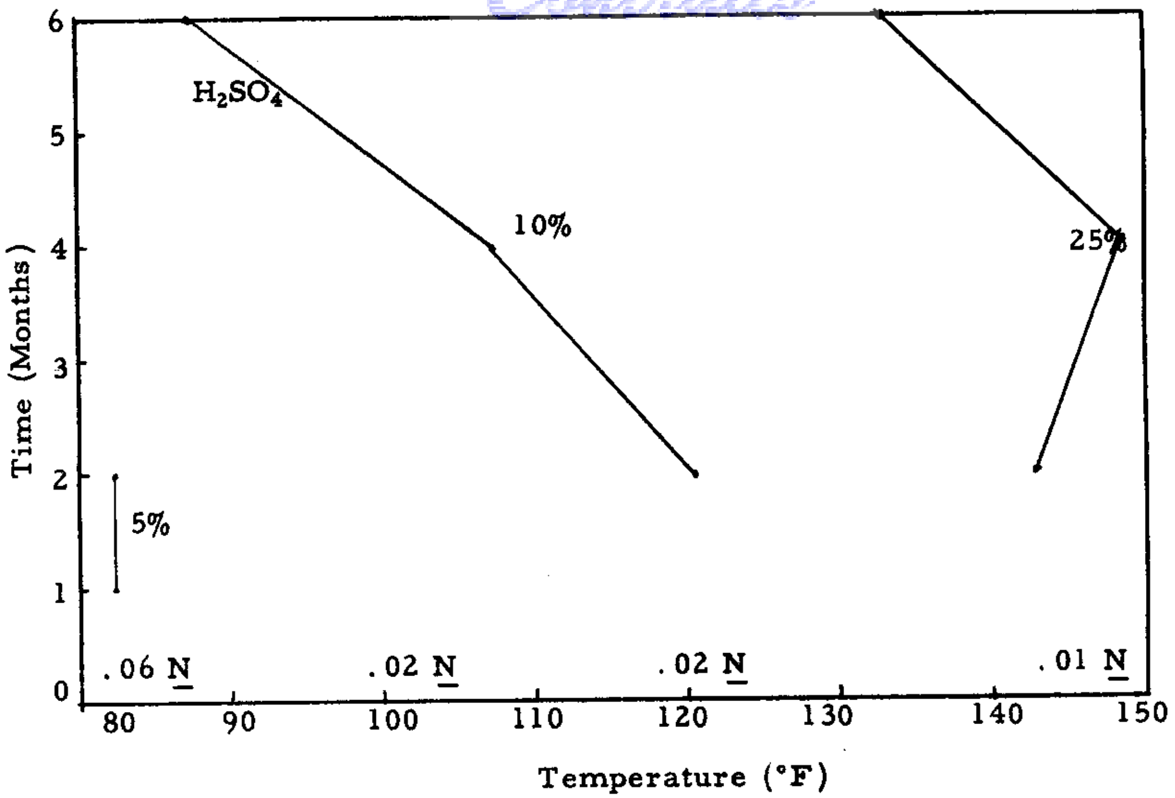


Figure 87. Time vs. Temperature to Effect Specific Strength Losses when nylon is treated in HNO$_2$ control and aged in solution.



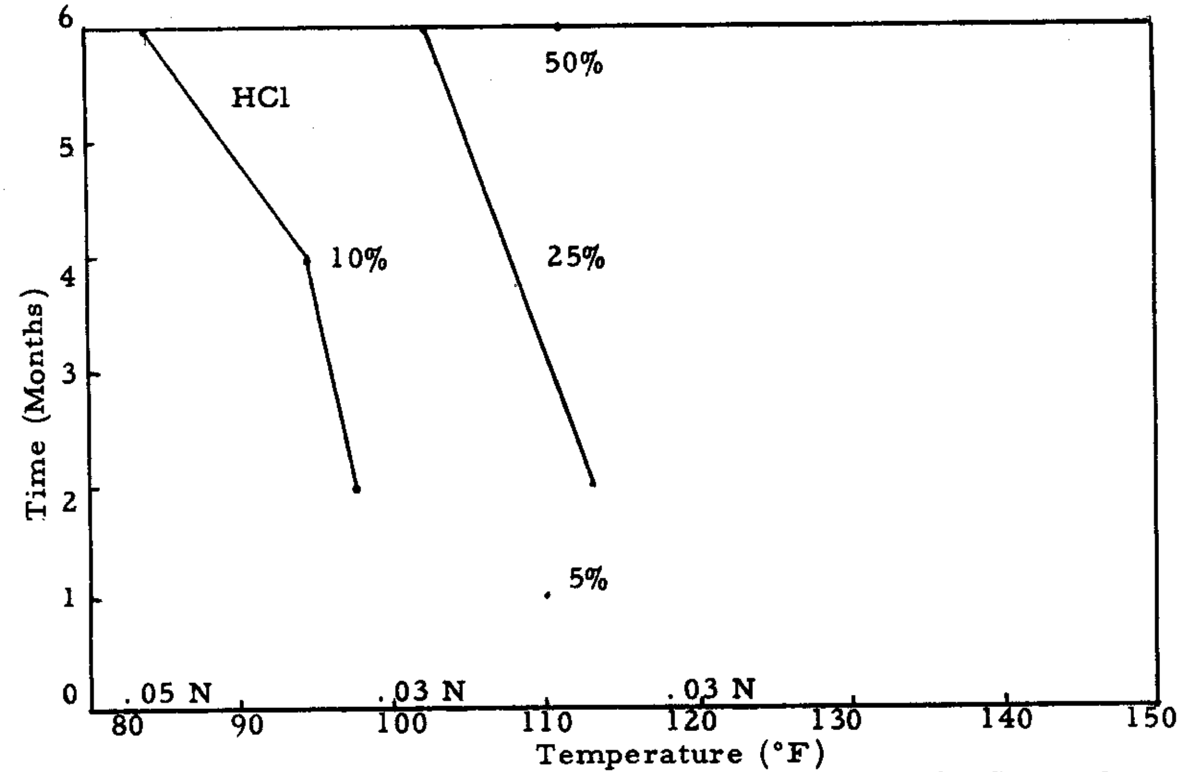


Figure 88. Time vs. Temperature to Effect Specific Strength Losses when nylon is treated in H_2SO_4 and HCl and aged at low relative humidity; initial concentration of acid used at each temperature condition is shown.

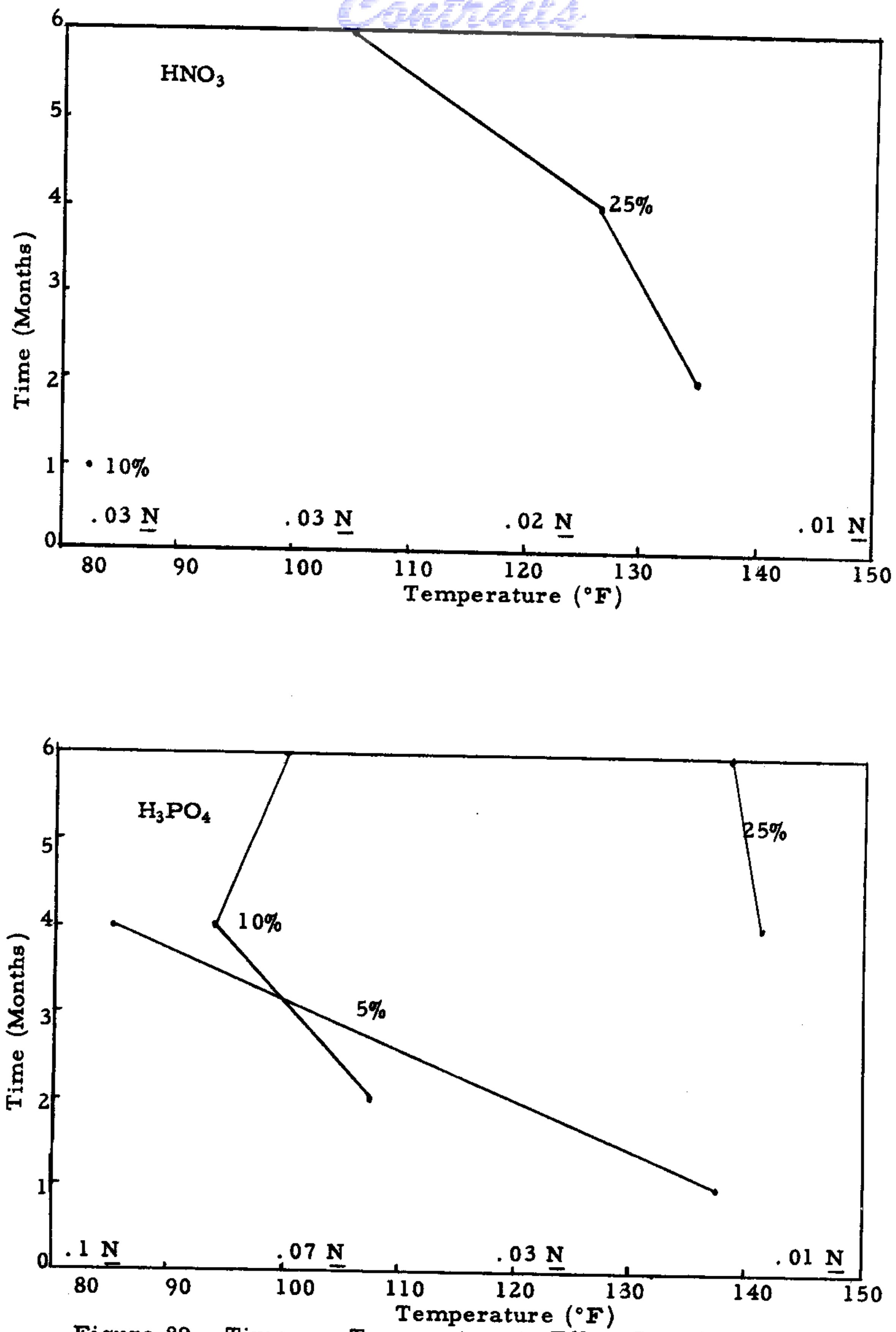


Figure 89. Time vs. Temperature to Effect Specific Strength Losses when nylon is treated in HNO_3 and H_3PO_4 and aged at low relative humidity; initial concentration of acid used at each temperature condition is shown.

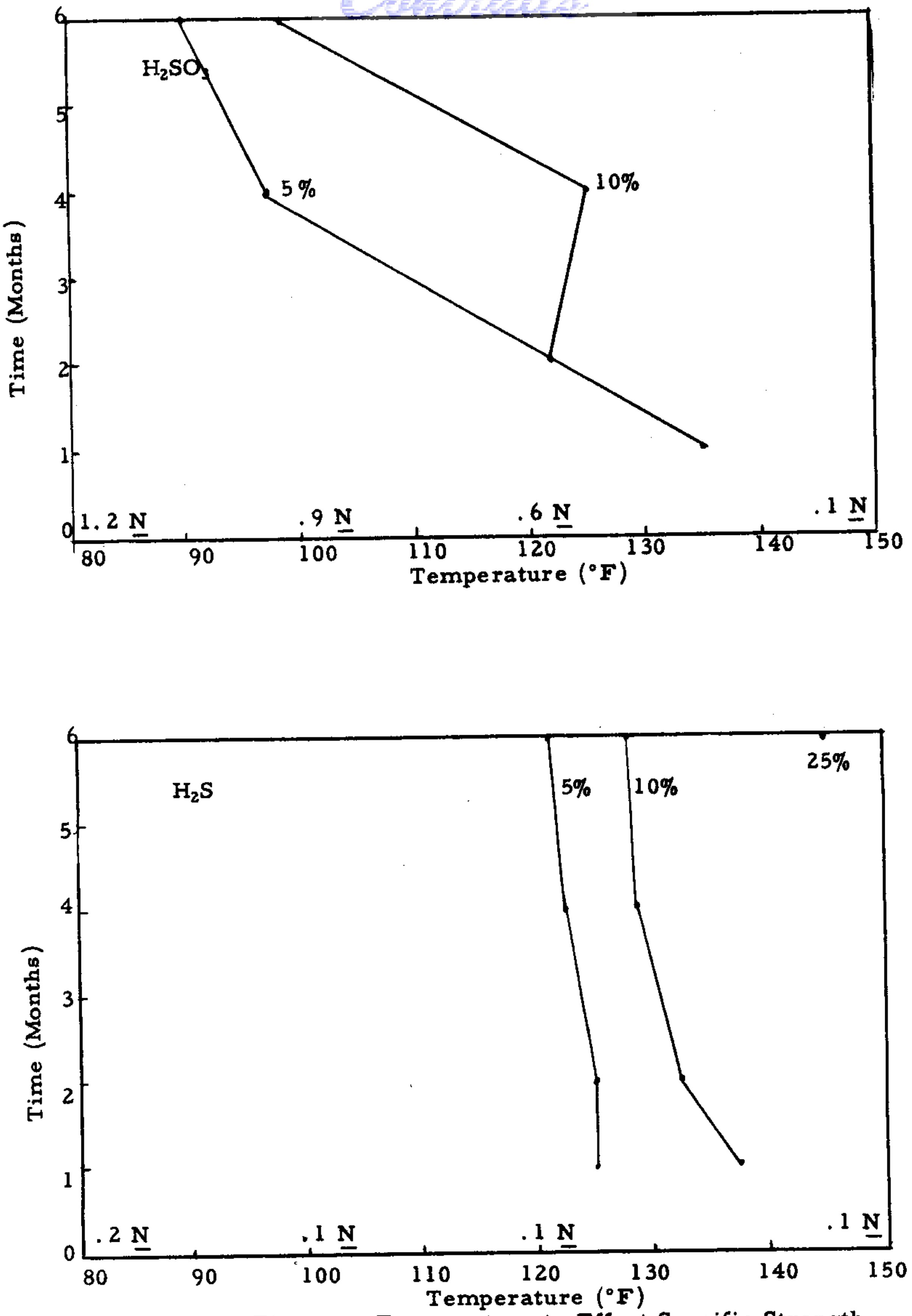


Figure 90. Time vs. Temperature to Effect Specific Strength Losses when nylon is treated in H_2SO_3 and H_2S and aged at low relative humidity; initial concentration of acid used at each temperature condition is shown.

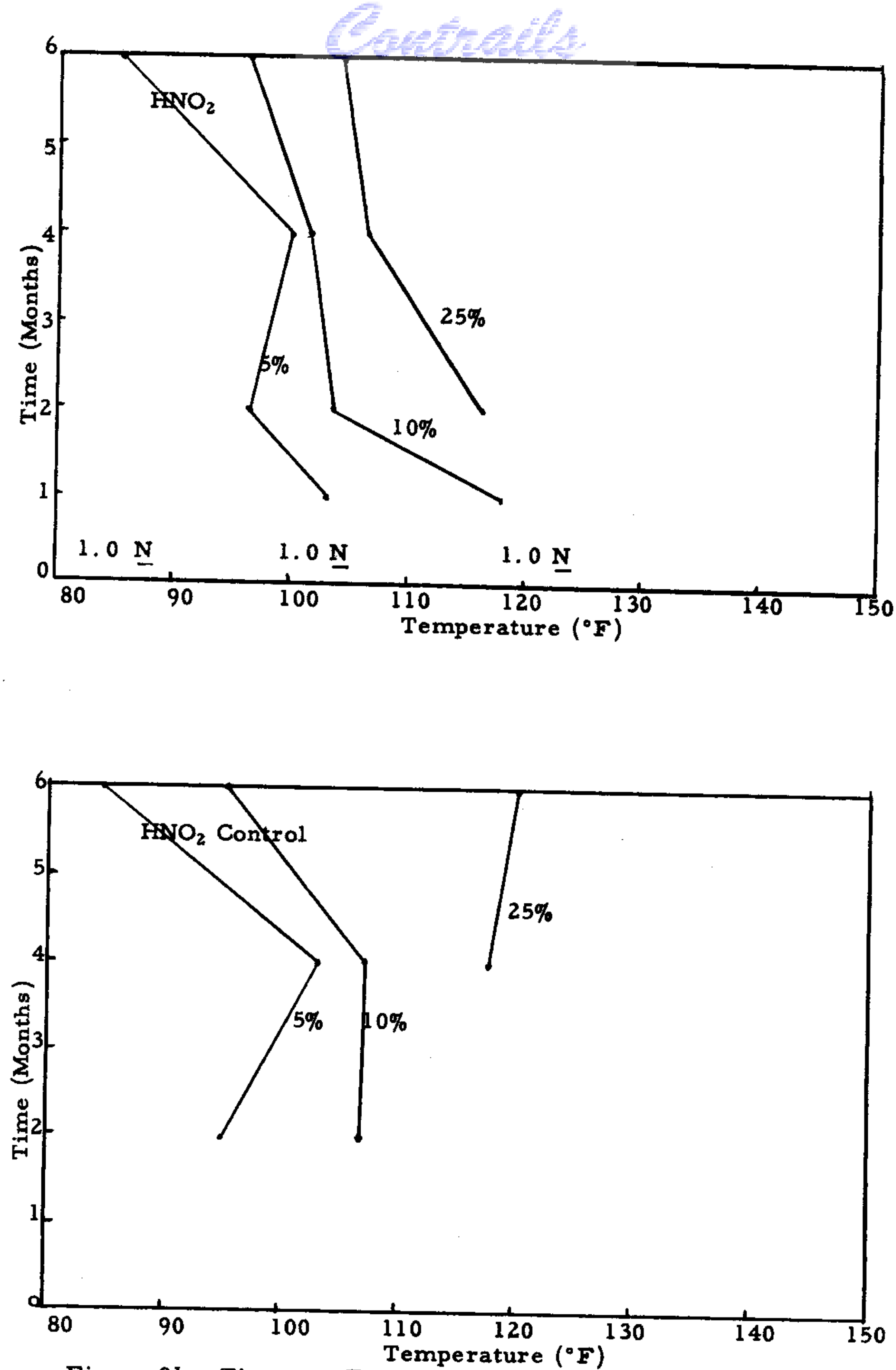


Figure 91. Time vs. Temperature to Effect Specific Strength Losses when nylon is treated in HNO$_2$ and HNO$_2$ Control and aged at low relative humidity; initial concentration of HNO$_2$ used at each temperature condition is shown.

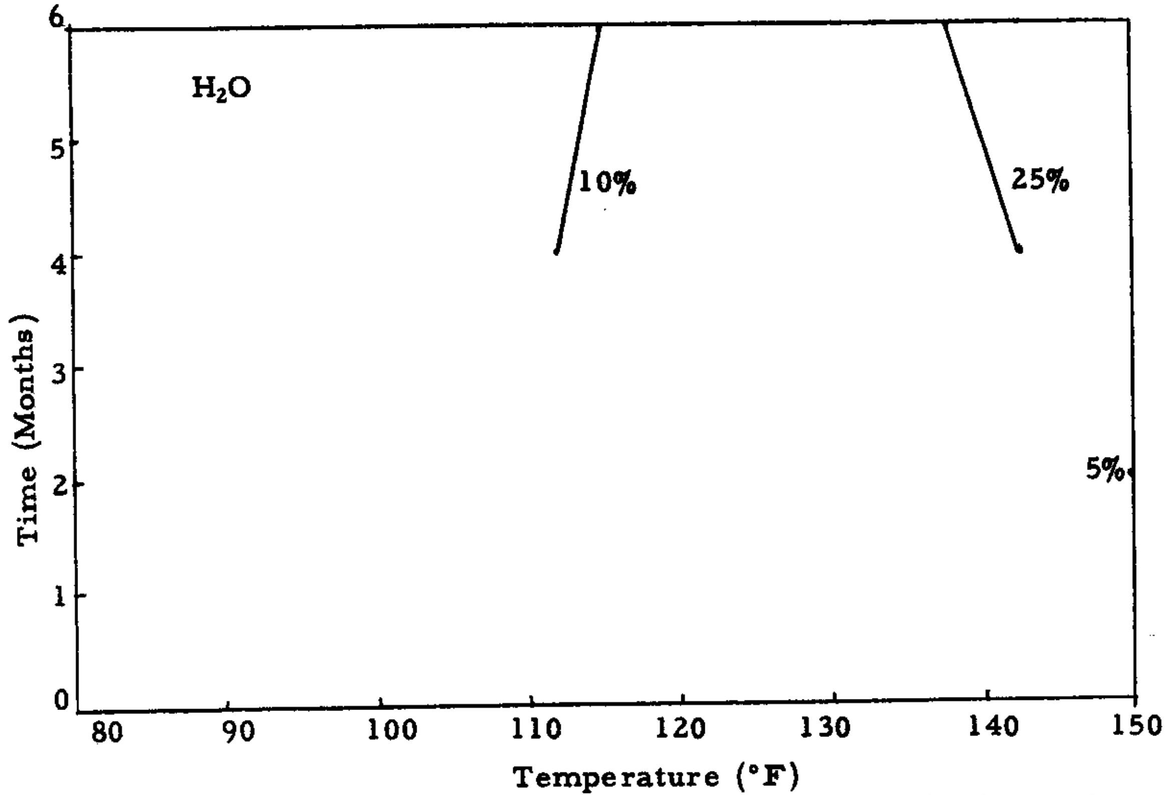


Figure 92. Time vs. Temperature to Effect Specific Strength Loss when nylon is in H_2O and aged at low relative humidity.

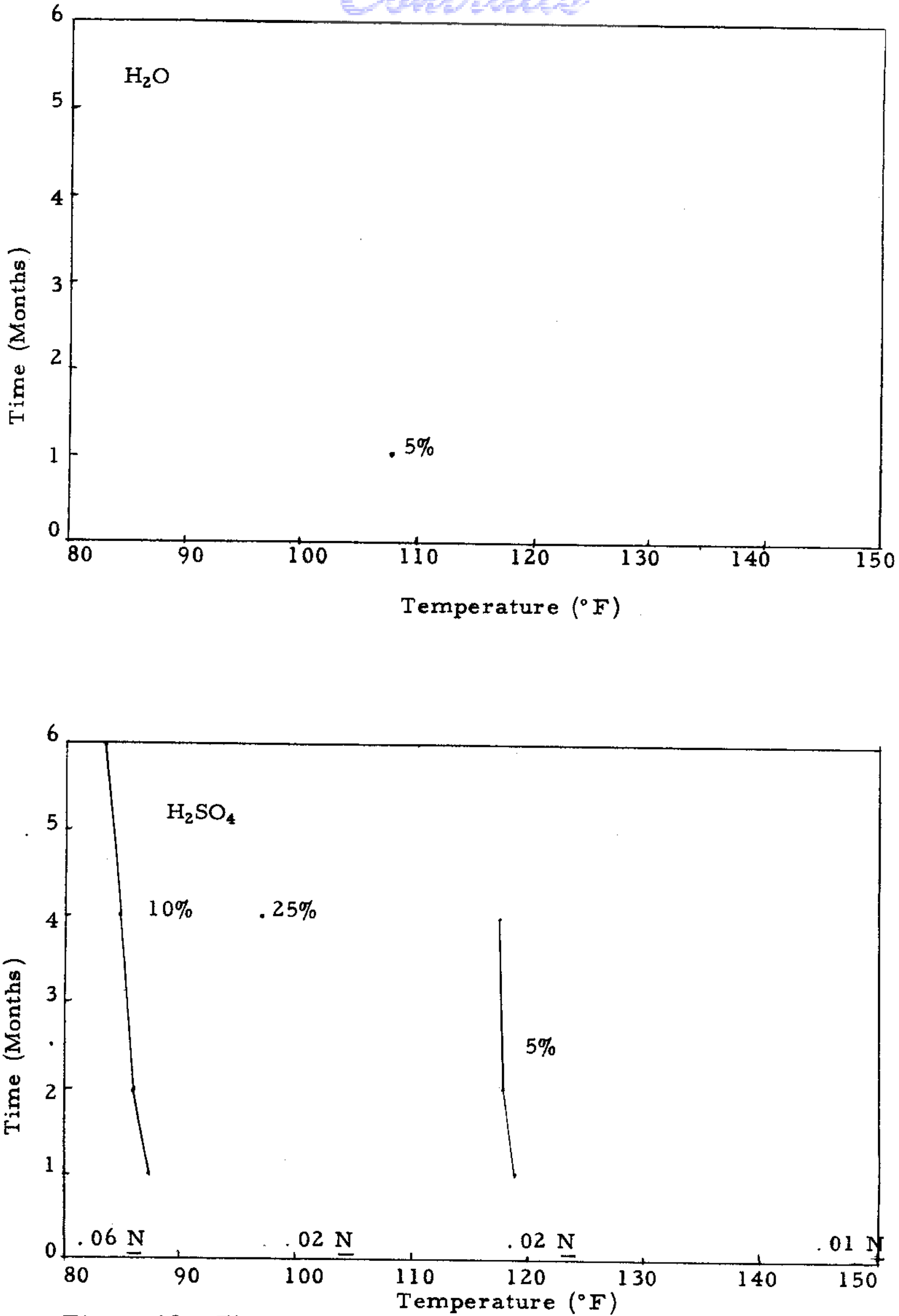


Figure 93. Time vs. Temperature to Effect Specific Strength Losses when nylon is treated in H_2O and H_2SO_4 and aged at high relative humidity; initial concentration of H_2SO_4 used at each temperature condition is shown.

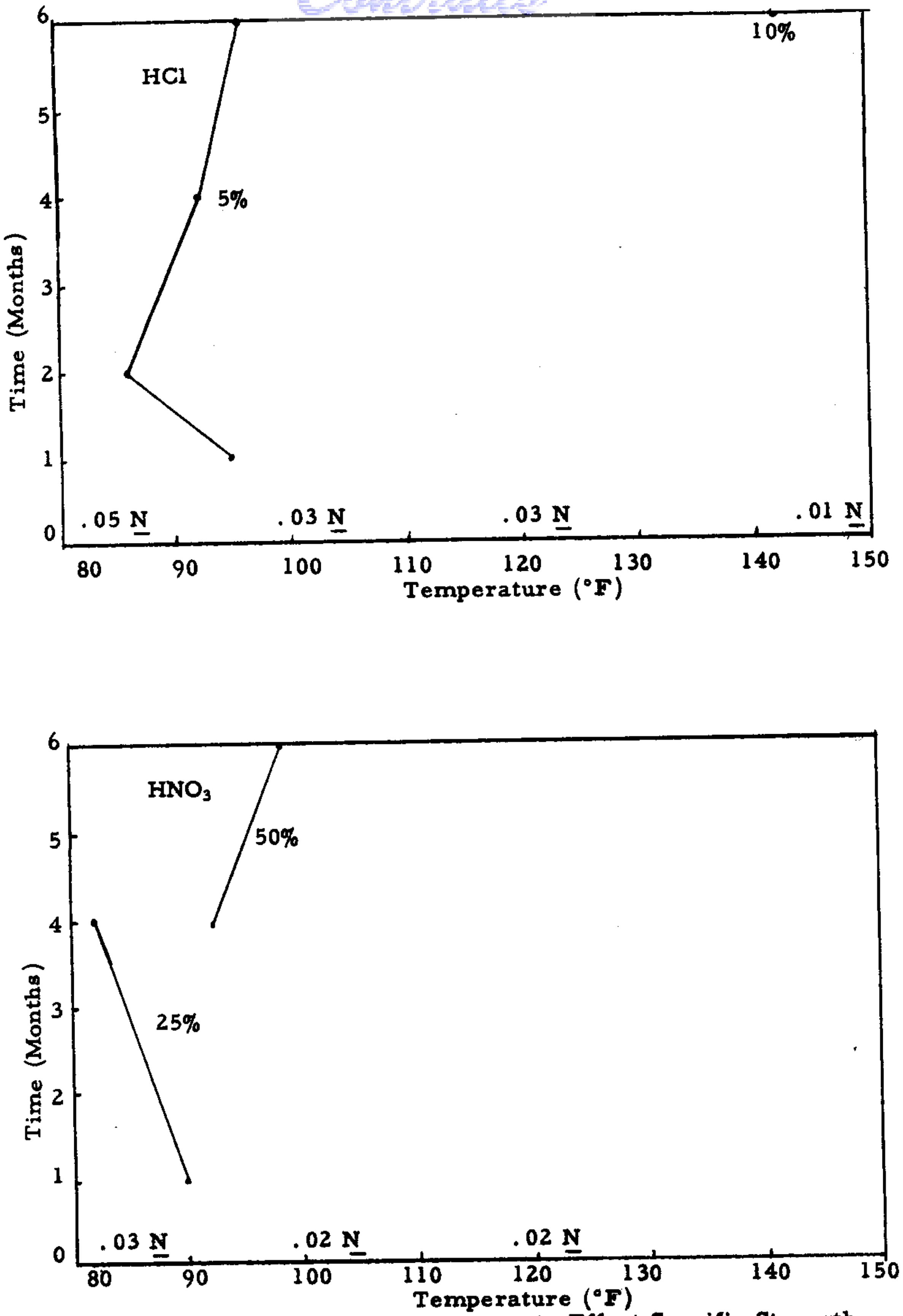


Figure 94. Time vs. Temperature to Effect Specific Strength Losses when nylon is treated in HCl and HNO_3 and aged at high relative humidity; initial concentration of acid used at each temperature condition is shown.

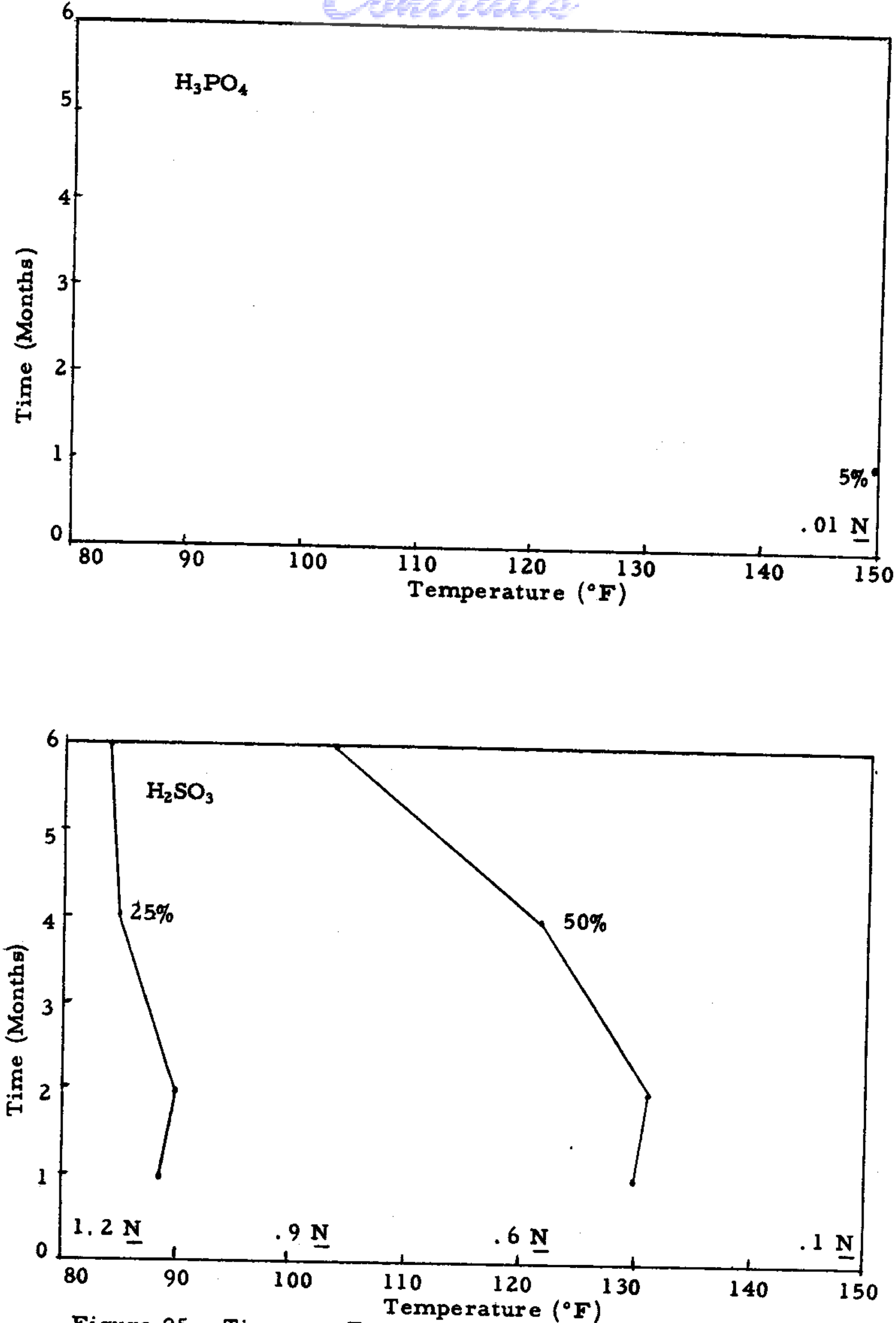


Figure 95. Time vs. Temperature to Effect Specific Strength Losses when nylon is treated in H_3PO_4 and H_2SO_3 and aged at high relative humidity; initial concentration of acid used at each temperature condition is shown.

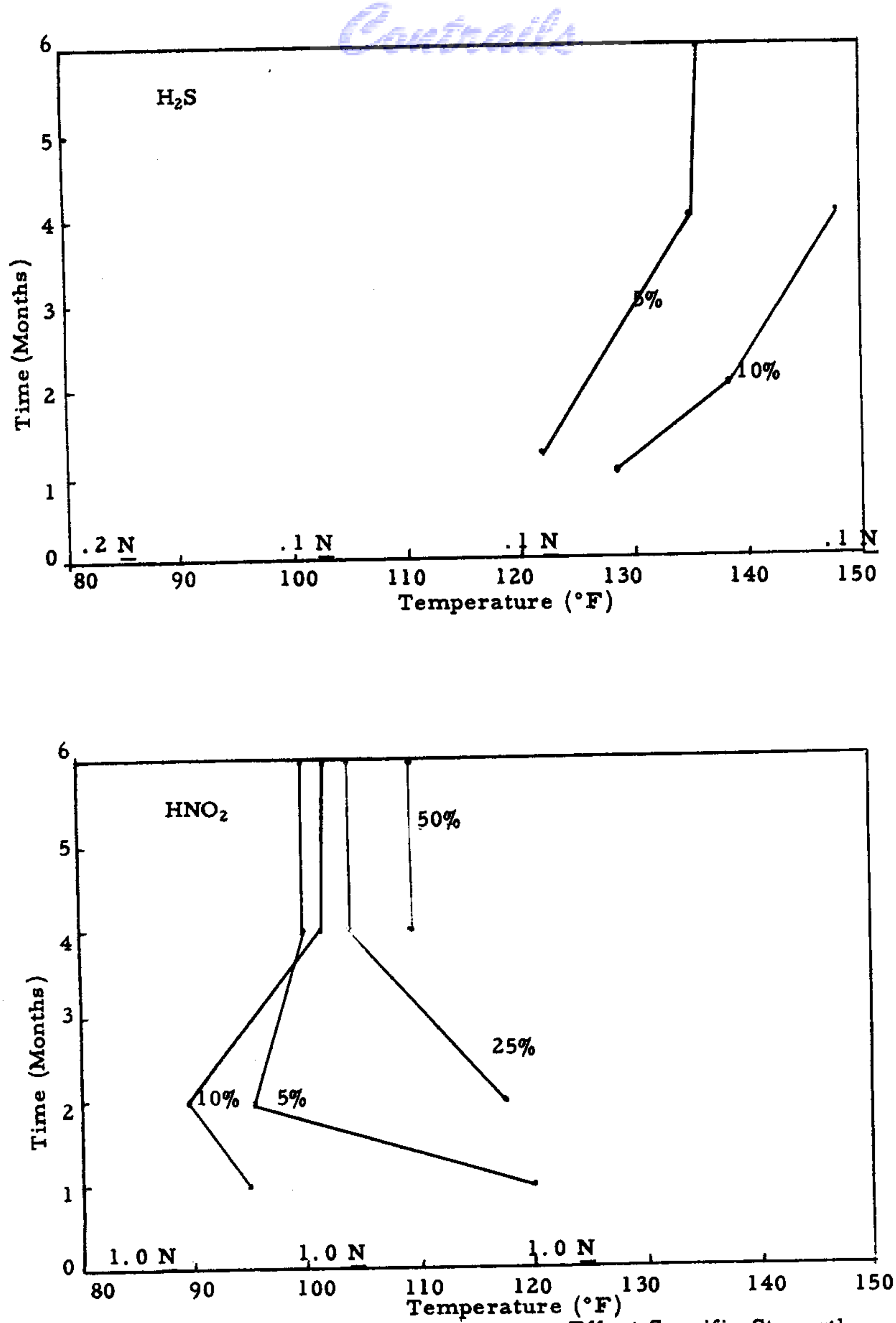


Figure 96. Time vs. Temperature to Effect Specific Strength Losses when nylon is treated in H_2S and HNO_2 and aged at high relative humidity; initial concentration of acid used at each temperature condition is shown.

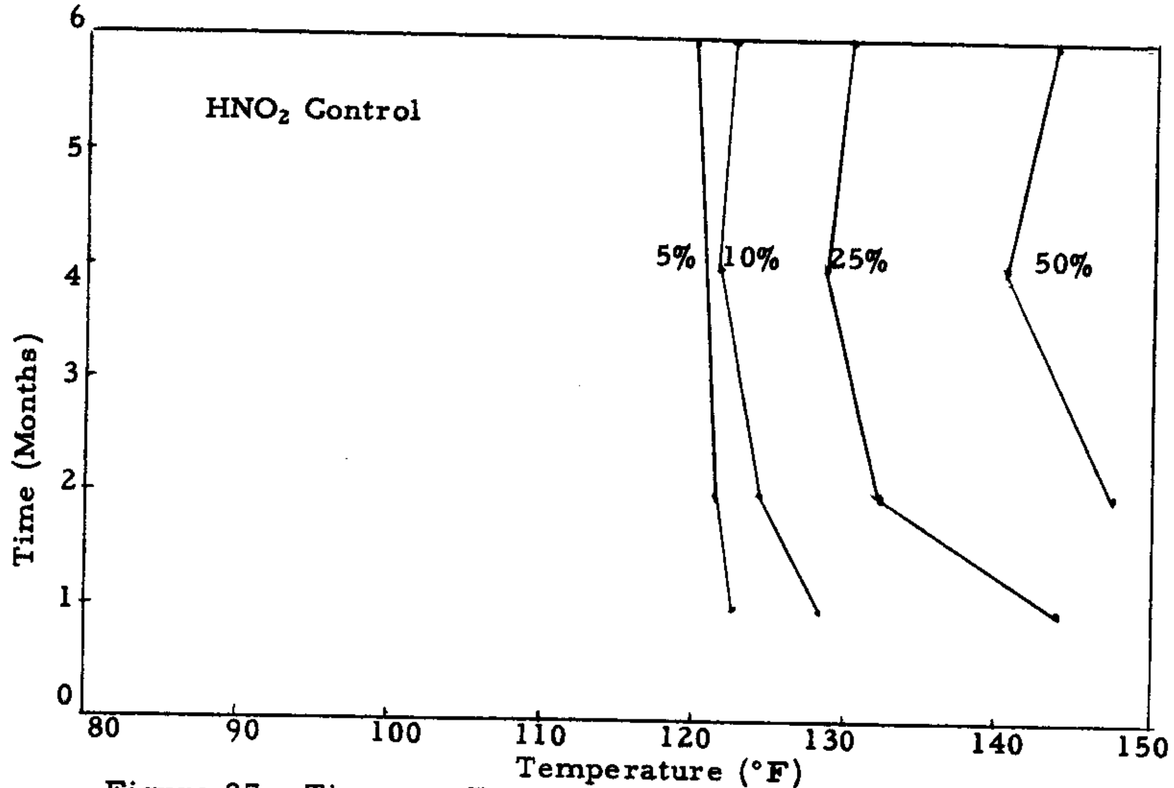


Figure 97. Time vs. Temperature to Effect Specific Strength Losses when nylon is treated in HNO_2 Control and aged at high relative humidity.

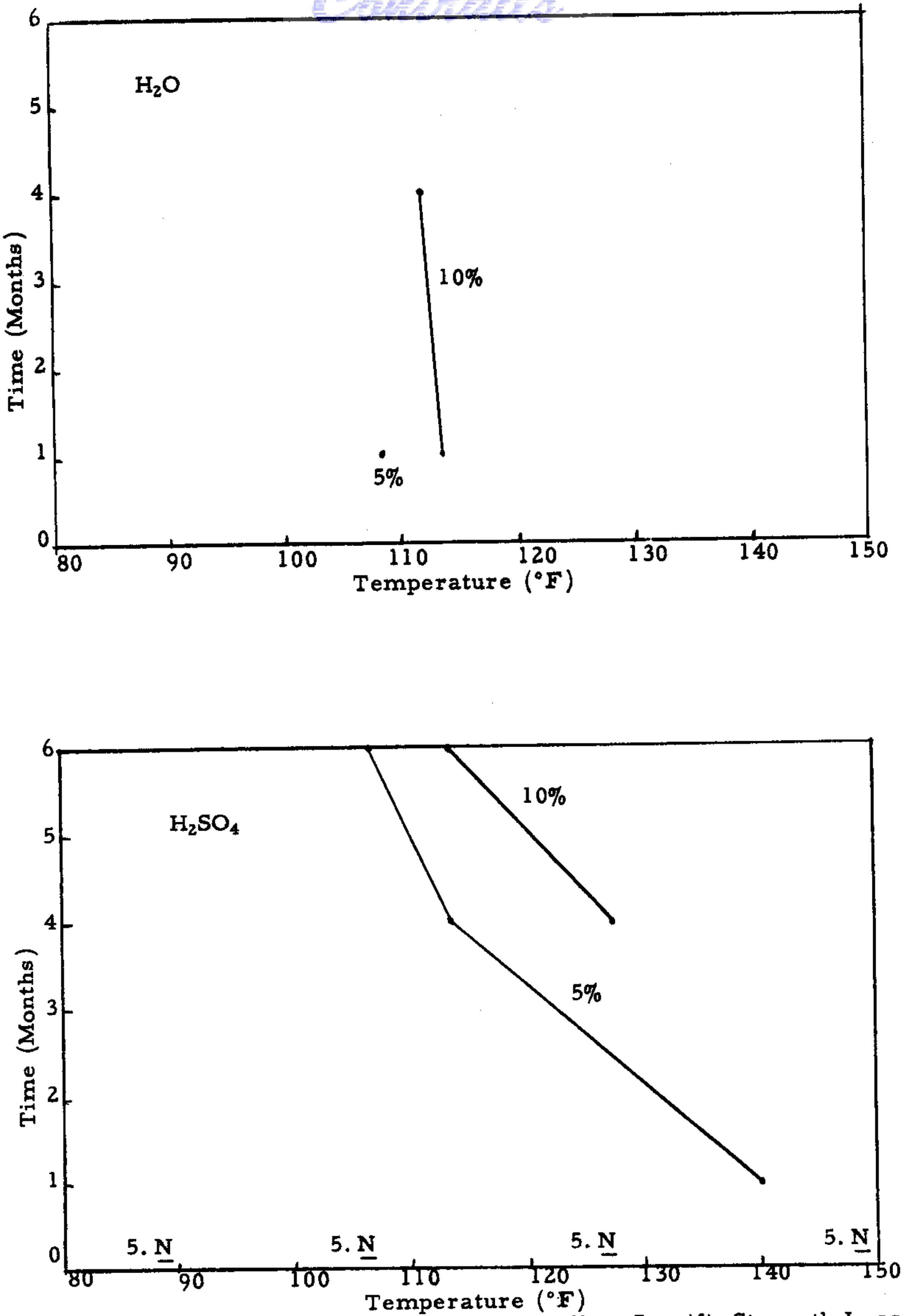
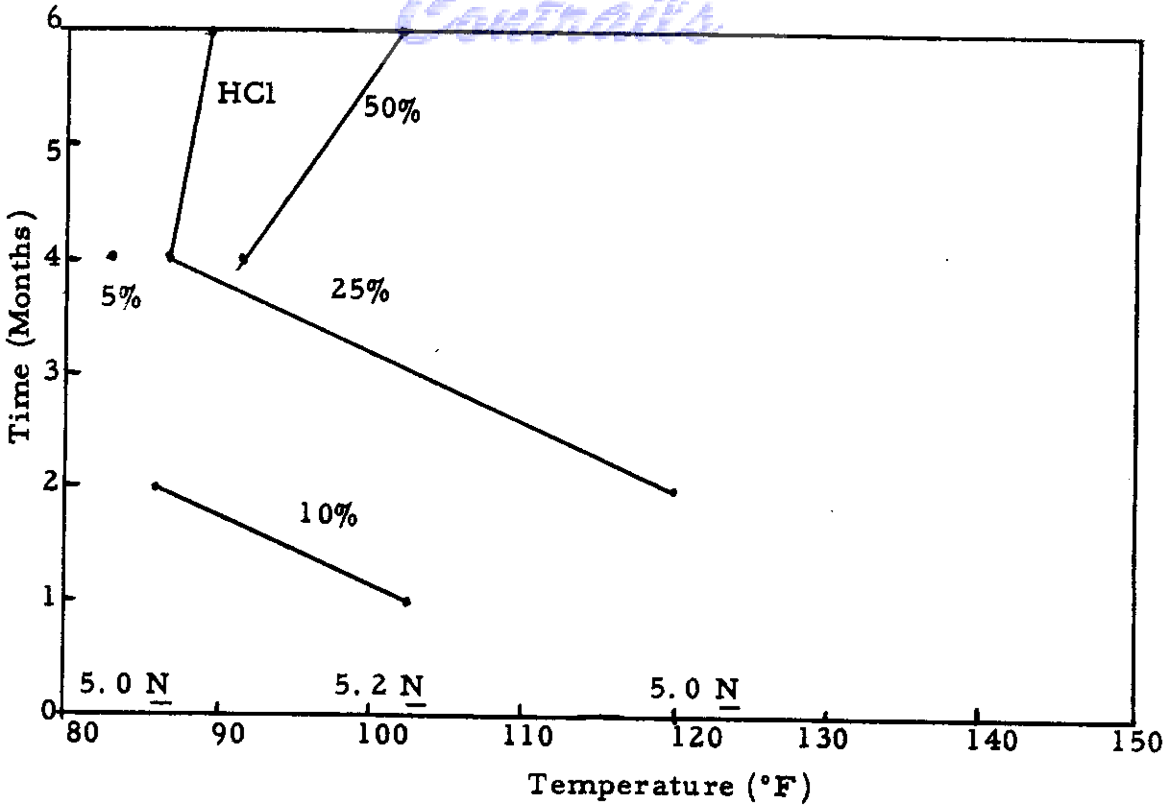


Figure 98. Time vs. Temperature to Effect Specific Strength Losses when Dacron (Type II) is treated in H_2O and H_2SO_4 and aged in solution; initial concentration of H_2SO_4 used at each temperature condition is shown.



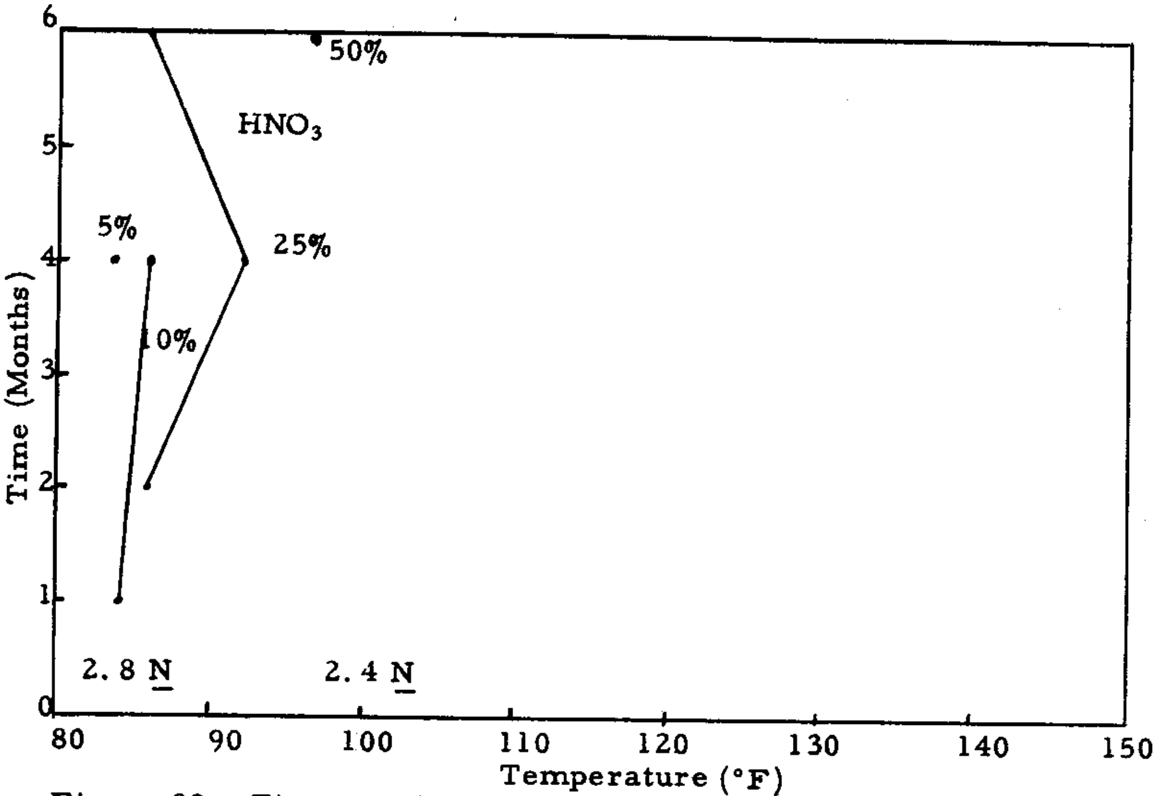


Figure 99. Time vs. Temperature to Effect Specific Strength Losses when Dacron (Type II) is treated in HCl and HNO_3 and aged in solution; initial concentration of acid used at each temperature condition is shown.

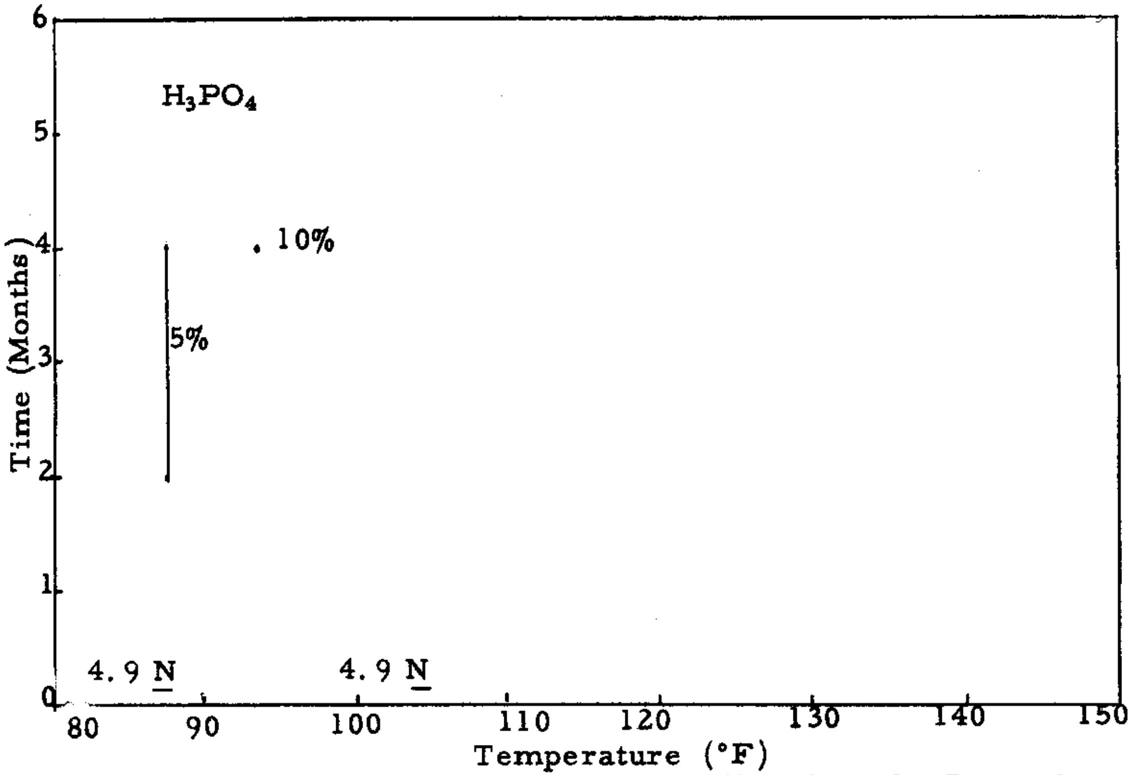
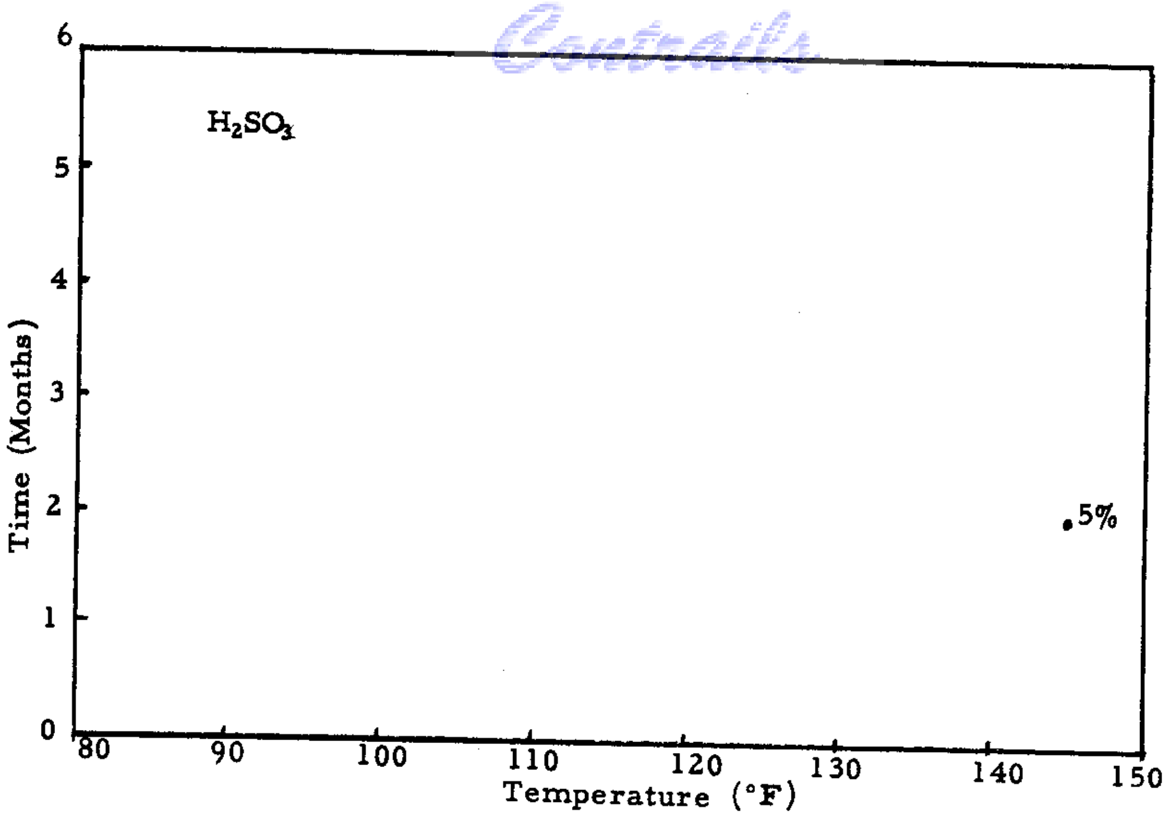


Figure 100. Time vs. Temperature to Effect Specific Strength Losses when Dacron (Type II) is treated in H_3PO_4 and aged in solution; initial concentration of acid used at each temperature condition is shown.



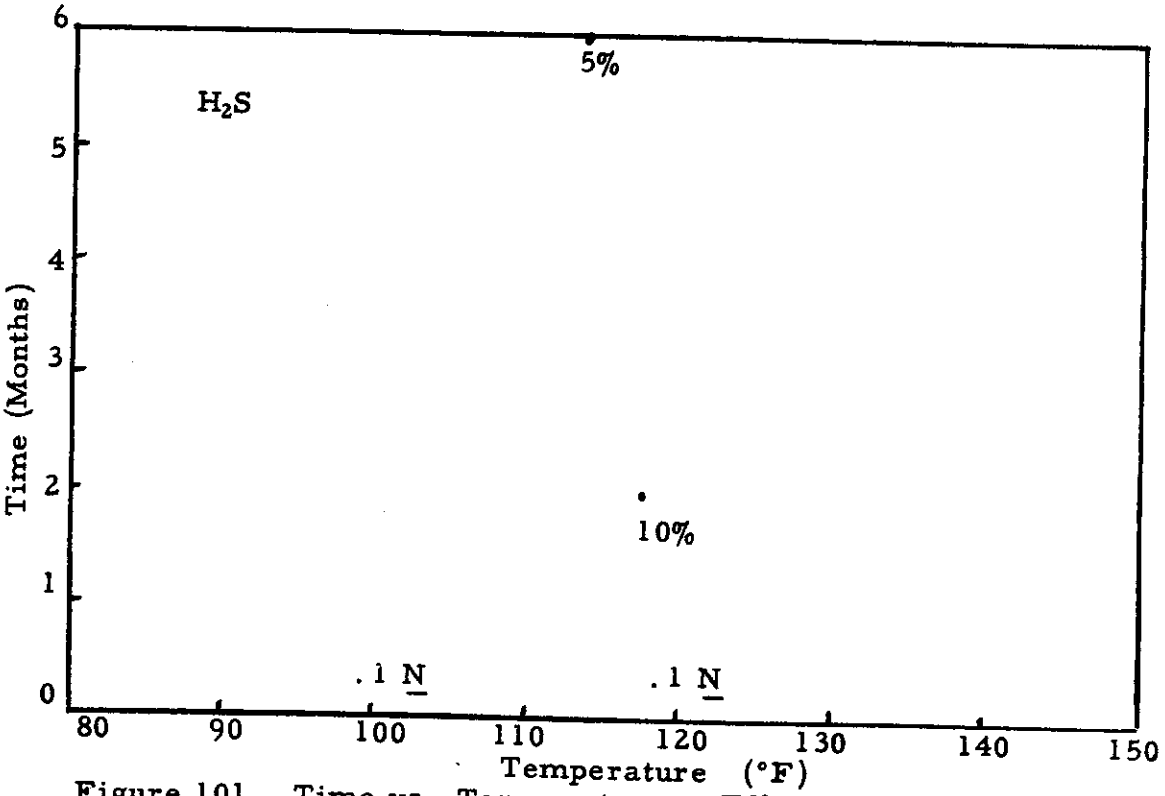
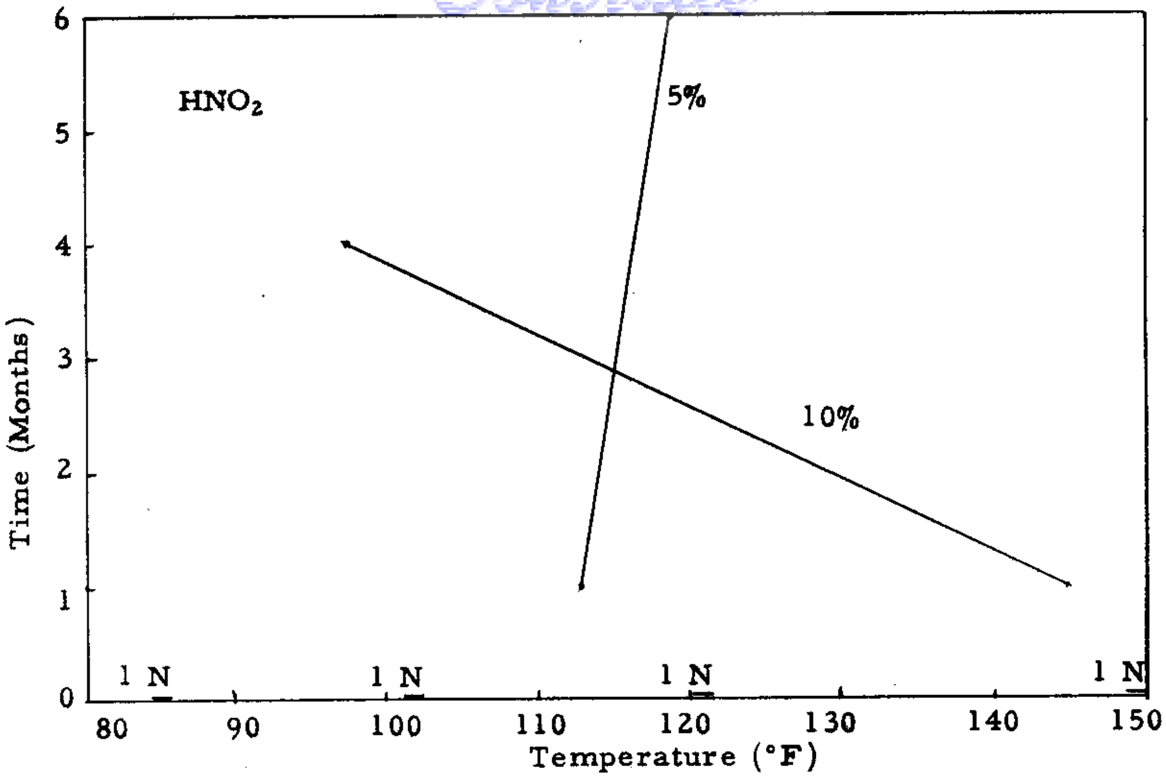


Figure 101. Time vs. Temperature to Effect Specific Strength losses when Dacron (Type II) is treated in H_2SO_3 and H_2S and aged in solution; initial concentration of acid used at each temperature condition is shown.



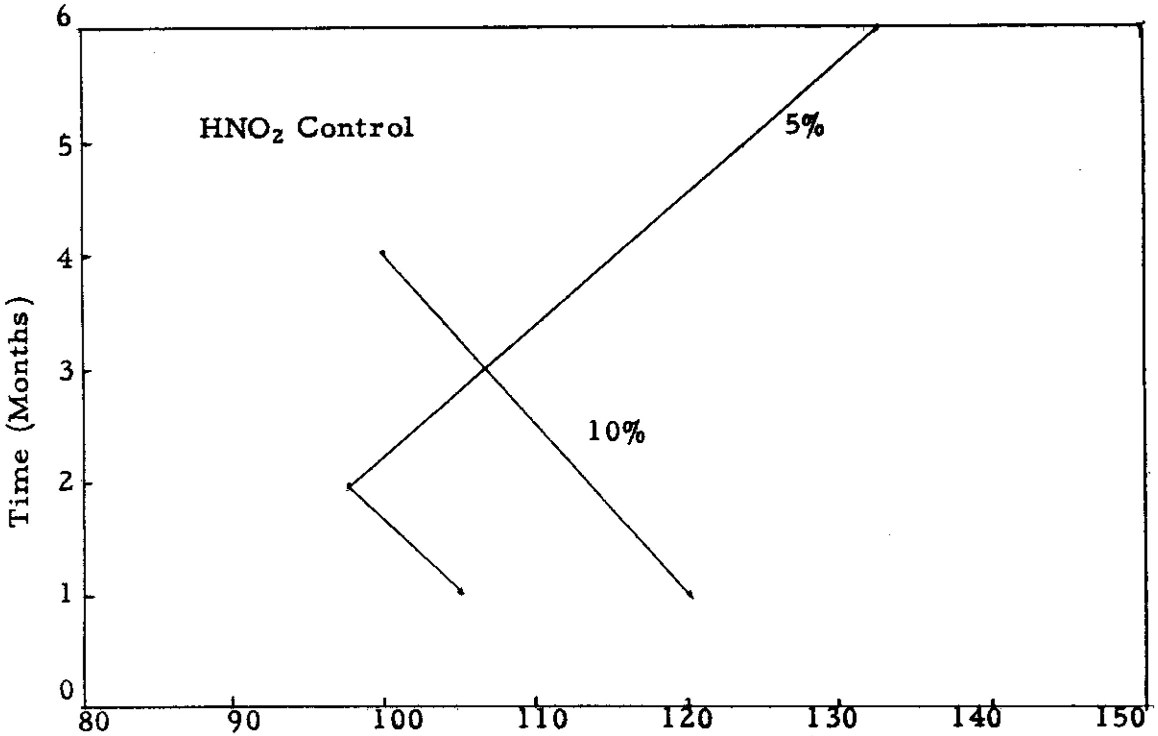
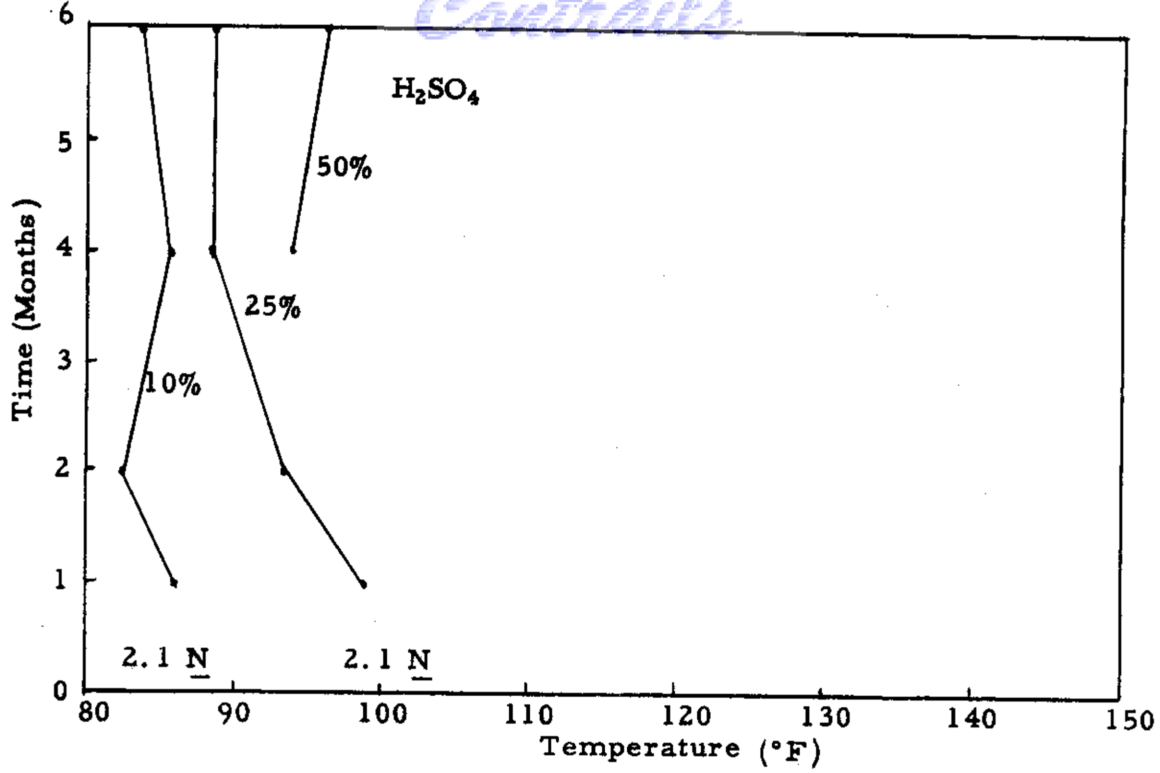


Figure 102. Time vs. Temperature to Effect Specific Strength Losses when Dacron (Type II) is treated in HNO_2 and HNO_2 Control and aged in solution; initial concentration of HNO_2 used at each temperature condition is shown.



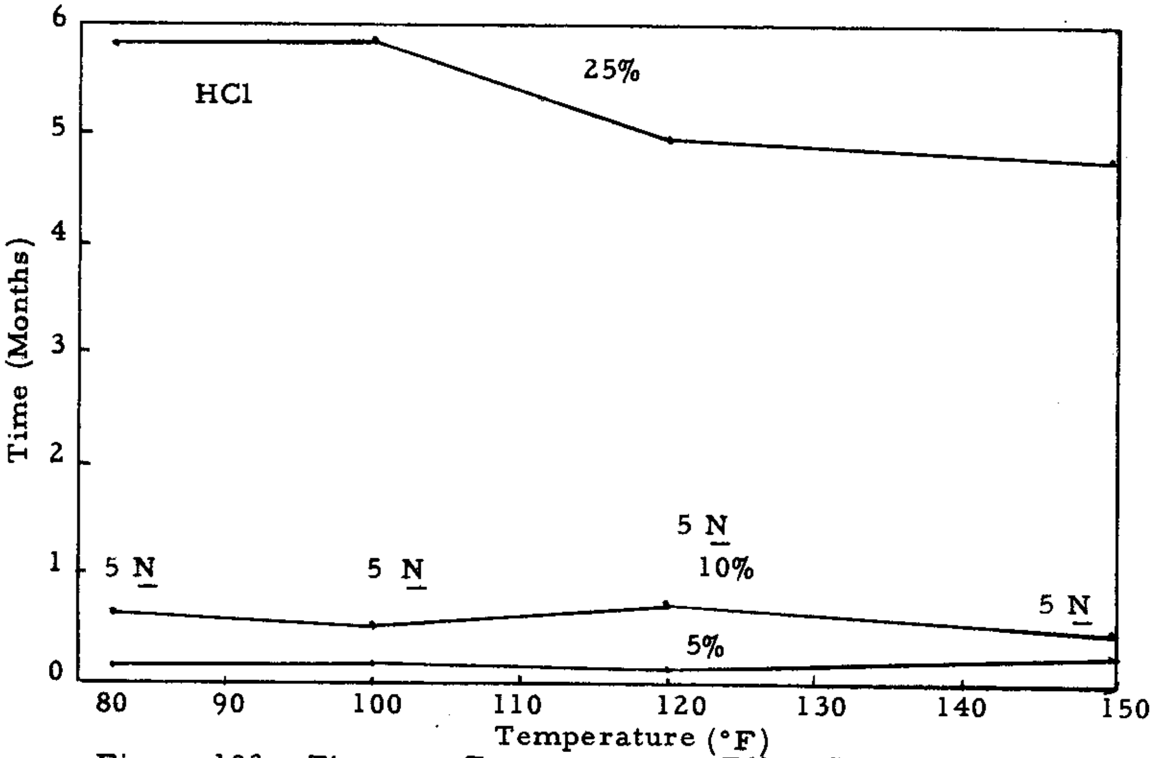


Figure 103. Time vs. Temperature to Effect Specific Strength Losses when Dacron (Type II) is treated in H_2SO_4 and HCl and aged at low relative humidity; initial concentration of acid used at each temperature condition is shown.

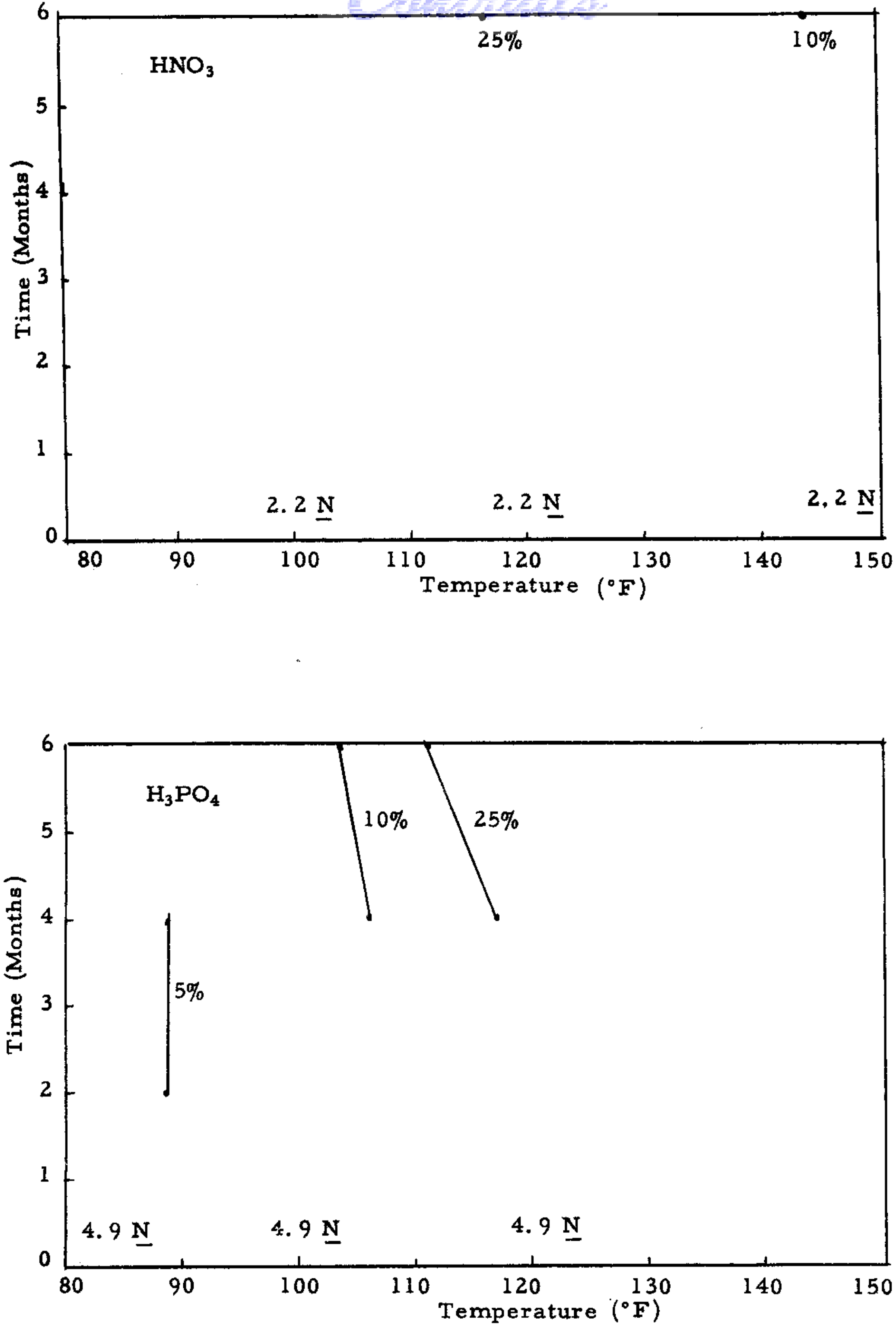


Figure 104. Time vs. Temperature to Effect Specific Strength Losses when Dacron (Type II) is treated in HNO_3 and H_3PO_4 and aged at low relative humidity; initial concentration of acid used at each temperature condition is shown.

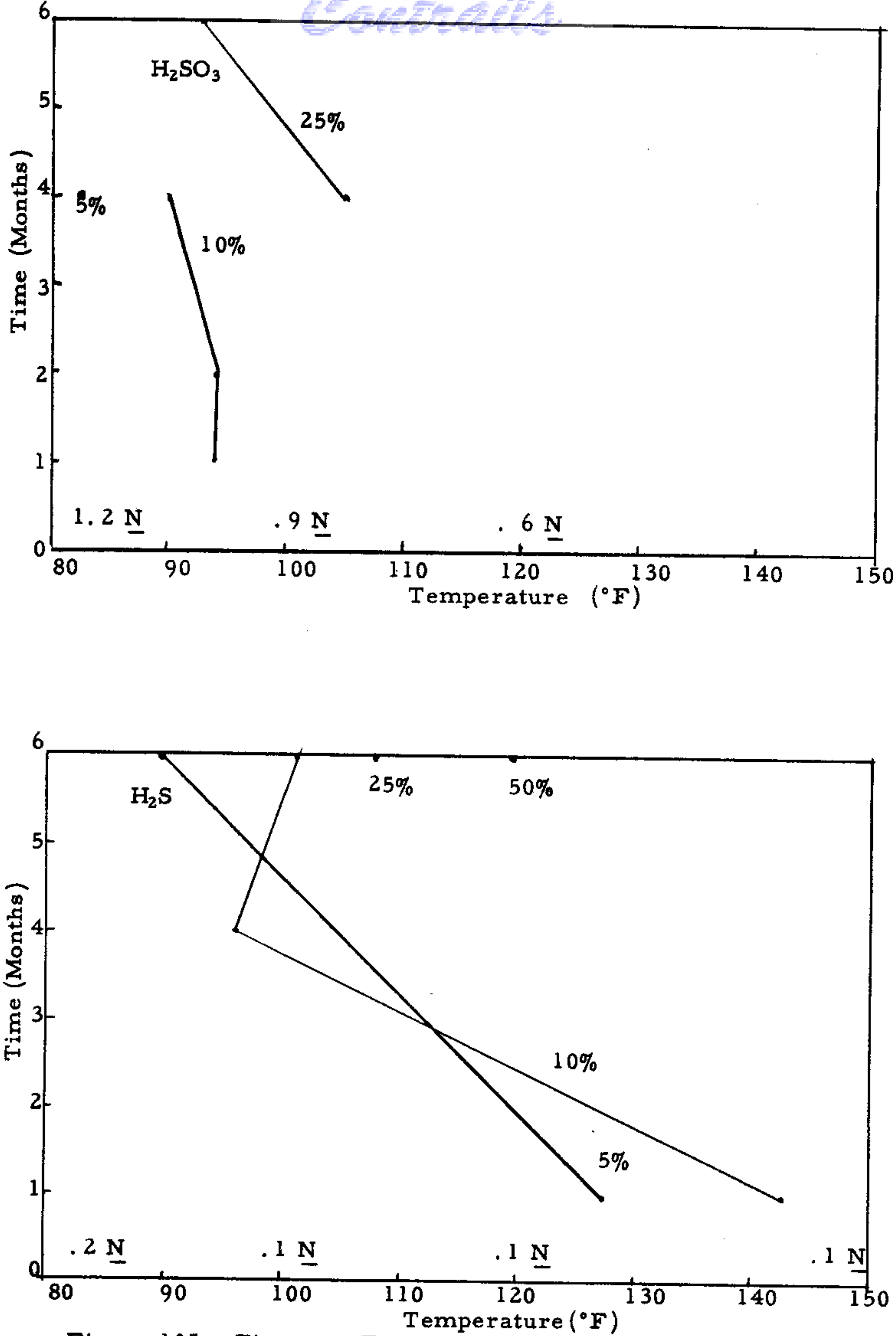


Figure 105. Time vs. Temperature to Effect Specific Strength Losses when Dacron (Type II) is treated in H_2SO_3 and H_2S and aged at low relative humidity; initial concentration of acid used at each temperature condition is shown.

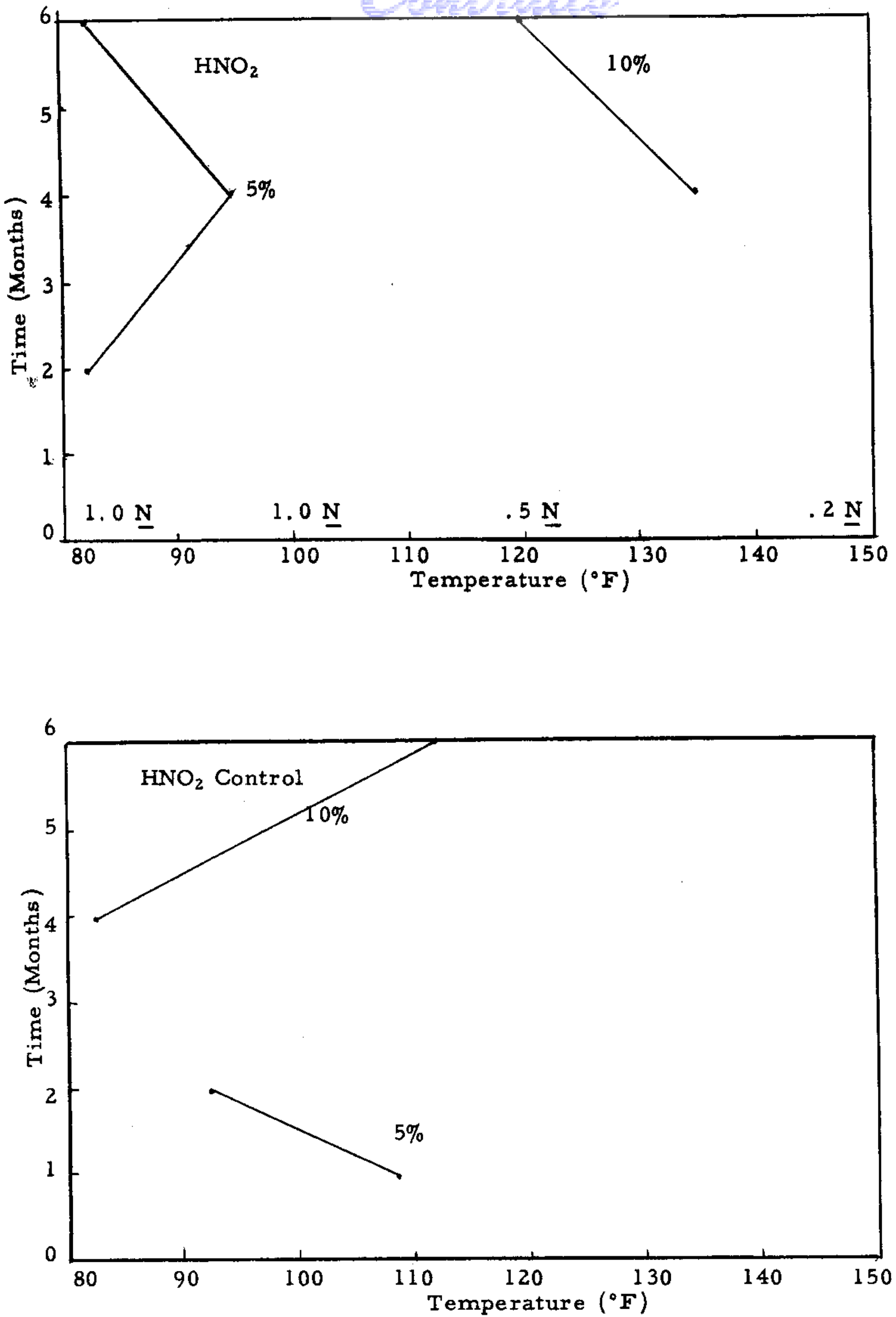


Figure 106. Time vs. Temperature to Effect Specific Strength Losses when Dacron (Type II) is treated in HNO_2 and HNO_2 Control and aged at low relative humidity; initial concentration of HNO_2 used at each temperature condition is shown.

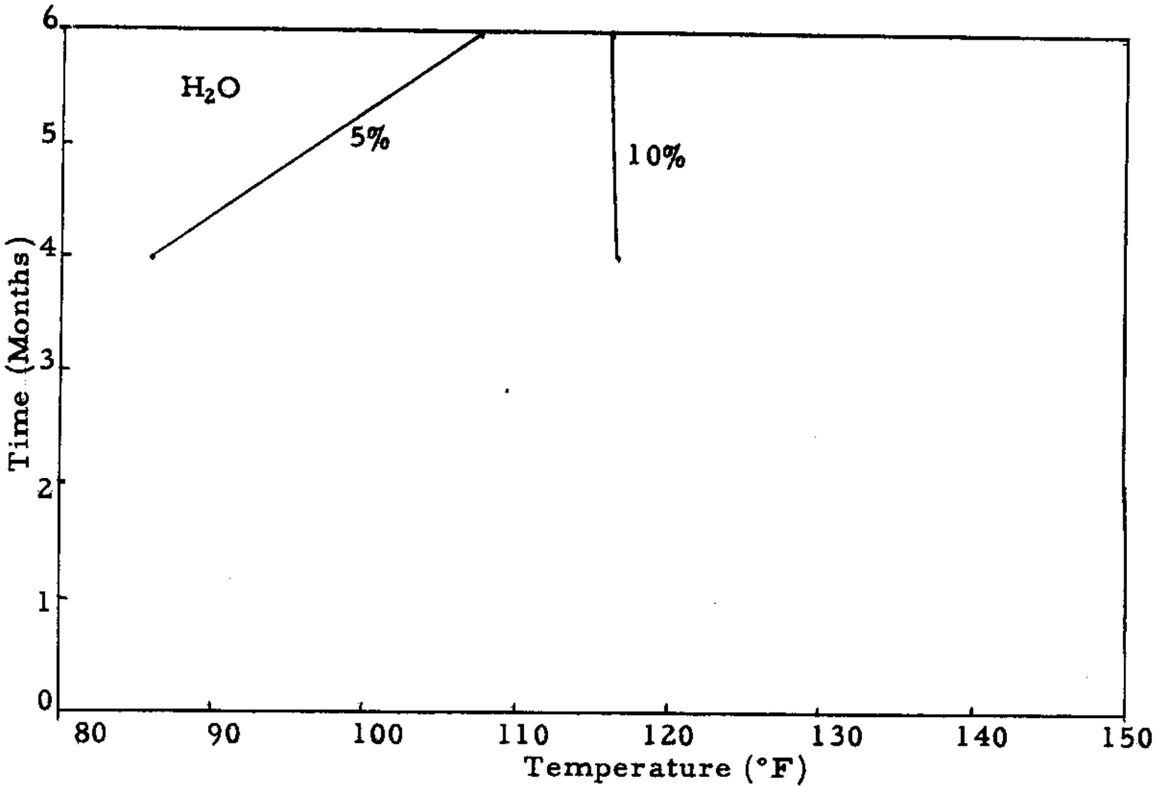
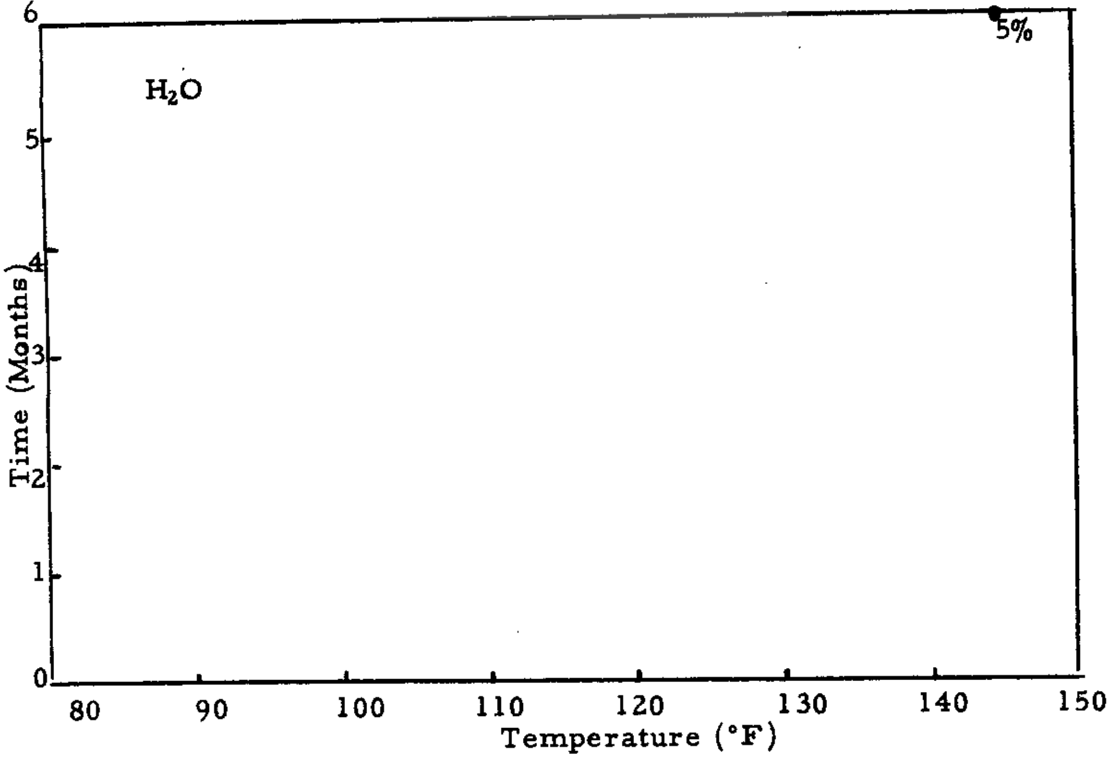


Figure 107. Time vs. Temperature to Effect Specific Strength Losses when Dacron (Type II) is treated in H_2O and aged at low relative humidity.



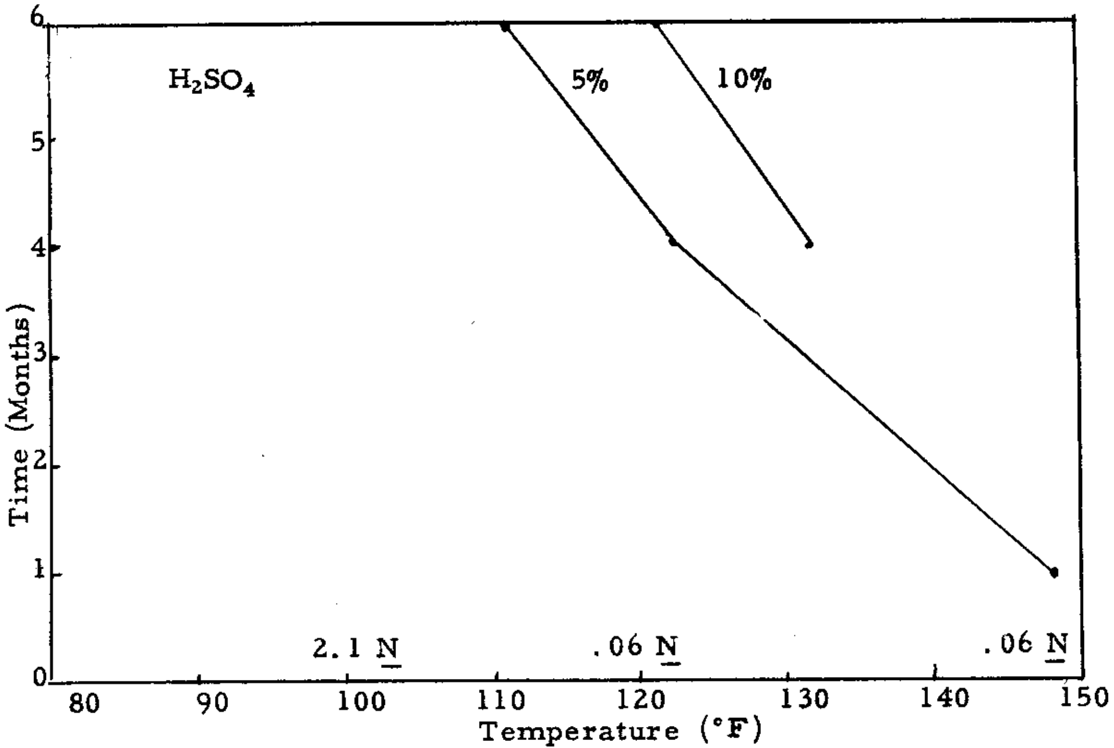


Figure 108. Time vs. Temperature to Effect Specific Strength Losses when Dacron (Type II) is treated in H_2O and H_2SO_4 and aged at high relative humidity; initial concentration of H_2SO_4 used at each temperature condition is shown.

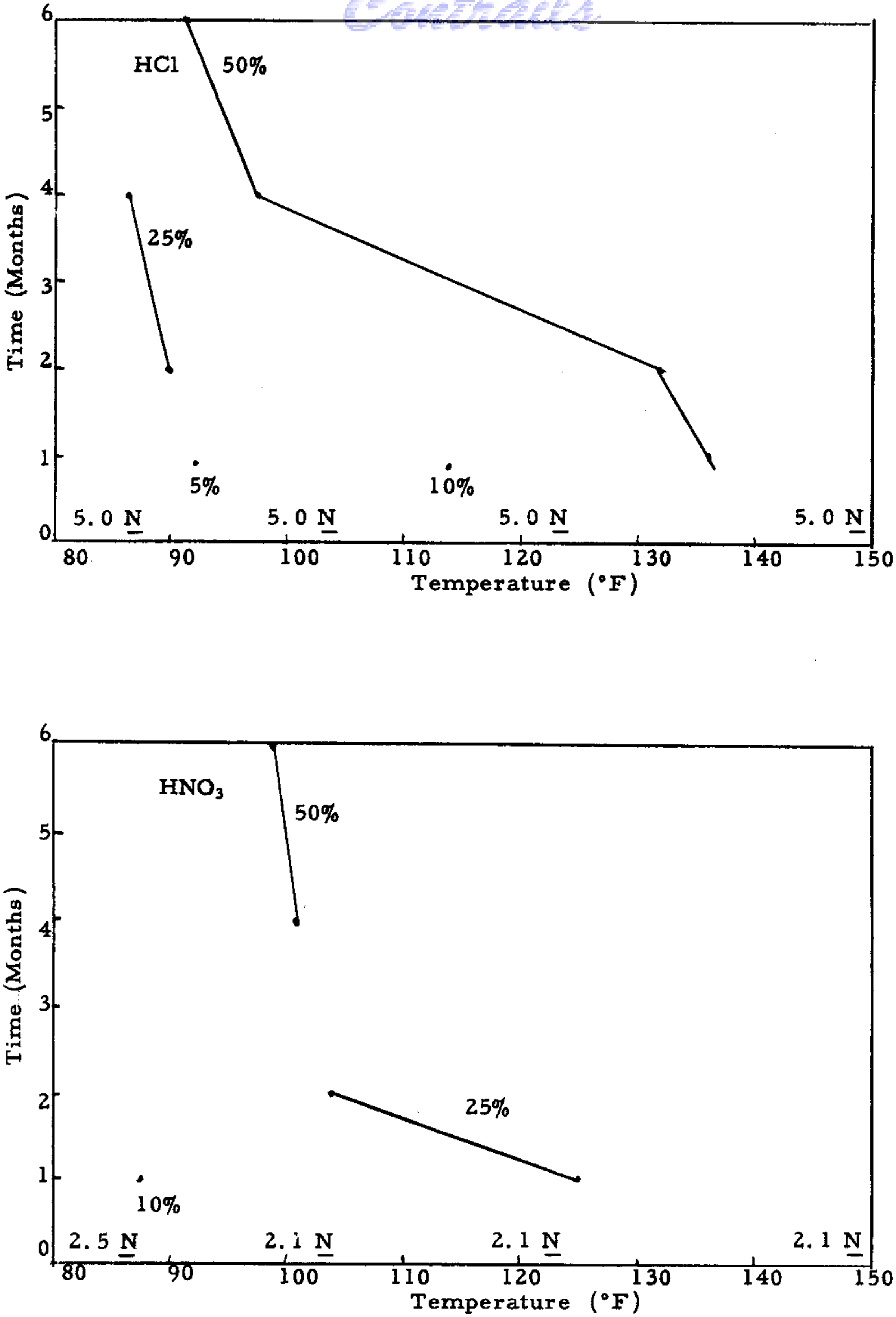


Figure 109. Time vs. Temperature to Effect Specific Strength Losses when Dacron (Type II) is treated in HCl and HNO_3 and aged at high relative humidity; initial concentration of acid used at each temperature condition is shown.

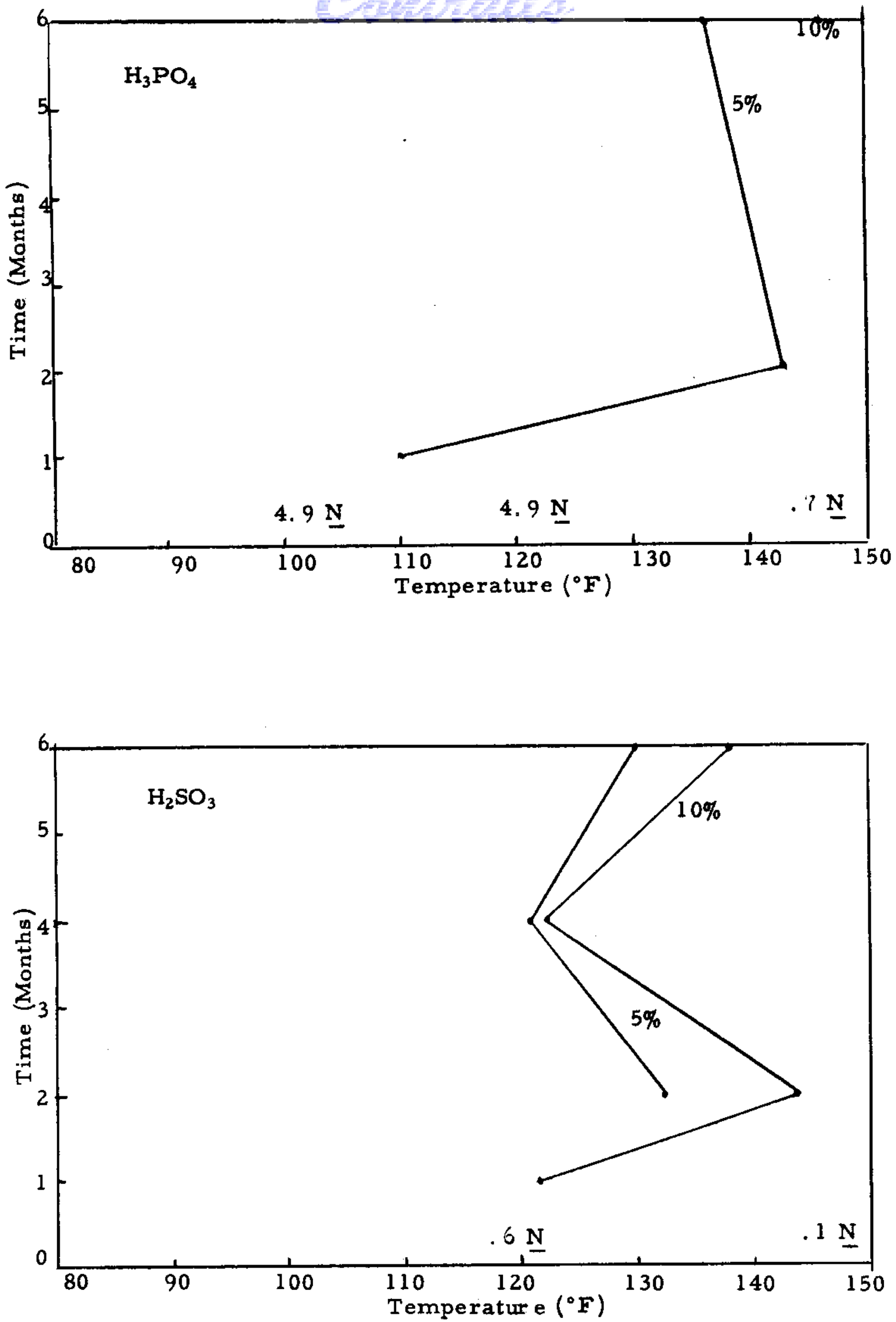
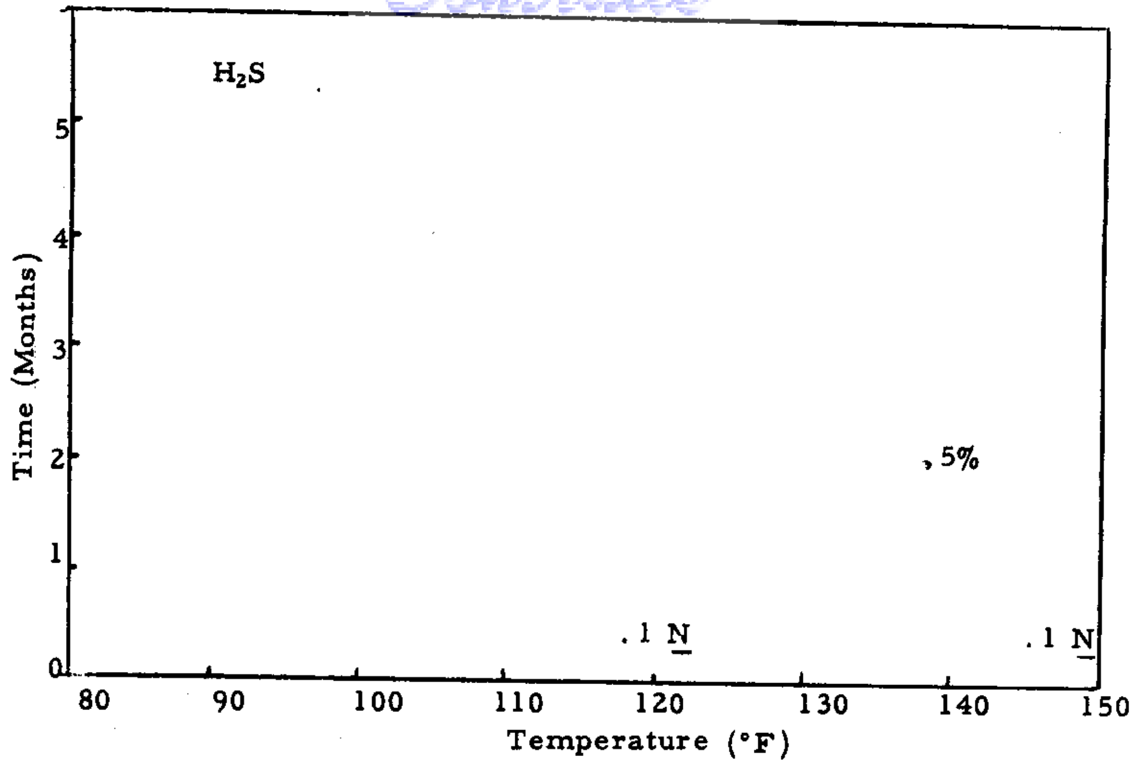


Figure 110. Time vs. Temperature to Effect Specific Strength Losses when Dacron (Type II) is treated in H_3PO_4 and H_2SO_3 and aged at high relative humidity; initial concentration of acid used at each temperature condition is shown.



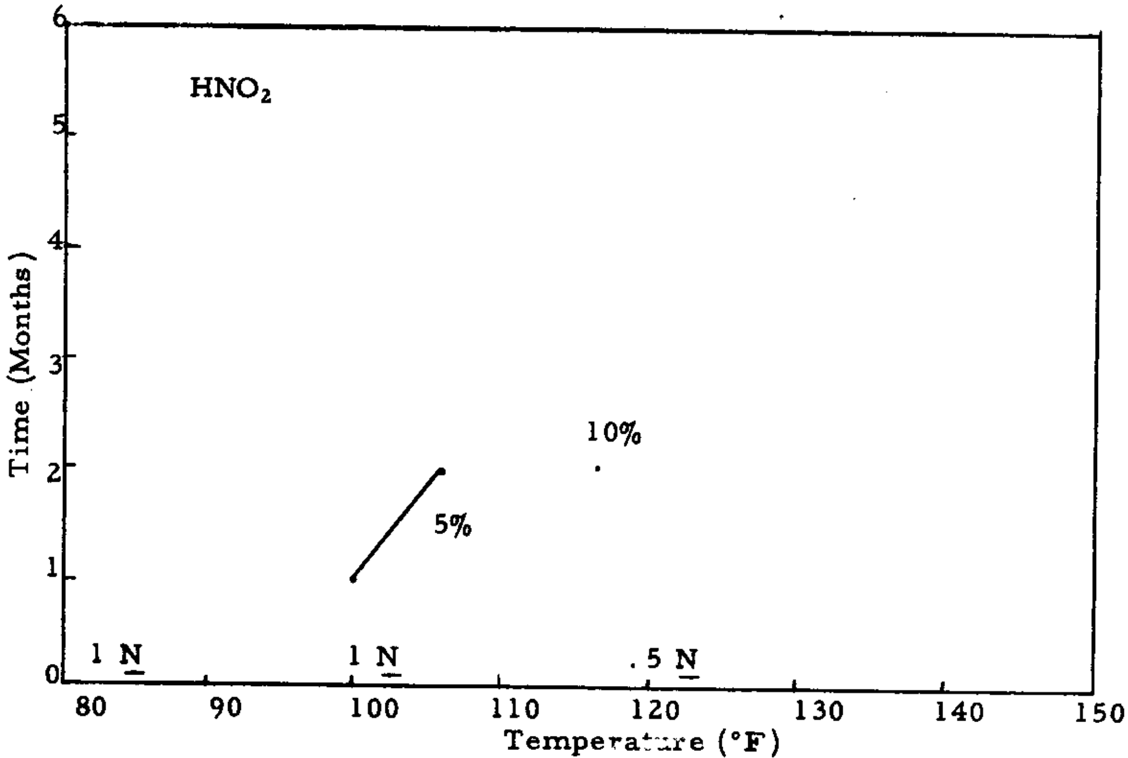


Figure 111. Time vs. Temperature to Effect Specific Strength Losses when Dacron (Type II) is treated in H_2S and HNO_2 and aged at high relative humidity; initial concentration of acid used at each temperature condition is shown.

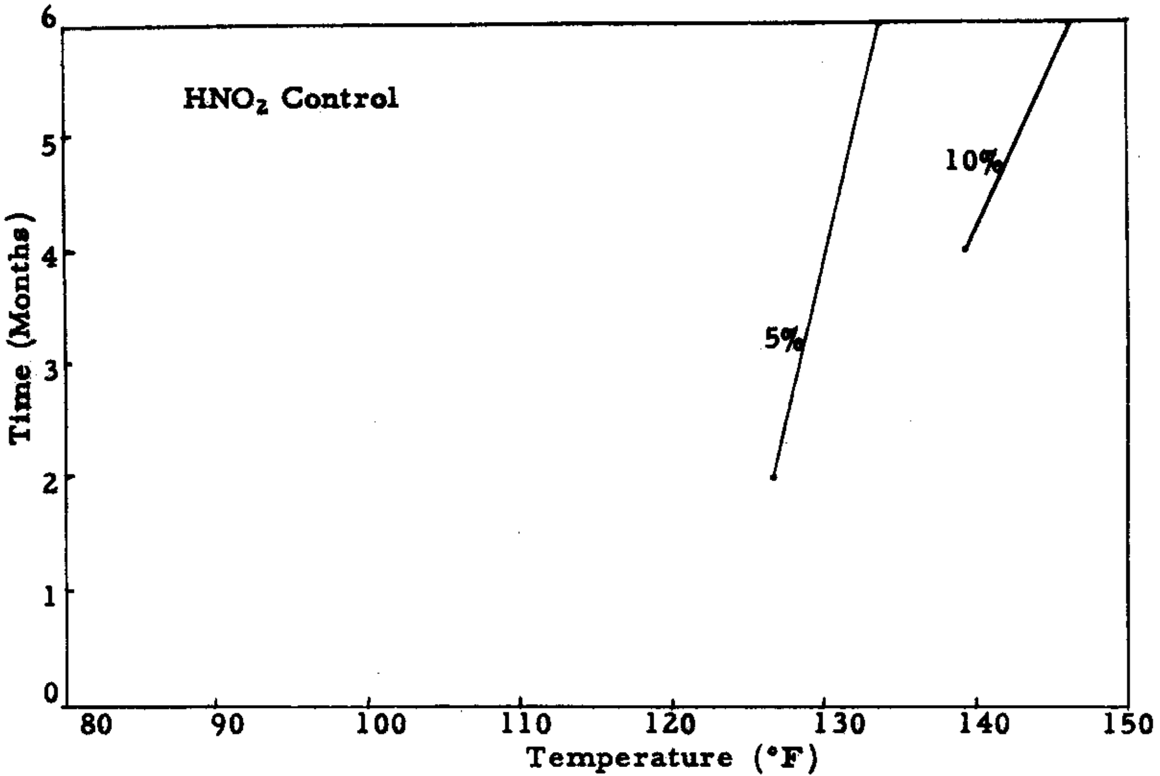


Figure 112. Time vs. Temperature to Effect Specific Strength Losses when Dacron (Type II) is treated in HNO_2 Control and aged at high relative humidity.

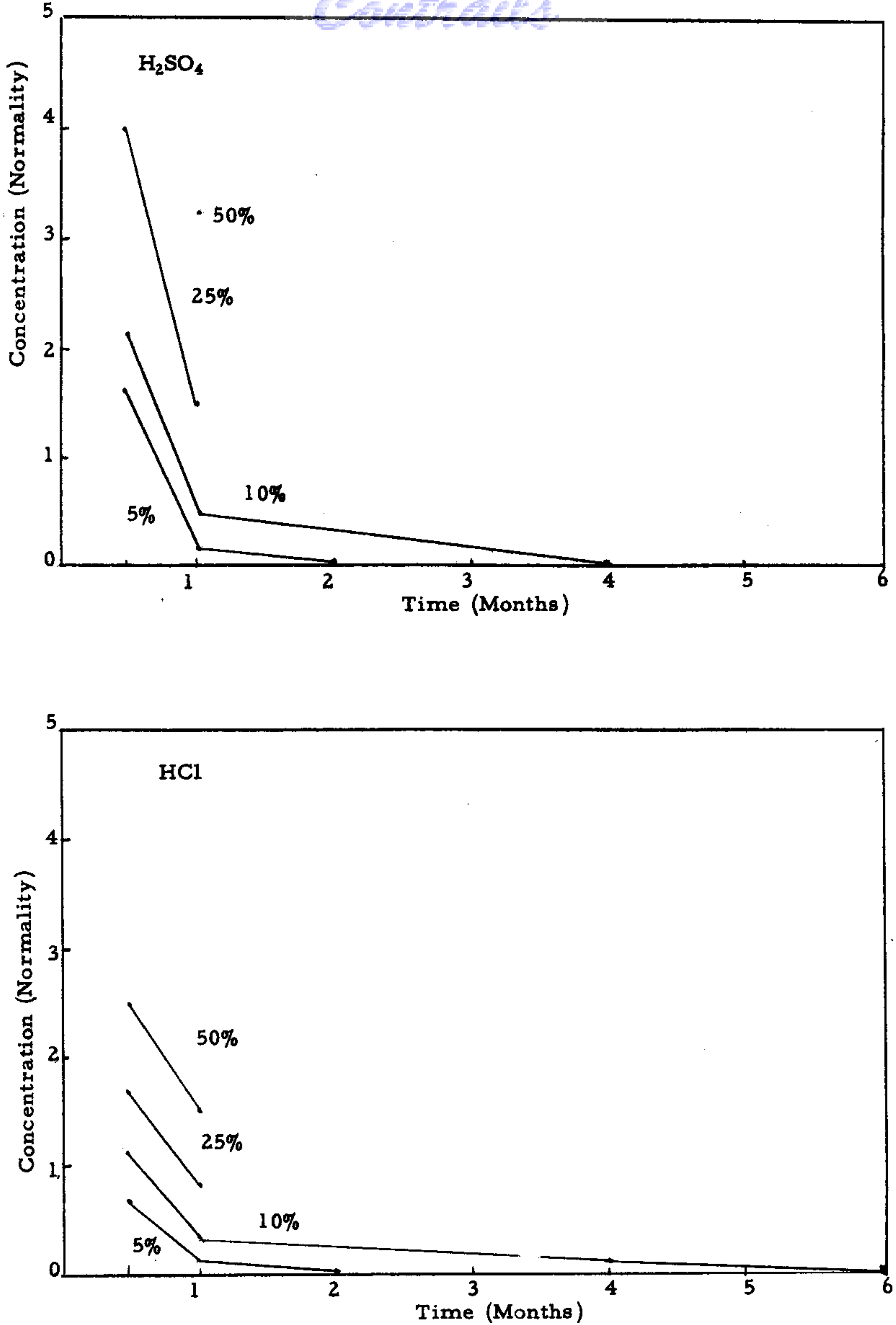


Figure 113. Concentration vs. Time to Effect Specific Strength Losses when nylon is treated in H_2SO_4 and HCl and aged in solution at 100°F.

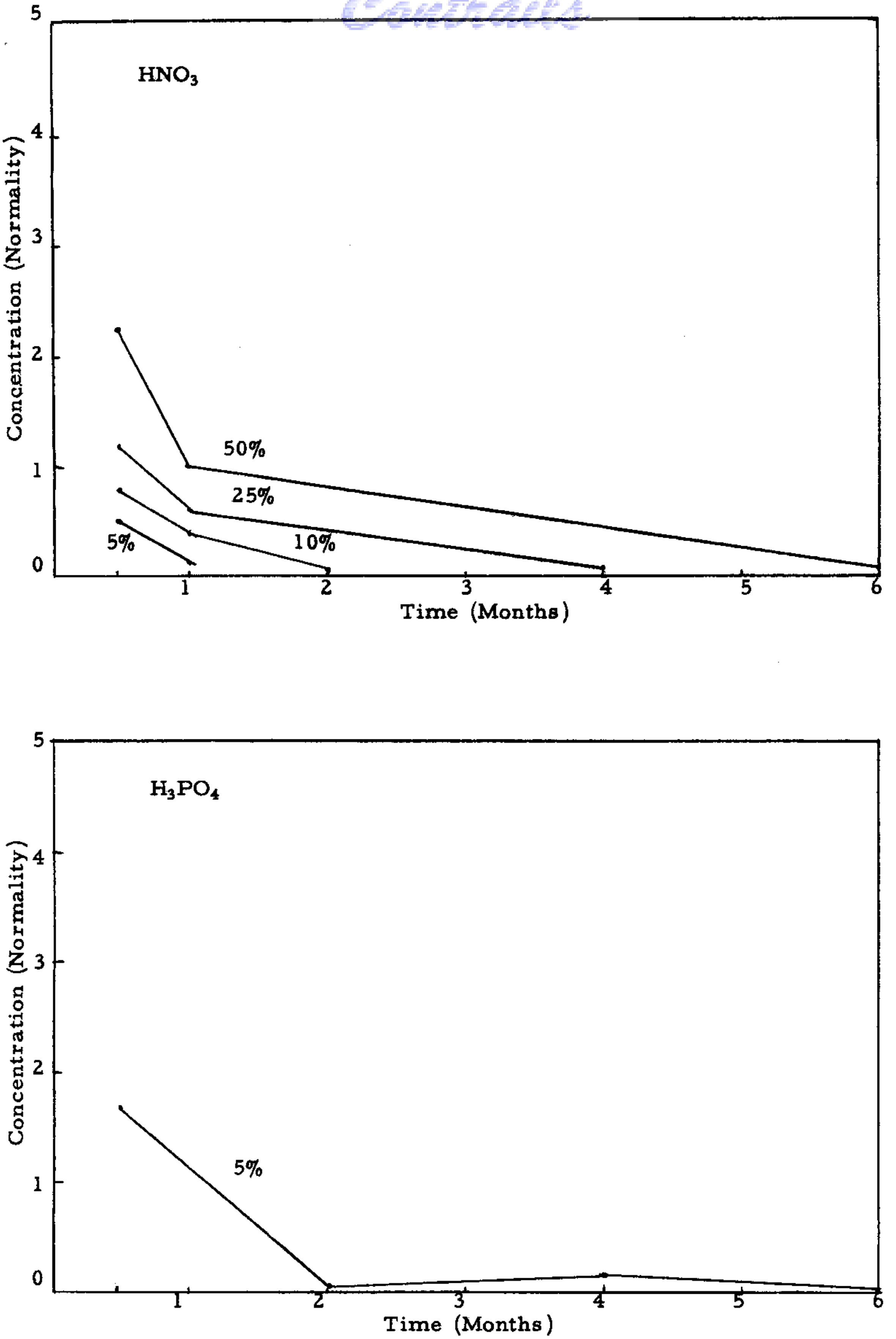
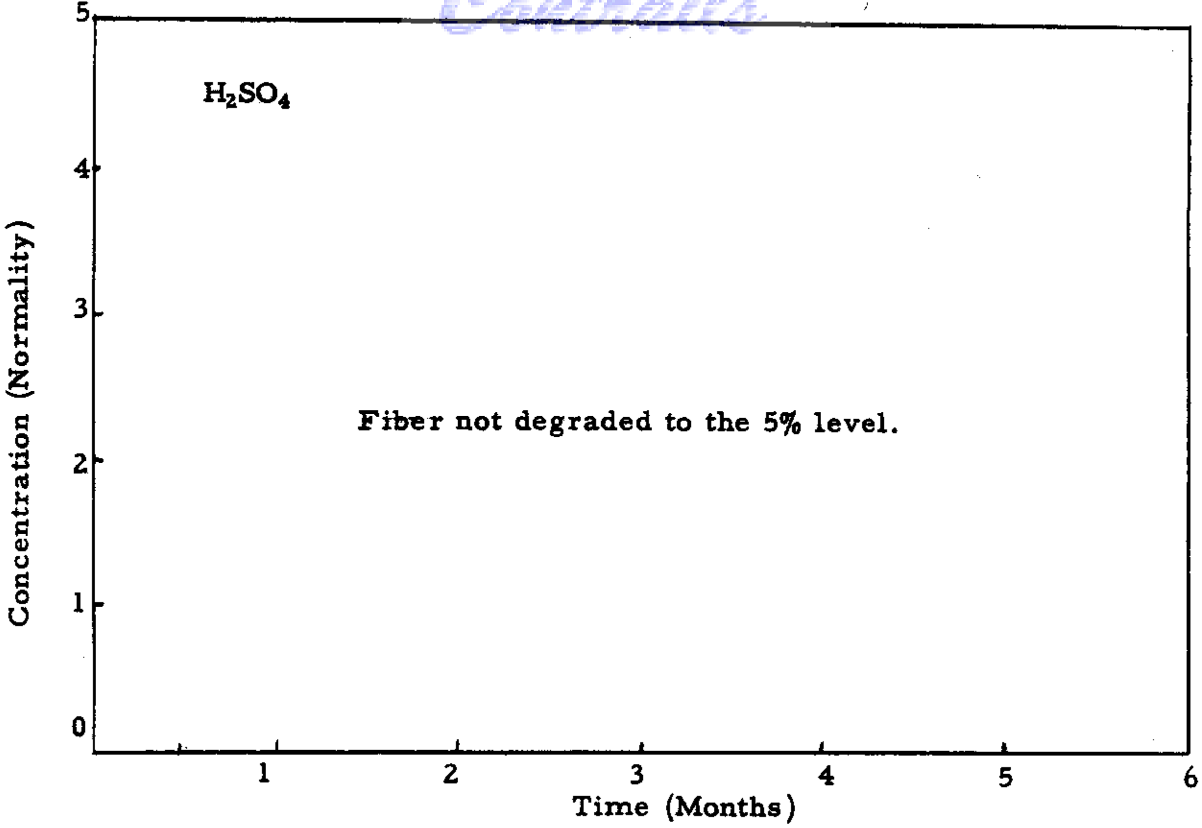


Figure 114. Concentration vs. Time to Effect Specific Strength Losses when nylon is treated in HNO$_3$ and H$_3$PO$_4$ and aged in solution at 100°F.



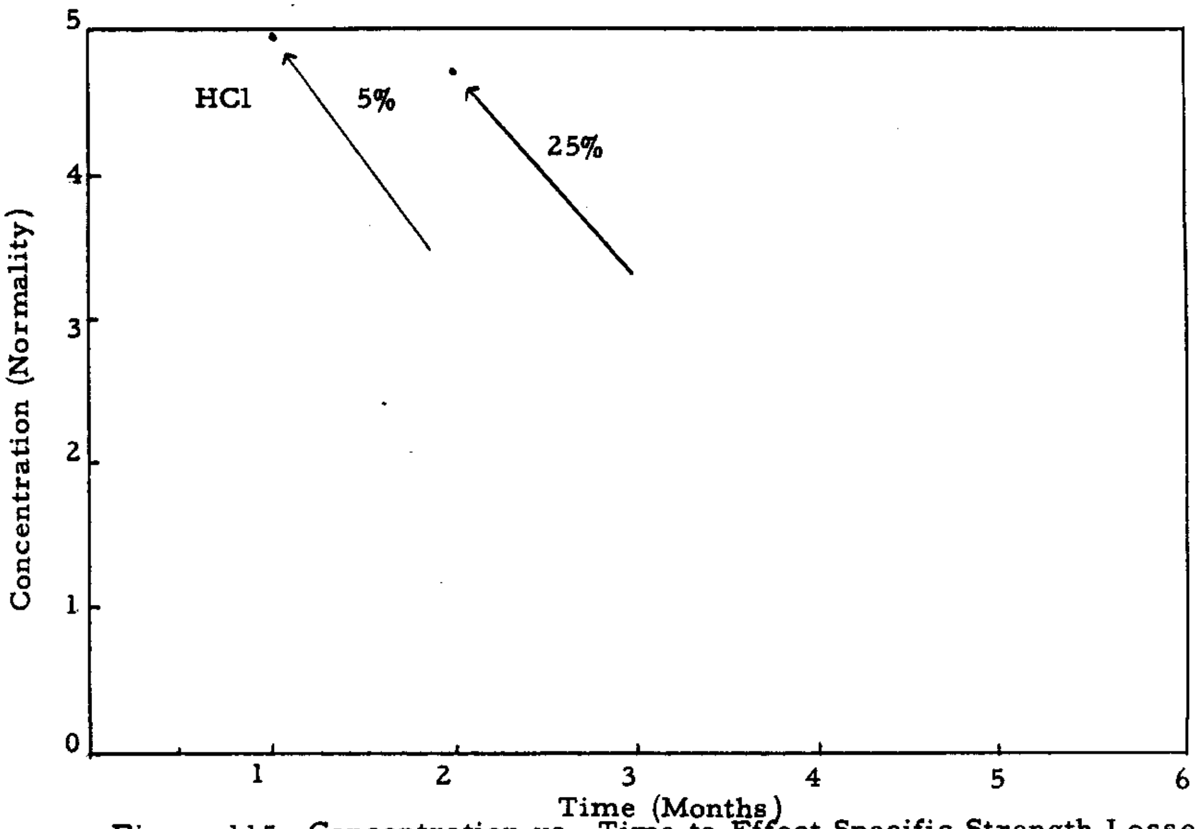
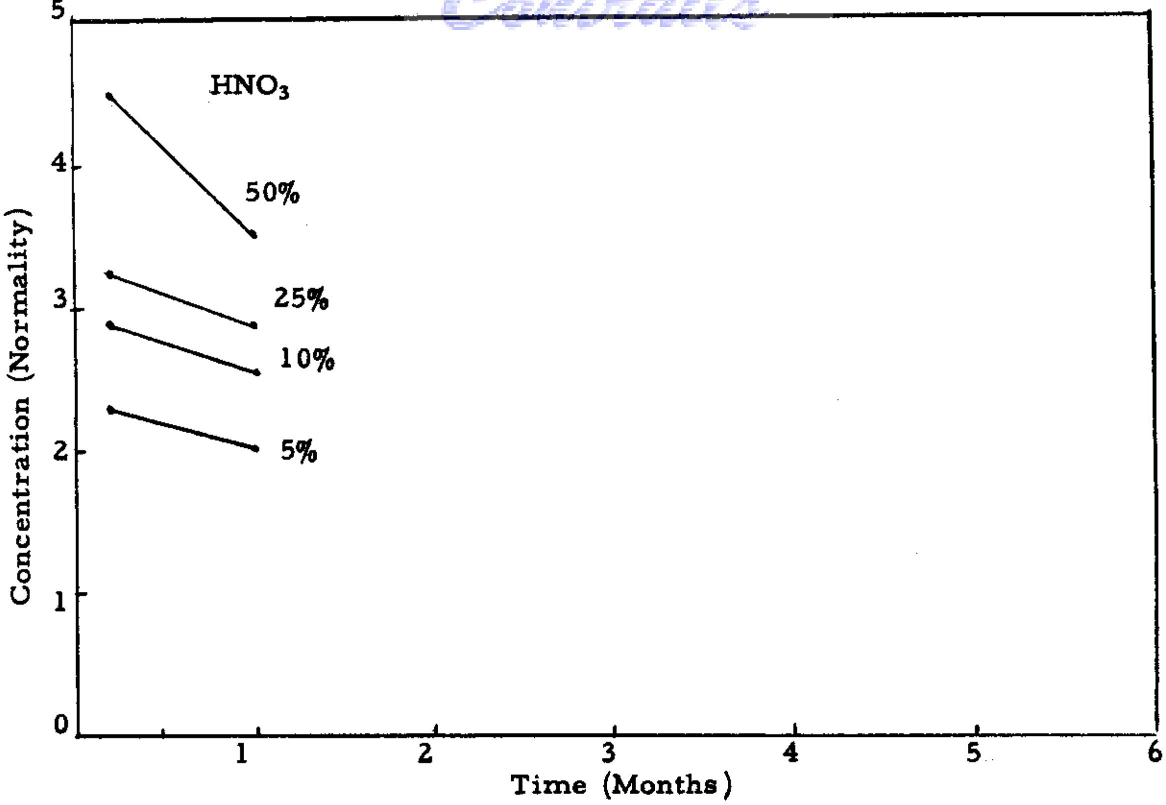


Figure 115. Concentration vs. Time to Effect Specific Strength Losses when Dacron (Type I and II) is treated in H_2SO_4 and HCl and aged in solution at 100°F.



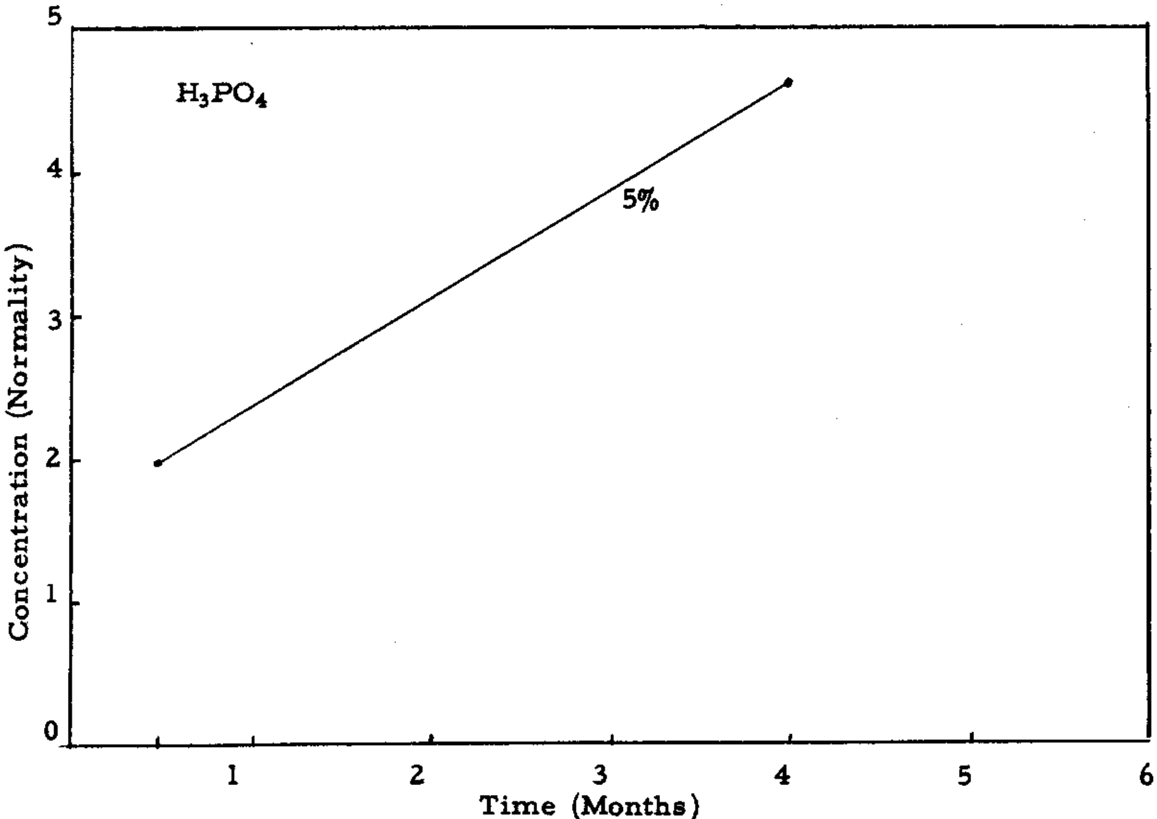
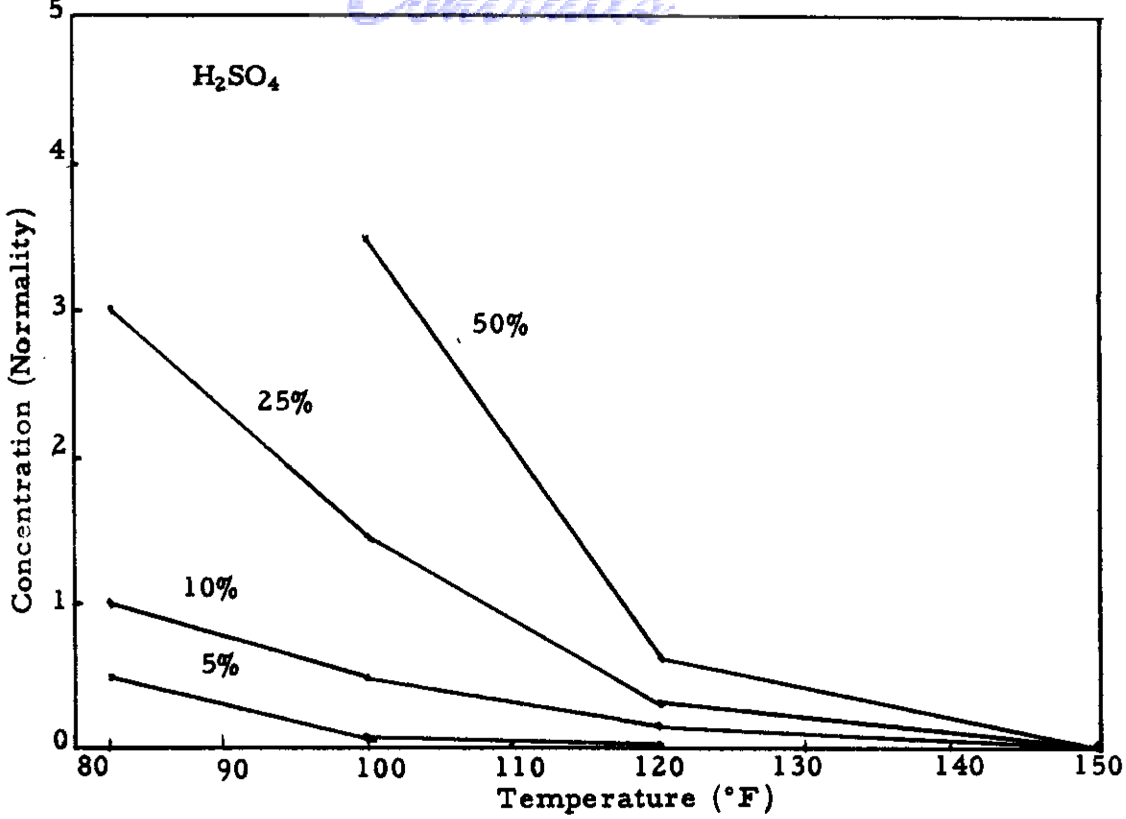


Figure 116. Concentration vs. Time to Effect Specific Strength Losses when Dacron (Type I and II) is treated in HNO$_3$ and H$_3$PO$_4$ and aged in solution at 100°F.



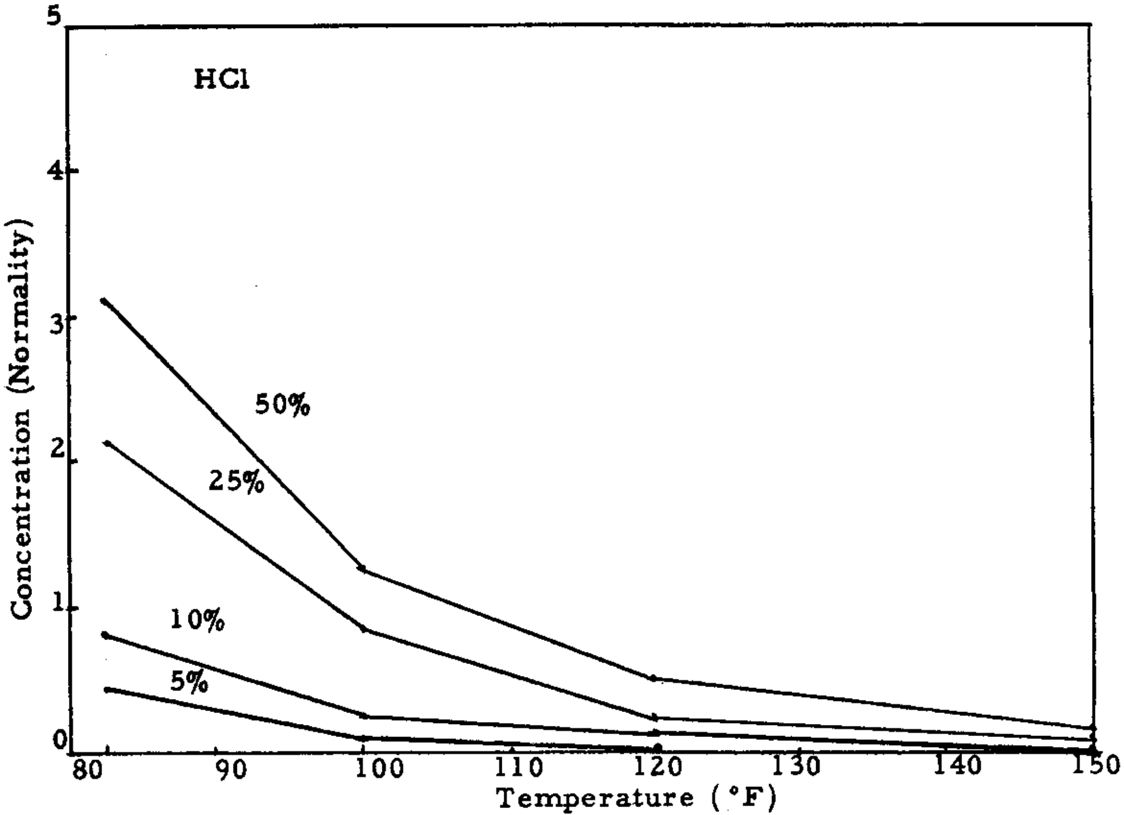


Figure 117. Concentration vs. Temperature to Effect Specific Strength Losses when nylon is treated in H_2SO_4 and HCl and aged in solution for one month.

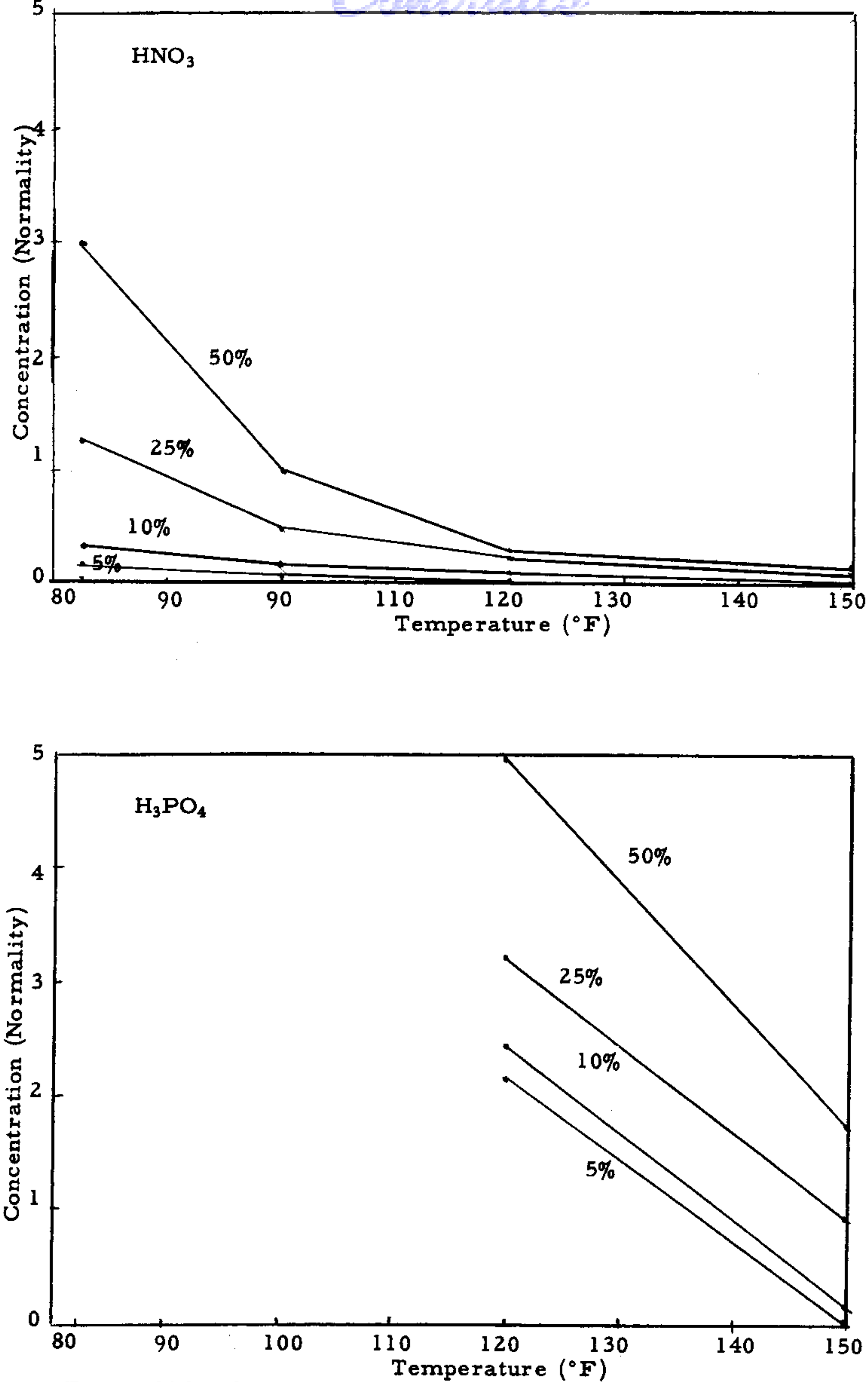


Figure 118. Concentration vs. Temperature to Effect Specific Strength Losses when nylon is treated in HNO_3 and H_3PO_4 and aged in solution for one month.

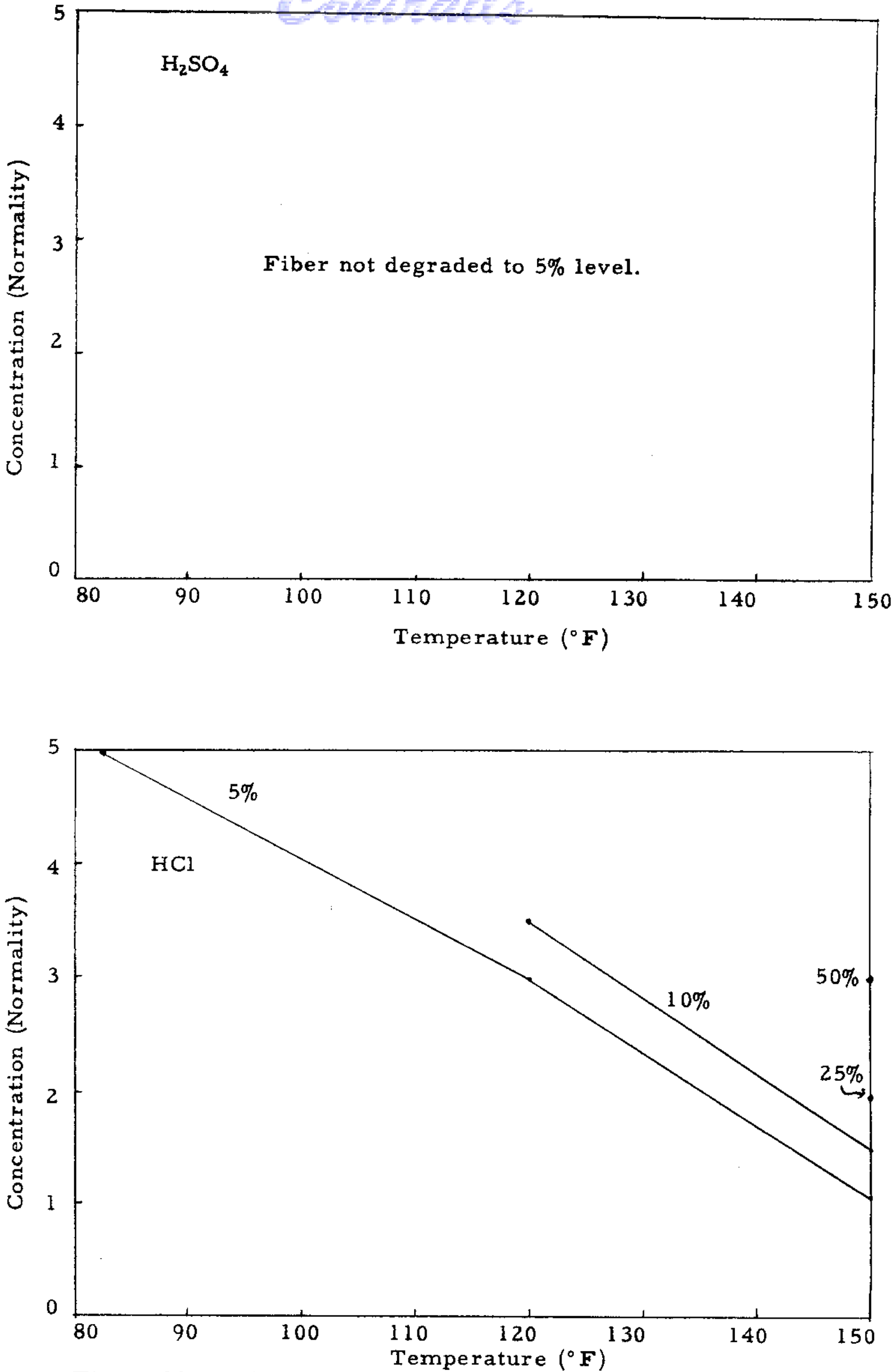
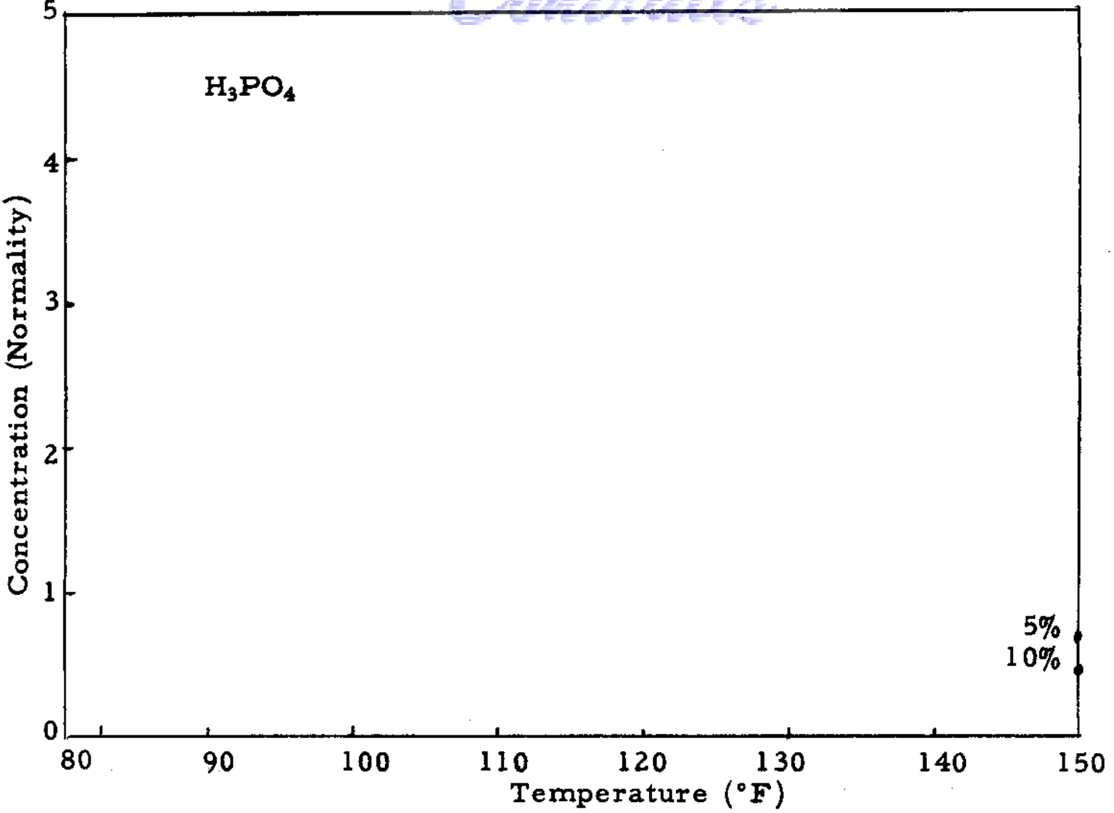


Figure 119. Concentration vs. Temperature to Effect Specific Strength Losses when Dacron (Type I) is treated in H_2SO_4 and HCl and aged in solution for one month.



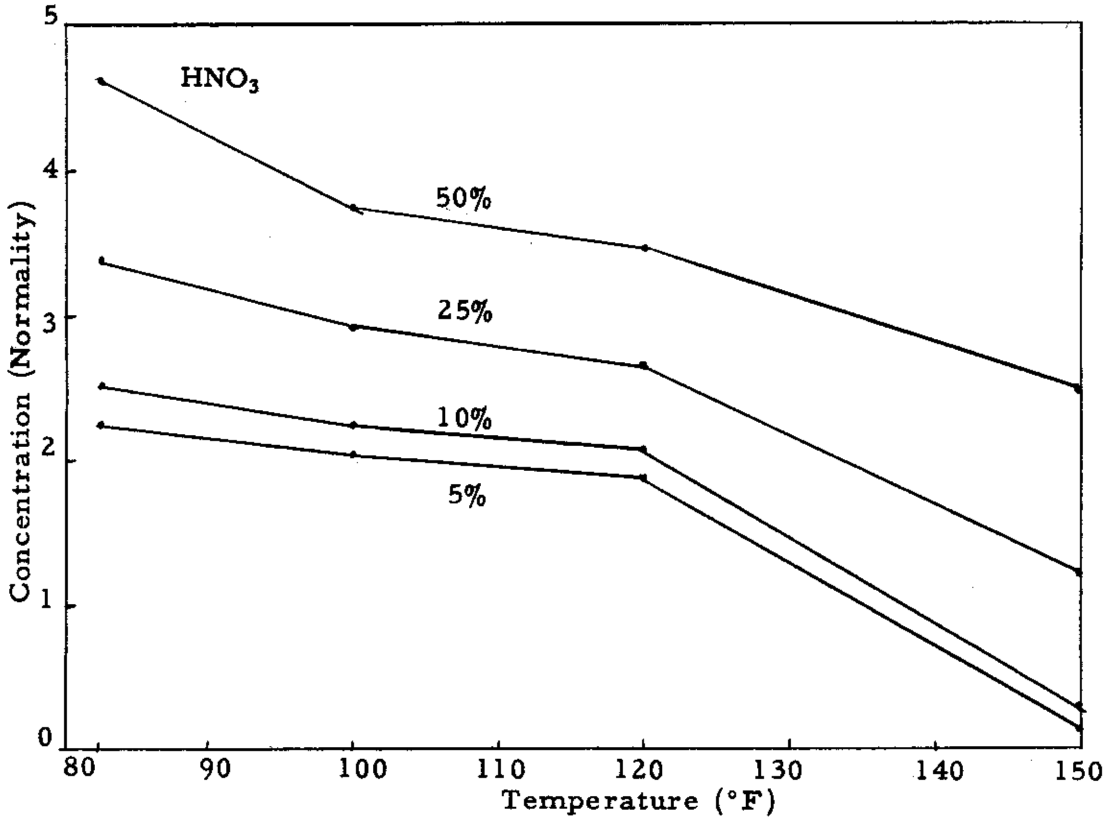


Figure 120. Concentration vs. Temperature to Effect Specific Strength Losses when Dacron (Type I) is treated in H_3PO_4 and HNO_3 and aged in solution for one month.

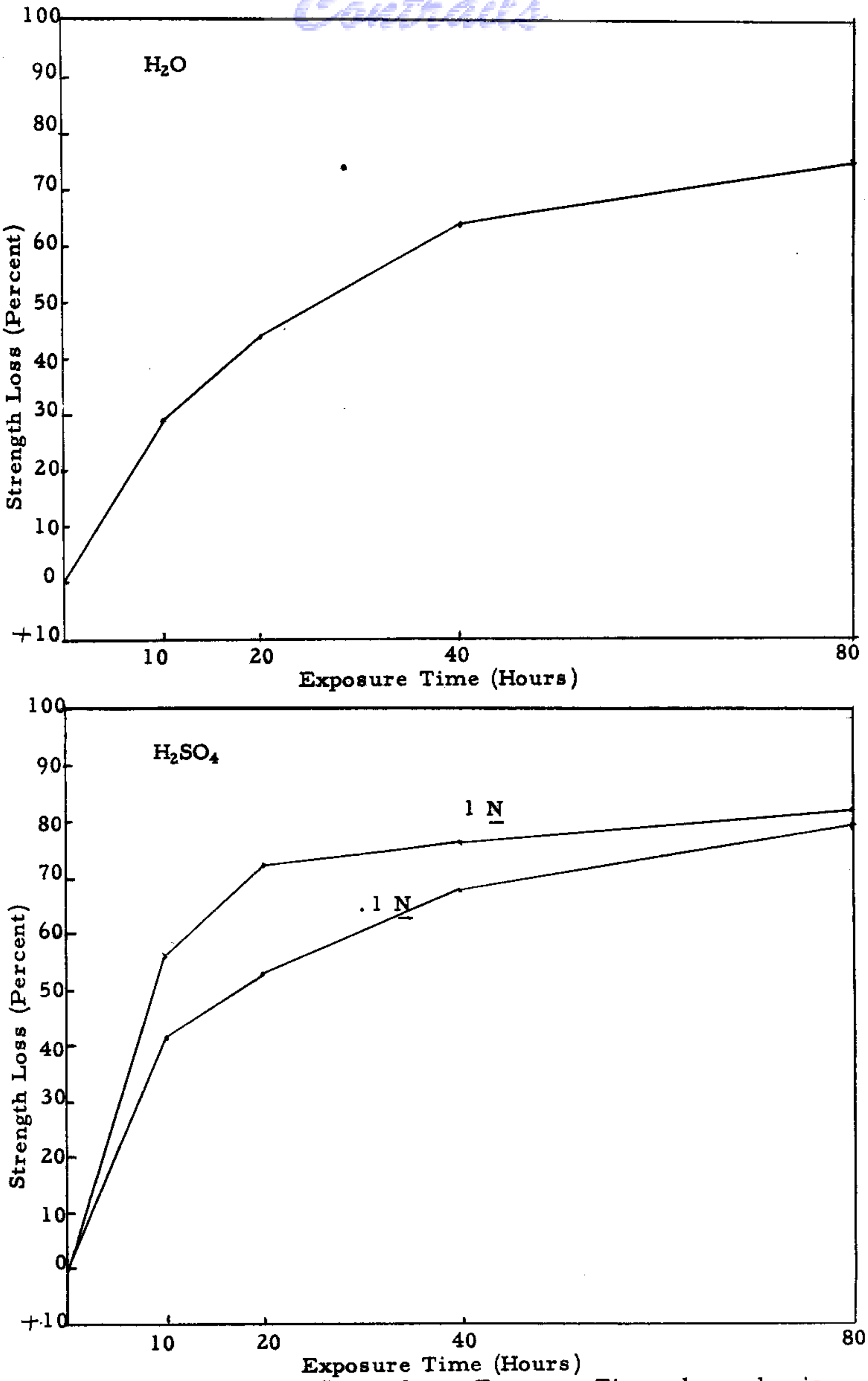


Figure 121. Loss in Strength vs. Exposure Time when nylon is treated in H_2O and H_2SO_4 and exposed to light in Fade-Ometer.

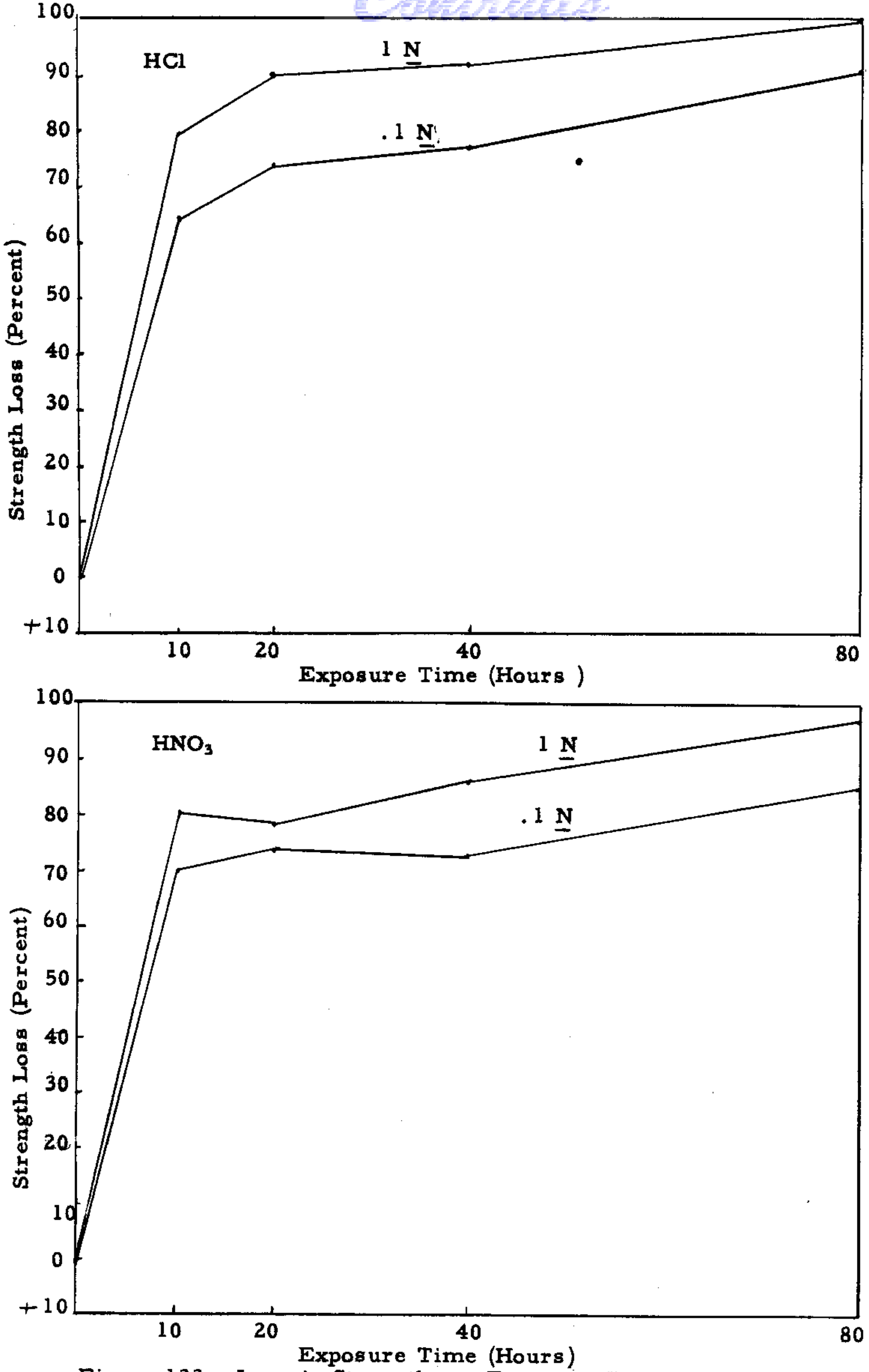


Figure 122. Loss in Strength vs. Exposure Time when nylon is treated in HCl and HNO_3 and exposed to light in Fade-Ometer.

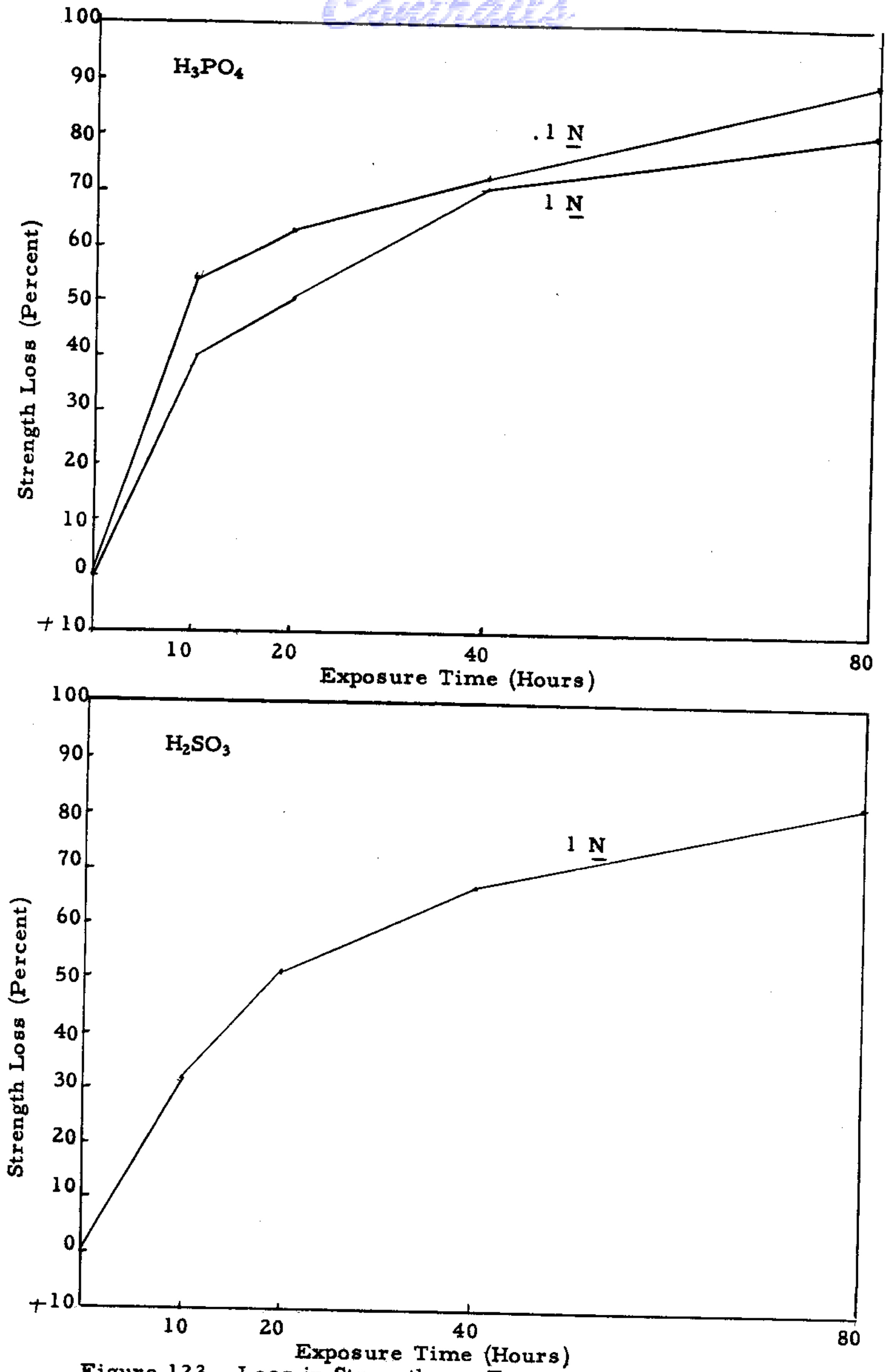


Figure 123. Loss in Strength vs. Exposure Time when nylon is treated in H_3PO_4 and H_2SO_3 and exposed to light in Fade-Ometer.

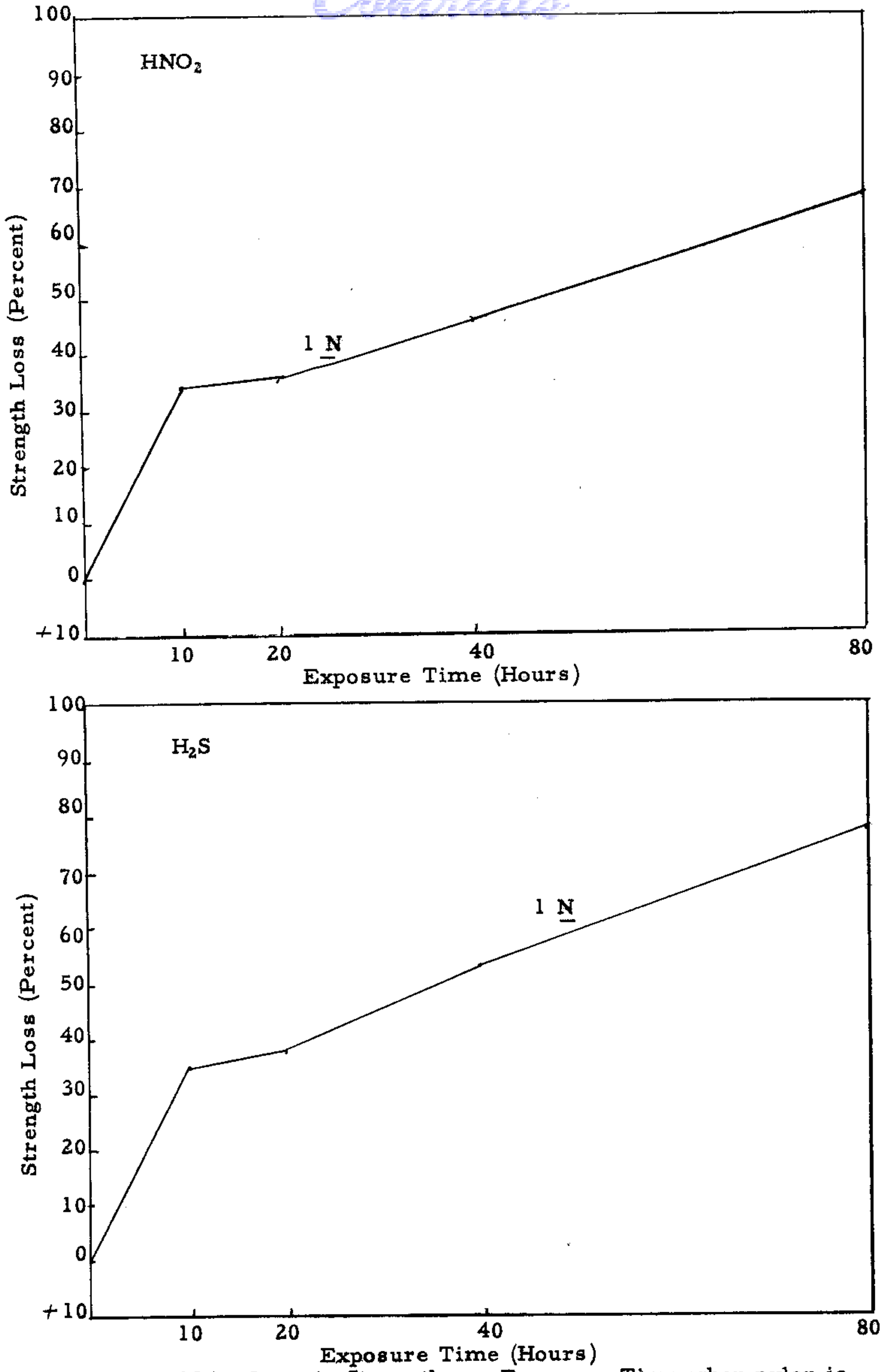


Figure 124. Loss in Strength vs. Exposure Time when nylon is treated in HNO_2 and H_2S and exposed to light in Fade-Ometer.

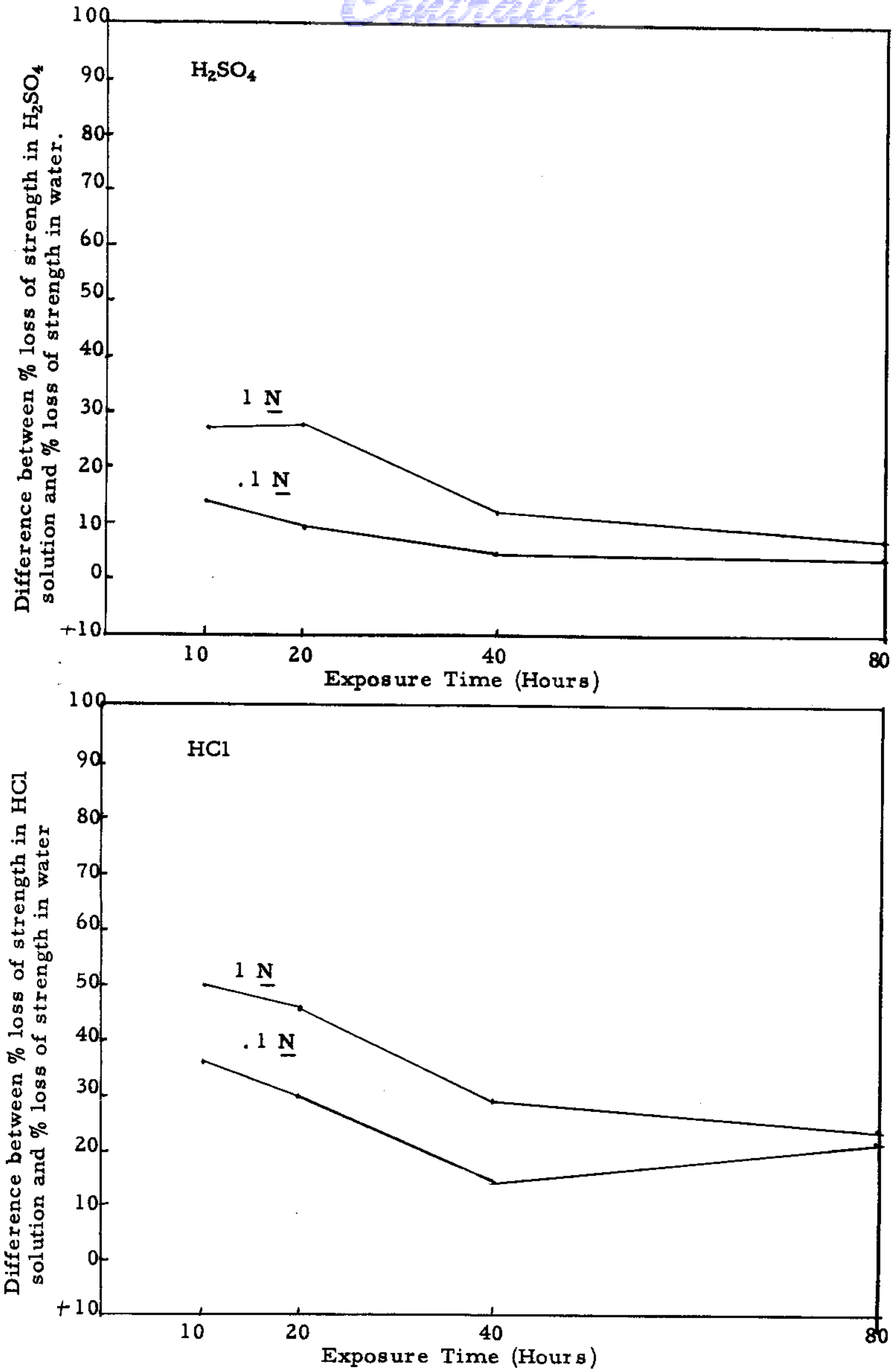


Figure 125. Difference between % loss of strength of nylon in H_2SO_4 and HCl solutions and % loss of strength in water vs. exposure time in Fade-Ometer.

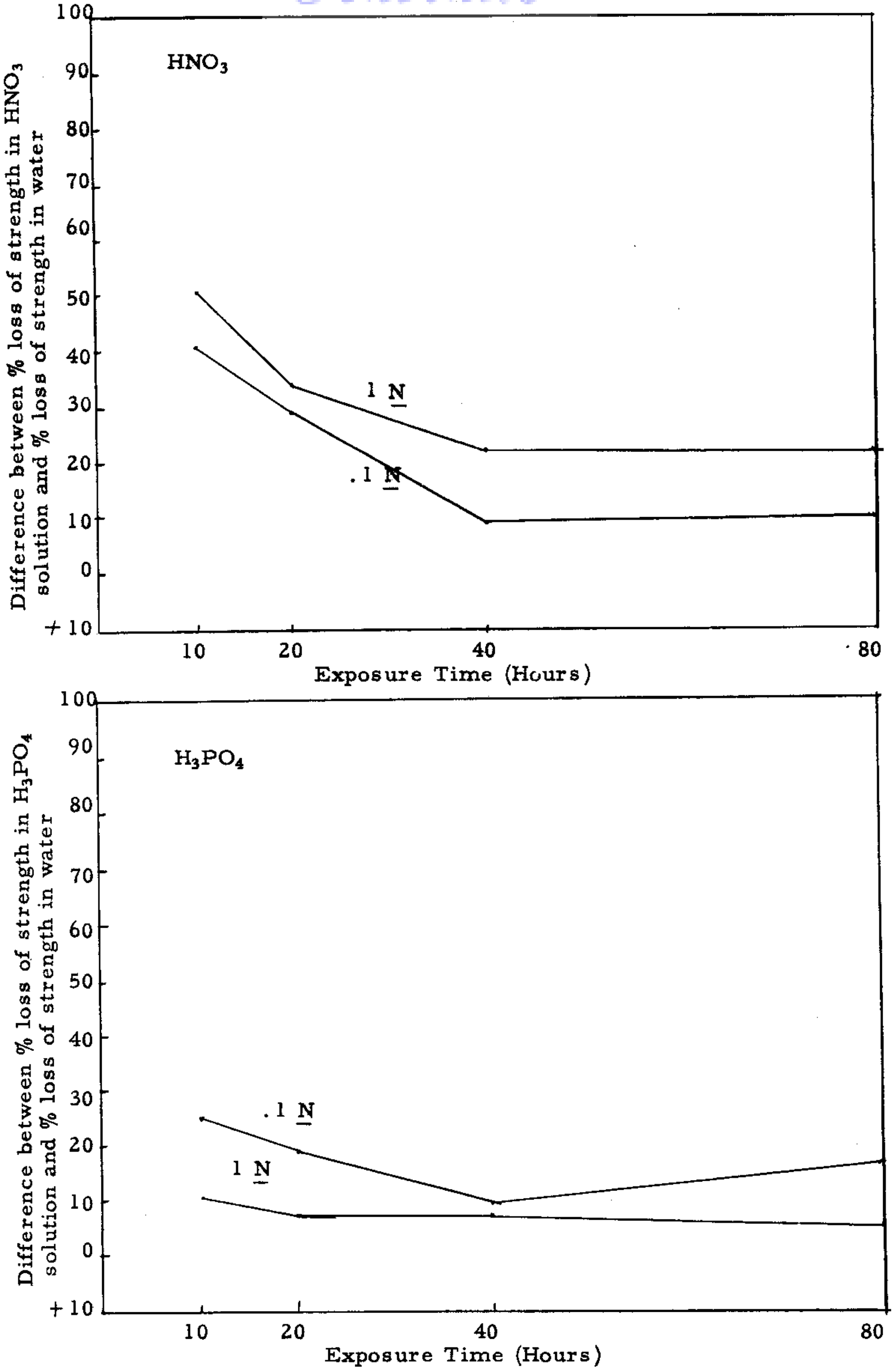
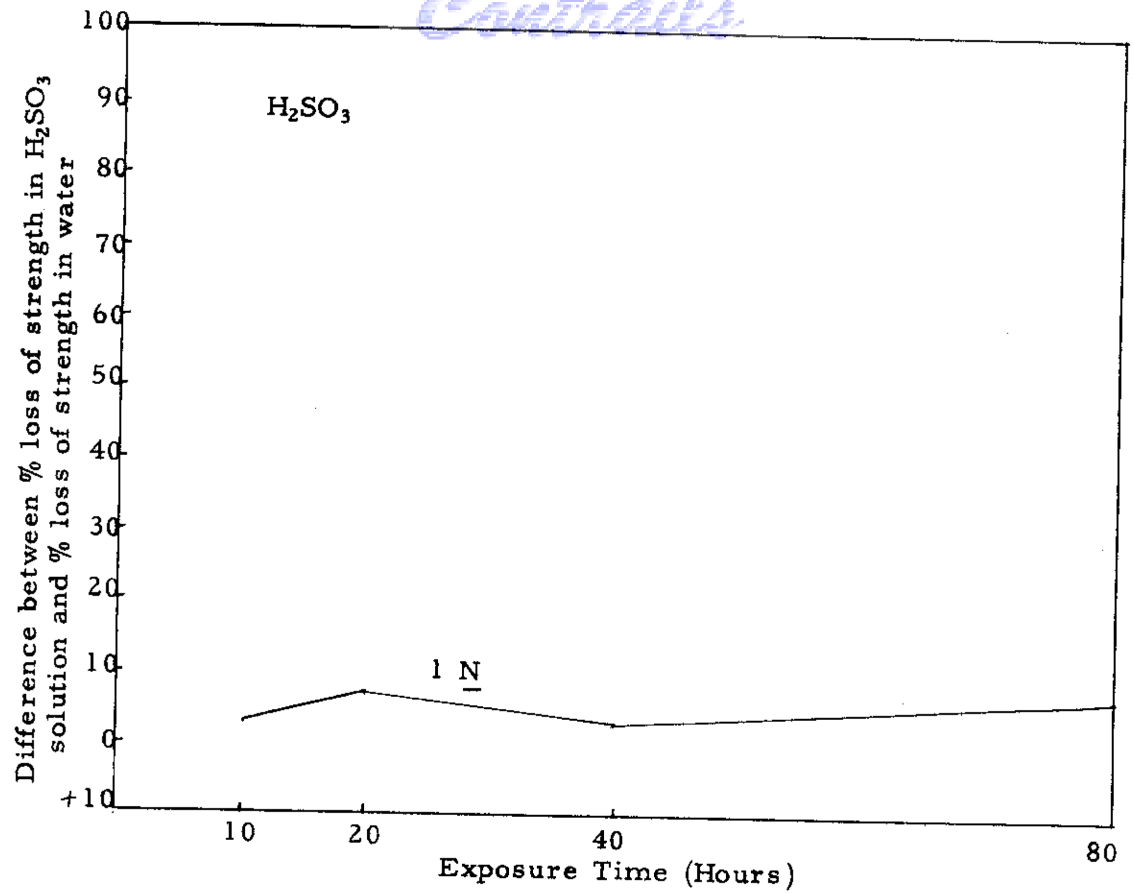


Figure 126. Difference between % loss of strength of nylon in HNO_3 and H_3PO_4 solutions and % loss of strength in water vs. exposure time in Fade-Ometer



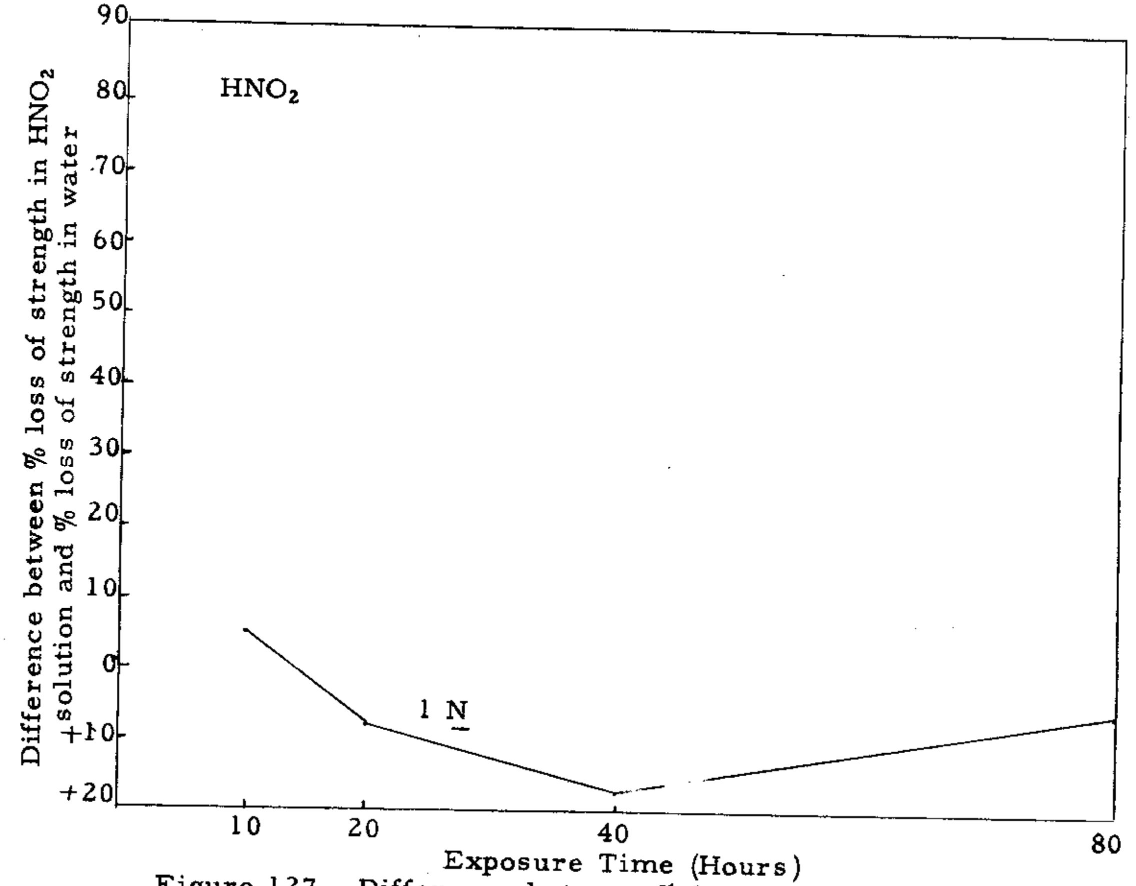


Figure 127. Difference between % loss of strength of nylon in H_2SO_3 and HNO_2 solutions and % loss of strength in water vs. exposure time in Fade-Ometer.

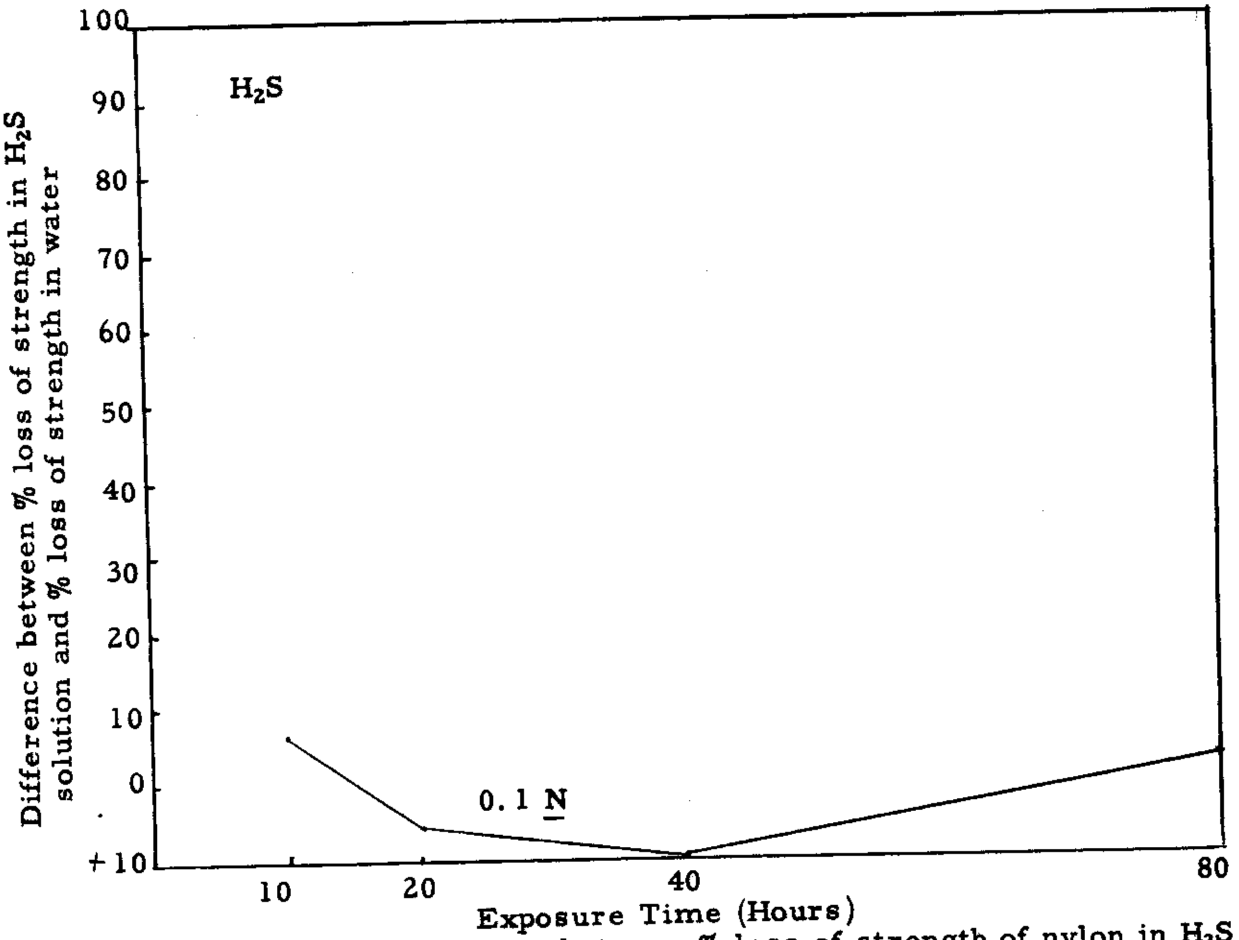


Figure 128. Difference between % loss of strength of nylon in H$_2$S solutions and % loss of strength in water vs. exposure time in Fade-Ometer.

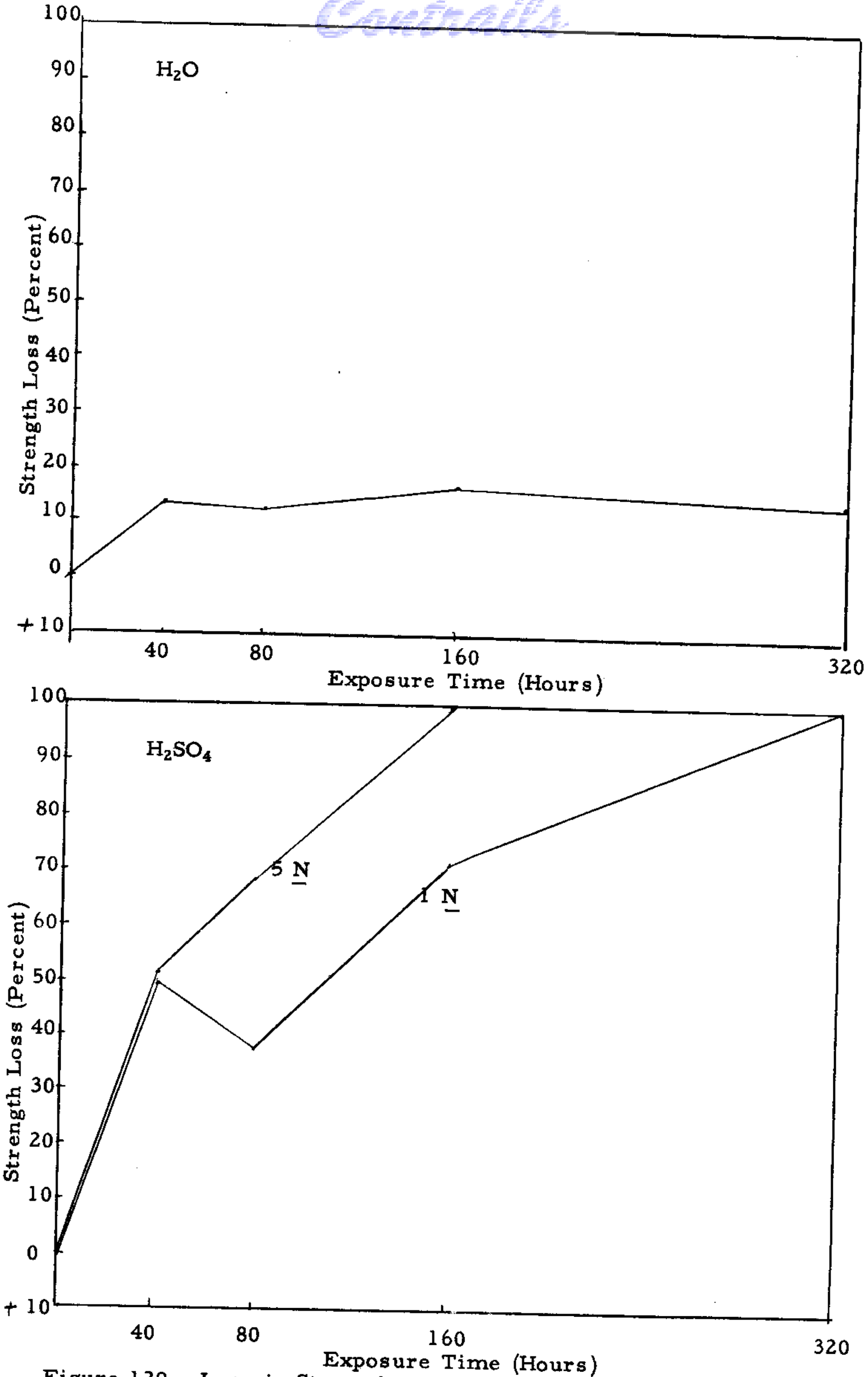


Figure 129. Loss in Strength vs. Exposure Time when Dacron (Type II) is treated in H_2O and H_2SO_4 and exposed to light in Fade-Ometer.

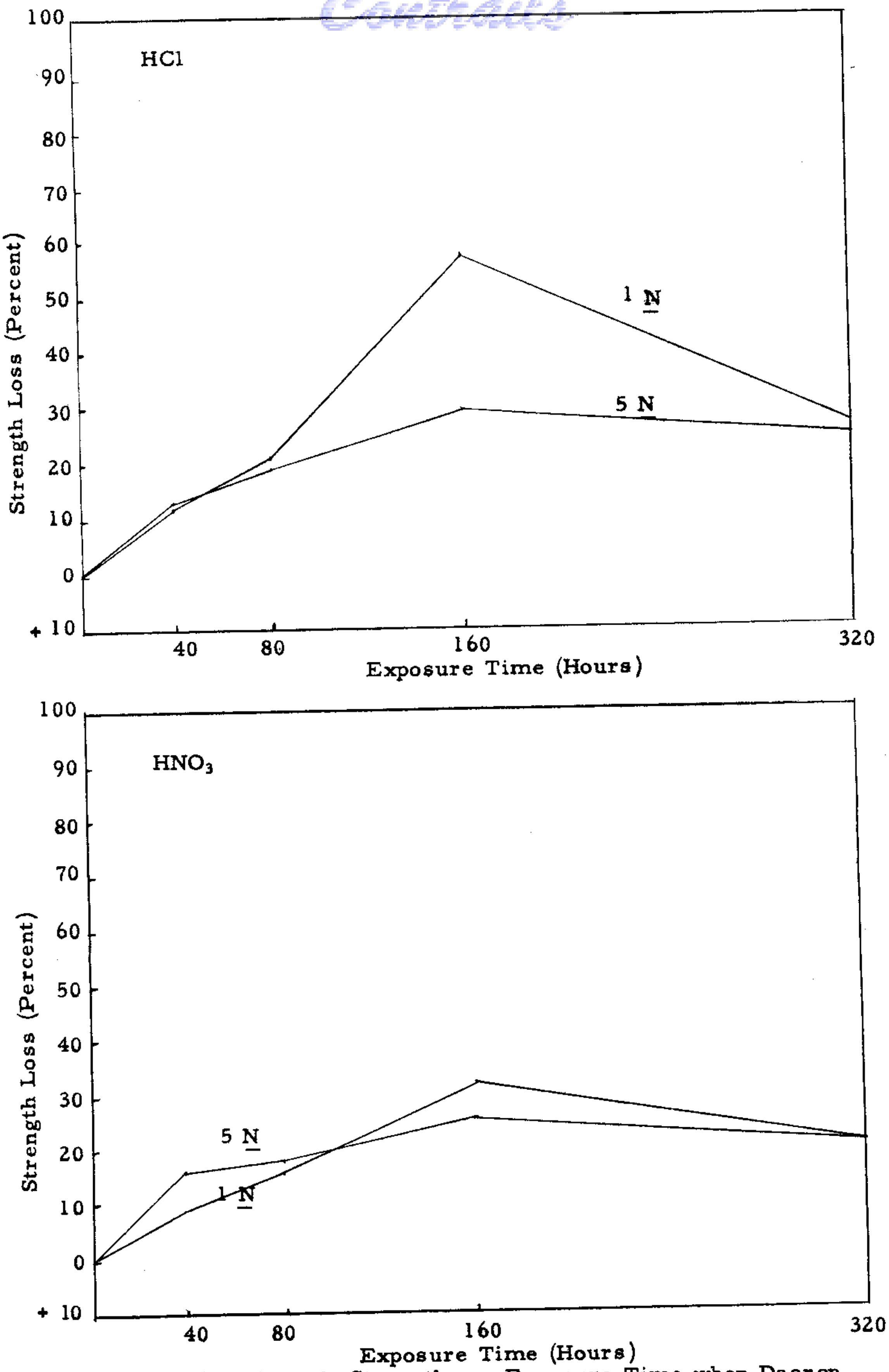


Figure 130. Loss in Strength vs. Exposure Time when Dacron (Type II) is treated in HCl and HNO$_3$ and exposed to light in Fade-Ometer.

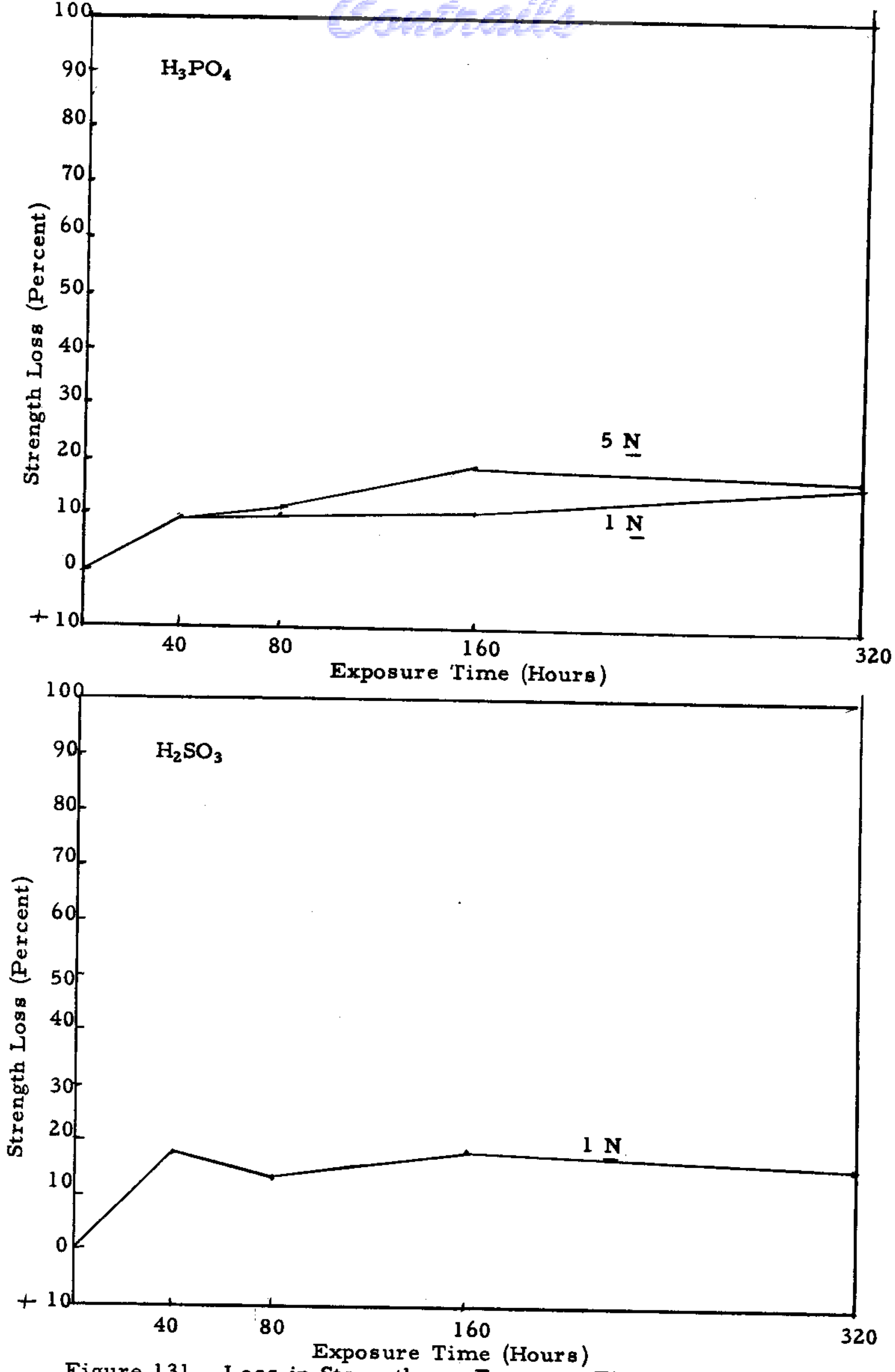


Figure 131. Loss in Strength vs. Exposure Time when Dacron (Type II) is treated in H_3PO_4 and H_2SO_3 and exposed to light in Fade-Ometer.

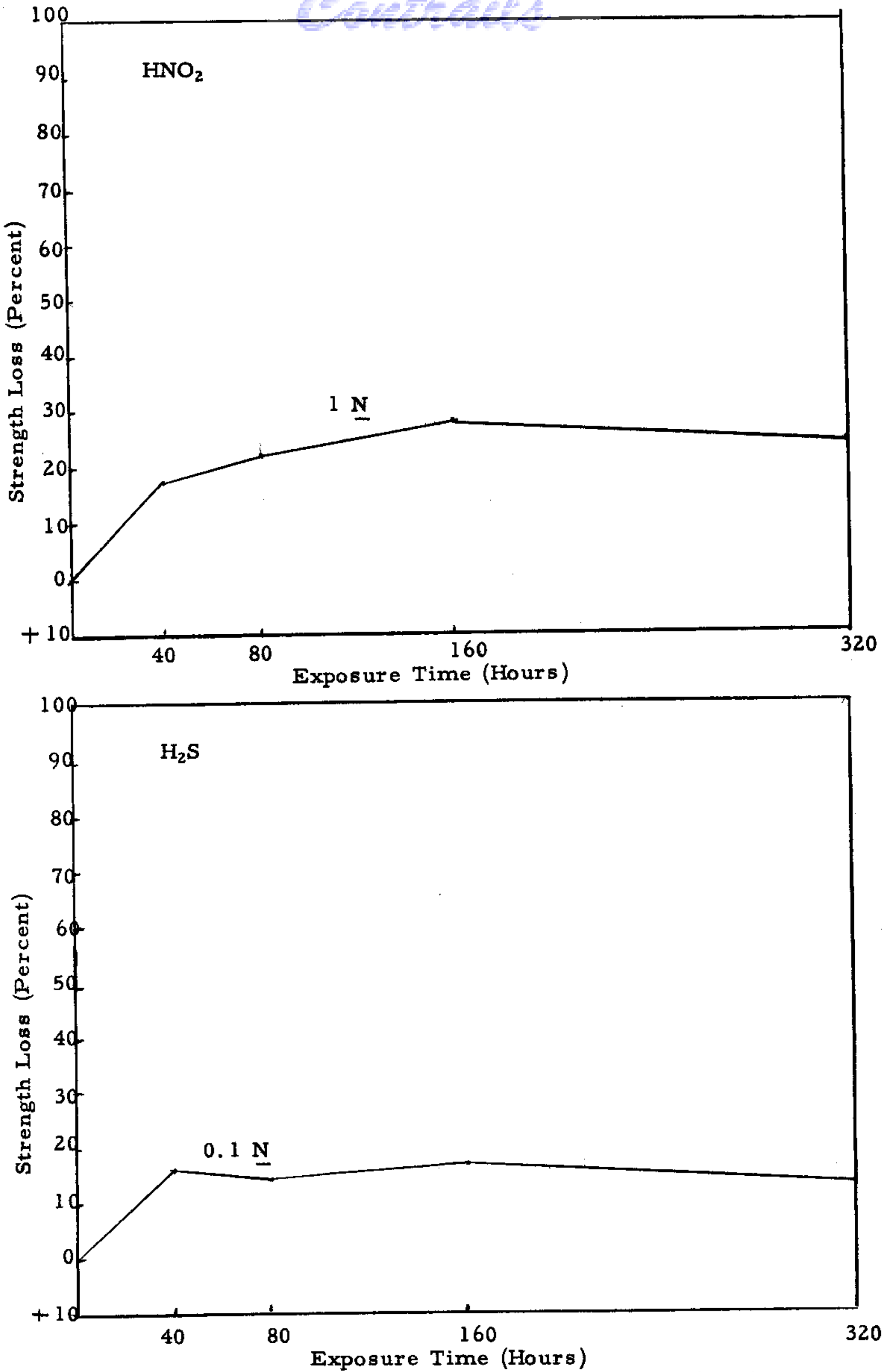


Figure 132. Loss in Strength vs. Exposure Time when Dacron (Type II) is treated in HNO_2 and H_2S and exposed to light in Fade-Ometer.

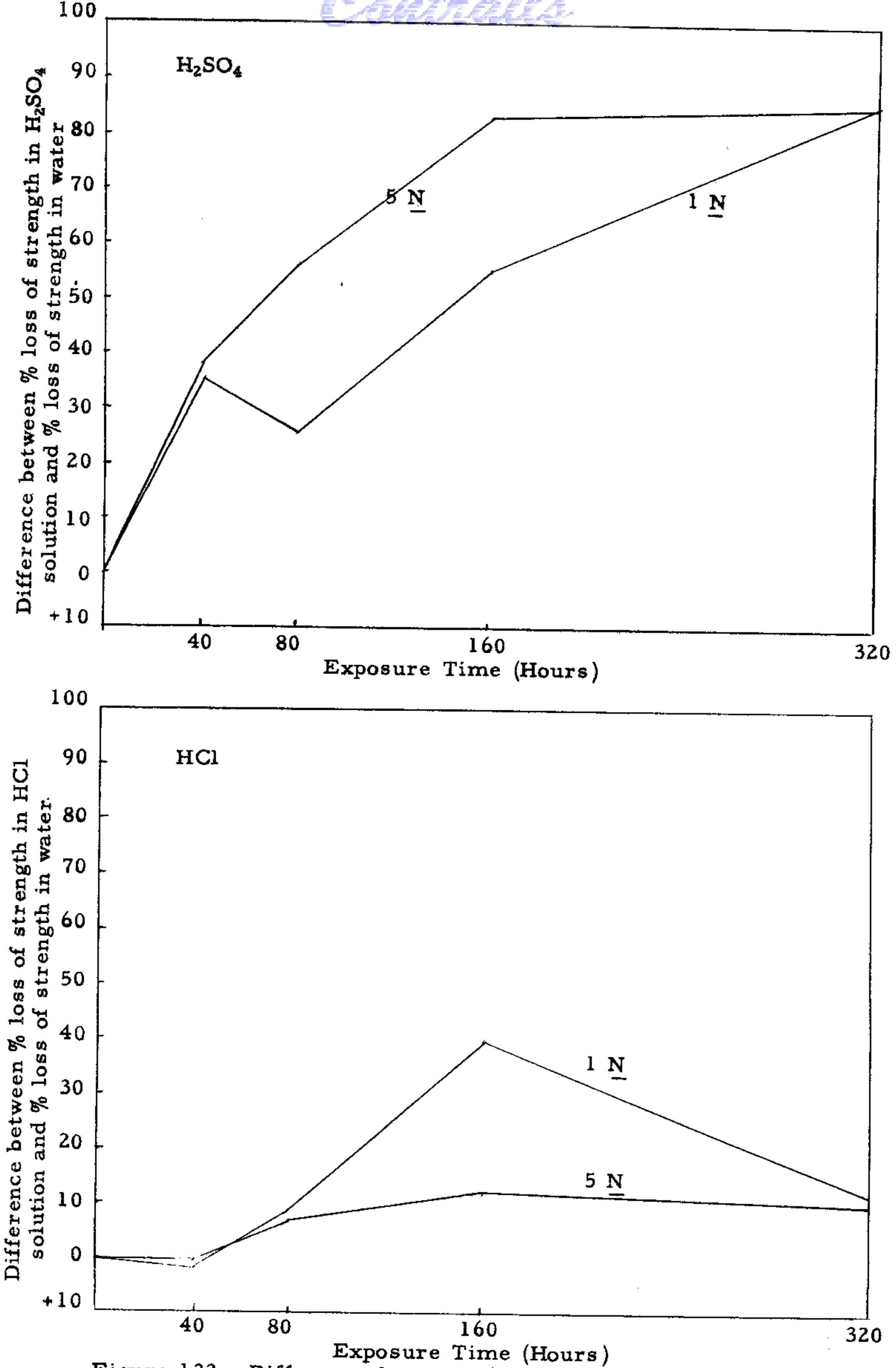


Figure 133. Difference between % loss of strength of Dacron (Type II) in H_2SO_4 and HCl solutions and % loss of strength in water vs. exposure time in Fade-Ometer.

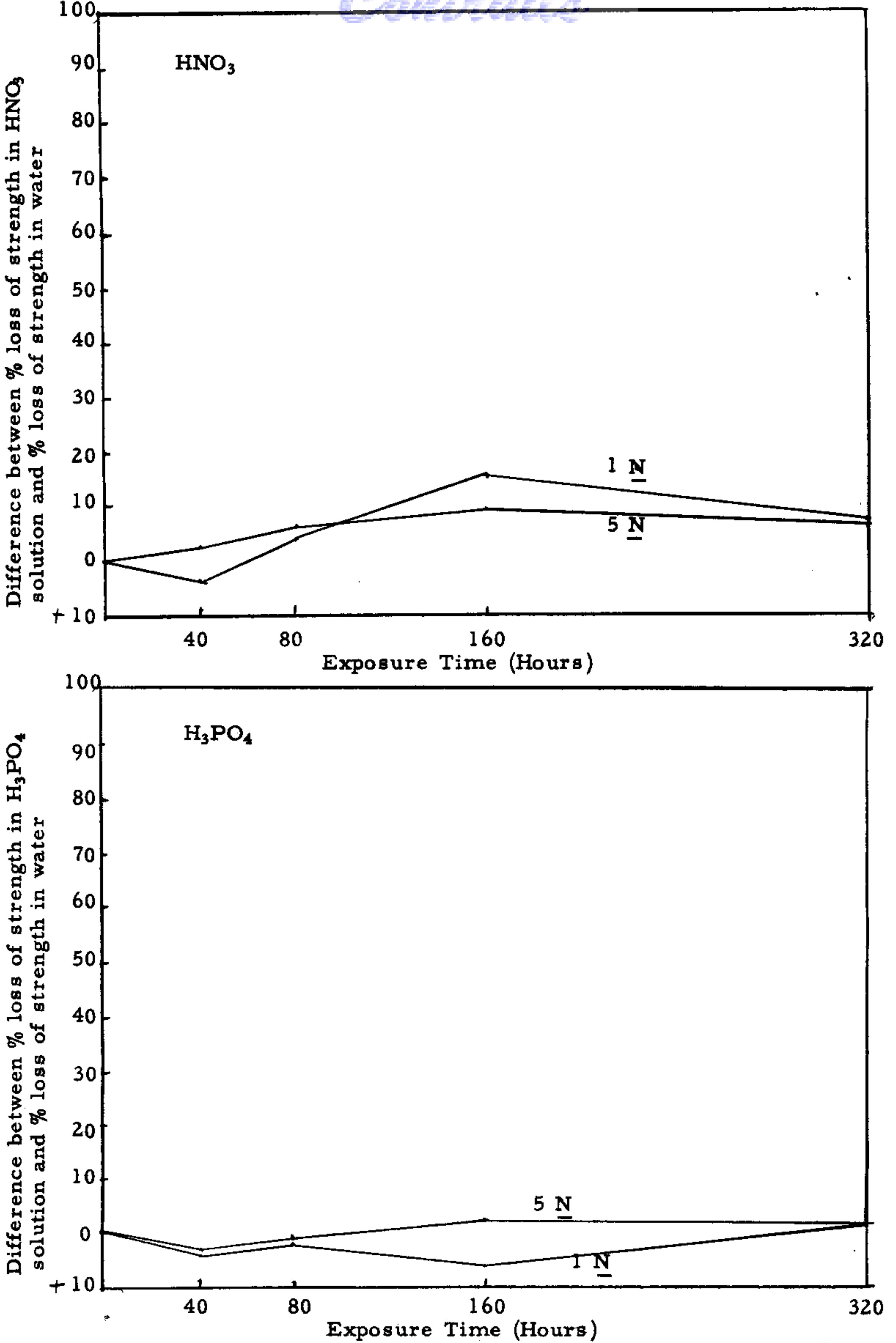
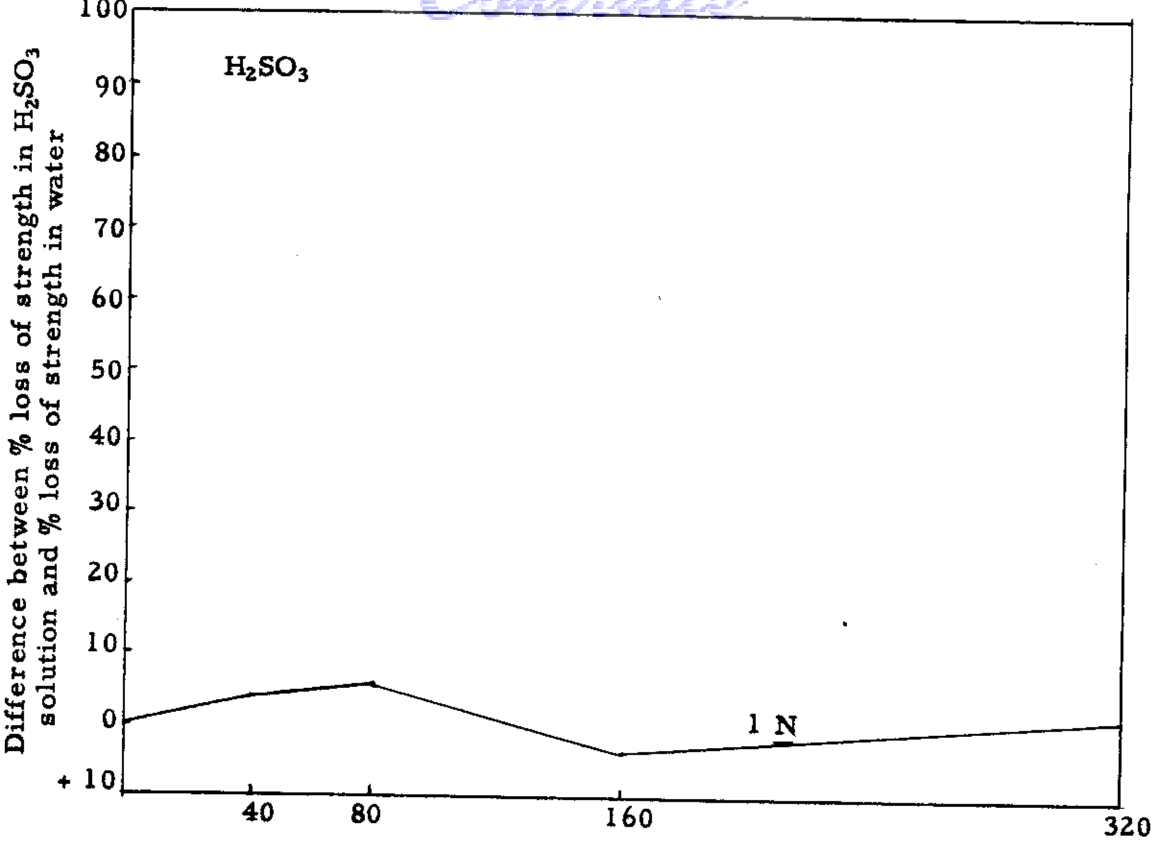


Figure 134. Difference between % loss of strength of Dacron (Type II) in HNO$_3$ and H$_3$PO$_4$ solutions and % loss of strength in water vs. exposure time inFade-Ometer.



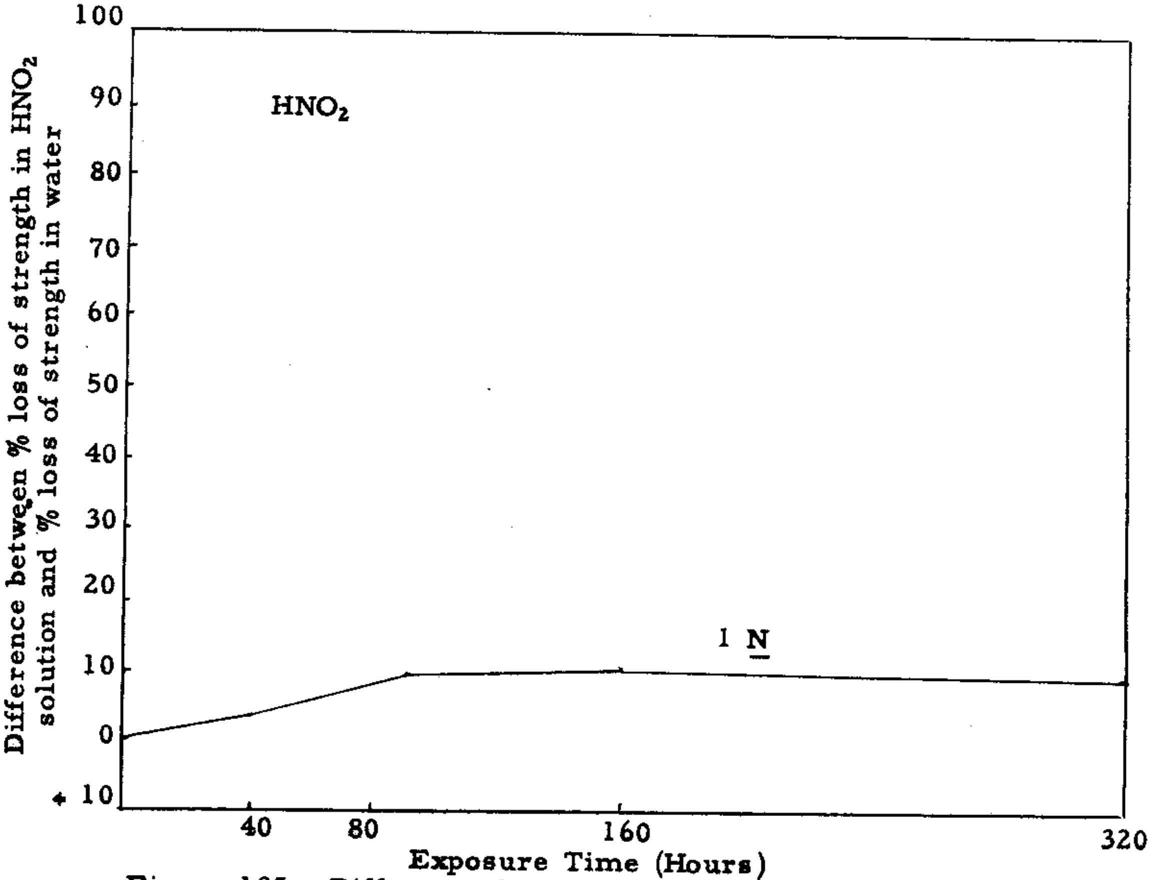


Figure 135. Difference between % loss of strength of Dacron (Type II) in H_2SO_3 and HNO_2 solutions and % loss of strength in water vs. exposure time in Fade-Ometer.

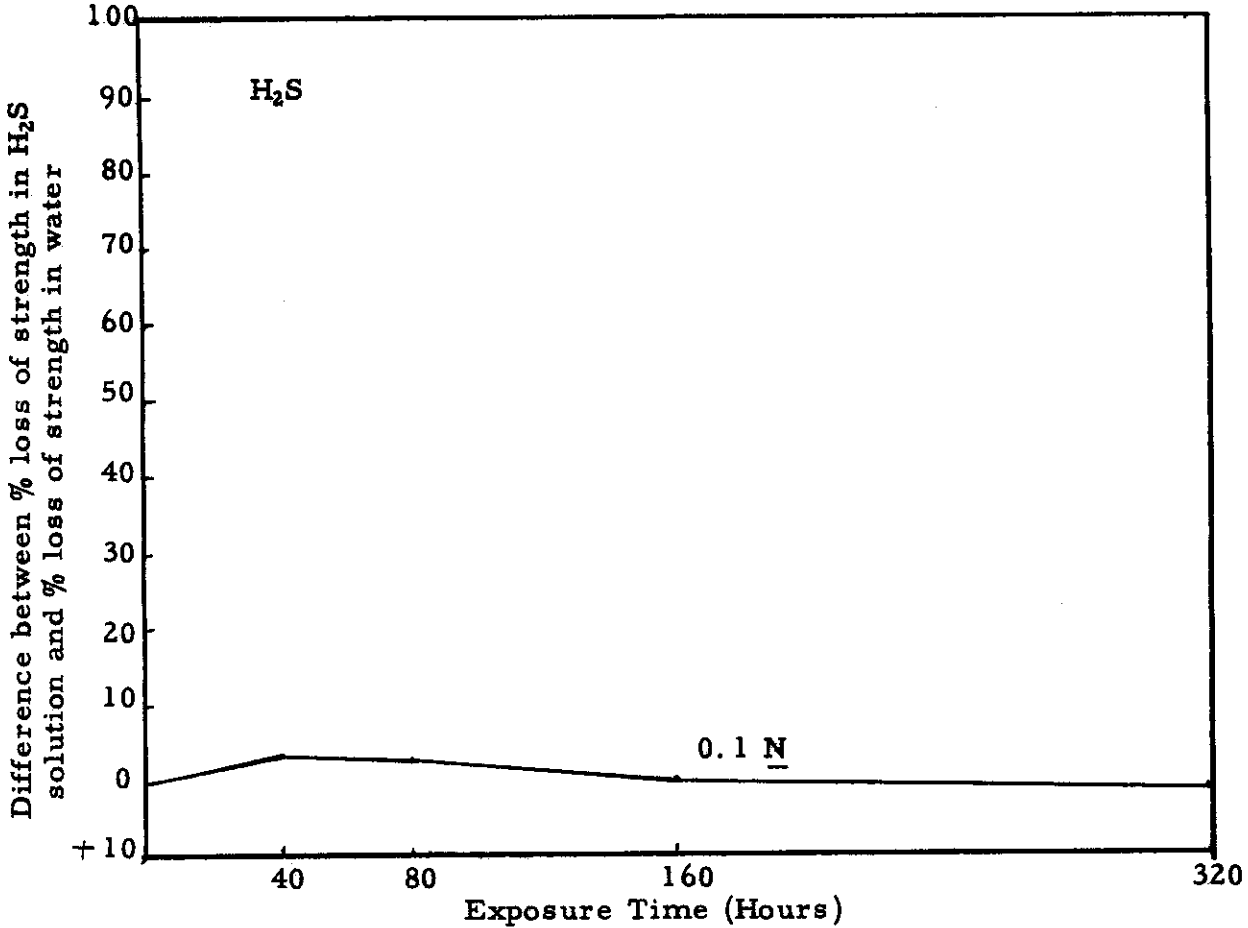


Figure 136. Difference between % loss of strength of Dacron (Type II) in H_2S solutions and % loss of strength in water vs. exposure time in Fade-Ometer.

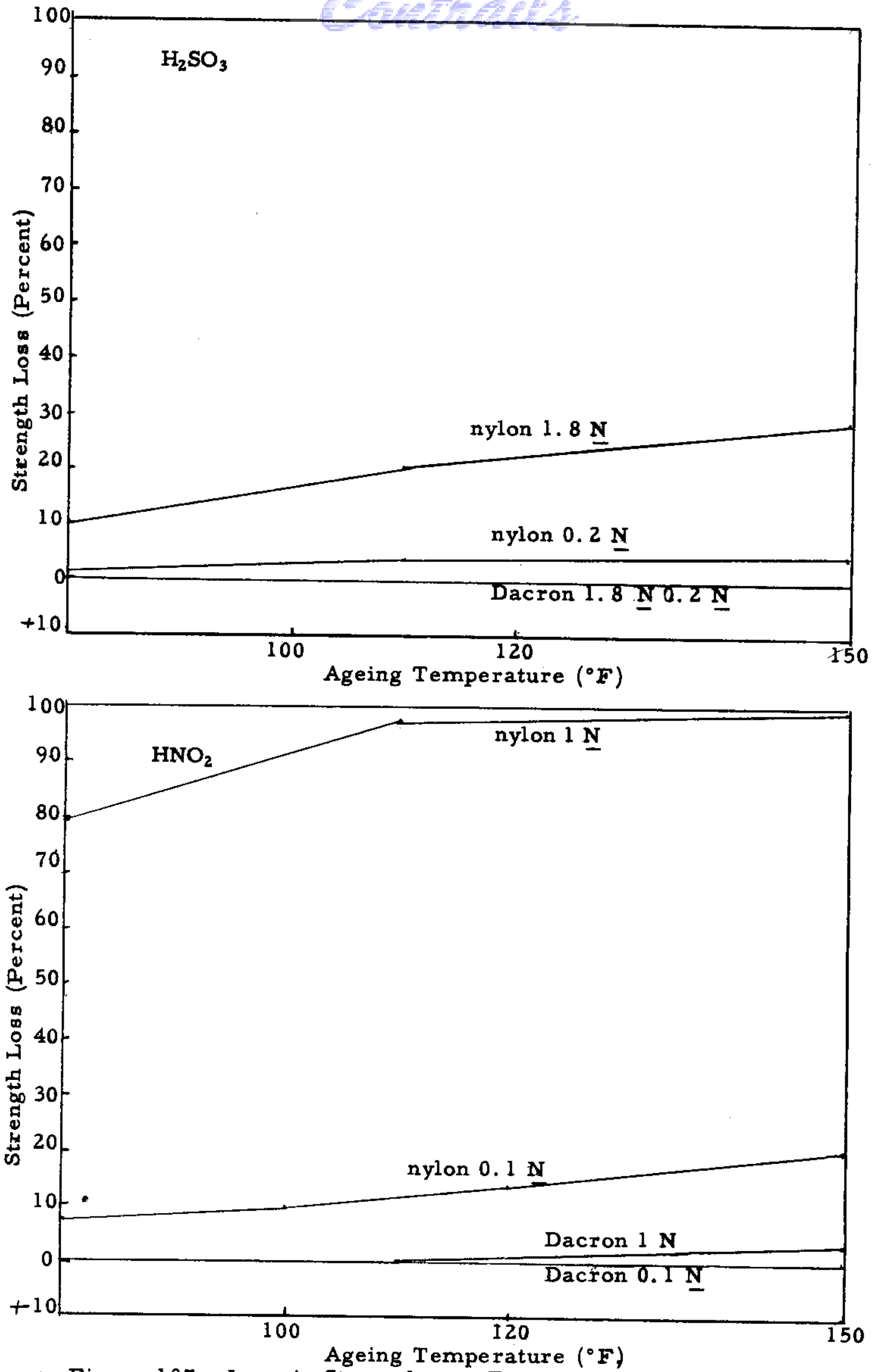


Figure 137. Loss in Strength vs. Temperature when nylon and Dacron (Type II) fabrics are exposed for one month to vapors from H_2SO_3 and HNO_2 solutions at high relative humidity.

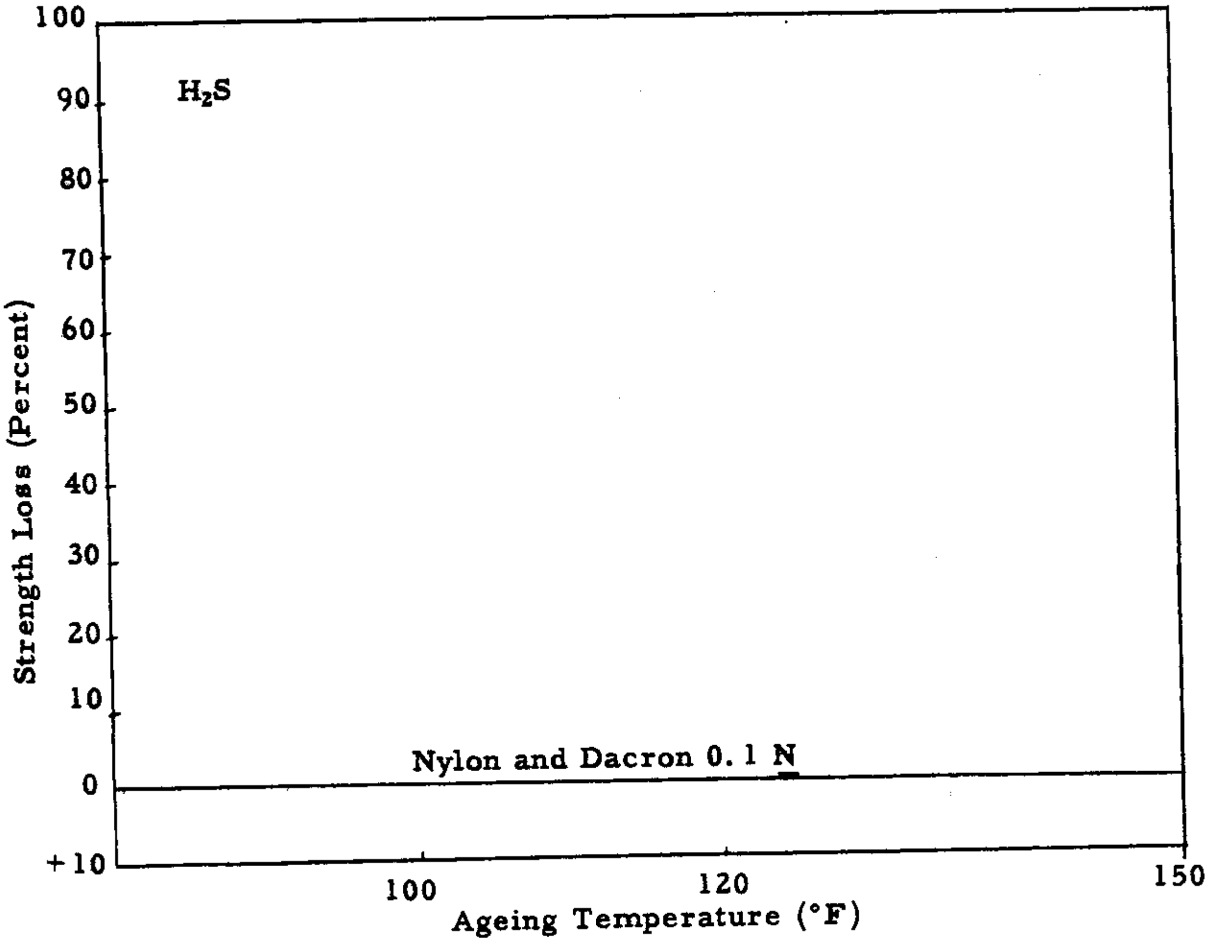


Figure 138. Loss in Strength vs. Temperature when nylon and Dacron (Type II) fabrics are exposed for one month to vapors from H_2S solutions at high relative humidity.

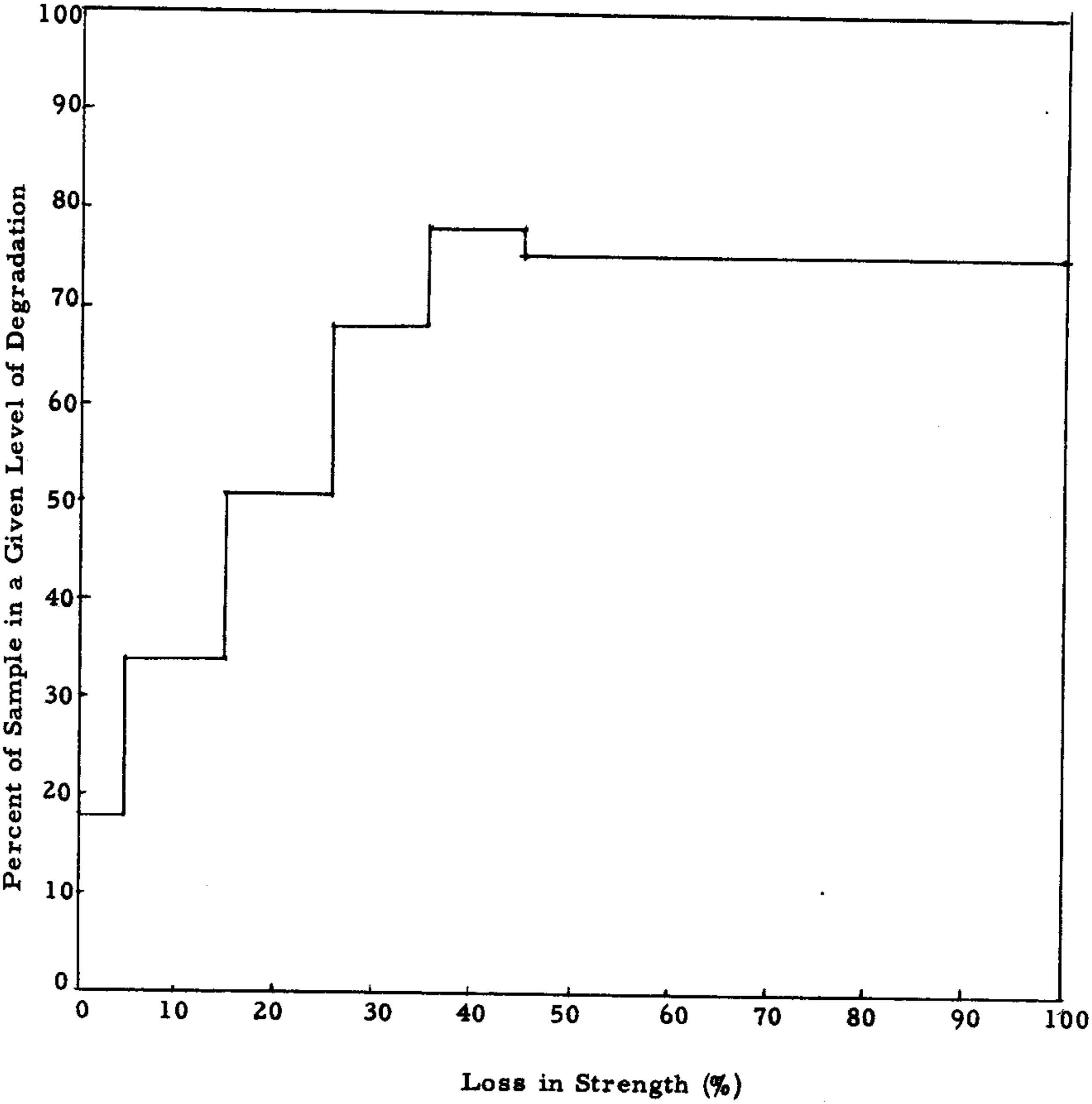


Figure 139. Percent of Nylon Samples in a given level of degradation which fluoresce noticeably different from the nylon control under ultraviolet light vs. Loss in Strength.

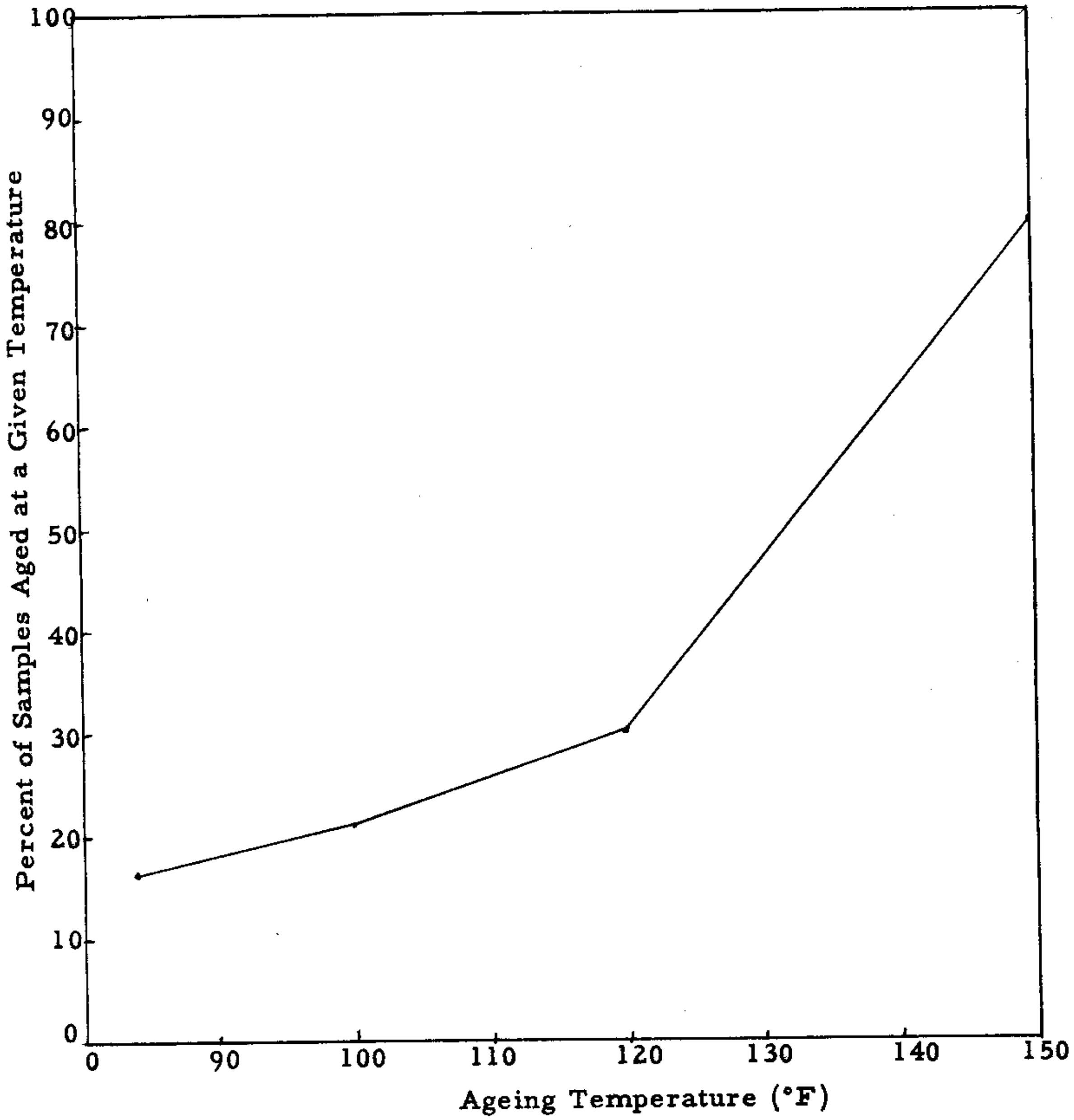


Figure 140. Percent of Nylon Samples aged at a given temperature which fluoresce noticeably different from the nylon control under ultraviolet light vs. ageing temperature.

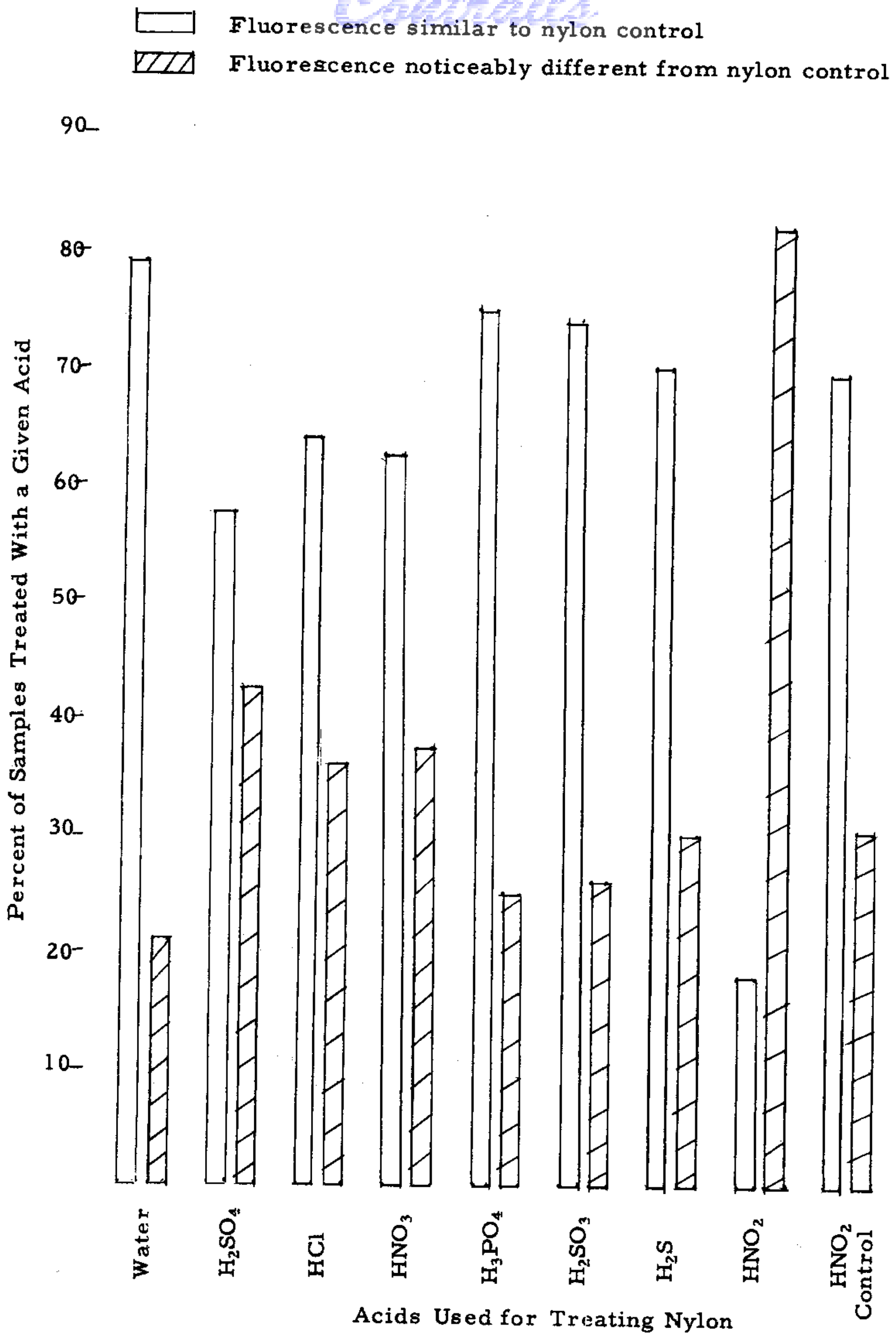


Figure 141. Percent of nylon samples treated with a given acid which fluoresce similar to and noticeably different from the nylon control under ultraviolet light vs. acids used for treating nylon.

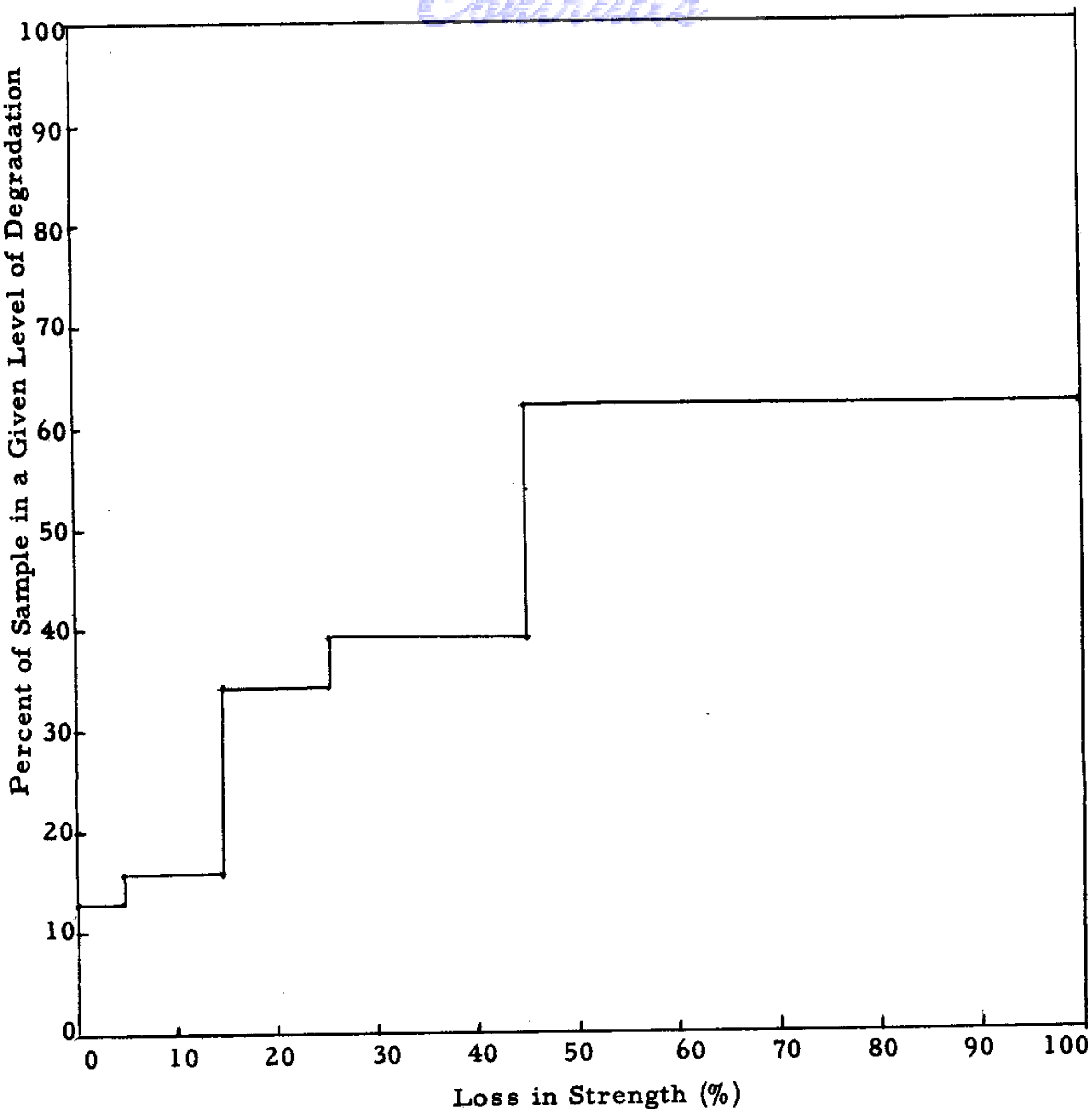


Figure 142. Percent of Nylon Samples in a given level of degradation which fluoresce noticeably different from the nylon control under visible light vs. loss in strength.

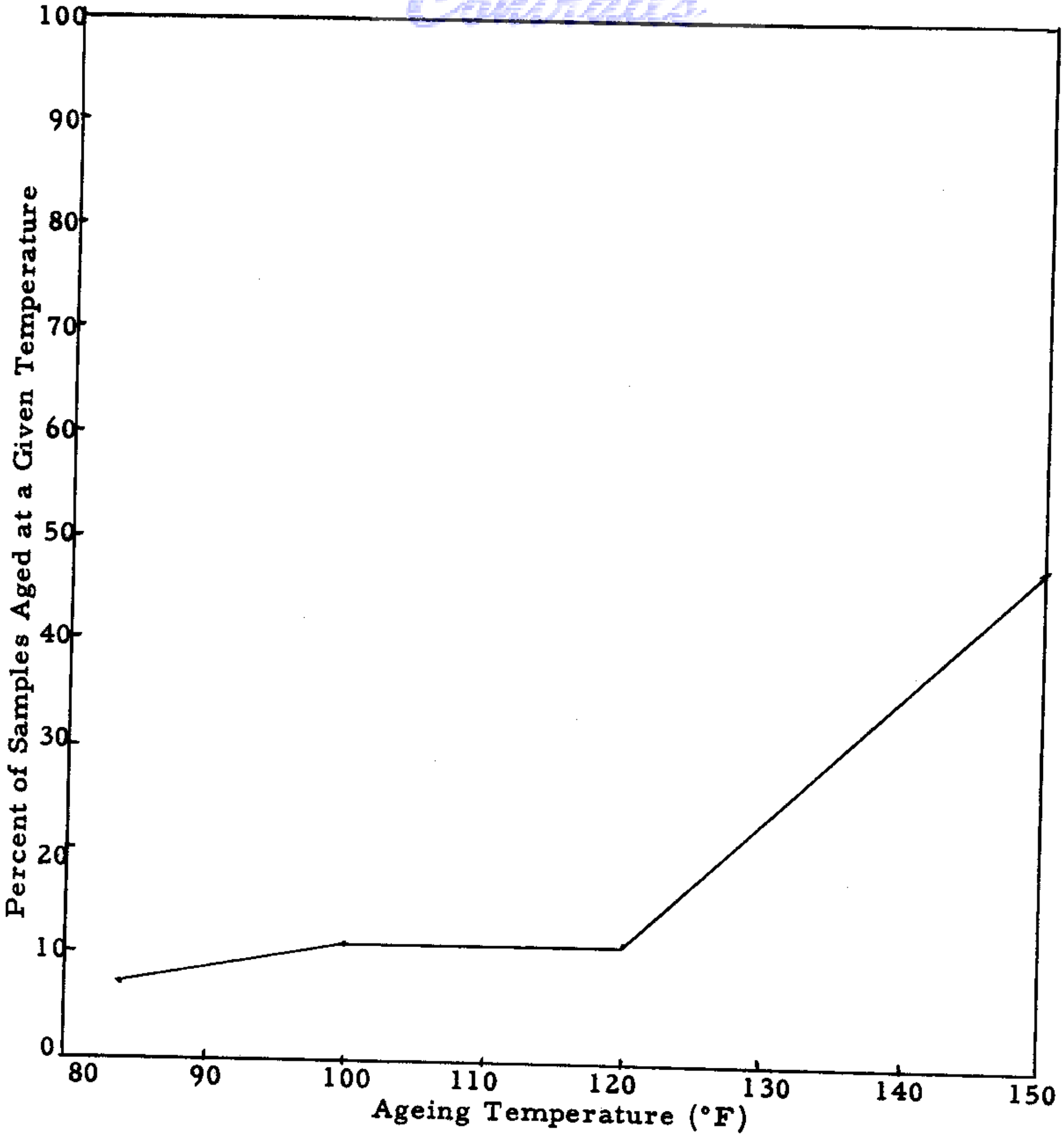


Figure 143. Percent of Nylon Samples aged at a given temperature which fluoresce noticeably different from the nylon control under visible light vs. Ageing Temperature.

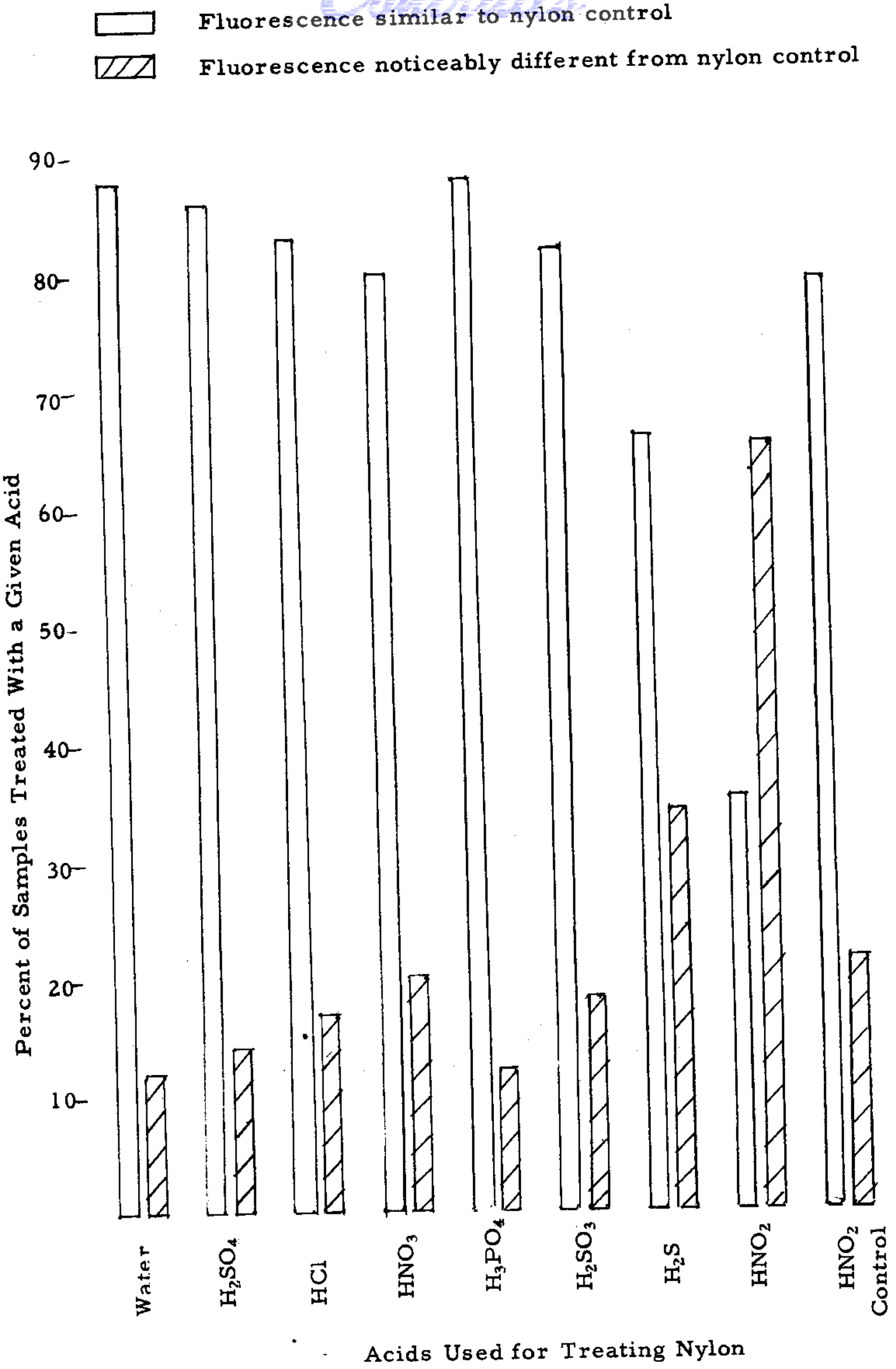


Figure 144 Percent of nylon samples treated with a given acid which fluoresce similar to and noticeably different from the nylon control under visible light vs. acids used for treating nylon.

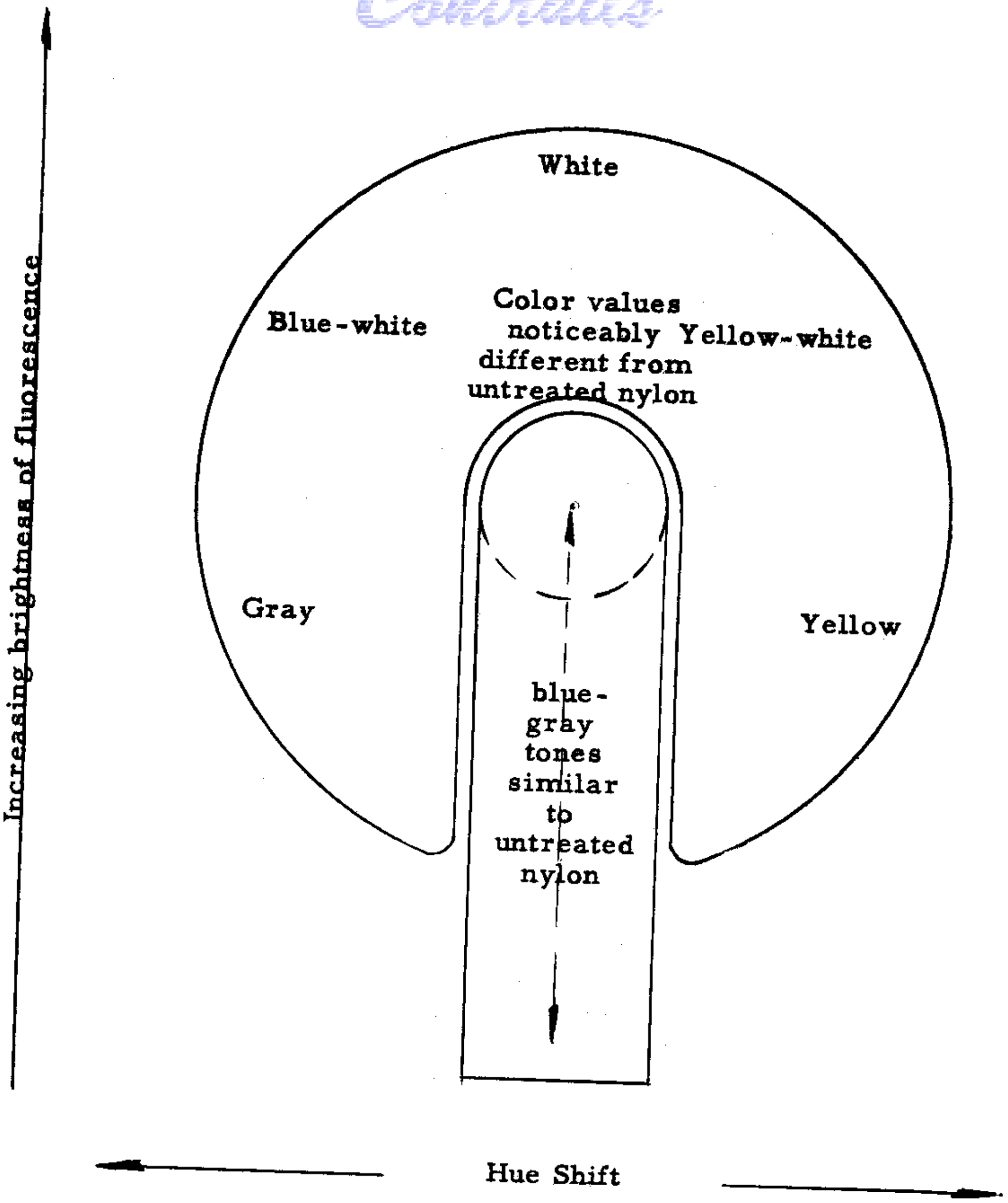


Figure 145. Changes in appearance of the fluorescence of aged nylon samples under ultraviolet light.

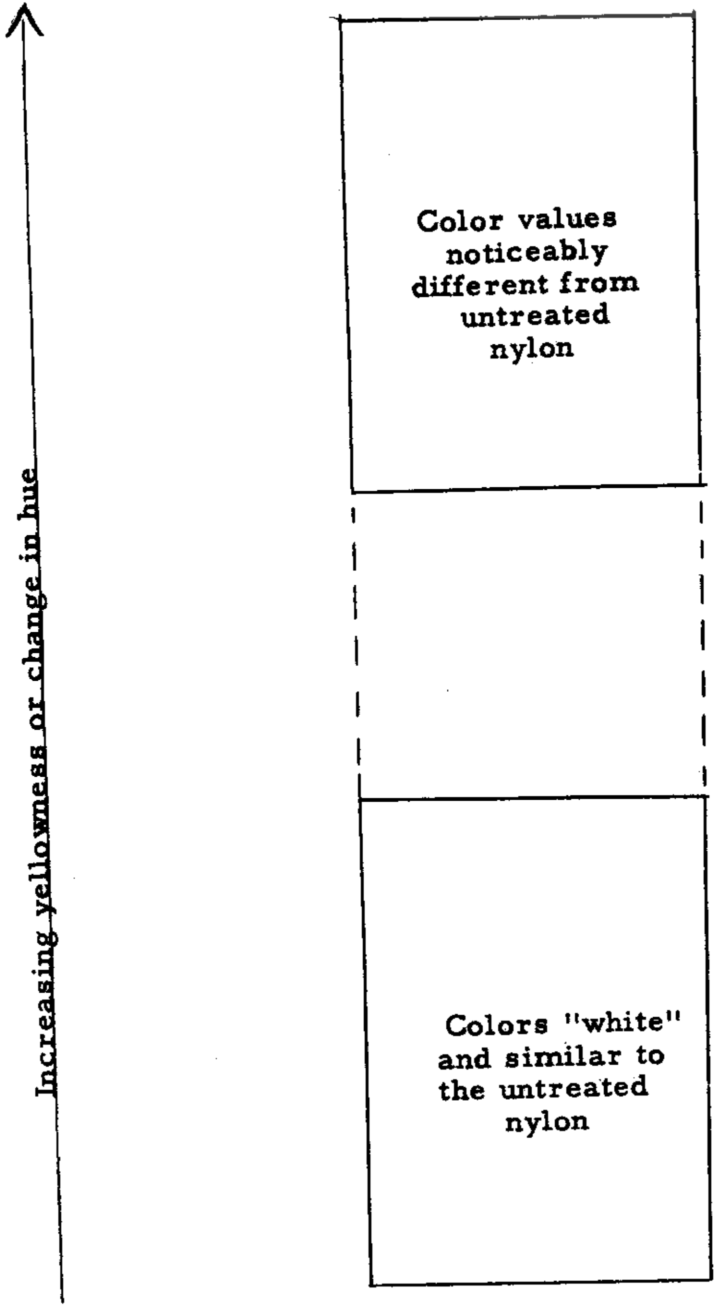


Figure 146. Changes in appearance of aged nylon samples under visible light.