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AN INVESTIGATION OF STATIC PREVENTION IN WOOLEN

CARPETS, USING CONDUCTIVE MATERIALS

A THESIS

Presented to

The Faculty of the Graduate Division

by

Emil Paul Schilling

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Master of Science in Textiles

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AN INVESTIGATION OF STATIC PREVENTION IN WOOLEN

CARPETS, USING CONDUCTIVE MATERIALS

Approved:

Chairman

Date approved by Chairman: 2/17/69

DEDICATED

To my wonderful and loving wife, Lerke, and to my

parents, Mr. and Mrs. John Schwartz

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## SUMMARY

An investigation of static prevention in woolen carpets, using conductive materials has been conducted.

An apparatus to produce an accumulation of electric charges on carpet samples was built. This device was then installed in a constant humidity chamber. For measuring the static build-up and decay, a field mill and a Rothschild recorder were used. Untreated woolen carpet samples were compared to samples having been treated with a chemical antistatic agent and to samples containing a small percentage of stainless steel fibers. Leather as well as rubber were used as generating materials on all samples. The static build-up and decay were measured in order to test the effectiveness of these different means of static prevention. The tests were conducted at different levels of relative humidity, in order to evaluate the effect of humidity on static charge build-up and decay of differently treated carpets.

Both methods of suppression proved to be very effective, provided that the relative humidity did not fall below 30 per cent. Below 30 per cent the chemical agent was a little more effective than the stainless steel fibers. Above 60 per cent relative humidity no suppression was required because there was no significant build-up any longer. The static build-up caused by rubber soles was considerably larger than the one caused by leather soles. All samples decayed very rapidly. After ten minutes of decay there was practically no charge left on any of the samples.

# CHAPTER I

## INTRODUCTION AND HISTORY

Static electricity was discovered long before the other aspects of electricity were studied. Its simplest manifestation is the attraction which certain bodies exhibit for each other, as well as for other bodies after they are brought into contact and then separated.

The Greek scientist, Thales of Milet, around 600 B. C., noted that when amber is rubbed with silk it acquires the capacity to attract small particles of dust. It was not mere coincidence that this observation was made with these two kinds of materials, for they are the most important bearers of static electricity in every-day life, namely, plastic and fiber. The word "electricity," coined in the eighteenth century, was derived from the Greek word amber, "electron."[1]

The first written comments involving static electricity appeared in 1759 by Robert Symmer, who noticed that when he wore silk stockings over wool sufficient electricity was generated in taking the stockings off to cause them to inflate and to repel each other with considerable force.[2] References to electric shocks experienced as a result of striking fur, also date back to about the same time and the fact that shocks are commonly experienced when one comes in contact with metal objects or other people, in very dry regions, is well known.

The cause of this phenomenon is the electrostatic charge acquired by the human body through the process of walking on or rubbing against articles made of natural or artificial fibers, rubber, or plastic.[3] Thus a person walking on a carpet on a cold dry day may become electrically charged and then when touching a metal knob he may receive a shock. Shocks caused in this way can be quite unpleasant and they may in some cases lead to accidents.

The carpet producers are quite concerned with this unpleasant phenomenon and new means of suppression are constantly under investigation. In order to suppress the effects of these electrostatic charges it is required that the carpets be sufficiently conductive, so that the charge can be dispersed as soon as it is separated.

The purpose of this research was to investigate and compare different means of making woolen carpets sufficiently conductive to suppress any significant build-up of static charges.

# CHAPTER II

# GENERATION AND NATURE OF STATIC

## Theory of Generation

The development of the modern theory of elementary particles forms the basis of our present concept of static electricity. A negative electric charge is the consequence of an excess of electrons over protons. Whereas the protons are tightly bound in the nuclei of the atoms, some of the electrons surround the nucleus in a comparatively loose attachment and are, therefore, easily detached. Thus a loss of electrons confers a positive charge, and a gain of electrons confers a negative charge to a body.

When two surfaces are brought into contact, electrons continuously pass across the interface in both directions. In general, this exchange of electrons is not entirely symmetrical and, even with identical bodies, by chance, one of the two bodies acquires an excess of electrons at the expense of the other. As long as contact exists this has no further consequences. When, however, the surfaces are separated one of the two bodies remains with the excess and the other with the deficiency of electrons, therefore, the objects are charged with electrical charges of the same magnitude but opposite sign.[4]

Figure 1 shows an idealized comparison of some of the different situations possible when static is generated. Each of the three cases involves what happens when two surfaces are pressed together and then

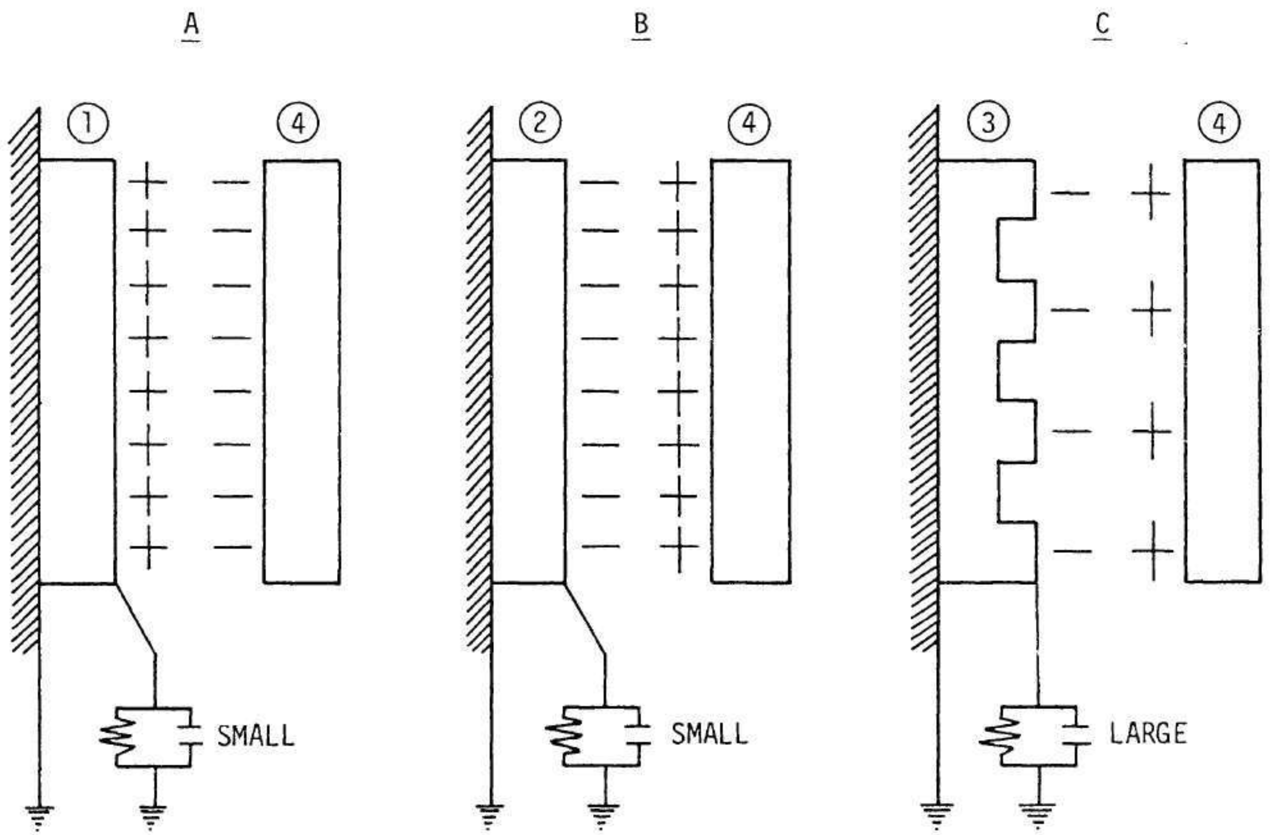


Figure 1. Typical Situations Involving Static Electricity

separated, one surface being common to all three situations. In A, test surface No. 1 takes on eight units of plus charge, and the common surface No. 4 eight units minus charge. The test surface is assumed to have a small resistance and capacity to ground, actually through the material, but indicated schematically as separate, so that charge leakage can take place relatively rapidly. In B, the only difference is that the test surface No. 2 takes on a minus charge. However, in C, a reduced area of contact results in only four units of minus charge, and a large resistance and capacity to ground results in relatively slow leakage.[5]

The sign of the charge developed on the test surface is related to its position in the electrostatic series; the magnitude of the charge developed depends partly on the surface contact area; and the rate of leakage of the charge depends, in many cases, on the electrical properties of the material under test. If the material is a good conductor, the charge may last from only a fraction of a second to a few seconds. On good insulators the charge may remain for seconds, minutes, or even hours, since the charges are not mobile.[6]

## Electrostatic Series

As mentioned previously, the position in the electrostatic series determines the sign of an electrostatic charge. Most authorities define an electrostatic series as a "grouping of materials arranged according to their electrostatic susceptibility."[7] An electrostatic series (see Table 1) is arranged in a vertical list so that any material rubbed against another one located in a lower position on the list will acquire a positive charge. Conversely, if an item is rubbed against a material in a higher position on that list, it will acquire a negative charge.

| Lehmicke[8] | Hersh and Montgomery[9] | Frotscher[10] | Frotscher | Ballou[11] |
|---|---|---|---|---|
| | 33% R. H. | 35% R. H. | 65% R. H. | 15% R. H. |
| | + | + | + | + |
| Glass | Wool | Glass | Glass | Wool |
| Human Hair | Nylon | Wool | Wool | Nylon |
| Nylon Yarn | Viscose | Steel | Viscose | Silk |
| Nylon Polymer | Cotton | Viscose | Cotton | Viscose Rayon |
| Wool | Silk | Cotton | Acetate | Cordura Rayon |
| Silk | Acetate | Acetate | Polyacrylonitrile | Cotton |
| Viscose Rayon | Lucite | Polyester | (Steel) | Fiberglass |
| Cotton | Polyvinyl-Alcohol | Polyacrylonitrile | Polyester | Spun Ramie |
| Paper | Dacron | Polyethylene | Polyethylene | Cellulose Acetate |
| Ramie | Orlon | | | Dacron Yarn |
| Steel | Polyvinylchloride | | | Orlon Yarn |
| Hard Rubber | Dynel | | | Polyethylene |
| Acetate Rayon | Velon | | | Saran |
| Synthetic Rubber | Polyethylene | | | |
| Orlon | Teflon | | | |
| Saran | | | | |
| Polyethylene | | | | |

It can be noted that each of the series is arranged a little different. This is due to the fact that in each case the testing conditions and the methods of testing were different.

## Static Generation on Carpets

A separation of charges takes place whether the test samples are only pressed together or if they are rubbed together as is the case when a person walks on a carpet. When a person walks on a carpet a charge is separated and communicated to the body, which is an electrical conductor. Continuance of the walking process results in a build-up of charge. When the air is humid, the moisture content of the carpet renders it sufficiently electrically conducting to disperse any charge as soon as it is formed. It is not known precisely at what relative humidity the charge build-up ceases; with some materials more than 65 per cent is required. Of course at low humidities the build-up of charge is more apparent and shocks are more likely to be felt.

B. G. Tunmore[12] describes a series of experiments which were devised to determine the voltage reached by a person walking on a carpet, the amount of charge on the body, and the degree of unpleasantness experienced when a sudden discharge to earth took place. The experiments were carried out in a special room, about the size of a normal living room, in which a comfortable temperature was maintained. The humidity was kept very low. Measurements proved that it is possible to attain 18,000 volts on the body in the course of normal activities but that the total charge was very small.

The effects experienced when the body discharged through a finger brought into contact with a grounded earthed conductor were examined. A slight sensation was felt when the potential on the body was 9,000 volts. At 12,000 volts the spark and accompanying shock were sufficient to alarm a nervous person, and above 15,000 volts the experience was very definitely unpleasant. Unpleasant experiences are likely to occur when the body potential exceeds 10,000 volts, and since higher levels than this are attained by walking on carpets, the fact that electrostatic generation from this cause can lead to discomfort is established.

## Methods of Suppression

There are several means by which the severity of the electrostatic problem can be reduced, but none provides a complete answer. In each case, the method seeks to facilitate the leakage of electrical charges from the fabric. This can be accomplished by modifying atmospheric conditions, by increasing the conductivity of the carpet, or by the use of chemical antistatic agents which reduce the electrical resistance of the carpet's surface.

Modifying the atmospheric conditions around the carpet is probably the method most widely in use today. It is a normal practice in air conditioned buildings and is very effective in most cases.[13] By raising the relative humidity the fiber's moisture regain is increased. This is directly related to the surface resistivity of the carpet and, therefore to its ability to leak away electrical charges.[14]

An increase in conductivity of the carpet can be achieved by blending a small percentage of stainless steel fibers into the carpet yarn. The effectiveness of this procedure, however, has not been completely established. Tests conducted at Cornell University[15] using 400 square yards of specially woven carpet containing six different blends of stainless steel and wool fibers, proved to be very successful. However, tests described by Slater[16] showed that the inclusion of stainless steel fibers did not produce the desired results. Slater conducted an investigation, charging woolen carpets containing stainless steel fibers with shoe-sole materials and comparing the results with those of woolen carpets without metal fibers. In his paper it is suggested that the effectiveness of the method in reducing static effects is greatly dependent on the area of carpet used and on the flooring beneath the carpet, in addition to the atmospheric conditions.

Another solution very much in use today is the treatment of carpet yarns or carpets with chemical antistatic agents. These are incorporated into the carpet surface in order to lower its electrical resistivity. They include both salts and organic surface active agents of the wetting or detergent variety. They all operate by absorbing moisture from the air. This they are able to do even at quite low humidities and so when they are applied to the carpet the moisture content is retained even when the surrounding air is quite dry. Of course there is a limit of relative humidity below which an agent ceases to function but this is seldom reached in normal buildings.[17]

The choice as to which agent to use is however accompanied by innumerable problems. The primary requirement is, of course, high effectiveness. But beyond that, the ideal antistatic agent should be colorless, compatible with dyestuffs and finishing agents, and without adverse effects on the carpet's principle properties. In addition to that, it must be insoluble in soap and detergent solutions as well as in standard cleaning solvents. It should be applicable in liquid form, be noncorrosive, and it should not decline with age.[18]

No such ideal agent has been found but progress is being made in that direction. The problems that have to be overcome include the fact that carpets treated with antistatic agents tend to soil easier and bright colors might appear dull or streaky. Also many products are effective antistats when initially applied but lose their ability to control static through chemical degradation, gradual removal by wear or cleaning.

Another possibility for the use of chemical antistatic agents is to incorporate them into the carpet backing. One chemical company has developed a chemical coating compound which can be applied during the backing operation without altering the flow or speed of production. Since this compound is not on the surface of the carpet, it does neither increase the soiling nor does it change the aesthetic appeal of the carpet. Also cleaning cannot remove this compound as easily as if it was applied to the surface of the carpet.[19]

# CHAPTER III

# MATERIALS, INSTRUMENTATION, AND PROCEDURE

## Testing Materials

Three groups of carpet samples were tested during this investigation. The construction of all three sample groups was the same. They were all tufted, had a looped pile, weighed 38 ounces per square yard, and they all had a jute backing. What distinguished the sample groups from each other was their antistatic treatment. The first group consisted of 100 per cent wool fibers which had not been treated at all. The second group consisted of 99 per cent wool and one per cent stainless steel fibers and the third group consisted of 100 per cent wool fibers which had been treated with a chemical antistatic agent, Emerstat 7451.

Each sample was cut to fit the generating disk (see Figure 2). They were cut into two parts, in order to facilitate mounting, and after being glued to the disk they resembled one round sample measuring 130 square inches.

## Generating Materials

Since the experiments were supposed to demonstrate the effects on a person walking on a carpet, the generating materials used were the kind that can be found in shoe soles namely, leather and rubber.

## Instrumentation

For the generation of static electricity on the carpet samples tested, a rotating device, designed by the author, was used. This de-

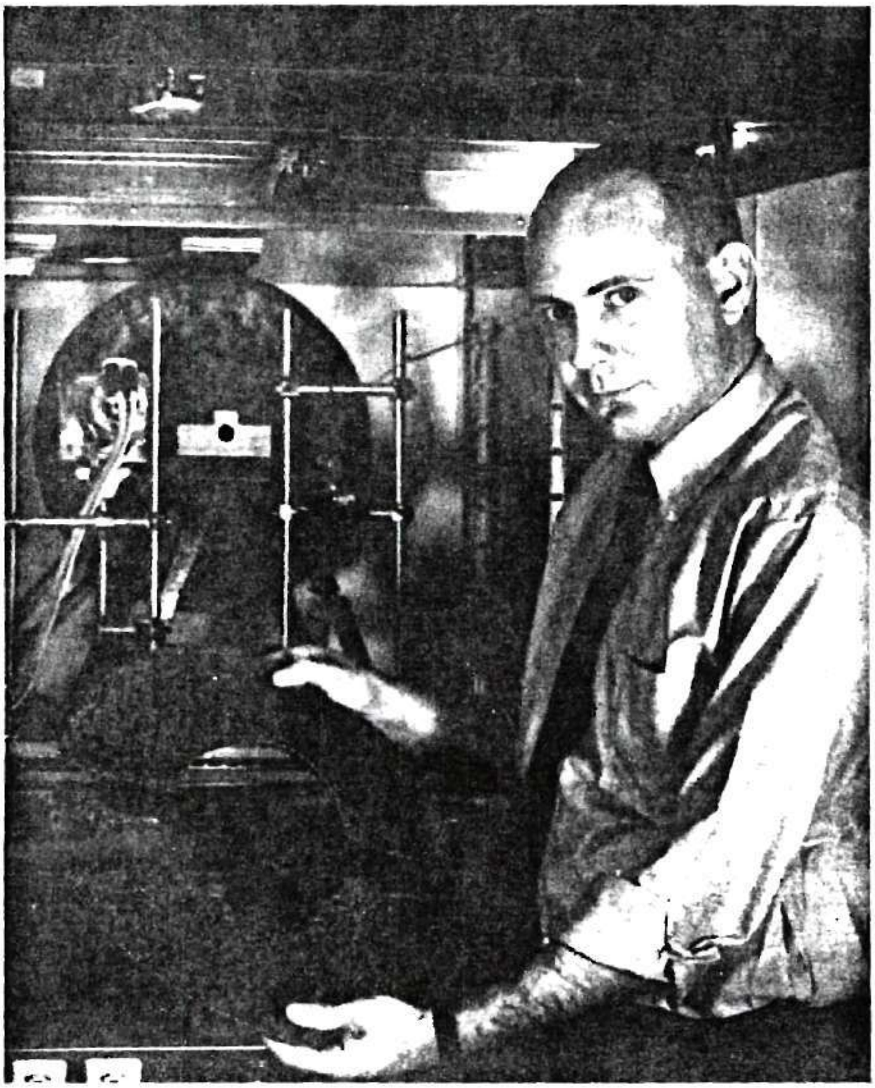

Figure 2. Carpet Sample

vice was installed in a constant humidity chamber which made it possible to perform tests at any desired humidity. The instrument used to determine the static electricity build-up and decay was a static voltmeter called a "field mill." To this instrument a recorder was connected in order to obtain corresponding graphs of all readings. See Figure 3.

The generating device, see Figure 4, consisted of a masonite disk, 15 inches in diameter, which was mounted on a shaft. The disk and shaft were driven by a variable speed motor capable of producing 10 to 280 revolutions per minute. This motor was connected by means of sprockets to the shaft, with a two-to-one reduction sprocket system being used.

Facing the right side of the disk an aluminum frame, consisting of two vertical and two horizontal bars, was located, supporting a clamp which held the generating material to the carpet sample. A 1,500 gram weight was attached to the end of the clamp in order to keep the pressure on the sample constant. Two wires were attached to the clamp itself which made it possible to remove the generating material at any time without opening the constant humidity chamber.

Facing the left side of the disk another frame consisting of two vertical and one horizontal bar was located. This frame supported the sensing head of the field mill. The sensing head was screwed tightly to the horizontal bar with its front plate being exactly two centimeters away from the carpet sample.

The instrument used to measure the static electricity build-up and decay is called a "field mill." Its principle was described as early as 1943 by Schwenkhagen,[20] however, many modifications have been made since. Today the principle of the field mill is regarded as the only

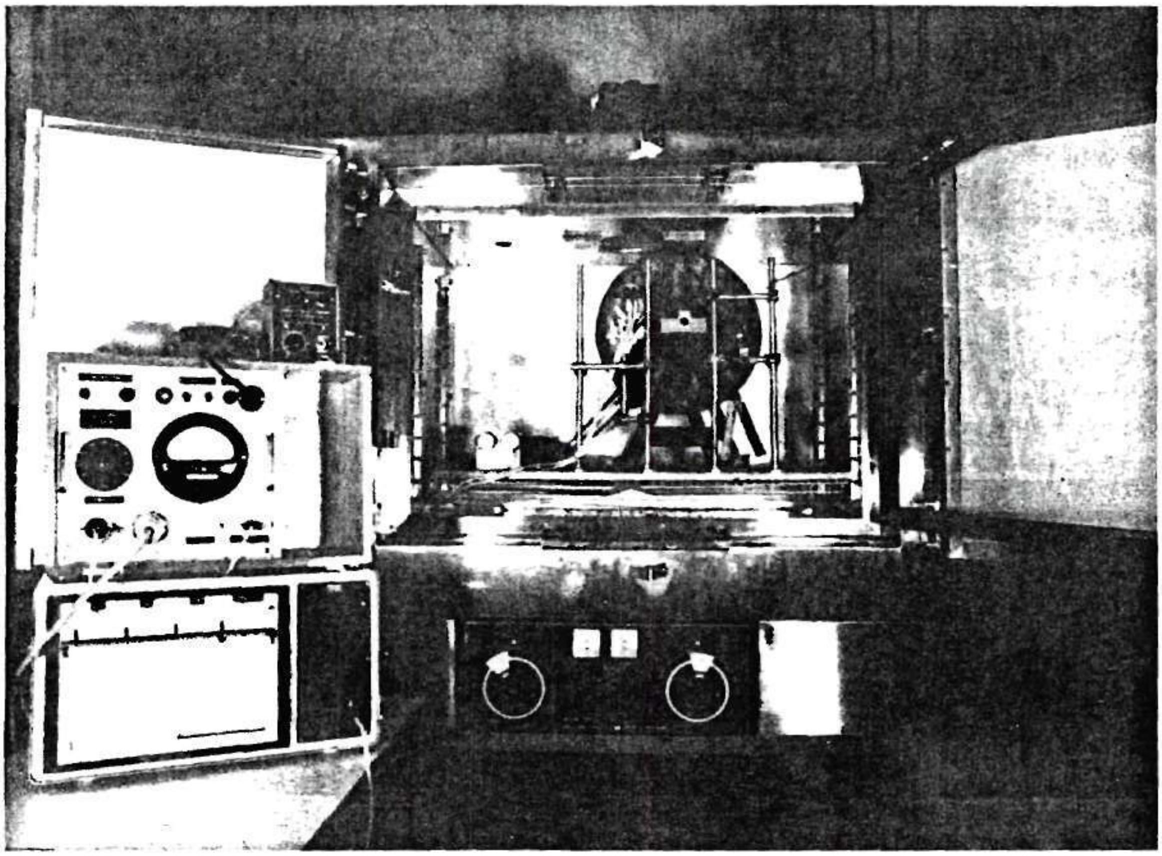

Figure 3. Testing Equipment

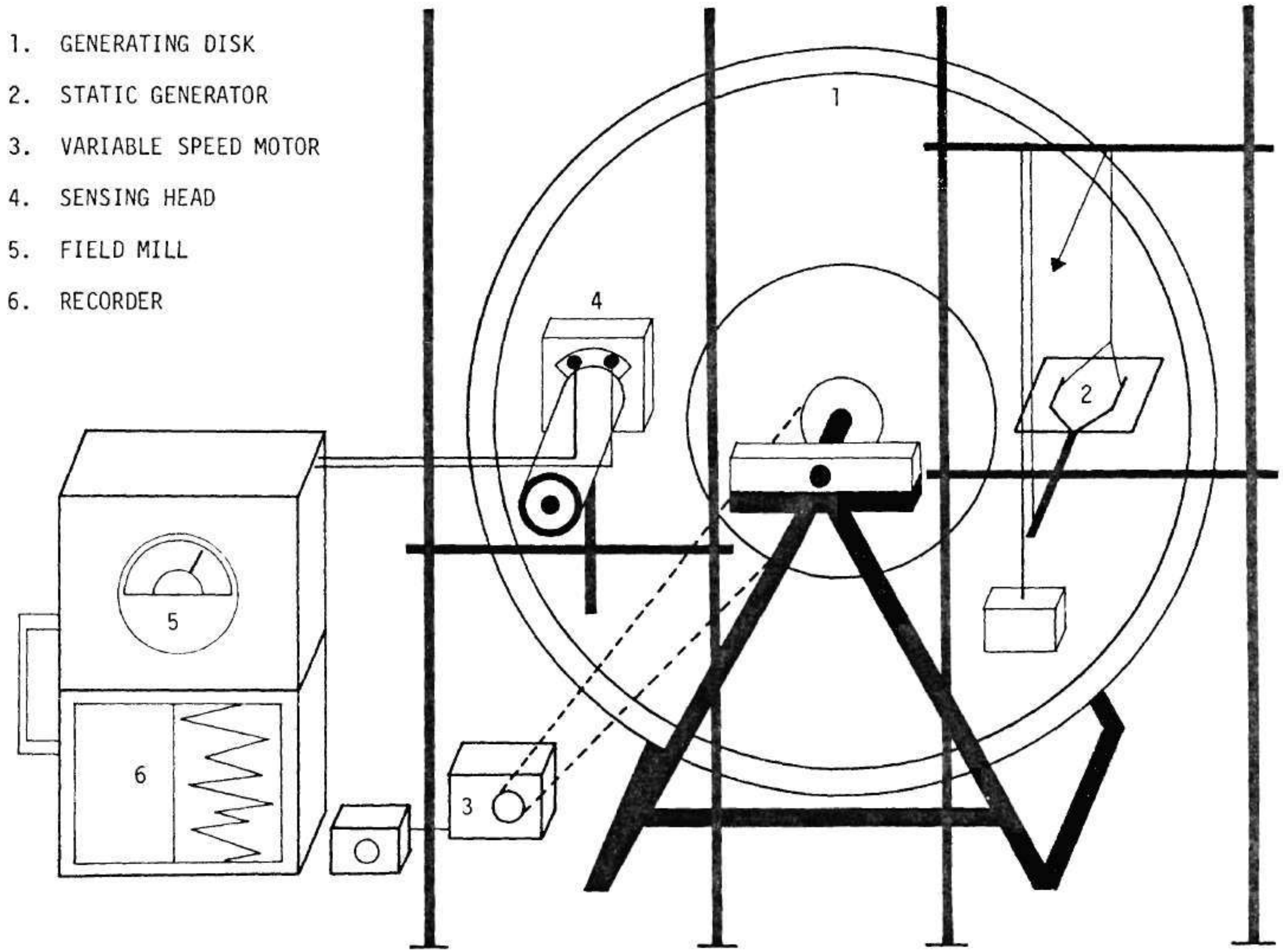


Figure 4. Generating Apparatus

accurate and reliable system to measure static by induction. It is also the most convenient, accurate, and trouble free instrument available for measuring static inside and outside the laboratory even when operated by unskilled personnel.

In this instrument the electrostatic field, formed between the charged material and the stationary sensing electrode, is chopped by a grounded rotating shield. Thus the name "field mill" given to this type of instrument comes from the action of chopping or "milling" the electrostatic field. In the position of the shield, shown in Figure 5, the electrode is exposed to the field; when the shield rotates to a position between the electrode and the charged material, the electrode is shielded from the field. By this method an alternating potential is induced on the electrode. Because this potential is changing according to the frequency of the chopper, an AC current is set up. This AC signal has an amplitude which is proportional to the field strength. This signal can be amplified and read off an AC meter.[22]

The generating device as well as the sensing head of the field mill was installed in a constant humidity chamber, thus making it possible to obtain any desired relative humidity. In order to obtain the desired humidity two dials outside the chamber had to be set to the proper dry-bulb temperature and its respective wet-bulb temperature. Regular tap water was utilized as cooling media. In the front of the chamber a tight sealing glass door was located which made it possible to observe everything that happened inside. On the left wall three openings had been built in, two of which carried the connecting wires between the sensing head of the field mill and the amplifier; the third one was used

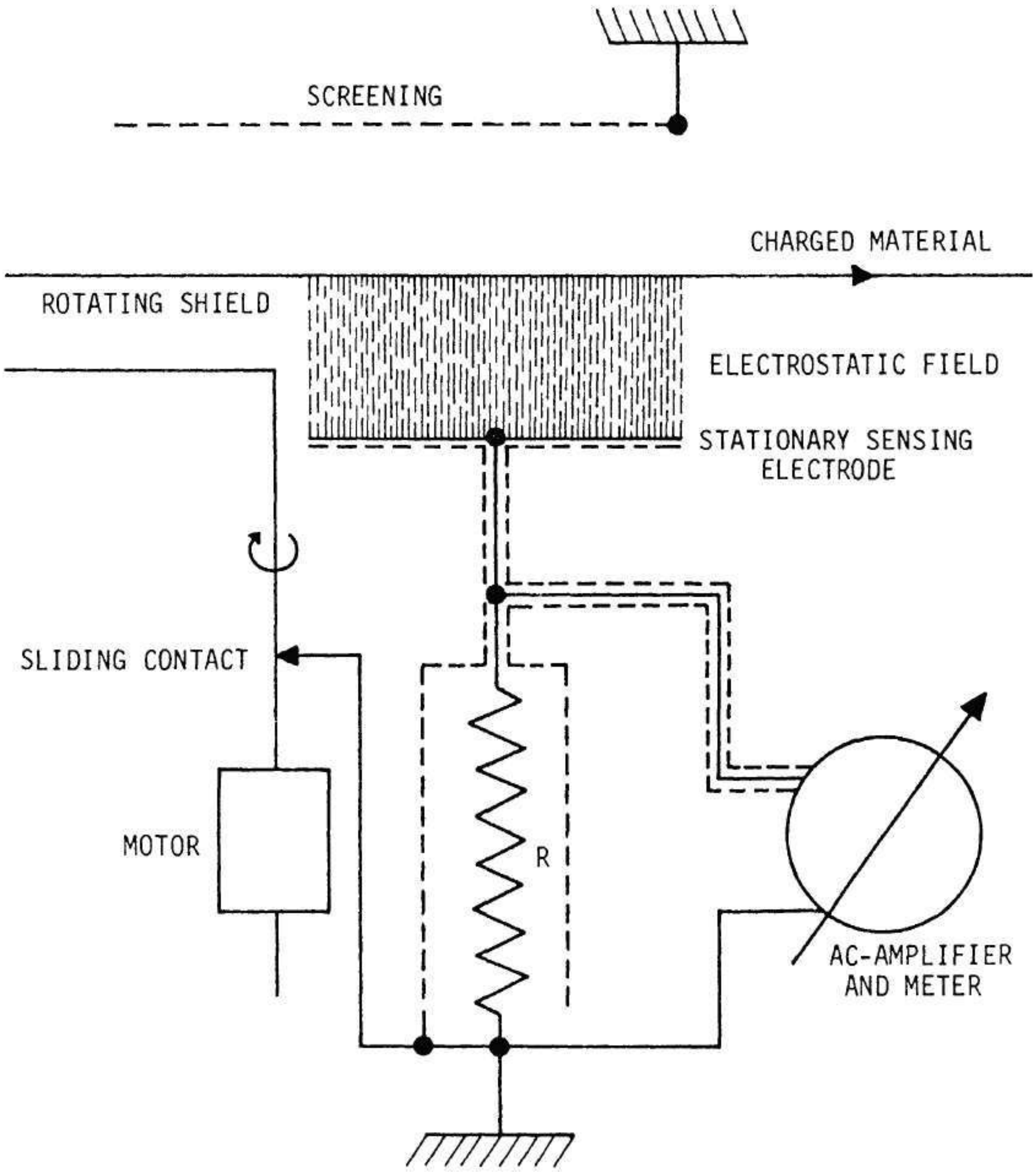


Figure 5. Field Mill

to supply the generator motor with power.

## Procedure

After the carpet sample had been cut to size it was mounted on the masonite disk by means of rubber cement. While the rubber cement was left to dry the constant humidity chamber, the field mill, and the recorder were calibrated. Thereafter the dry bulb dial and the wet bulb dial of the constant humidity chamber were set to the desired temperatures. When the thermometers inside the chamber indicated that the desired temperatures had been reached, which meant also that the desired relative humidity had been established, the field mill was turned on. The field mill was allowed to warm up for ten minutes during which time the carpet sample inside the chamber was conditioned to its surrounding relative humidity. After these ten minutes everything was ready for the first test. The wire connected to the charging material was loosened so that the material could press itself against the carpet sample, a 1,500 gram weight being responsible for constant pressure. Then the variable speed motor was turned to 70 revolutions per minute and at the same time a stop watch was activated. The sample was then charged for twenty minutes, the static build-up being recorded every minute. After the twenty minutes had expired the charging material was removed again. Due to the fact that without pressure the disk would now start to increase its speed, the motor had to be adjusted in order to maintain the 70 revolutions per minute. Now the decay was measured for ten minutes, again the readings being recorded every minute. After the ten minutes had expired the variable speed motor was turned off. One test cycle had now been completed and a different humidity had to be established in the chamber. Every sample was tested at relative humidities of 20 per cent, 30 per cent, 40 per cent, 50 per cent, 60 per cent, and 70 per cent, using first leather and then rubber as generating material.

# CHAPTER IV

## DISCUSSION OF RESULTS

It can be noted from Table 2 and 3, and Figure 6 and 7 that the two methods used in preventing static build-up on carpets were almost equally effective, the chemical agent being a little better. Among the charging materials, rubber caused a much higher static build-up than leather. In every case, however, the relative humidity was the important factor as far as the maximum build-up of charges was concerned. At 60 and 70 per cent relative humidity, it did not make any difference which method of suppression was used. Even without any suppression, there was not enough static build-up to cause alarm. At 40 and 50 per cent relative humidity, there was no considerable build-up with either method of suppression; however, the untreated sample had a large enough build-up to cause an uncomfortable shock. At 20 and 30 per cent relative humidity neither method was effective enough to prevent an uncomfortable shock and the untreated wool sample caused a very severe shock, accompanied by a spark.

All samples decayed very rapidly, as shown in Table 4 through 39. Except at very low relative humidities, there was practically no electrostatic charge left after the samples had been allowed to decay for ten minutes.

Table 2. Maximum Charge Build-Up, When Charged with Leather (in volts/meter)

| Relative Humidity | 100% Wool (Untreated) | 99% Wool, 1% stainless steel | 100% Wool (Treated) |
|---|---|---|---|
| 20% | 30,000 | 14,000 | 13,000 |
| 30% | 25,000 | 11,000 | 10,500 |
| 40% | 13,500 | 6,000 | 6,000 |
| 50% | 10,000 | 5,000 | 4,500 |
| 60% | 4,000 | 2,500 | 2,200 |
| 70% | 1,200 | 600 | 500 |

Table 3. Maximum Charge Build-Up, When Charged with Rubber (in volts/meter)

| Relative Humidity | 100% Wool (Untreated) | 99% Wool, 1% stainless steel | 100% Wool (Treated) |
|---|---|---|---|
| 20% | 38,000 | 20,000 | 16,000 |
| 30% | 30,000 | 14,000 | 13,000 |
| 40% | 22,000 | 8,000 | 7,500 |
| 50% | 14,000 | 6,000 | 5,000 |
| 60% | 7,000 | 3,500 | 3,500 |
| 70% | 4,000 | 1,000 | 900 |

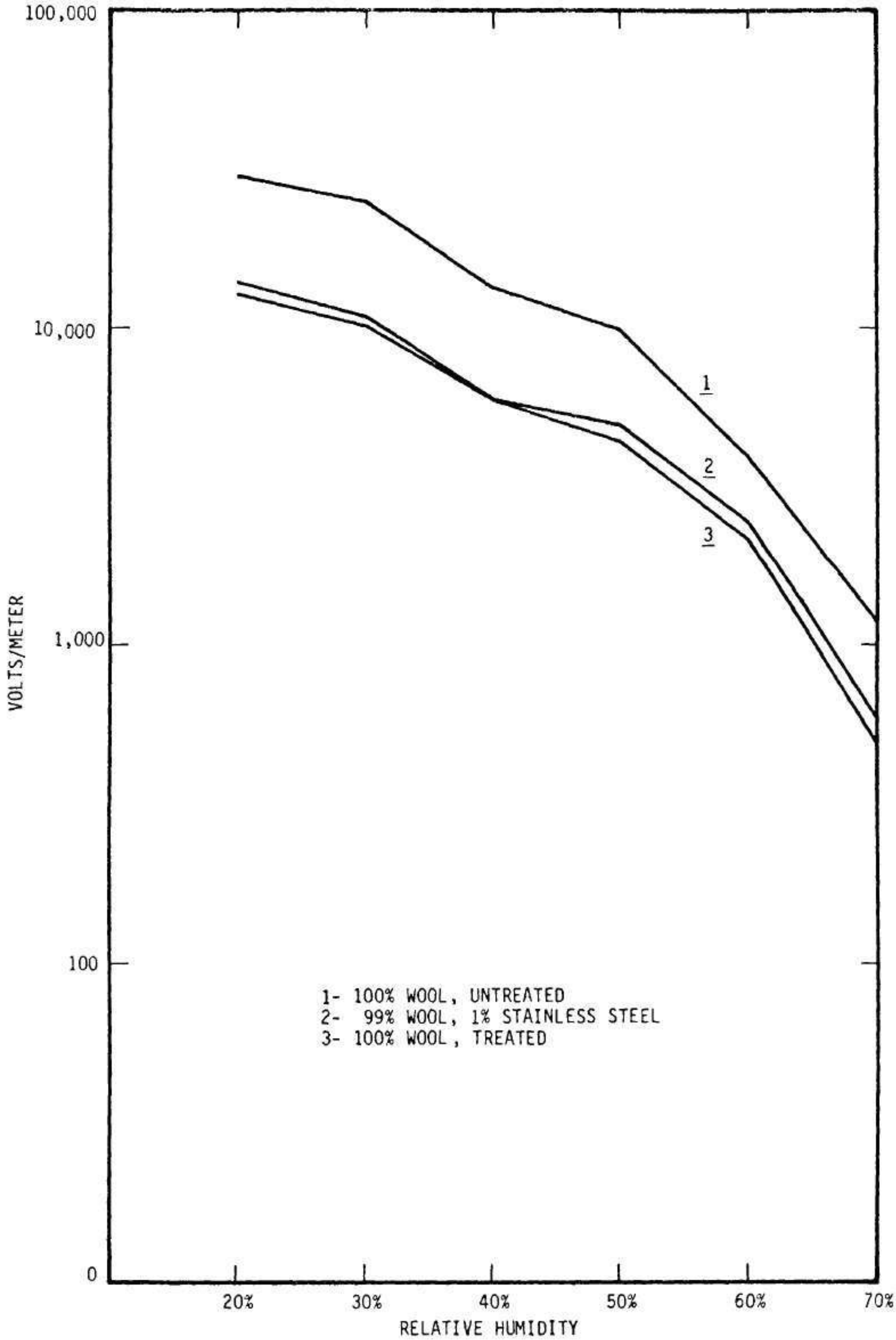


Figure 6. Maximum Charges at Different Humidities.
Samples Charged with Leather

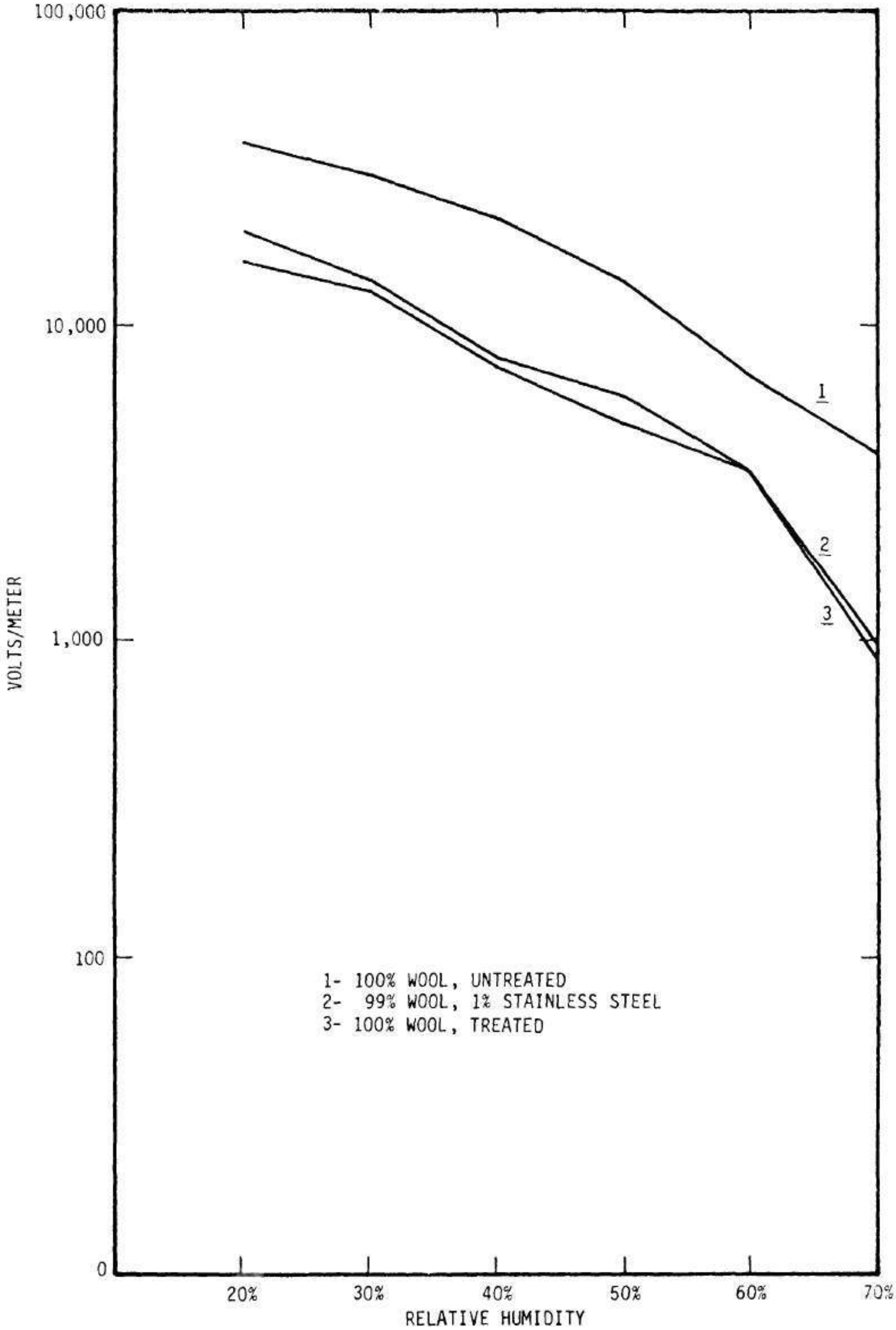


Figure 7. Maximum Charges at Different Humidities. Samples Charged with Rubber

# CHAPTER V

# CONCLUSIONS AND RECOMMENDATIONS

## Conclusions

All samples tested in this investigation had a relatively low static build-up above a relative humidity of 60 per cent. The untreated carpet samples only reached a maximum build-up of 7,000 volts per meter, which is not enough to cause a noticeable shock. Below 60 per cent relative humidity it became necessary to employ a method of static suppression. Both methods tested proved to be effective as long as the relative humidity did not sink below 35 per cent. Below 35 per cent neither method was very effective.

All samples decayed rather rapidly which meant that in no case there was an accumulation of charges due to charge build-up on top of remaining charges.

In most instances the chemical antistatic agent appeared to be a little more effective than the stainless steel fibers. However, taking into consideration the inherent disadvantages of most chemical antistatic agents, soil attraction, chemical degradation, etc., the stainless steel fibers were the best method of static suppression tested during this investigation.

## Recommendations

There is a definite difference in static build-up and decay from material to material. Work could be undertaken to establish the effectiveness of stainless steel fibers in nylon, acrylic and polyester carpets.

Since stainless steel fibers can only be used in carpets made with spun yarns, an investigation could be carried out, evaluating the use of copper wires in carpets containing continuous filaments.

This investigation only dealt with one type of carpet construction. Today there is a strong tendency to increase the tufts per square inch of a carpet considerably. The relationship between static build-up on a carpet and its tufts per square inch should be investigated.

# APPENDIX

Table 4. Static Build-Up and Decay of Wool Sample, Charged with Leather, at 20% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 14,000 | 7,000 |
| 2 | 15,000 | 4,000 |
| 3 | 16,000 | 3,000 |
| 4 | 17,000 | 2,500 |
| 5 | 18,000 | 2,000 |
| 6 | 19,000 | 1,500 |
| 7 | 20,000 | 1,400 |
| 8 | 21,000 | 1,300 |
| 9 | 22,000 | 1,200 |
| 10 | 23,000 | 1,100 |
| 11 | 24,000 | |
| 12 | 25,000 | |
| 13 | 26,000 | |
| 14 | 27,000 | |
| 15 | 27,500 | |
| 16 | 28,000 | |
| 17 | 28,500 | |
| 18 | 29,000 | |
| 19 | 29,500 | |
| 20 | 30,000 | |

Table 5. Static Build-Up and Decay of Wool Sample, Charged with Leather, at 30% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 10,000 | 5,000 |
| 2 | 12,000 | 3,000 |
| 3 | 13,000 | 2,000 |
| 4 | 14,000 | 1,500 |
| 5 | 15,000 | 1,200 |
| 6 | 16,000 | 1,000 |
| 7 | 17,000 | 950 |
| 8 | 18,000 | 900 |
| 9 | 19,000 | 850 |
| 10 | 20,000 | 800 |
| 11 | 20,500 | |
| 12 | 21,000 | |
| 13 | 21,500 | |
| 14 | 22,000 | |
| 15 | 22,500 | |
| 16 | 23,000 | |
| 17 | 23,500 | |
| 18 | 24,000 | |
| 19 | 24,500 | |
| 20 | 25,000 | |

Table 6. Static Build-Up and Decay of Wool Sample, Charged with Leather, at 40% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 7,000 | 500 |
| 2 | 7,500 | 200 |
| 3 | 8,000 | 140 |
| 4 | 8,500 | 90 |
| 5 | 9,000 | 70 |
| 6 | 9,500 | 60 |
| 7 | 10,000 | 60 |
| 8 | 10,500 | 60 |
| 9 | 11,000 | 50 |
| 10 | 11,500 | 50 |
| 11 | 12,000 | |
| 12 | 12,000 | |
| 13 | 12,000 | |
| 14 | 12,250 | |
| 15 | 12,500 | |
| 16 | 12,750 | |
| 17 | 13,000 | |
| 18 | 13,250 | |
| 19 | 13,500 | |
| 20 | 13,500 | |

Table 7. Static Build-Up and Decay of Wool Sample, Charged with Leather, at 50% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 3,500 | 300 |
| 2 | 4,000 | 100 |
| 3 | 4,500 | 80 |
| 4 | 5,000 | 70 |
| 5 | 5,500 | 60 |
| 6 | 6,000 | 60 |
| 7 | 6,500 | 50 |
| 8 | 7,000 | 50 |
| 9 | 7,000 | 50 |
| 10 | 7,500 | 50 |
| 11 | 7,500 | |
| 12 | 8,000 | |
| 13 | 8,000 | |
| 14 | 8,500 | |
| 15 | 8,500 | |
| 16 | 9,000 | |
| 17 | 9,000 | |
| 18 | 9,500 | |
| 19 | 9,500 | |
| 20 | 10,000 | |

Table 8. Static Build-Up and Decay of Wool Sample, Charged with Leather, at 60% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 1,500 | 100 |
| 2 | 1,700 | 80 |
| 3 | 1,900 | 60 |
| 4 | 2,100 | 50 |
| 5 | 2,300 | 50 |
| 6 | 2,500 | 50 |
| 7 | 2,700 | 40 |
| 8 | 2,900 | 40 |
| 9 | 3,100 | 40 |
| 10 | 3,200 | 40 |
| 11 | 3,300 | |
| 12 | 3,400 | |
| 13 | 3,500 | |
| 14 | 3,600 | |
| 15 | 3,700 | |
| 16 | 3,800 | |
| 17 | 3,850 | |
| 18 | 3,900 | |
| 19 | 3,950 | |
| 20 | 4,000 | |

Table 9. Static Build-Up and Decay of Wool Sample, Charged with Leather, at 70% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 700 | 55 |
| 2 | 750 | 50 |
| 3 | 800 | 45 |
| 4 | 850 | 45 |
| 5 | 900 | 40 |
| 6 | 950 | 40 |
| 7 | 1,000 | 40 |
| 8 | 1,000 | 40 |
| 9 | 1,050 | 40 |
| 10 | 1,050 | 40 |
| 11 | 1,100 | |
| 12 | 1,100 | |
| 13 | 1,150 | |
| 14 | 1,150 | |
| 15 | 1,200 | |
| 16 | 1,200 | |
| 17 | 1,200 | |
| 18 | 1,200 | |
| 19 | 1,200 | |
| 20 | 1,200 | |

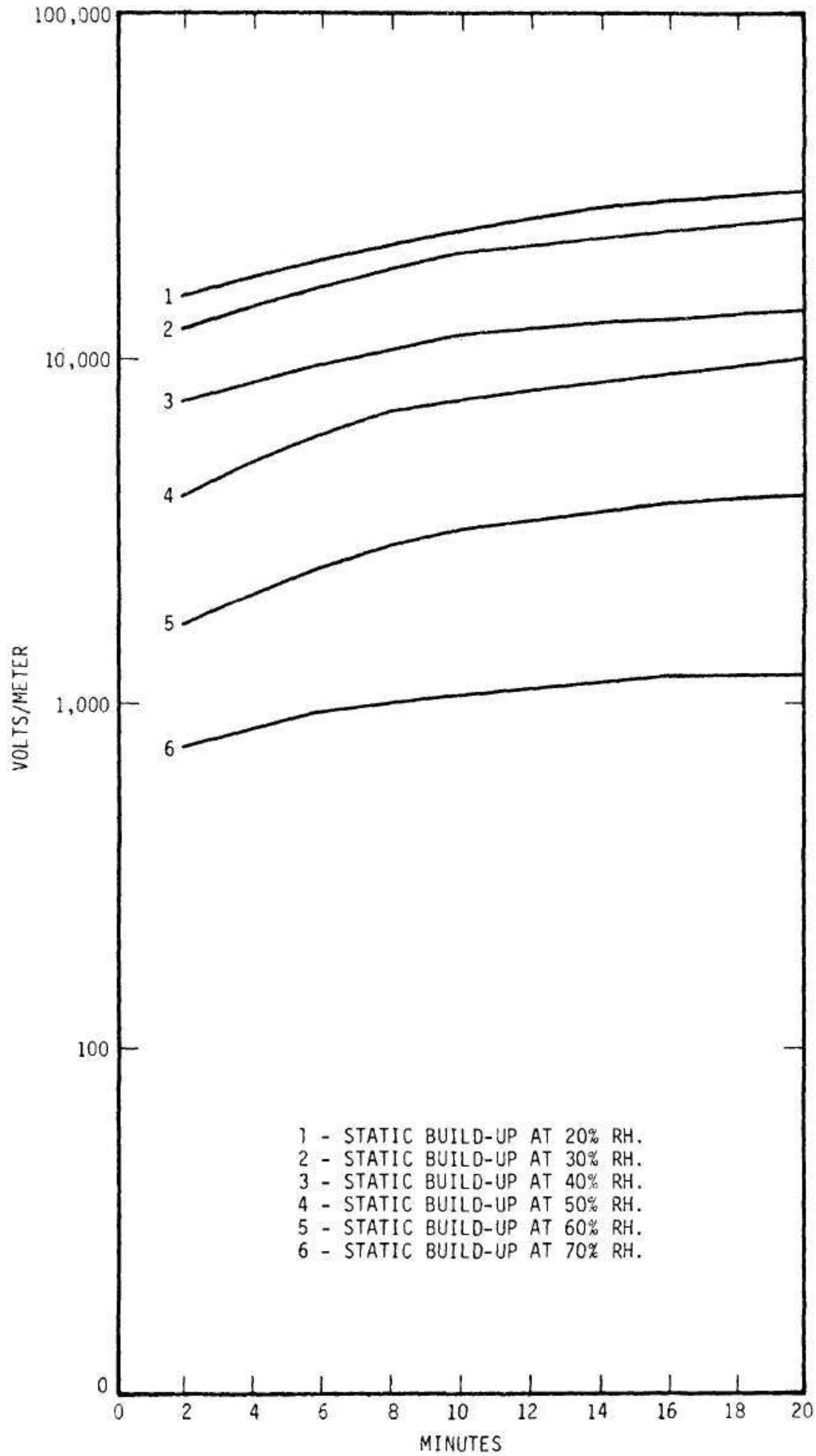


Figure 8. Static Build-Up on Wool Samples, Charged with Leather

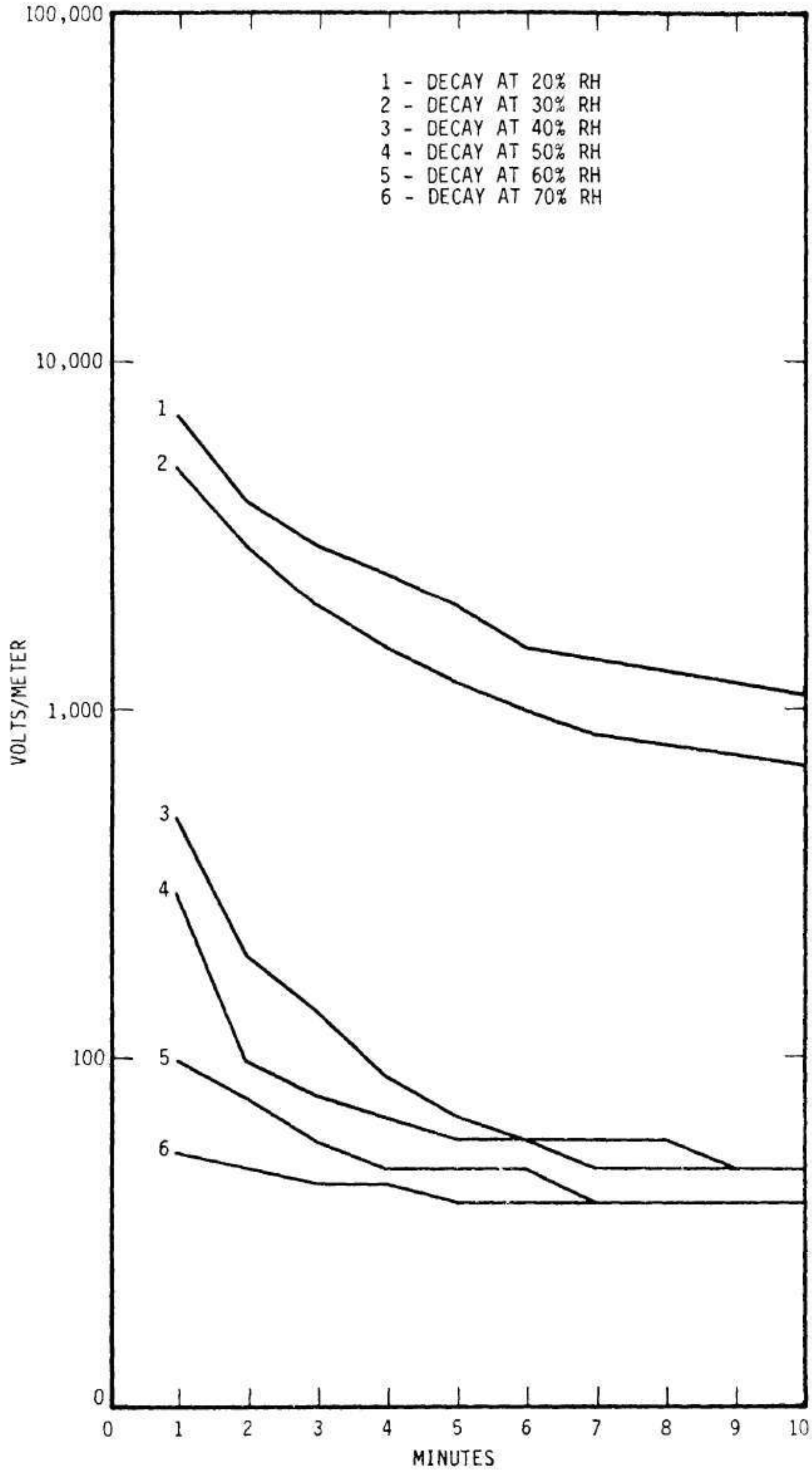


Figure 9. Decay of Wool Samples Charged with Leather

Table 10. Static Build-Up and Decay of Wool Sample, Charged with Rubber, at 20% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 18,000 | 12,000 |
| 2 | 20,000 | 7,000 |
| 3 | 21,000 | 5,500 |
| 4 | 22,000 | 4,500 |
| 5 | 23,000 | 4,000 |
| 6 | 24,000 | 3,500 |
| 7 | 25,000 | 3,000 |
| 8 | 26,000 | 2,500 |
| 9 | 27,000 | 2,300 |
| 10 | 28,000 | 2,000 |
| 11 | 29,000 | |
| 12 | 30,000 | |
| 13 | 31,000 | |
| 14 | 32,000 | |
| 15 | 33,000 | |
| 16 | 34,000 | |
| 17 | 35,000 | |
| 18 | 36,000 | |
| 19 | 37,000 | |
| 20 | 38,000 | |

Table 11. Static Build-Up and Decay of Wool Sample, Charged with Rubber, at 30% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 13,000 | 7,000 |
| 2 | 15,000 | 4,500 |
| 3 | 16,000 | 3,500 |
| 4 | 17,000 | 2,500 |
| 5 | 18,000 | 2,000 |
| 6 | 19,000 | 1,800 |
| 7 | 20,000 | 1,500 |
| 8 | 21,000 | 1,300 |
| 9 | 22,000 | 1,200 |
| 10 | 23,000 | 1,100 |
| 11 | 24,000 | |
| 12 | 25,000 | |
| 13 | 26,000 | |
| 14 | 27,000 | |
| 15 | 27,500 | |
| 16 | 28,000 | |
| 17 | 28,500 | |
| 18 | 29,000 | |
| 19 | 29,500 | |
| 20 | 30,000 | |

Table 12. Static Build-Up and Decay of Wool Sample, Charged with Rubber, at 40% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 9,000 | 4,000 |
| 2 | 10,000 | 2,500 |
| 3 | 11,000 | 1,500 |
| 4 | 12,000 | 1,100 |
| 5 | 13,000 | 900 |
| 6 | 14,000 | 600 |
| 7 | 15,000 | 500 |
| 8 | 16,000 | 400 |
| 9 | 16,500 | 300 |
| 10 | 17,000 | 200 |
| 11 | 17,500 | |
| 12 | 18,000 | |
| 13 | 18,500 | |
| 14 | 19,000 | |
| 15 | 19,500 | |
| 16 | 20,000 | |
| 17 | 20,500 | |
| 18 | 21,000 | |
| 19 | 21,500 | |
| 20 | 22,000 | |

Table 13. Static Build-Up and Decay of Wool Sample, Charged with Rubber, at 50% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 5,000 | 600 |
| 2 | 6,000 | 300 |
| 3 | 7,000 | 120 |
| 4 | 7,500 | 100 |
| 5 | 8,000 | 90 |
| 6 | 8,500 | 80 |
| 7 | 9,000 | 70 |
| 8 | 9,500 | 60 |
| 9 | 10,000 | 60 |
| 10 | 10,500 | 60 |
| 11 | 11,000 | |
| 12 | 11,500 | |
| 13 | 12,000 | |
| 14 | 12,500 | |
| 15 | 13,000 | |
| 16 | 13,250 | |
| 17 | 13,500 | |
| 18 | 13,750 | |
| 19 | 14,000 | |
| 20 | 14,000 | |

Table 14. Static Build-Up and Decay of Wool Sample, Charged with Rubber, at 60% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 2,500 | 180 |
| 2 | 3,000 | 140 |
| 3 | 3,500 | 110 |
| 4 | 4,000 | 90 |
| 5 | 4,200 | 80 |
| 6 | 4,400 | 70 |
| 7 | 4,600 | 60 |
| 8 | 4,800 | 60 |
| 9 | 5,000 | 50 |
| 10 | 5,200 | 50 |
| 11 | 5,400 | |
| 12 | 5,600 | |
| 13 | 5,800 | |
| 14 | 6,000 | |
| 15 | 6,200 | |
| 16 | 6,400 | |
| 17 | 6,600 | |
| 18 | 6,800 | |
| 19 | 6,900 | |
| 20 | 7,000 | |

Table 15. Static Build-Up and Decay of Wool Sample, Charged with Rubber, at 70% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 1,700 | 150 |
| 2 | 1,900 | 100 |
| 3 | 2,100 | 80 |
| 4 | 2,300 | 70 |
| 5 | 2,500 | 60 |
| 6 | 2,600 | 50 |
| 7 | 2,700 | 50 |
| 8 | 2,800 | 40 |
| 9 | 2,900 | 40 |
| 10 | 3,000 | 40 |
| 11 | 3,100 | |
| 12 | 3,200 | |
| 13 | 3,300 | |
| 14 | 3,400 | |
| 15 | 3,500 | |
| 16 | 3,600 | |
| 17 | 3,700 | |
| 18 | 3,800 | |
| 19 | 3,900 | |
| 20 | 4,000 | |

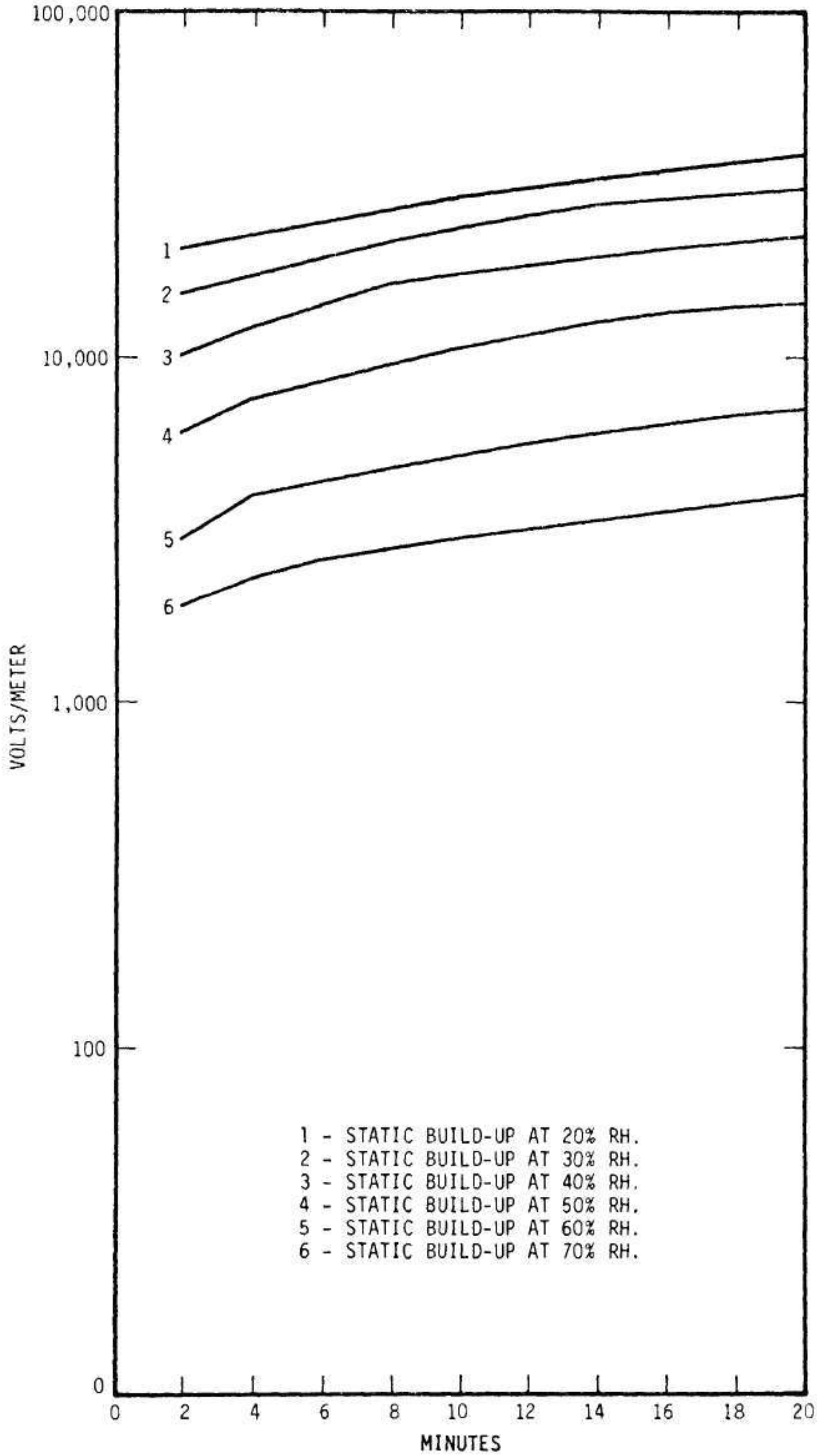


Figure 10. Static Build-Up on Wool Samples, Charged with Rubber

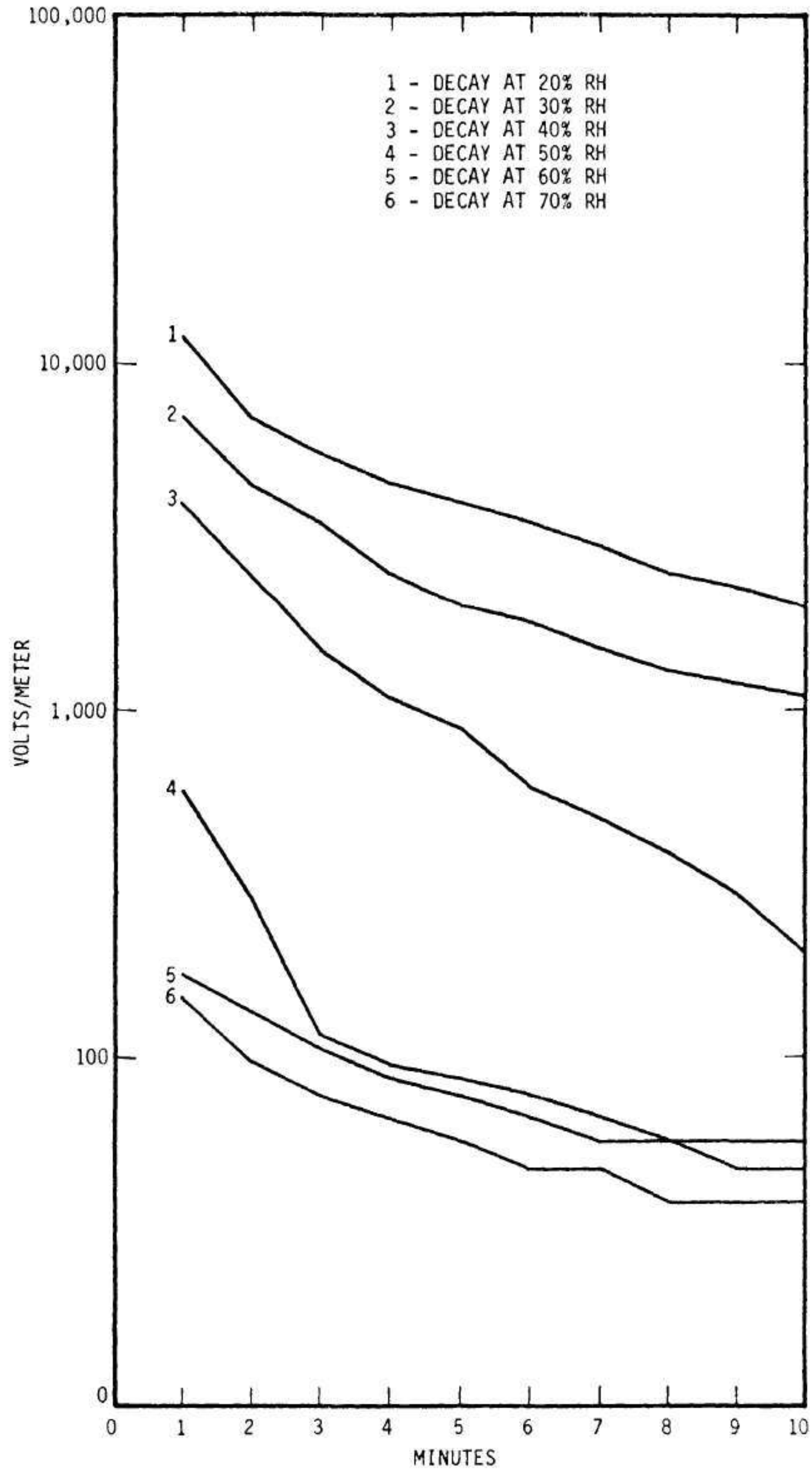


Figure 11. Decay of Wool Samples Charged with Rubber

Table 16. Static Build-Up and Decay of Wool plus Stainless Steel Sample, Charged with Leather, at 20% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 8,000 | 3,000 |
| 2 | 9,000 | 1,300 |
| 3 | 9,500 | 1,000 |
| 4 | 10,000 | 650 |
| 5 | 10,000 | 550 |
| 6 | 10,500 | 450 |
| 7 | 10,500 | 400 |
| 8 | 11,000 | 350 |
| 9 | 11,000 | 320 |
| 10 | 11,500 | 300 |
| 11 | 11,500 | |
| 12 | 12,000 | |
| 13 | 12,250 | |
| 14 | 12,500 | |
| 15 | 12,750 | |
| 16 | 13,000 | |
| 17 | 13,250 | |
| 18 | 13,500 | |
| 19 | 13,750 | |
| 20 | 14,000 | |

Table 17. Static Build-Up and Decay of Wool plus Stainless Steel Sample, Charged with Leather, at 30% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 7,500 | 1,000 |
| 2 | 7,500 | 500 |
| 3 | 7,500 | 300 |
| 4 | 8,000 | 200 |
| 5 | 8,000 | 150 |
| 6 | 8,000 | 120 |
| 7 | 8,500 | 90 |
| 8 | 8,500 | 70 |
| 9 | 9,000 | 60 |
| 10 | 9,000 | 60 |
| 11 | 9,500 | |
| 12 | 9,500 | |
| 13 | 10,000 | |
| 14 | 10,000 | |
| 15 | 10,000 | |
| 16 | 10,500 | |
| 17 | 10,500 | |
| 18 | 10,500 | |
| 19 | 10,500 | |
| 20 | 11,000 | |

Table 18. Static Build-Up and Decay of Wool plus Stainless Steel Sample, Charged with Leather, at 40% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 3,000 | 130 |
| 2 | 4,000 | 80 |
| 3 | 4,500 | 60 |
| 4 | 4,500 | 60 |
| 5 | 4,500 | 60 |
| 6 | 5,000 | 55 |
| 7 | 5,000 | 55 |
| 8 | 5,000 | 55 |
| 9 | 5,000 | 50 |
| 10 | 5,500 | 50 |
| 11 | 5,500 | |
| 12 | 5,500 | |
| 13 | 5,500 | |
| 14 | 5,500 | |
| 15 | 5,750 | |
| 16 | 6,000 | |
| 17 | 6,000 | |
| 18 | 6,000 | |
| 19 | 6,000 | |
| 20 | 6,000 | |

Table 19. Static Build-Up and Decay of Wool plus Stainless Steel Sample, Charged with Leather, at 50% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 2,500 | 120 |
| 2 | 3,000 | 70 |
| 3 | 3,000 | 60 |
| 4 | 3,500 | 60 |
| 5 | 3,750 | 60 |
| 6 | 4,000 | 60 |
| 7 | 4,000 | 50 |
| 8 | 4,000 | 50 |
| 9 | 4,250 | 50 |
| 10 | 4,500 | 50 |
| 11 | 4,750 | |
| 12 | 5,000 | |
| 13 | 5,000 | |
| 14 | 5,000 | |
| 15 | 5,000 | |
| 16 | 5,000 | |
| 17 | 5,000 | |
| 18 | 5,000 | |
| 19 | 5,000 | |
| 20 | 5,000 | |

Table 20. Static Build-Up and Decay of Wool plus Stainless Steel Sample, Charged with Leather, at 60% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 1,500 | 60 |
| 2 | 1,500 | 40 |
| 3 | 1,500 | 40 |
| 4 | 1,700 | 40 |
| 5 | 2,000 | 40 |
| 6 | 2,000 | 40 |
| 7 | 2,000 | 30 |
| 8 | 2,250 | 30 |
| 9 | 2,500 | 30 |
| 10 | 2,500 | 30 |
| 11 | 2,500 | |
| 12 | 2,500 | |
| 13 | 2,500 | |
| 14 | 2,500 | |
| 15 | 2,500 | |
| 16 | 2,500 | |
| 17 | 2,500 | |
| 18 | 2,500 | |
| 19 | 2,500 | |
| 20 | 2,500 | |

Table 21. Static Build-Up and Decay of Wool plus Stainless Steel Sample, Charged with Leather, at 70% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 400 | 45 |
| 2 | 400 | 40 |
| 3 | 500 | 40 |
| 4 | 500 | 40 |
| 5 | 500 | 35 |
| 6 | 600 | 35 |
| 7 | 600 | 35 |
| 8 | 600 | 35 |
| 9 | 600 | 35 |
| 10 | 600 | 30 |
| 11 | 600 | |
| 12 | 600 | |
| 13 | 600 | |
| 14 | 600 | |
| 15 | 600 | |
| 16 | 600 | |
| 17 | 600 | |
| 18 | 600 | |
| 19 | 600 | |
| 20 | 600 | |

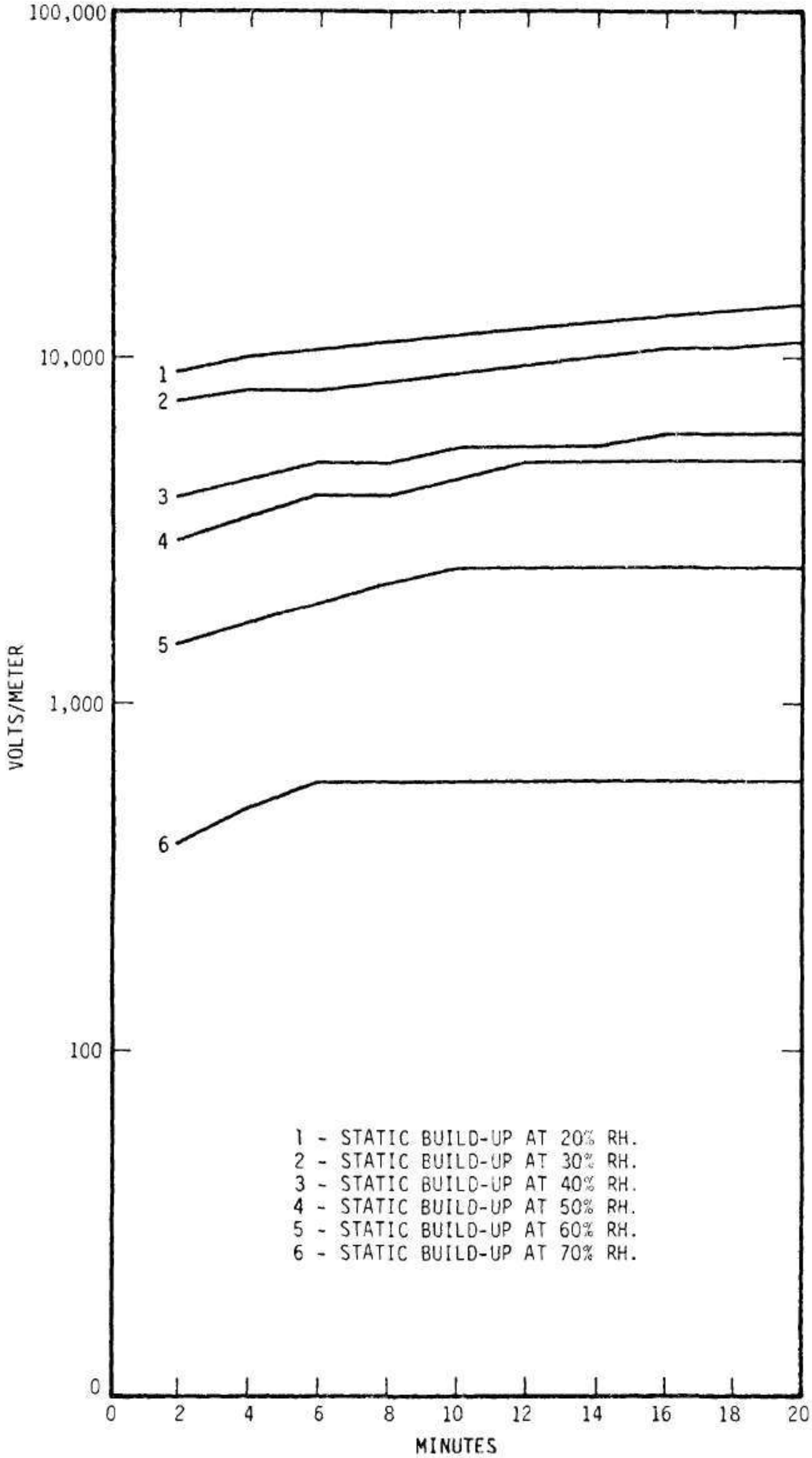


Figure 12. Static Build-Up on Wool plus Stainless Steel Samples, Charged with Leather

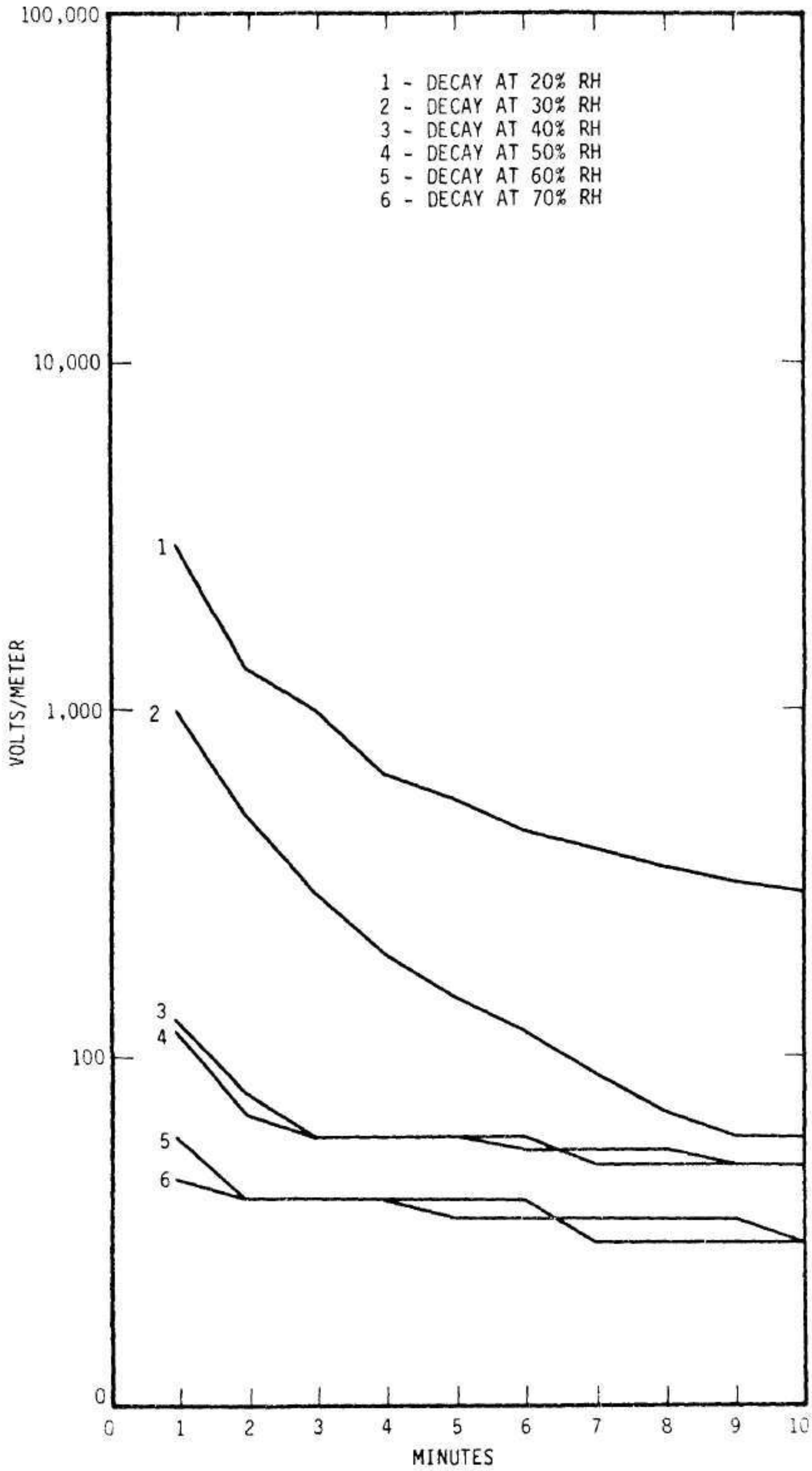


Figure 13. Decay of Wool plus Stainless Steel Samples, Charged with Leather

Table 22. Static Build-Up and Decay of Wool plus Stainless Steel Sample, Charged with Rubber, at 20% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 10,000 | 4,000 |
| 2 | 11,000 | 3,000 |
| 3 | 12,000 | 2,500 |
| 4 | 13,000 | 1,500 |
| 5 | 13,500 | 1,000 |
| 6 | 14,000 | 900 |
| 7 | 14,500 | 800 |
| 8 | 15,000 | 700 |
| 9 | 15,500 | 600 |
| 10 | 16,000 | 500 |
| 11 | 16,500 | |
| 12 | 17,000 | |
| 13 | 17,500 | |
| 14 | 18,000 | |
| 15 | 18,500 | |
| 16 | 19,000 | |
| 17 | 19,250 | |
| 18 | 19,500 | |
| 19 | 19,750 | |
| 20 | 20,000 | |

Table 23. Static Build-Up and Decay of Wool plus Stainless Steel Sample, Charged with Rubber, at 30% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 8,000 | 2,500 |
| 2 | 8,500 | 1,500 |
| 3 | 9,000 | 1,200 |
| 4 | 9,500 | 1,000 |
| 5 | 10,000 | 700 |
| 6 | 10,000 | 500 |
| 7 | 10,500 | 400 |
| 8 | 11,000 | 300 |
| 9 | 11,000 | 250 |
| 10 | 11,500 | 200 |
| 11 | 12,000 | |
| 12 | 12,000 | |
| 13 | 12,500 | |
| 14 | 13,000 | |
| 15 | 13,000 | |
| 16 | 13,250 | |
| 17 | 13,500 | |
| 18 | 13,750 | |
| 19 | 14,000 | |
| 20 | 14,000 | |

Table 24. Static Build-Up and Decay of Wool plus Stainless Steel Sample, Charged with Rubber, at 40% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 4,000 | 250 |
| 2 | 4,500 | 120 |
| 3 | 5,000 | 80 |
| 4 | 5,500 | 70 |
| 5 | 5,500 | 60 |
| 6 | 6,000 | 50 |
| 7 | 6,000 | 50 |
| 8 | 6,250 | 50 |
| 9 | 6,500 | 50 |
| 10 | 6,750 | 50 |
| 11 | 7,000 | |
| 12 | 7,250 | |
| 13 | 7,500 | |
| 14 | 7,750 | |
| 15 | 8,000 | |
| 16 | 8,000 | |
| 17 | 8,000 | |
| 18 | 8,000 | |
| 19 | 8,000 | |
| 20 | 8,000 | |

Table 25. Static Build-Up and Decay of Wool plus Stainless Steel Sample, Charged with Rubber, at 50% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 3,500 | 170 |
| 2 | 3,500 | 100 |
| 3 | 4,000 | 80 |
| 4 | 4,000 | 70 |
| 5 | 4,250 | 60 |
| 6 | 4,500 | 60 |
| 7 | 4,750 | 50 |
| 8 | 5,000 | 50 |
| 9 | 5,250 | 50 |
| 10 | 5,500 | 40 |
| 11 | 5,750 | |
| 12 | 6,000 | |
| 13 | 6,000 | |
| 14 | 6,000 | |
| 15 | 6,000 | |
| 16 | 6,000 | |
| 17 | 6,000 | |
| 18 | 6,000 | |
| 19 | 6,000 | |
| 20 | 6,000 | |

Table 26. Static Build-Up and Decay of Wool plus Stainless Steel Sample, Charged with Rubber, at 60% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 2,000 | 80 |
| 2 | 2,000 | 60 |
| 3 | 2,000 | 60 |
| 4 | 2,250 | 50 |
| 5 | 2,500 | 50 |
| 6 | 2,750 | 50 |
| 7 | 3,000 | 40 |
| 8 | 3,250 | 40 |
| 9 | 3,500 | 40 |
| 10 | 3,500 | 40 |
| 11 | 3,500 | |
| 12 | 3,500 | |
| 13 | 3,500 | |
| 14 | 3,500 | |
| 15 | 3,500 | |
| 16 | 3,500 | |
| 17 | 3,500 | |
| 18 | 3,500 | |
| 19 | 3,500 | |
| 20 | 3,500 | |

Table 27. Static Build-Up and Decay of Wool plus Stainless Steel Sample, Charged with Rubber, at 70% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 500 | 70 |
| 2 | 600 | 60 |
| 3 | 600 | 50 |
| 4 | 700 | 50 |
| 5 | 700 | 40 |
| 6 | 800 | 40 |
| 7 | 850 | 40 |
| 8 | 900 | 40 |
| 9 | 950 | 40 |
| 10 | 1,000 | 40 |
| 11 | 1,000 | |
| 12 | 1,000 | |
| 13 | 1,000 | |
| 14 | 1,000 | |
| 15 | 1,000 | |
| 16 | 1,000 | |
| 17 | 1,000 | |
| 18 | 1,000 | |
| 19 | 1,000 | |
| 20 | 1,000 | |

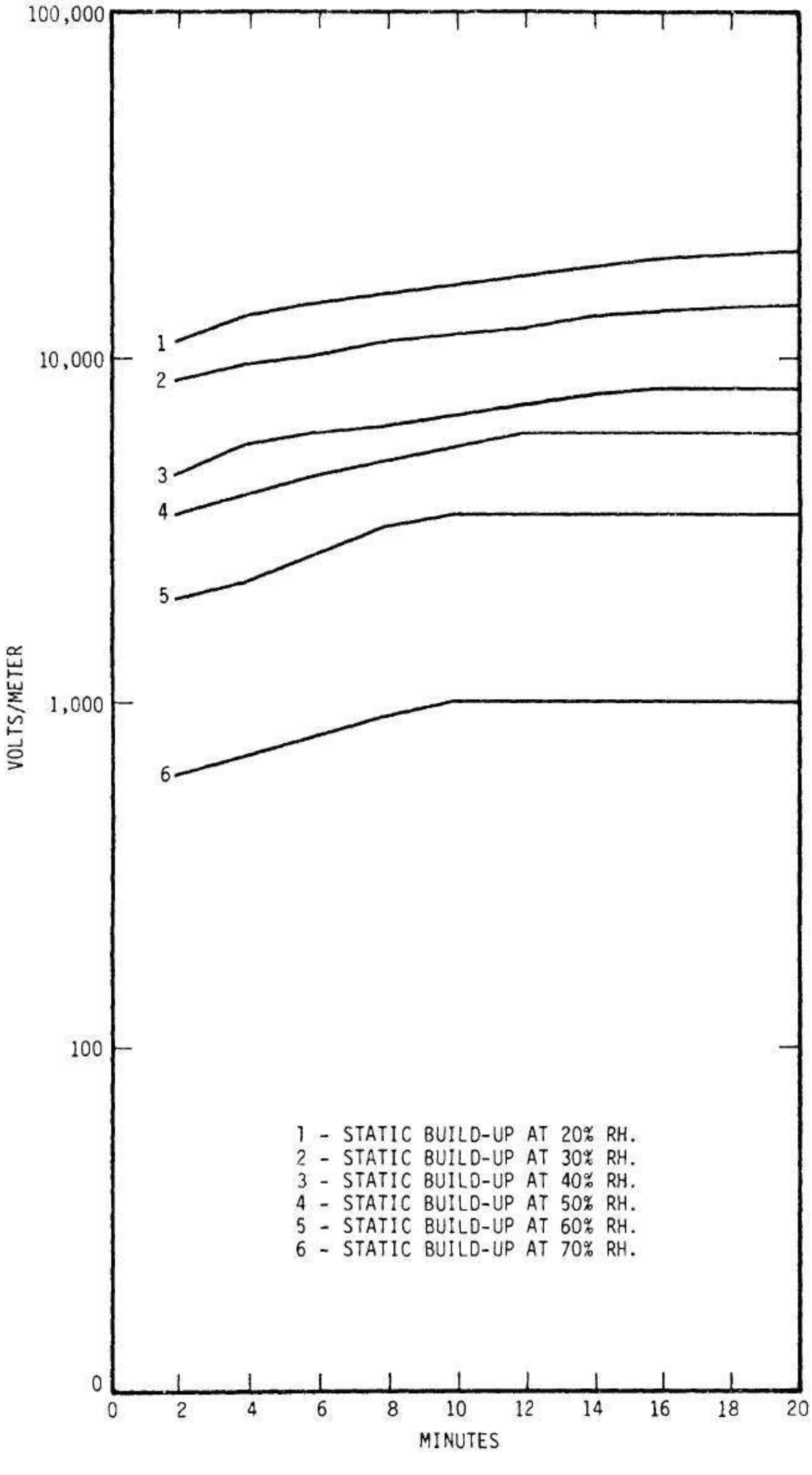


Figure 14. Static Build-Up on Wool plus Stainless Steel Samples, Charged with Rubber

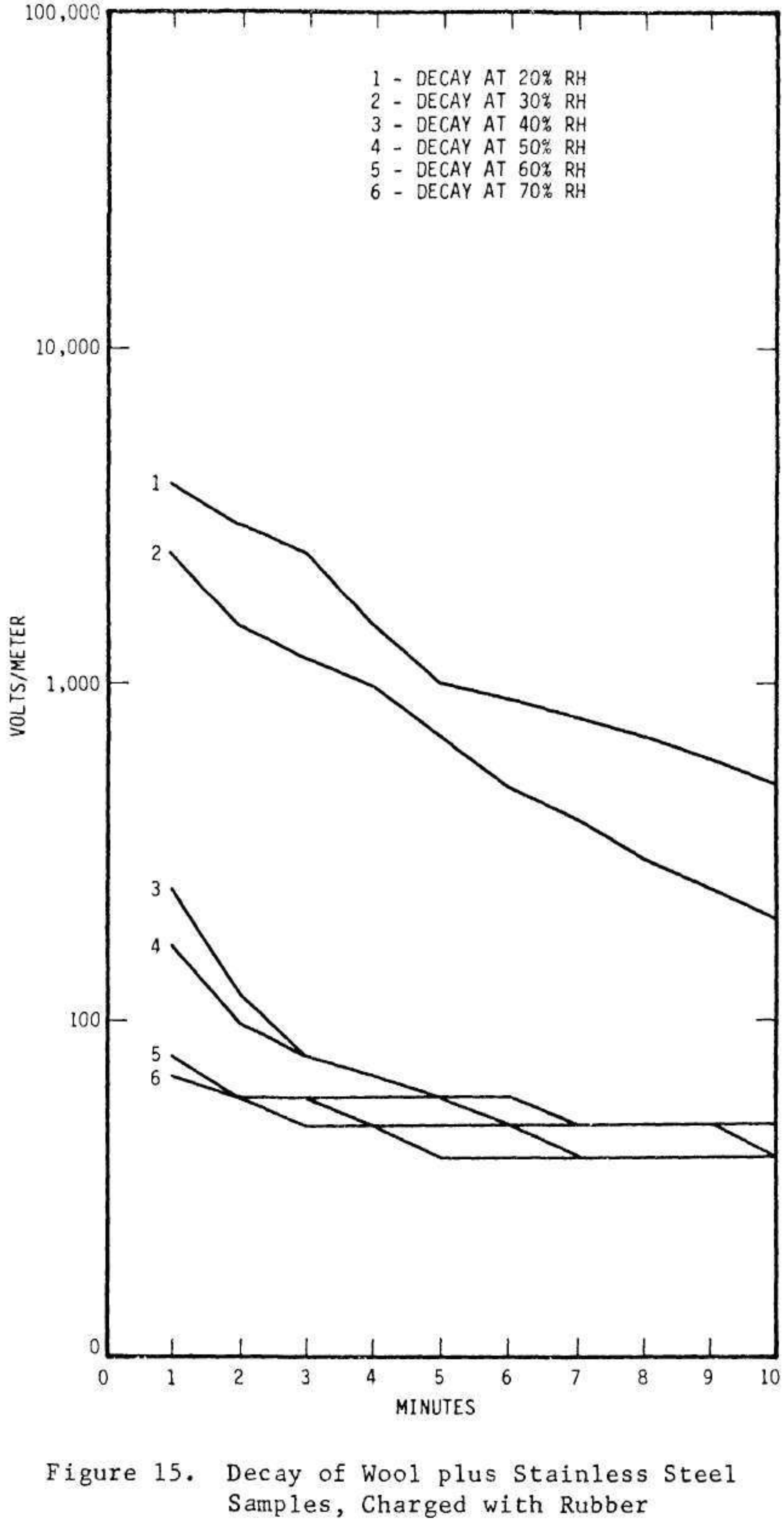


Figure 15. Decay of Wool plus Stainless Steel Samples, Charged with Rubber

Table 28. Static Build-Up and Decay of Chemically Treated Wool Sample, Charged with Leather, at 20% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 5,500 | 2,500 |
| 2 | 6,000 | 1,500 |
| 3 | 6,500 | 850 |
| 4 | 7,000 | 600 |
| 5 | 7,500 | 500 |
| 6 | 8,000 | 400 |
| 7 | 8,500 | 300 |
| 8 | 9,000 | 250 |
| 9 | 9,500 | 200 |
| 10 | 10,000 | 170 |
| 11 | 10,500 | |
| 12 | 11,000 | |
| 13 | 11,250 | |
| 14 | 11,500 | |
| 15 | 11,750 | |
| 16 | 12,000 | |
| 17 | 12,250 | |
| 18 | 12,500 | |
| 19 | 12,750 | |
| 20 | 13,000 | |

Table 29. Static Build-Up and Decay of Chemically Treated Wool Sample, Charged with Leather, at 30% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 5,000 | 1,200 |
| 2 | 5,500 | 700 |
| 3 | 6,000 | 400 |
| 4 | 6,250 | 300 |
| 5 | 6,500 | 200 |
| 6 | 6,750 | 100 |
| 7 | 7,000 | 80 |
| 8 | 7,250 | 60 |
| 9 | 7,500 | 60 |
| 10 | 7,750 | 60 |
| 11 | 8,000 | |
| 12 | 8,250 | |
| 13 | 8,500 | |
| 14 | 8,750 | |
| 15 | 9,000 | |
| 16 | 9,250 | |
| 17 | 9,500 | |
| 18 | 9,750 | |
| 19 | 10,000 | |
| 20 | 10,500 | |

Table 30. Static Build-Up and Decay of Chemically Treated Wool Sample, Charged with Leather, at 40% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 2,500 | 400 |
| 2 | 3,000 | 300 |
| 3 | 3,250 | 220 |
| 4 | 3,500 | 150 |
| 5 | 3,750 | 100 |
| 6 | 4,000 | 70 |
| 7 | 4,250 | 60 |
| 8 | 4,500 | 60 |
| 9 | 4,750 | 50 |
| 10 | 5,000 | 50 |
| 11 | 5,250 | |
| 12 | 5,500 | |
| 13 | 5,750 | |
| 14 | 6,000 | |
| 15 | 6,000 | |
| 16 | 6,000 | |
| 17 | 6,000 | |
| 18 | 6,000 | |
| 19 | 6,000 | |
| 20 | 6,000 | |

Table 31. Static Build-Up and Decay of Chemically Treated Wool Sample, Charged with Leather, at 50% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 2,000 | 160 |
| 2 | 2,500 | 90 |
| 3 | 3,000 | 70 |
| 4 | 3,250 | 60 |
| 5 | 3,500 | 60 |
| 6 | 3,750 | 60 |
| 7 | 4,000 | 50 |
| 8 | 4,000 | 50 |
| 9 | 4,000 | 50 |
| 10 | 4,000 | 50 |
| 11 | 4,000 | |
| 12 | 4,500 | |
| 13 | 4,500 | |
| 14 | 4,500 | |
| 15 | 4,500 | |
| 16 | 4,500 | |
| 17 | 4,500 | |
| 18 | 4,500 | |
| 19 | 4,500 | |
| 20 | 4,500 | |

Table 32. Static Build-Up and Decay of Chemically Treated Wool Sample, Charged with Leather, at 60% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 1,400 | 120 |
| 2 | 1,500 | 80 |
| 3 | 1,600 | 80 |
| 4 | 1,700 | 70 |
| 5 | 1,700 | 70 |
| 6 | 1,800 | 70 |
| 7 | 1,800 | 60 |
| 8 | 2,000 | 60 |
| 9 | 2,000 | 60 |
| 10 | 2,000 | 50 |
| 11 | 2,200 | |
| 12 | 2,200 | |
| 13 | 2,200 | |
| 14 | 2,200 | |
| 15 | 2,200 | |
| 16 | 2,200 | |
| 17 | 2,200 | |
| 18 | 2,200 | |
| 19 | 2,200 | |
| 20 | 2,200 | |

Table 33. Static Build-Up and Decay of Chemically Treated Wool Sample, Charged with Leather, at 70% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 200 | 60 |
| 2 | 200 | 60 |
| 3 | 200 | 50 |
| 4 | 300 | 50 |
| 5 | 300 | 50 |
| 6 | 300 | 40 |
| 7 | 400 | 40 |
| 8 | 400 | 40 |
| 9 | 400 | 40 |
| 10 | 500 | 40 |
| 11 | 500 | |
| 12 | 500 | |
| 13 | 500 | |
| 14 | 500 | |
| 15 | 500 | |
| 16 | 500 | |
| 17 | 500 | |
| 18 | 500 | |
| 19 | 500 | |
| 20 | 500 | |

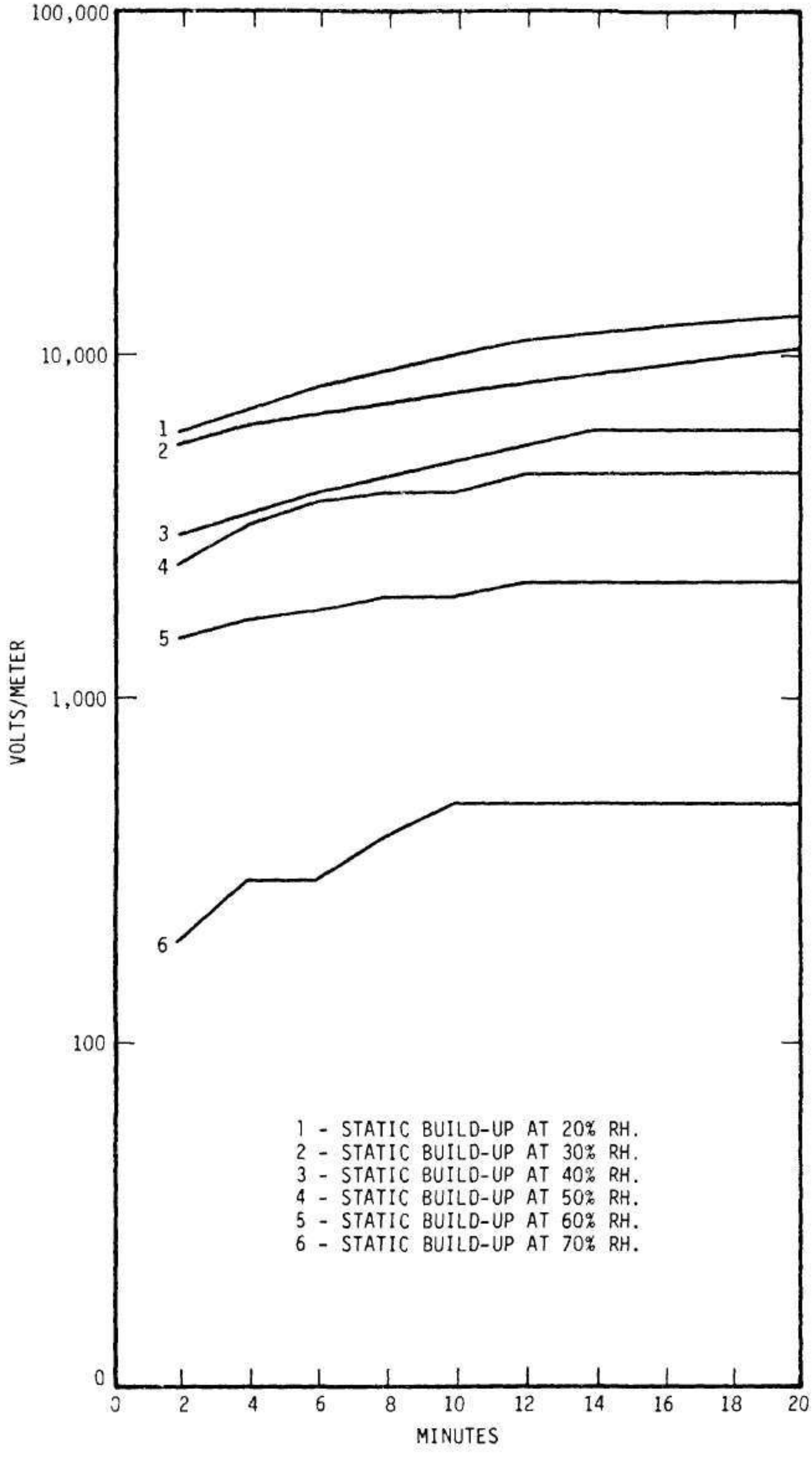


Figure 16. Static Build-Up on Chemically Treated Wool Samples, Charged with Leather

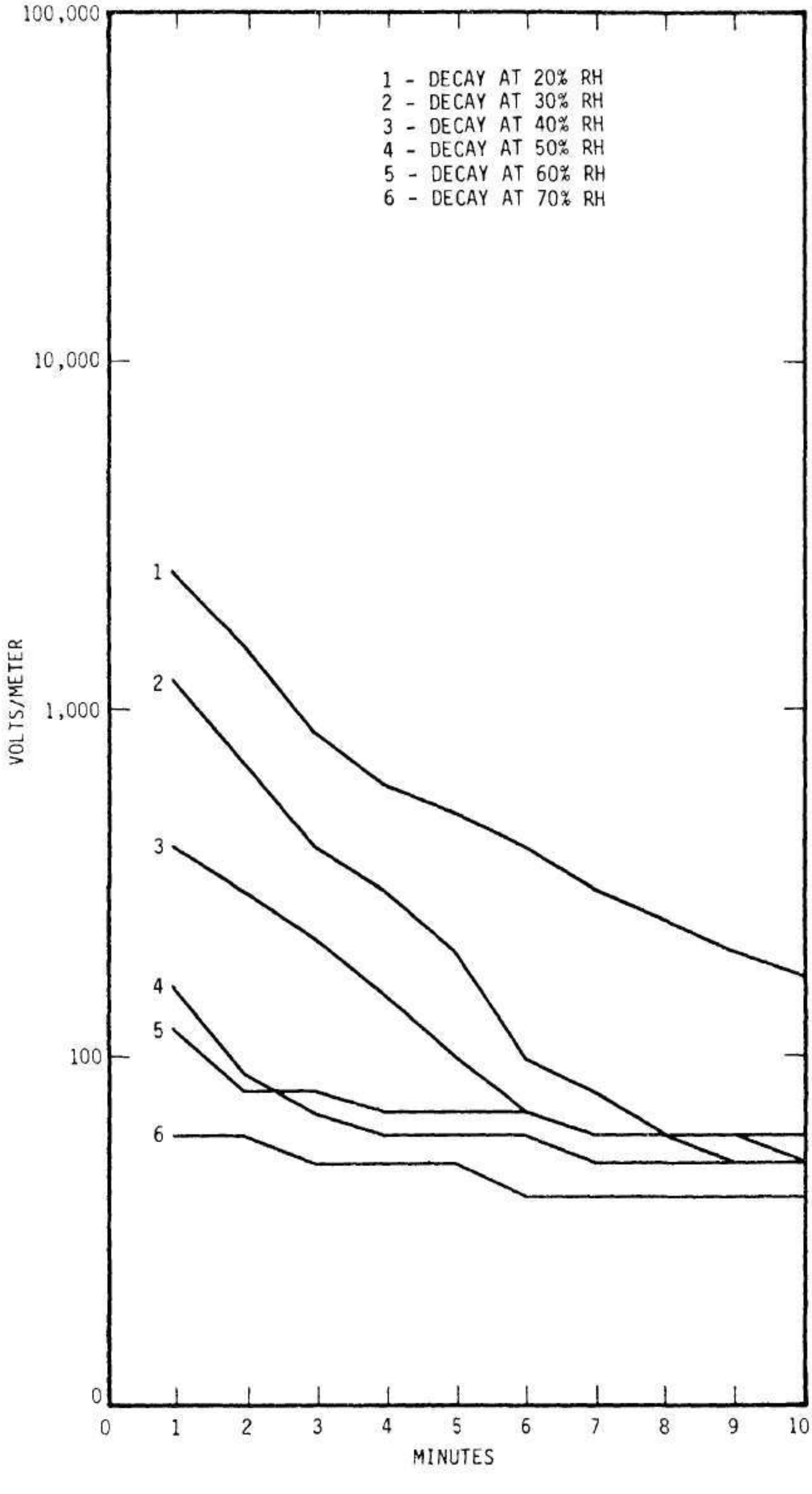


Figure 17. Decay of Chemically Treated Wool Samples, Charged with Leather

Table 34. Static Build-Up and Decay of Chemically Treated Wool Sample, Charged with Rubber, at 20% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 7,000 | 3,000 |
| 2 | 8,000 | 2,000 |
| 3 | 9,000 | 1,500 |
| 4 | 10,000 | 1,100 |
| 5 | 10,500 | 1,000 |
| 6 | 11,000 | 900 |
| 7 | 11,500 | 800 |
| 8 | 12,000 | 700 |
| 9 | 12,500 | 600 |
| 10 | 13,000 | 550 |
| 11 | 13,500 | |
| 12 | 14,000 | |
| 13 | 14,250 | |
| 14 | 14,500 | |
| 15 | 14,750 | |
| 16 | 15,000 | |
| 17 | 15,250 | |
| 18 | 15,500 | |
| 19 | 15,750 | |
| 20 | 16,000 | |

Table 35. Static Build-Up and Decay of Chemically Treated Wool Sample, Charged with Rubber, at 30% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 5,000 | 2,500 |
| 2 | 5,500 | 1,700 |
| 3 | 6,000 | 1,300 |
| 4 | 6,500 | 1,000 |
| 5 | 7,000 | 800 |
| 6 | 7,500 | 700 |
| 7 | 8,000 | 600 |
| 8 | 8,500 | 500 |
| 9 | 9,000 | 450 |
| 10 | 9,500 | 400 |
| 11 | 10,000 | |
| 12 | 10,500 | |
| 13 | 11,000 | |
| 14 | 11,500 | |
| 15 | 11,750 | |
| 16 | 12,000 | |
| 17 | 12,250 | |
| 18 | 12,500 | |
| 19 | 12,750 | |
| 20 | 13,000 | |

Table 36. Static Build-Up and Decay of Chemically Treated Wool Sample, Charged with Rubber, at 40% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 4,000 | 450 |
| 2 | 4,500 | 350 |
| 3 | 5,000 | 200 |
| 4 | 5,250 | 160 |
| 5 | 5,500 | 140 |
| 6 | 5,750 | 120 |
| 7 | 6,000 | 80 |
| 8 | 6,250 | 70 |
| 9 | 6,500 | 60 |
| 10 | 6,750 | 60 |
| 11 | 7,000 | |
| 12 | 7,000 | |
| 13 | 7,250 | |
| 14 | 7,250 | |
| 15 | 7,500 | |
| 16 | 7,500 | |
| 17 | 7,500 | |
| 18 | 7,500 | |
| 19 | 7,500 | |
| 20 | 7,500 | |

Table 37. Static Build-Up and Decay of Chemically Treated Wool Sample, Charged with Rubber, at 50% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 2,000 | 180 |
| 2 | 2,500 | 100 |
| 3 | 2,750 | 80 |
| 4 | 3,000 | 70 |
| 5 | 3,250 | 70 |
| 6 | 3,500 | 60 |
| 7 | 3,750 | 60 |
| 8 | 4,000 | 60 |
| 9 | 4,250 | 50 |
| 10 | 4,500 | 50 |
| 11 | 4,750 | |
| 12 | 5,000 | |
| 13 | 5,000 | |
| 14 | 5,000 | |
| 15 | 5,000 | |
| 16 | 5,000 | |
| 17 | 5,000 | |
| 18 | 5,000 | |
| 19 | 5,000 | |
| 20 | 5,000 | |

Table 38. Static Build-Up and Decay of Chemically Treated Wool Sample, Charged with Rubber, at 60% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 1,800 | 140 |
| 2 | 1,800 | 100 |
| 3 | 2,000 | 80 |
| 4 | 2,000 | 70 |
| 5 | 2,200 | 70 |
| 6 | 2,200 | 60 |
| 7 | 2,500 | 60 |
| 8 | 2,500 | 60 |
| 9 | 2,500 | 50 |
| 10 | 3,000 | 50 |
| 11 | 3,000 | |
| 12 | 3,200 | |
| 13 | 3,200 | |
| 14 | 3,500 | |
| 15 | 3,500 | |
| 16 | 3,500 | |
| 17 | 3,500 | |
| 18 | 3,500 | |
| 19 | 3,500 | |
| 20 | 3,500 | |

Table 39. Static Build-Up and Decay of Chemically Treated Wool Sample, Charged with Rubber, at 70% Relative Humidity

| Minutes | Static Build-Up (in V/M) | Decay (in V/M) |
|---|---|---|
| 1 | 500 | 80 |
| 2 | 500 | 70 |
| 3 | 600 | 60 |
| 4 | 600 | 60 |
| 5 | 600 | 50 |
| 6 | 700 | 50 |
| 7 | 700 | 50 |
| 8 | 700 | 40 |
| 9 | 800 | 40 |
| 10 | 800 | 40 |
| 11 | 900 | |
| 12 | 900 | |
| 13 | 900 | |
| 14 | 900 | |
| 15 | 900 | |
| 16 | 900 | |
| 17 | 900 | |
| 18 | 900 | |
| 19 | 900 | |
| 20 | 900 | |

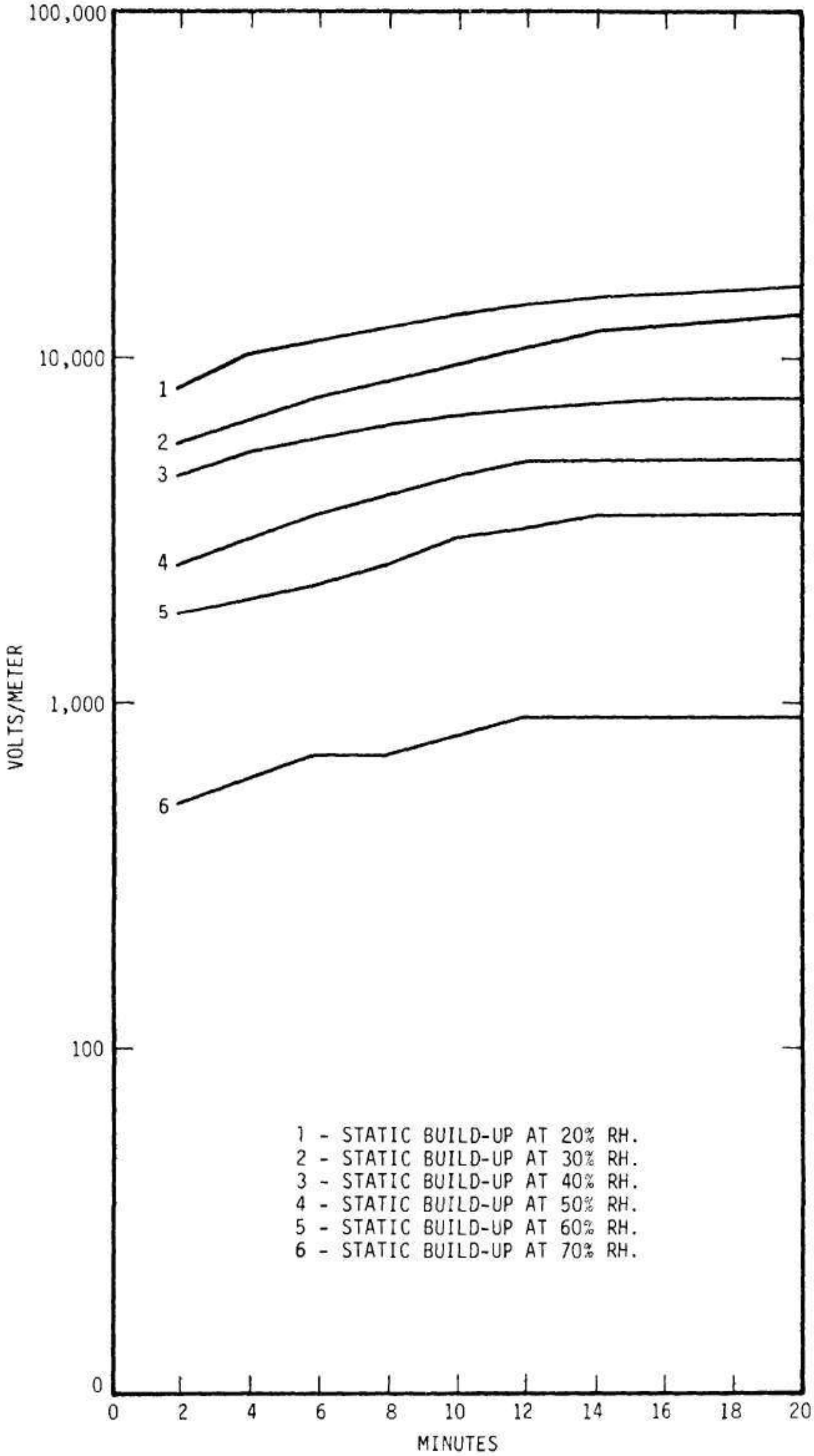


Figure 18. Static Build-Up on Chemically Treated Wool Samples, Charged with Rubber

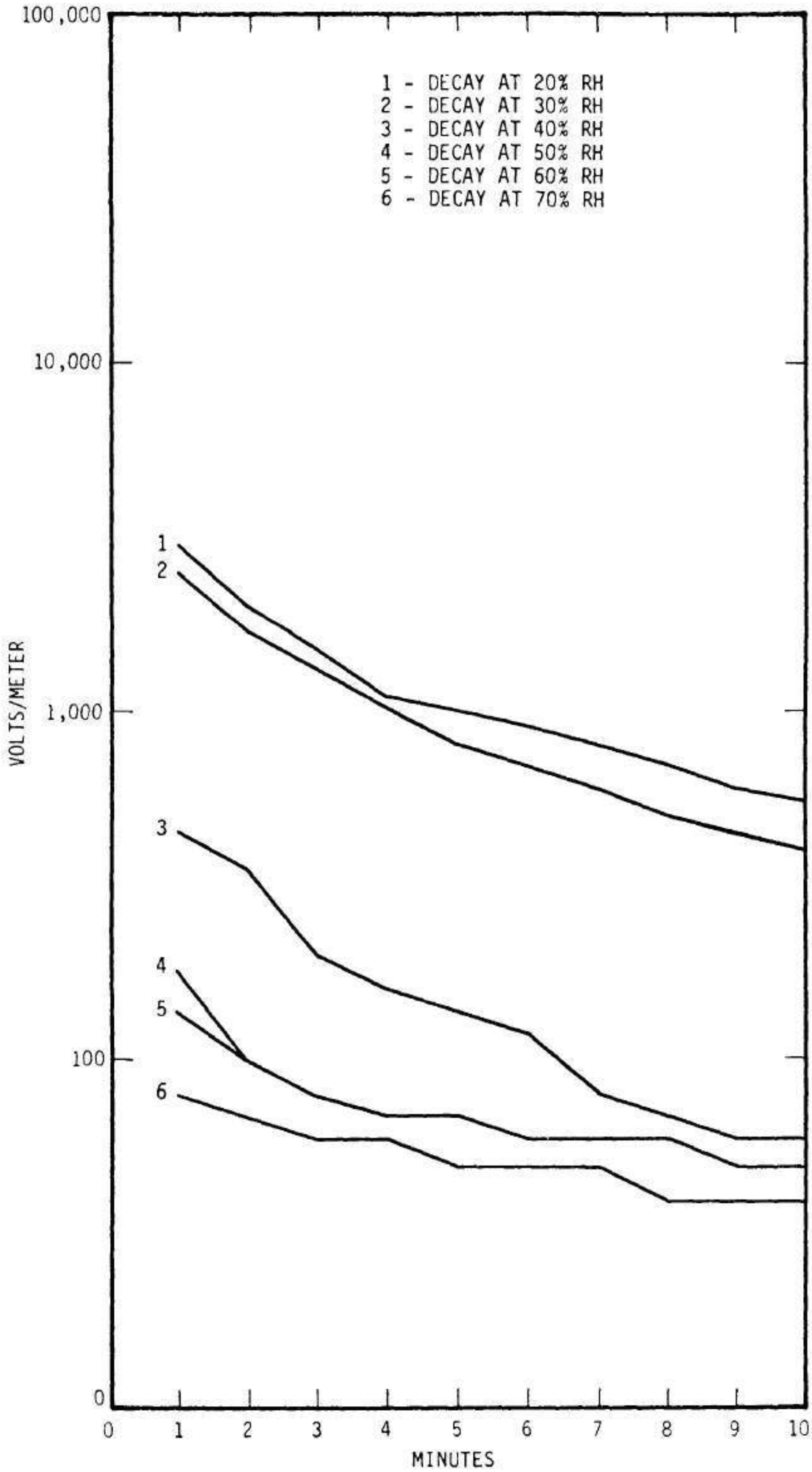


Figure 19. Decay of Chemically Treated Wool Samples, Charged with Rubber

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