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ABC Analysis of Industrial Process in the Electronic Industry of Mexicali

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Abstract

In the manufacturing processes of the electronics industry developed by electrical and electronic equipment and systems, there are variations that indicate the different types of causes that may manifest themselves. These changes in the operating specifications of industrial machinery can happen because electrical failures sometimes occur continuously or in certain daily, weekly and monthly periods. The analysis are carried out at this time mainly to know the operational performance (RO) of the equipment and systems of companies of the electronic turn. This generates imbalances in the planning activities in the programming of the different types of products that are manufactured and with it the decrease of manufactured units and in the majority of the times, economic losses occur. Being the city of Mexicali, a region of the northwest of Mexico where they are installed great amount of industrial plants of the electronic branch, a study with the objective of determining the main causes of the generation of electrical faults of the industrial machinery was developed. The most important tool used was the "ABC Graph" with the information obtained from the operation of the equipment and systems of an electronic branch company located in Mexicali, where it was observed that the RO was lower in the winter season. This occurred due to the deterioration of electrical connections and connectors of industrial equipment and systems due to the presence of atmospheric corrosion on their metal surfaces, which are mainly made of copper material. This electrochemical phenomenon occurs in interiors of the electronics industry, when the relative humidity (RH) and temperature levels are greater than 80% and 35 ° C combined with concentrations of sulfides that exceed air quality standards at certain times of the year. The study was developed in the period from 2016 to 2017.
Keywords: ABC graphics; Manufacturing processes; Electronic industry; Operational performance; Atmospheric corrosion.

1. Introduction

The electronic industry represents a large part of the productive sector worldwide, which is why it is of great importance in the economy of each country where these types of companies are installed and are engaged in the manufacture of electronic goods [1]. It uses tools with statistical methods such as the "ABC Chart" for inventory control analysis of parts of industrial machinery and raw materials, in addition to RO evaluations and productive performance (PR) [2]. The electrical and electronic equipment and systems used in industrial plants contain a variety of macro, micro and nano electronic devices that perform the functions for the industrial machinery to operate properly and its capacity determines the RO of these equipment and systems used in the manufacturing processes. If the functionality of some of these electronic components decreases, other devices are affected and with this the industrial machines do not operate at their maximum performance, which sometimes does not work at this level because it is not required [3]. Some of the causes of the equipment and systems of companies do not have their maximum RO, is because it is generated that causes atmospheric corrosion. This electrochemical phenomenon occurs due to the effect of condensation caused by the mentioned HR and temperature levels and which influences the formation of water films on metal surfaces that may be visible or invisible. This causes damage to the surface of the connections and connectors of the electrical and electronic equipment, forming copper sulfides (Cu) as corrosion products that after eliminating this degraded material [4]. Based on that, mass is lost from the surface of Cu, decreasing the electrical resistance and generating defective electrical conductivity or can cause a short circuit that is caused by a fire in a company. The deterioration of the metallic surfaces of the electrical and electronic components of the industrial machinery is due to the mentioned climatic factors and to the presence of sulfides in the interiors of industrial plants of the electronic turn [5]. These air pollutants that cause aggressive environments are generated by external sources to companies such as the geothermal power plant that generates electricity to the city of Mexicali

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and its valley, as well as border cities of the state of California of the United States, neighboring this area from the country. Sulfides as gases penetrate through holes, slits and systems of air conditioners and even sometimes by filters that are placed in the buildings of companies [6].

Due to this situation, the connections, devices and parts that require electrical power to carry out activities in industrial machines, reduce their operational life time and stop working earlier than expected by the supplier of this type of parts. The companies always have an adequate planning in each production department in relation to the control of inventories of the parts of equipment and systems of the electronic industry [7]. Only occasionally, due to the presence of the electrochemical phenomenon, it is necessary to replace the parts of the damaged industrial machines before the end of their life period. This generates an imbalance in the inventories and sometimes due to the lack of prevention there may be a device or system used in the electronics companies, without operating for long periods of time. Due to this, a main cause arises, which is the reduction of the productive performance and with this economic losses to the companies, and a great concern to the operative, specialized, managerial personnel and to the owners of the industries [8]. This occurs in certain companies in the city of Mexicali and means that when there are no profits in the electronic industry of this city, there are dismissals of employees for not being able to support the production and sales expenses. That is why in addition to the productive sector, this situation worries the government of the region because it is part of the labor source leaving unprotected whole families when only the husband or sometimes the couple works. In order to have control of this type of situation, specialists in corrosion and equipment materials and electronic systems, develop protection plans. But while this is solved, which is very common in all companies in the region, tools such as the "ABC Chart" are used. This is done with the objective of always being prepared with the necessary replacements and to prevent the equipment and systems of these companies from operating [9].

1.1. ABC Charts in Inventory Control

The "ABC Charts" are an important tool in the manufacturing areas of the electronic industry with the use of statistical methods that provide relevant information of certain events that are of interest in various types of operations [2]. This type of graphs are generated based on data obtained in the activities that are evaluated and organized in tables that are later represented in the graphic representations. Based on the results shown in the graphs, the priorities of the events are indicated, either for the organization of parts of industrial machinery and materials used in the main production areas. In addition, the "ABC Charts" are used to analyze the operational performance of equipment and systems and the workforce of operational personnel used in industrial plants of the electronic or other branch and the productive performance to determine the gains or losses in companies [10]. The information obtained is concentrated in sections by levels of percentages and shows the three main types of groups that make up the various data evaluated, that sometimes an area of the "ABC Graph", can be a single data or can sometimes be two or more in each group. These data can be part of the letters of the graph: A which is a section of the graph, B an area of the same graphical representation and C as the last set of data analyzed. The "ABC Chart" is also called "ABC Distribution", "Pareto Chart" or "Graphical Representation of the 80/20 Rule" [11]. This tool is of great support for production control in the electronics industry.

1.2. RO of Electronic Industry Equipment and Machines

The RO of the industrial machinery of industrial plants of the electronic branch, is of great importance in the generation of profits or the presence of economic losses. The development of activities with good functionality in the electrical and electronic equipment and systems of this type of industry, leads to obtain the expected results in the daily, weekly, monthly, seasonal and annual planning operations [9]. The RO is part of the productive performance where the machines and labor that are part of the companies are involved. With the use of "ABC Charts", you can obtain information on the behavior of the manufacturing processes, to identify the causes of possible events with difficulties in their activities and, in addition, to increase the RP that is what is always desired throughout industrial plant. It is very useful to know the RO of each equipment and system in order to carry out the proper planning with which the maximum benefit of the industrial machinery is obtained [12, 13]. In the machines used in the electronic industry, electrical faults (FE) usually occur during certain periods of the year, in continuous or discontinuous periods due to the great diversity of devices and electronic components, mainly connections and connectors, which deteriorate more quickly and ease. This sometimes causes a machine to be left unattended for short or sometimes long periods of time, which are an important cause of the concerns of operational, specialized, managerial and company owners [7]. The electrical faults are presented in the equipment and system of the electronic industry, by the generation of the electrochemical phenomenon, being in greater intensity in the winter time by the effect of condensation, forming the visible or invisible thin layers of water which is the electrolyte. This causes an exchange of electrons from the anodic area where oxidation is generated to the cathodic zone, which is the section of the materials, such as the Cu where the reduction occurs [14]. The industrial machines of the company where the study was carried out contain three types of areas where the equipment that installs the electronic components is installed axially (horizontally), another radially (vertically). The last part belongs to the electric test machines to determine if the products manufactured in the area of automatic insertion of electronic devices, do not contain manufacturing errors and can be sent to the next manufacturing area of the company.

1.3. Indoor Atmospheric Corrosion of Industrial Plants

The highest levels of 80% and 35 ° C of HR and temperature, are the main factor of atmospheric corrosion in industrial interiors of arid environments such as the city of Mexicali, where sometimes there is no air flow. This generates a greater change in the valence state of metals such as Cu which decay faster [15]. Corrosion is caused by the chemical reaction of exposure to metals by sulfides, NOX, ammonia and mainly organic compounds, being the sulfides those that generate a greater effect in the deterioration of metallic materials [8]. This occurs when the oxide films formed on the surface of Cu, is not evenly covered, and is covered only in some areas of the surface of this metal, and where an instantaneous reaction occurs with the sulfates that form aggressive environments, being a factor promoting corrosion [11]. The use of copper in the electronic industry in electrical and electronic equipment and systems is of great interest because of its excellent electrical and thermal properties, and because of its great use they are exposed to indoor environmental conditions of this type of industry. In the corrosion process, Cu undergoes modifications that change its physicochemical properties [4]. The objective of this investigation was to know the process of the RC in the surface of Cu of MC in this coastal environment, showing after a period of six months, and causing low electric current, which originates the electrical faults [16]. One of the aspects for EF to occur is that the air quality indexes (ICA) of air pollutants such as sulfides in this city are exceeded every year, in greater quantity which promotes easy and rapid corrosion in machinery industrial installed in interiors of companies. These indexes are proposed by the Ministry of Environment and Natural Resources (SEMARNAT) and the Environmental Protection Agency (EPA) [8].

2. Methodology

The various problematic situations that occurred in an industrial plant of the electronic branch of the city of Mexicali, regarding the low operating performance of electrical and electronic equipment and systems, led to the proposal of said company to conduct an investigation to find out the causes that originated this RO [1]. The main tool was the "Graphic ABC" with which various graphic representations were generated and the main causes were organized. The investigation included evaluations from the month of January 2010 to December 2011.

2.1. Materials and Methods

For analysis of the RO of the industrial machine of the company where the study was conducted, various activities were developed and the most appropriate tools were used for the study that are presented below:

a) Evaluation of the information of electrical faults of the industrial machinery of the company with the Excel program that is basic and later for a more detailed study the MatLab was used, which is a specialized system with statistical methods.

b) Analysis of climatic factors with specialized devices to monitor humidity and temperature in hourly, daily, weekly, monthly, seasonal and annual periods, using the same programs mentioned in the previous section.

c) Evaluation of the corrosion rate that indicated the deterioration of the materials of the electrical connections and connectors of the electro-electronic systems.

d) Analysis of the sulfide concentration levels in the company where the study was carried out for weekly, monthly, seasonal and annual periods to know the degree of the effect on the deterioration of copper materials used in industrial machinery.

e) Determination with the "ABC Graphic" of the main causes of electrical faults to order them according to the level of intensity and occurrence, and in the periods of highest and lowest incidence.

3. Results

3.1. Evaluation with ABC Graph of Electrical Faults of Industrial Machines

The industrial machine of the company where the study was developed showed RO indices varied in different periods of the investigation. At times of the day where there were electrical faults with a level a little higher than the standard, from 10 AM in the months of June, July and August and from 1PM in December, January and February. This happened in this way due to the effect of condensation, because in the summer time the visible or invisible water film forms and evaporates faster than in the winter period. Tables 1, 2 and 3 show the analysis with the "ABC Chart", according to the types of areas where the electronic devices are installed and the test is done already placed on the electronic boards. These representations are the causes of higher level than the one of less intensity for the hourly, daily, weekly, monthly, seasonal and annual analysis. Both in the axial and radial machines the causes of their defective inoperativeness were compared, only with the difference in the direction of the installation of the electronic components in the electronic boards of the products manufactured, such as televisions and computers in the company where He developed the study. Various types of causes were evaluated, showing in the tables in an organized manner the most relevant to evaluate with the "ABC Charts". Tables 1, 2 and 3 show the electrical failure rates for each period evaluated, showing that in the winter season was where the problematic situations of the low operative performance of the industrial machinery of the company where the study was allowed were presented.

Table-1. Monthly Evaluation with the "ABC Graphics" Method of Electrical Failures in Axial Machine (2016-2017)

Type of Electrical Failures (FE)	Periods					
	Hourly	**Daily**	**Weekly**	**Monthly**	**Seasonally**	**Anually**
Inadequate alignment of main part of electronic component installation	1 (33%) 10 AM	1 (31%) Jueves	1 (30 %) Semana 03	1 (34 %) Enero	1 (33 %) Invierno	1 (30 %) 2011
Deficiency in compressed air supply of the electro-pneumatic system of the machine	2 (26%) 12AM	2 (25%) Lunes	2 (25 %) Semana 49	2 (26 %) Diciembre	1 (28 %) Invierno	2 (25 %) 2011
Defective operation of the electronic components in feeder system by lack of adjustment in machine	3 (18%) 05 PM	3 (21 %) Martes	3 (21 %) Semana 07	3 (18 %) Febrero	2 (21 %) Invierno	3 (22 %) 2011
Inadequate communication of the computer with the operation program with the machine	4 (13%) 02 PM	4 (15 %) Jueves	4 (13 %) Semana 30	4 (12 %) Agosto	4 (11 %) Verano	4 (14 %) 2010
Mismatch in badly installed component detection systems	5 (10%) 04 PM	5 (08 %) Viernes	5 (11 %) Semana 25	5 (10 %) Julio	5 (07 %^) Verano	5 (09 %) 2010

Table-2. Monthly Evaluation with the "ABC Graphics" Method of Electrical Failures in A Radial Machine (2016-2017)

Type of Electrical Failures (FE)	Periods					
	Hourly	**Daily**	**Weekly**	**Monthly**	**Seasonally**	**Anually**
Inadequate alignment of main part of electronic component installation	1 (31%) 11 AM	1 (32%) Jueves	1 (29 %) Semana 04	1 (30 %) Enero	1 (31 %) Invierno	1 (29 %) 2011
Deficiency in compressed air supply of the electro-pneumatic system of the machine	2 (25%) 12 PM	2 (23%) Martes	2 (24 %) Semana 47	2 (26 %) Diciembre	3 (26 %) Invierno	2 (26 %) 2011
Defective operation of the electronic components in feeder system by lack of adjustment in machine	3 (20%) 03 PM	3 (19 %) Martes	3 (21 %) Semana 08	3 (20 %) Febrero	4 (20 %) Invierno	3 (20 %) 2011
Inadequate communication of the computer with the operation program with the machine	4 (13%) 02 PM	4 (15 %) Viernes	4 (16 %) Semana 29	4 (13 %) Agosto	4 (15 %) Verano	4 (15 %) 2010
Mismatch in badly installed component detection systems	5 (11%) 05 PM	5 (11%) Viernes	5 (10 %) Semana 26	5 (11 %) Julio	5 (08 %^) Verano	5 (10 %) 2010

In Table 1, by hour level, the highest percentages of electrical faults occurred in the morning shift, while the lowest rates were in the evening hours. This indicates that in the course of the night and dawn the effect of condensation was generated and with the increase of at least 1 ° C to 2 ° C, in the morning, corrosion originated in the connections and electrical connectors of the electrical and electronic equipment and systems of the industrial plant analyzed. In the daily evaluations were presented on a larger scale the EF were in the days of the beginning and end of the week, where it was observed that the electrochemical phenomenon was presented continuously in these days. At the weekly level, the weekly periods with the highest FE indices were in the winter and summer months where the HR levels were greater than 80%, regardless of the temperature values. The same happened when analyzing in the monthly period where the winter season was key in the generation of electrical faults in the industrial machinery and in the annual level in 2011 was the highest FE indexes because every year in the city of Mexicali, At least the change of a small percentage from 1% to 3% of RH and an increase in summer and decrease in winter of at least 1 ° C in the temperature is observed. These small variations modify the external atmospheres of companies and vary the interior environments of these. This coupled with the fact that, as already mentioned above, air quality levels exceed each year in greater quantities and easily and quickly generate aggressive environments in the interiors of companies, causing economic losses. The same happened in the machines for installing components radially or vertically and in the electrical test of the by-products manufactured in this company. This generates a tension in the personnel of the company that together with people of the educational institution that participated in the study, improvements are made in all the production areas of the industrial plant evaluated.

Table-3. Monthly Evaluation with the "ABC Graphics" Method of Electrical Failures in an Electrical Probe Machine (2016-2017)

Type of Electrical Failures (FE)	Periods					
	Hourly	Daily	Weekly	Monthly	Seasonally	Anually
Missing board component not detected by the electrical test equipment	1 (30%) 10 AM	1 (31%) Jueves	1 (29 %) Semana 05	1 (31 %) Febrero	1 (30 %) Invierno	1 (29 %) 2011
Inadequate communication of the equipment to the computer and does not detect adequate position of components on the board	2 (24%) 11 AM	2 (24%) Martes	2 (25 %) Semana 48	2 (25 %) Enero	2 (25 %) Invierno	2 (25 %) 2011
Inadequate information in test equipment of the proper value of components installed on the board	3 (19%) 04 PM	3 (18 %) Lunes	3 (20 %) Semana 09	3 (19 %) Diciembr e	3 (21 %) Invierno	3 (19 %) 2011
Inadequate information in test equipment of the proper value of components installed on the board	4 (15%) 03 PM	4 (15 %) Viernes	4 (17 %) Semana 29	4 (14 %) Julio	4 (15 %) Verano	4 (16 %) 2010
Template detection of components installed on the board with defects caused confusion in programming	5 (12%) 05 PM	5 (12%) Jueves	5 (09 %) Semana 27	5 (11 %) Agosto	5 (09 %^) Verano	5 (11 %) 2010

According to analysis with the "ABC Chart", the EFs with higher levels of incidence and of greater concern for the company's personnel, were the first three data of each table, where the percentages were indicated. It should be noted that based on the evaluations with the "ABC Chart", other FEs were presented on a smaller scale and these were only taken because they were the most frequent and those indicated by the company to be evaluated and their information was organized on the basis of tables and graphs. The objective of the company was to know the FE indexes with levels close to or greater than 50% to determine the highest incidence and thus make improvements to the production processes. Based on the analyzes that provided the information organized in the tables, the graphical representations of the most frequent FE indices are shown in figures from 1 to 12, showing only the analysis of the hour, daily, weekly and monthly for being the most representative. These evaluations were carried out with the "ABC Charts", indicating the main types of causes of electrical faults in industrial machinery.

Figure-1. Hourly Evaluation of Electrical Failures Generated in an Axial Machine (2016-2017)

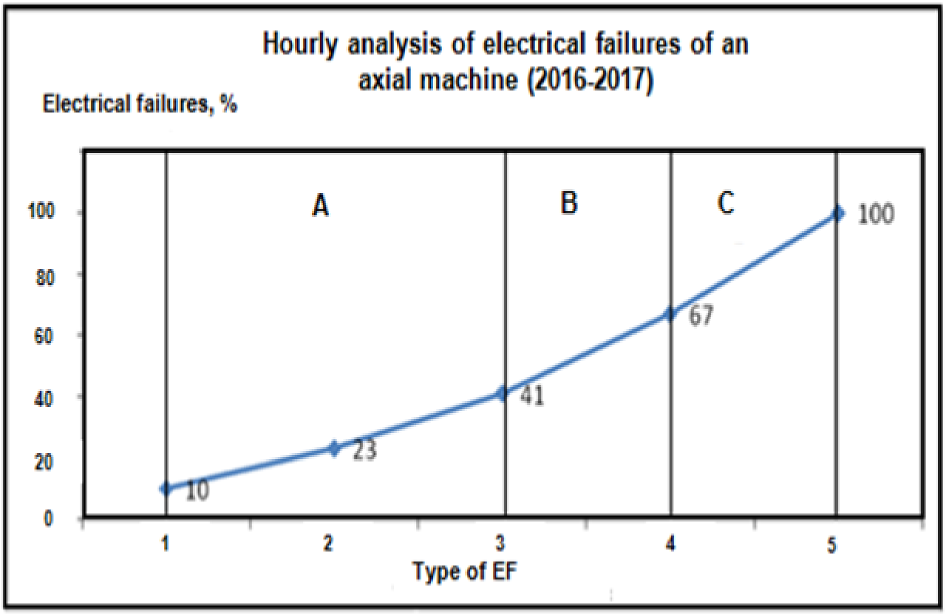


Figure 1 show the analysis of the incidence of electrical failures in the axial machine in a hourly period, where it is observed that the first two types of EF represent 41% in 67%, being the zone A. In region B of the graph, it indicates a level of 26% and combined to zone A are the highest range electrical faults being the first four of the FE types evaluated being expressed by zone B. Zone C shows the percentage complement at 100%, of the last type of FE. In this evaluation indicates according to the percentages which of the failures can be found an early solution or determine which is the easiest to solve to avoid unemployment of activities in production and thus economic losses. In Figure 2, the same process occurs as in Figure 1, the percentages being a little different in each area shown represented the daily period. This analysis supports having the vision of how to prevent industrial machinery from ceasing to operate. In zone A of Figure 2, the percentage of the first three types of FE is 44%, with 25% being the percentage index and together with the previous failures of this graph, they complement the 69% indicated by zone

B. Finally, there is zone C, with a difference of 31% from zone B, and representing the total level of FEs in this evaluation. This analysis is of the axial machine in the daily period.

Figure-2. Daily Evaluation of Electrical Failures Generated in an Axial Machine (2016-2017)

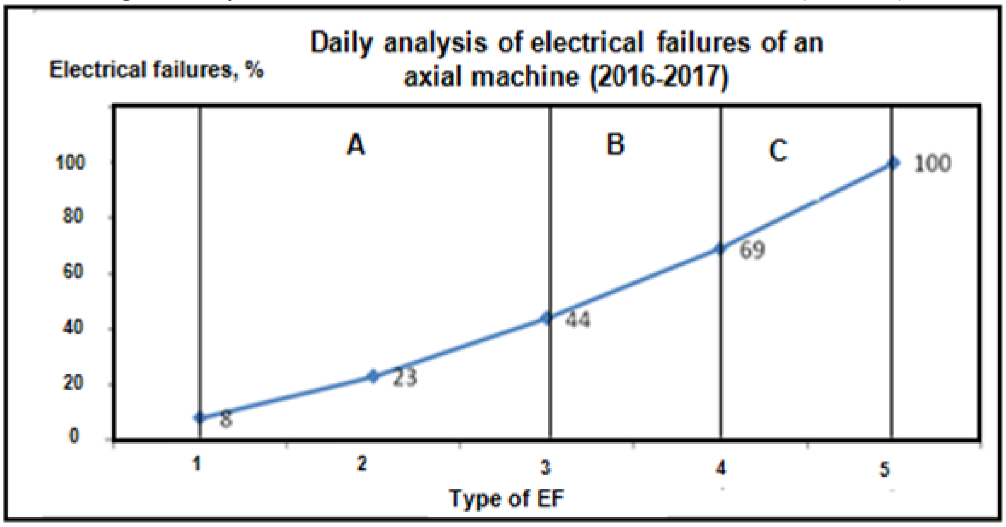
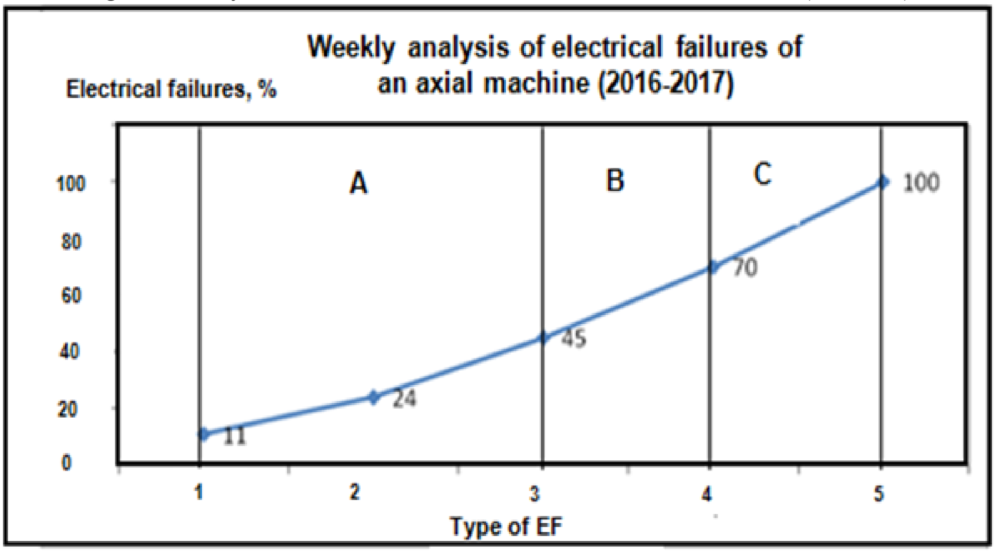


Figure-3. Weekly Evaluation of Electrical Failures Generated In an Axial Machine (2016-2017)



The previous graph that is figure 3 is part of the weekly evaluation in the axial machine of the weekly period, indicating that the three first types of failures represent 45%, being a little similar to the two graphs 1 and 2, being this the zone A, continuing with zone B that shows a percentage of 70%, this analysis being where the highest percentage level in this area is presented with respect to the hourly, daily, weekly and monthly evaluations. Finally we have zone C to obtain the final percentage, being a difference of the region before the C of 30%. Figure 4 indicates that represent the monthly period, the zones of graph A, B and C, with the first three types of FE with 44% that is region A, following with zone B combined with the A of 66% and finalizing the analysis with the area C representing a difference of the previous zone at the end of 34%. Figure 5 is part of the evaluation of the radial machine in the hourly period, where it is observed that the first three types of electrical faults represent the 44% that is zone A, continuing with region B that reaches 69% and by last zone C reaching the total percentage of 100%. Figure 6 presents percentage indices of the radial machine in the daily period, being 45% in area A, 68% in B and totaling 100%, region C, which indicates that, like the previous graphs, Three first types of FE represent about 70%. The analysis in figure 7 shows how the percentage rates of the radial machine with a weekly evaluation, being in region A 47%, continuing with region B that exceeded 70% (71%) and ending area C that entails to 100%.

Figure-4. Monthly Evaluation of Electrical Failures Generated In an Axial Machine (2016-2017)

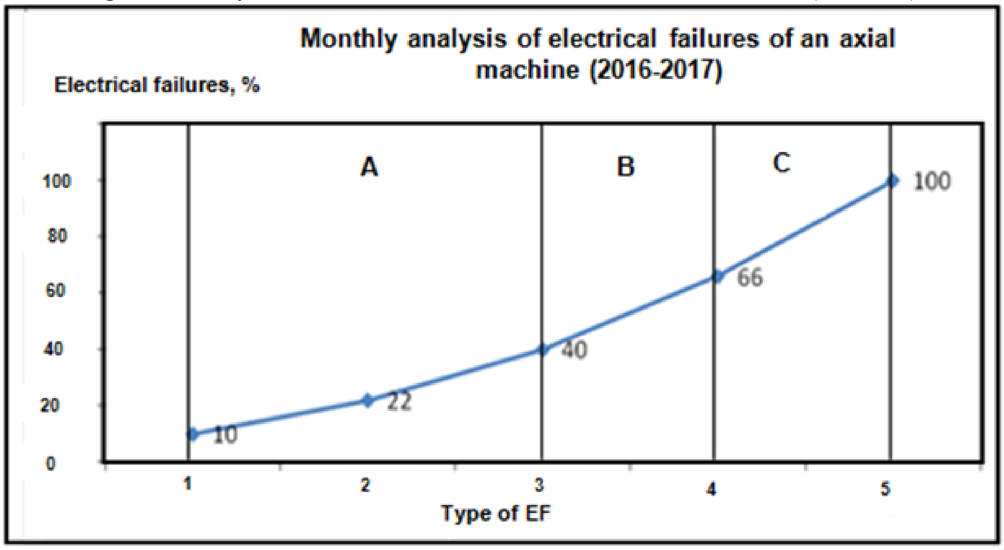
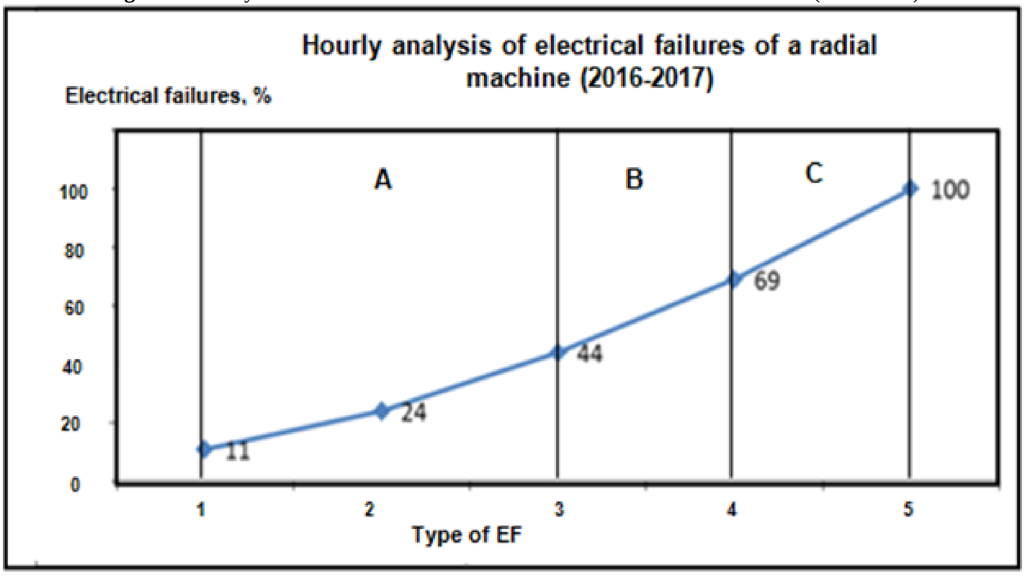


Figure-5. Hourly Evaluation of Electrical Failures Generated in a Radial Machine (2016-2017)



In the figures from 1 to 7, the zones representing the "ABC Charts" are shown, being of interest because based on these analyzes, the types of electrical faults with the highest incidence for this study are determined, which are part of the causes that reduce the operational level of the electrical and electronic equipment and systems used in the electronics industry. It should be noted that in the first three types of FE the percentage levels range between 40% and 45%, with electric failures where a great deal of attention is paid to reduce the operational stoppages that cause economic losses, which in any industry should be avoided.

Figure-6. Daily Evaluation of Electrical Failures Generated in a Radial Machine (2016-2017)

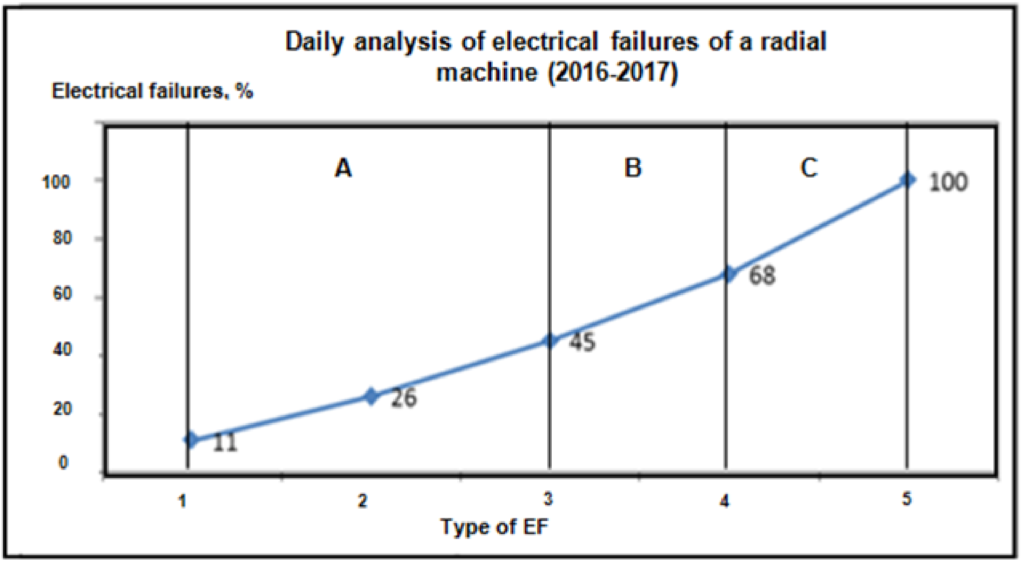


Figure-7. Weekly Evaluation of Electrical Failures Generated in a Radial Machine (2016-2017)

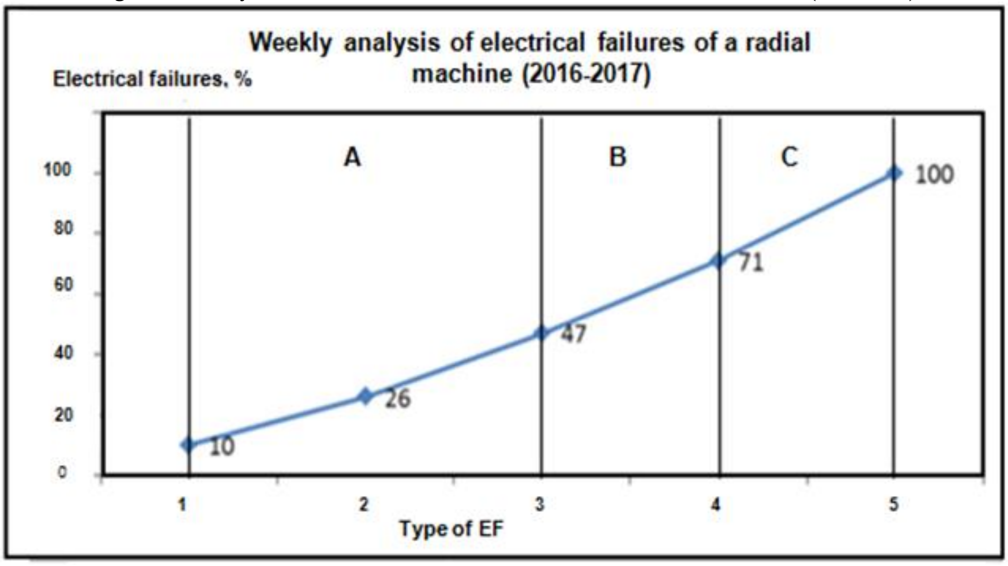


Figure 8 is part of the analysis of the radial machine in the monthly period showing percentage levels of 44% in zone A, 70% in region B and finally area C indicating 100%. In this graph, the differences between zones are contemplated to determine which of the five types of electrical faults evaluated, can be evaluated quickly and easily to gradually eliminate FEs that cause the concern of all personnel working in this area of the company.

Figure-8. Monthly Evaluation of Electrical Failures Generated in a Radial Machine (2016-2017)

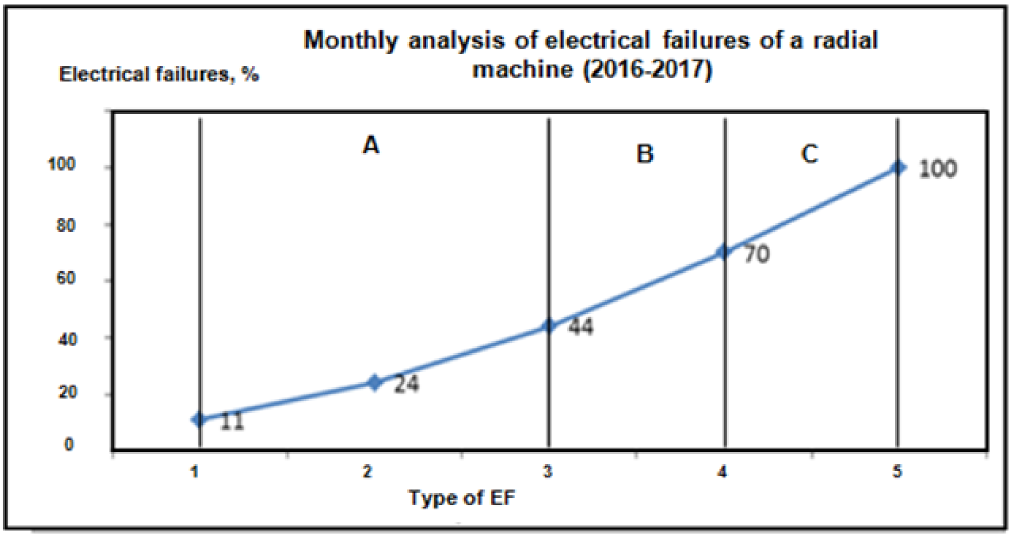


Figure 9 shows the percentages for zone A of 46%, for B for 70% and C for 100% of the percentage distribution with a difference of 30% with respect to area A. This indicated a tendency similar to the previous ones and it is of great support in the elimination of these types of FE. Figure 10 shows the percentage indices of 45% for region A, 69% for zone B and ending with 100% and with a difference of 31% with respect to zone B. With these representations as well as previous and subsequent ones they are part of the development of the analysis that leads to the reduction of operational stoppages in the industrial machinery influenced by the life time of the parts of these equipment and systems, in addition to atmospheric corrosion.

Figure-9. Hourly Evaluation of Electrical Failures Generated in a Electrical Probe Machine (2016-2017)

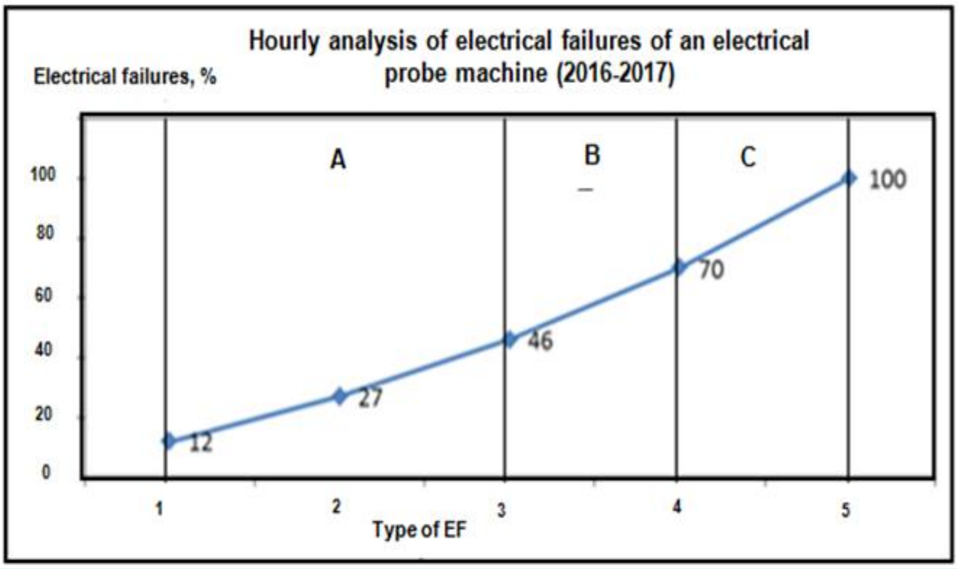


Figure-10. Daily Evaluation of Electrical Failures Generated in a Electrical Probe Machine (2016-2017)

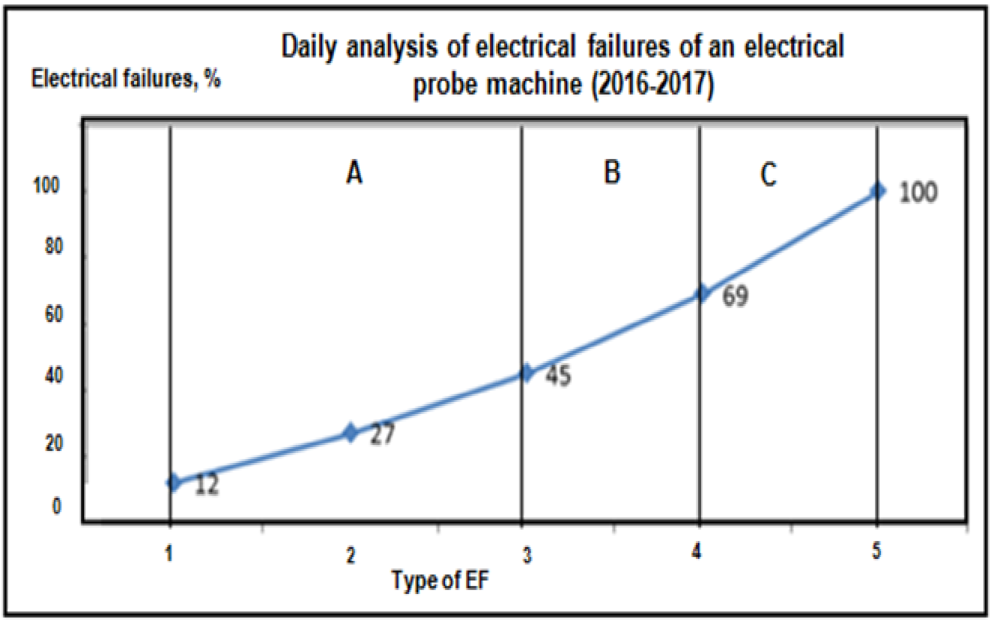


Figure 11 shows the percentage indices for region A of 46%, as well as 71% for zone B and the rest area C. The levels for figure 12 are 44% for zone A, 69% for B and 100% for region C. These representations indicate which of the types of electrical faults depending on their magnitude, incidence or form of presentation, are evaluated to determine how to reduce or eliminate them.

Figure-11. Weekly Evaluation of Electrical Failures Generated in a Electrical Probe Machine (2016-2017)

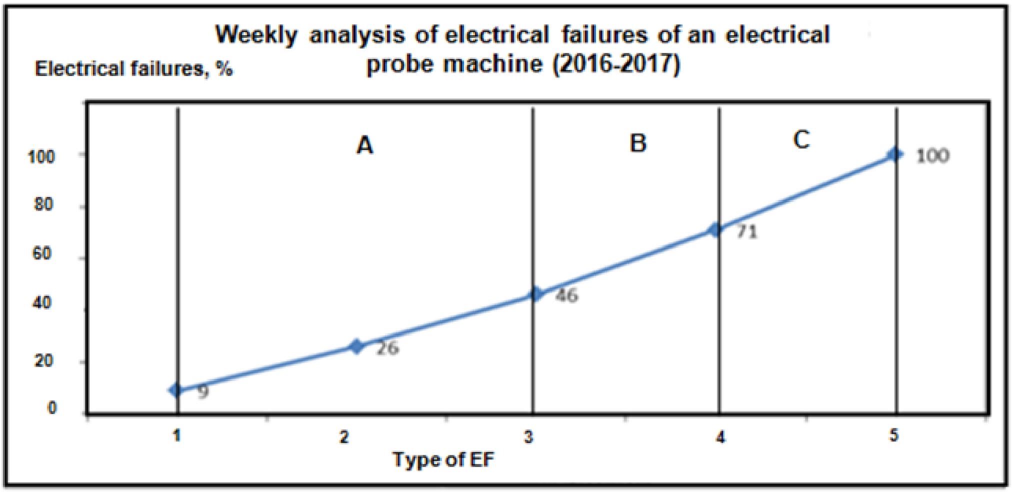
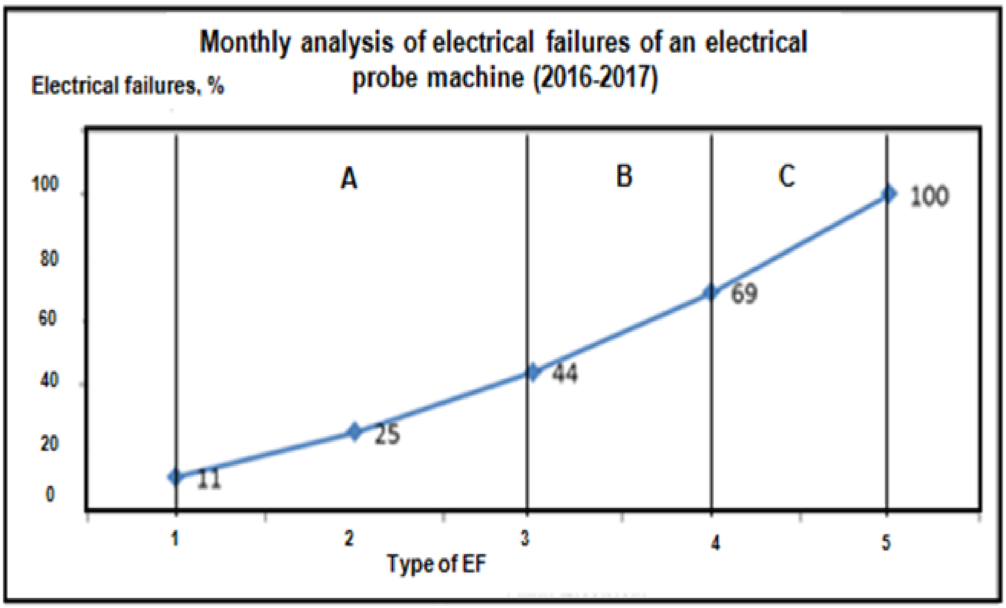
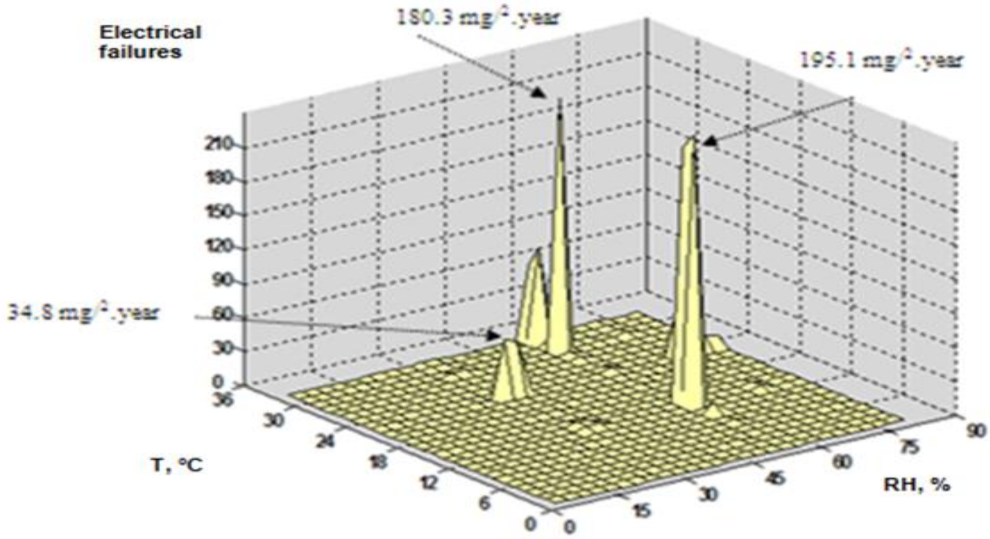


Figure-12. Monthly Evaluation of Electrical Failures Generated in a Electrical Probe Machine (2016-2017)



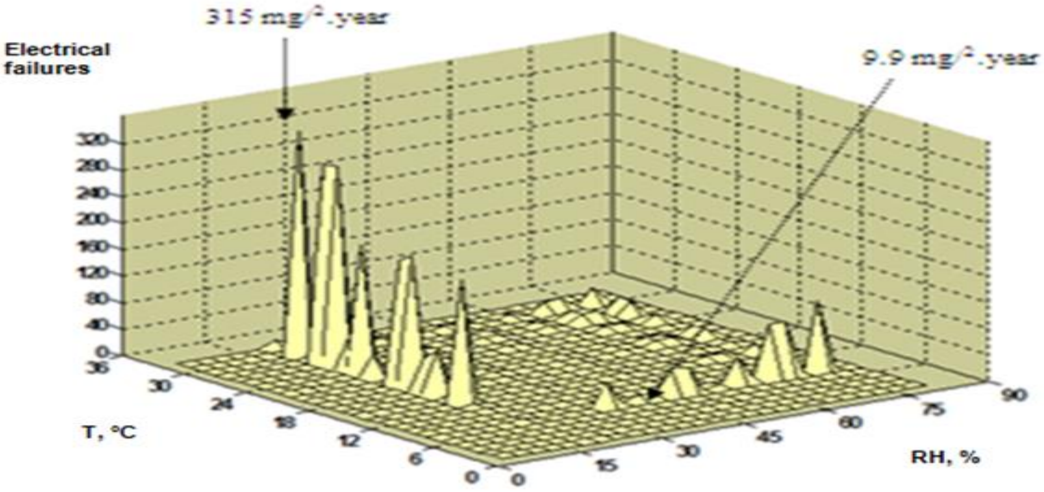
Once the evaluations with the ABC Charts were made, a correlation analysis of the climate variables, electrical faults and the corrosion rate (VC) was carried out, which indicates the degree of deterioration of the electrical connections and connectors of the electronic equipment and systems of the electronic industry. Evaluations were carried out for the winter season in each year of the study and in the axial machine, as it was where the FE were presented. Figure 13 that shows the analysis of 2010, presents the deterioration indexes with corrosivity levels (NC) as shown in the graph. The two highest values of the CV that were presented are 180.3 mg / m2.year and 195.1 mg / m2.year at HR values of 59% with a temperature of 11.3 ° C and 62% and 31 ° C. The lower index of the VC was 34.8 mg / m2.year with a RH of 31% and with a temperature of 22 ° C.

Figure-13. Correlation of Elecrtical Failures and Climatic Factors of an Axial Machine in winter (2016-2017)



For the years 2016 and 2017 in winter, the analysis of the VC correlated with the parameters of climate, air pollution in the interior of the industry where the study was carried out, and its relation with the electrical faults of the industrial machinery is presented in figure 14. The following graph shows the VC greater than 315 mg / m2.year at a RH of 21% and a temperature level of 32 ° C, and a VC of less than 9.9 mg / m2.year at a RH of 38% and an index of 8 ° C temperature.

Figure-14. Correlation of Elecrtical Failures and Climatic Factors of an Axial Machine in Summer (2016-2017)



3.2. Analysis of an Improvement Proposal for Operational Performance

Based on what happened in this company, it was determined that the use of "ABC Charts" is of great importance, together with other statistical methods currently used in the electronics industry to quickly and easily detect the causes of low performance operation of electrical and electronic equipment and systems. This contribution of the study carried out is currently operating with positive results. In addition, a proposal was sent to specialized personnel, managers and owners of companies located in this region of the Mexican Republic, of a moisture control system mainly to reduce the presence of corrosion. This is to avoid a low RO of the industrial machinery that generates economic losses. The proposed electronic system consists of a voltage power supply, a detection sensor designed and manufactured by the authors of this research, which is in the process of being patented, that is why it is only mentioned and can later be published in detail. .

4. Conclusions

The use of "ABC Graphics" in the manufacturing processes of the electronic industry, is a fundamental part in the detection of the main causes that cause stoppages of activities and so concern the personnel of this type of industrial plants. In this study, the most important options of what originated the low operational performance of the industrial machinery of the company that allowed the study to be identified were identified. The effect of corrosion on the deterioration of the electrical connections and connectors of electrical and electronic equipment and systems of this company was an important aspect in the generation of electrical faults. This meant that in certain time, daily, weekly, monthly, seasonal and annual periods the EFs with the highest incidence were presented, which kept the specialized and managerial staff alert, but neglected other operations that had to be carried out. The analysis by periods of time allowed to have a better vision for the fast and practical solution of the causes, and thus to avoid that they continued appearing. The"Gráfica ABC", represented an important tool for the evaluation of all the generation options of the FE and which of them and how to solve them as soon as possible.

Reference

[1] Gustavo López-Badilla, Catalina González-Hernández, and Antonio Valdez-Ceballos, 2011. "Análisis de corrosión en MEM de la industria electrónica en ambientes árido y marino del noroeste de México." *Revista Científica,* vol. 15, pp. 145-150.

[2] López Badilla, G., Tiznado Vázquez, H., Soto Herrera, G., De la Cruz, H. W., Valdez Salas, B., Schorr Wiener, M., and Zlatev, R., 2010. "Corrosión de dispositivos electrónicos por contaminantes atmosféricos en interiores de plantas industriales de ambientes áridos y marinos." *Nova Scientia Universidad de La Salle,* vol. 3, pp. 11-28.

[3] López-Badilla, G., Tiznado-Vázquez, H., and Soto-Herrera, G., 2011. "Análisis de EEA en la corrosión de cobre utilizado en la industria electrónica de ambientes áridos y marinos." *Nova Scientia, Universidad de La Salle,* vol. 4, pp. 1-16.

[4] Gustavo, L. B. *Análisis de la corrosión en equipos industriales electrónicos*. Mexicali, B.C: Periodice industrial Siglo XXI.

[5] Lopez, B. G., Valdez, S. B., Zlatev, K. R., Flores, P. J., Carrillo, B. M., and Schorr, W. M., 2007. "Corrosion of metals at indoor conditions in the electronics manufacturing industry." *AntiCorrosion Methods and Materials,*

[6] Chongchen, X., 2003. "Corrosion in microelectronics." *Partial Filfillment of Mate,* vol. 234,

[7] Veleva, L., Valdez, B., Lopez, G., Vargas, L., and Flores, J., 2008. "Atmospheric corrosion of electro-electronics metals in urban desert simulated indoor environment." *Corrosion Engineering Science and Technology,*

[8] López, B. G. and Tesis, d. D., 2008. *Caracterización de la corrosión en materiales metálicos de la industria electrónica en*. Mexicali, B.C.

[9] Cartier, E. N., 2004. "El costo basado en actividades y la teoría del costo." vol. 11,
[10] Drucker, P., 2003. "La administración en una época de grandes cambios con los Gráficos ABC," Editorial sudamericana.
[11] Kaplan, R. S. and Cooper, R., 2000. "Gráficos ABC, costo y efecto Editorial Gestión."
[12] Shank and Govindarajan, V., 2005. "La gerencia estratégica de costos, Grupo editorial Norma."
[13] Shank and Govindarajan, V., 2003. "Graficos ABC, el alto costo de producir Ed. Trillas."
[14] Moncmanova, A., 2007. *Environmental deterioration of materials*. WITPress, pp. 108-112.
[15] Asami, K., Kikuchi, M., and Hashimoto, K., 1997. "An auger electron spectroscopic study of the corrosion behavior of an amorphous Zr40Cu60 alloy." *Corrosion Science,* vol. 39, pp. 95-106.
[16] Van Ingelgem, Y., Vandendael, I., Vereecken, J., and Hubin, A., 2003. "Study of copper corrosion products formed during localized corrosion using field emission Auger electron spectroscopy." *Surface and Interface Analysis,* vol. 40, pp. 273-276.