

Study of Static Electricity effect on work stress

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Abstract – This study explains the effects of Static Electricity on Human Body leading to work stress and techniques that can be adopted to dissipate effectively. Study was conducted on participants who were experiencing stress related problems working in an Engineering Industry, were randomly divided into two groups. The first group wore normal clothes and second group wore clothes having antistatic properties. The atmospheric conditions were also set to dissipate electrical charges. E field created charge on their body were recorded with an electrostatic voltmeter at regular intervals with varying temperature and humidity to generate more data. The study proves significant health improvement of worker when the charges were properly dissipated and this resulted in overall work efficiency.

Key Words: Static Electricity, Electric field, Work efficiency, Stress

1. INTRODUCTION

Static electricity is an electrical charge that is at rest. It is created when two objects or materials that have been in contact with each other are separated. When in contact, the surface electrical charges of the objects try to balance each other. This happens by the free flow of electrons (negatively charged particles) from one object to the other. When the objects separate, they are left with either an excess or a shortage of electrons. This causes both objects to become electrically charged.

If these charges don't have a path to the ground, they are unable to move and become "static". If static electricity is not rapidly eliminated, the charge will build up. It will eventually develop enough energy to jump as a spark to some nearby grounded or less highly charged object in an attempt to balance the charge.

1.1 Charge Accumulation on Human Body

At the beginning times humans lived their lives in direct physical contact with the earth. The charges continually dissipated. In modern times humans have insulated themselves by wearing shoes and living in homes. They are no longer naturally grounded and this has led to accumulation of charges in the body. These charges that are accumulated in the body interfere with bioelectrical activities in the body creating health issues like stress, fatigue etc. But only minimal research has been done on this field.

Hence this study shows the significant improvement in work efficiency by adopting various techniques in the working environment to dissipate charges accumulated in the workers and monitoring health improvements.

1.2 Static Electricity in Engineering Industry

Where ever there is contact and separation between two insulators or either one of them as insulator, charges get built up. In engineering industry there are many processes that create accumulation of charges. Some specific locations where static electricity is generated include Piping Systems, filling operations, filtrations, dispersing operations etc. Since nowadays the workers are equipped with work place uniform and shoes not having antistatic properties, charges gets built up on them.

1.3 Dissipation methods

Most static electricity control measures provide ways for the Static charges to dissipate harmlessly before sparks occur. Some ways to prevent static charges from accumulating on materials are: Bonding and grounding, humidification, static collectors, isotopes and additives

1.3.1 Bonding and grounding

Bonding and grounding are common controls for static electricity. Bonding is connecting two or more conductive objects with a conductor, such as a copper wire, that equalizes the potential charge between them. Bonding is also connecting various parts of equipment and containers that are electrically separated by, for example, gaskets or caulking compounds. Note that bonding does not eliminate the static charge. Grounding is connecting one or more conductive objects directly to the earth using ground rods, cold water copper pipes, or building steel. Unlike bonding, grounding drains the static charges away as quickly as they are produced.

Static grounds must be connected to: Electrical conduit systems, gas or steam pipes, dry pipe sprinkler systems, lightning rods, metal storage racks and building support beams

1.3.2 Humidification

A relative humidity of 60% to 70% at 210°C (700°F) may prevent paper or layers of cloth and fibres from sticking

together. A high relative humidity, however, is no guarantee against the accumulation of static electricity. Therefore relying solely on humidification as a control measure in areas where there are flammable liquids, gases, or dusts is not advisable.

1.3.3 Static collectors

Devices that collect static electricity can be used on moving belts, plastic film, and similar nonconductive materials. Some examples of static collectors include: needle pointed copper combs; spring copper brushes; and metallic tinsel bars. A static collector works by its closeness to the source that generates the static electricity. If a discharge occurs, it is captured by the highly conductive collector; this prevents long hot sparks. To be effective, collectors must be properly grounded.

1.3.4 Additives

Another control is the use of anti-static additives (as in fuels). The additive increases the conductivity or lowers the resistance of the liquid. It also reduces the time it takes for the static charge to leak through the wall of the container and to the ground.

1.3.5 Controlling static electricity on people

Controls to prevent or reduce static electricity from building up on people include: Conductive flooring, conductive clothing and footwear (to allow the charge to be conducted away; these items must be free of dirt and other contaminants) cotton or linen clothing instead of wool, silk, or synthetic materials.

2. METHOD

Study was conducted on participants who are experiencing stress related problems, were randomly divided into two groups. The First group wore normal clothes and second group wore clothes specially treated with nano materials. The tests were conducted in an industry during work and various parameters were analysed by changing temperature, humidity for various duration of time. By varying these factors, huge data's were generated and health effects due to charge accumulation in their body were measured and studied. E- Field created charge on their body was recorded with electrostatic voltmeter at regular intervals and were analysed. The parameters specified in table 2 were measured in this simulated working environment and were tabulated to analyse the health effects of charge accumulation on their body when grounded and when not grounded to calculate the overall improvement in work efficiency of the worker. The health effects of workers are monitored by questionnaire method asking the workers about their improvement in health. The parameters measured were Electric field strength, temperature and humidity , work efficiency, respiratory condition, asthmatic, tiredness, fatigue, muscle

stiffness and pain, chronic back and joint pains, general well being.

This analysis can also bring the scope of improvement required in industries to minimise the health effects of static electricity on human body and to improve their work efficiency resulting in production gain.

Table -1: Data Generation

Exp. No.	Temp Degree. Celsius	RH %	Duration Hours	Voltage Discharge Volts
1	20	45	2	
2	20	45	4	
3	20	45	6	
4	20	45	8	
5	20	47	2	
6	20	47	4	
7	20	47	6	
8	20	47	8	
9	20	49	2	
10	20	49	4	
11	20	49	6	
12	20	49	8	

3. SELECTION OF TEST SUBJECTS

The participants were selected from engineering industry who were facing stress related health issues and were randomly divided into two groups. The age of participants selected were between 24 to 62 and these participants were selected from areas where possibility of charge accumulation is present. The test group consists of 25 Male subjects and 25 female subjects and the other group also consists of similar participants. The test group was provided with antistatic clothing and the floors were conductive in nature. Temperature and Humidity levels were varied for maximum dissipation. The other groups were provided with normal working condition. These groups were monitored by questionnaire method.

4. RESULTS AND DISCUSSION

Data's were generated by varying the temperature from 20 to 25 degree Celsius and RH values were also varied from 45% to 49%. For every interval of 2 hours voltage discharge were measured and the participants were asked about the

improvement in health by a questionnaire form. The E- field created charge measured was between 0.5V to 5V.

charges are properly dissipated and hence results in increased overall working efficiency.

Table - 2: Summary of health analysis:

Measurable Parameters	Test Subject		Control Subject	
	Same	Improved	Same	Improved
Respiratory Condition	4-15%	23-85%	20-87%	3-13%
Asthmatic	2-14%	25-86%	18-87%	5-13%
Tiredness	0-12%	27-88%	15-87%	8-13%
Fatigue	5-7%	22-93%	12-87%	11-13%
Muscle Stiffness And Pain	7-26%	20-74%	18-87%	5-13%
Chronic Back And Joint Pains	7-26%	20-74%	23-100%	0-0%
General Well Being	6-22%	21-78%	20-87%	3-13%
Work Efficiency	5-18%	22-82%	22-87%	1-13%

Analyzing the readings obtained for each participant an overall picture showed improvement in work efficiency. The participants were feeling relaxed and energetic compared to their previous conditions. This shows accumulation of charges on workers affects their work efficiency leading to fatigue and other health problems.

This study shows that when the workers in industries were naturally grounded by using antistatic clothing, conductive flooring and humidification methods, they are protected from static electricity and electric fields. The workers who complained fatigue, work stress, chronic back pains had significant relief.

5. CONCLUSIONS

In this study, by providing nano particle embedded antistatic clothing with air conditioned environment and conducting flooring in the workplace, a least resistant path has been created for dissipation of accumulated charges on the human body. Various parameters of the test subject and the control subject were measured and analyzed. By varying parameters such as temperature, humidity for various time durations, more data could be generated and the least electric field dissipated could be found out to establish the maximum work efficiency of the worker. This study also proves significant health improvement of worker when the

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