Chapter 1
Design of Experiments in an Electrochemical Process

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ABSTRACT

This chapter applies design of experiments to improve plating performance and better practices in an electrochemical process within a company making electronic components. Specifically, the electroplated process of a metal housing served as the object of study. This process consists of plating an aluminum housing with silver (Ag) to improve the electrical signal characteristics and properties. It includes multiple factors affecting the process, which are clearly seen in the diverse failures such as electric response, pollution by solid waste, among others. These directly impact production costs and delivery time. To minimize the mentioned failures, diverse critical factors were enlisted discovering that the principal problem is the homogeneous distribution of the final finish of the commented product. Particularly, the final finish is realized with silver so it directly affects the electric response as final quality test.

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INTRODUCTION

The Design of Experiments (DoE) is frequent in diverse areas of study. One of them is the industry, which is principally used in the design and improvement of products and processes. It is because the experimentation offers a close description on how the products could be used by certain individuals, and processes could be operated in determined environments. Particularly, the operation of the process served as a precursor for its improvement. The costs and the time employed in the improvement are two variables that limit it. However, the experimentation is one tool that is employed with this objective in mind. The principal idea is to use it until desired goals and/or indexes are achieved. This is considering the costs and time in order to reduce both using the experimentation. In other words, this means that experimentation is one form on improving the processes at low cost and using less time.

The EEC company is an industry that manufactures filters for electrical and radar devices, is autonomous and subsidiary of CE. The company started operations in 1987 and operates within the ''Maquiladora'' program. The design and manufacturing center is located in Tijuana, Mexico, while the sales, IT and customer service departments are located in California, United States. CEE is a company specifically dedicated to the manufacture of RF filters for High frequency and microwave. Over the years the product line has expanded to include ceramic filters, surface mounted filters and miniature filters. The company has 50,000 square feet assigned to assemblies, electrical tests, life tests, quality assurance, design engineering and technical service. It also has areas for machines, tools and electroplating finishing processes.

The production departments are organized to process engineering prototypes, issue small quantity orders and volume production lines. In addition, it has the ability to transform certain areas into clean rooms "class 100,000" for specific orders that require it. According to the company's sales catalog, Electronic Components has certifications in ISO 9000 and ISO 14000. This plant was certified in the functions of design, development, production, installation and customer service. On the other hand, clients vary in different sectors. Some examples of application of the final product are mobile and wireless telephones, GPS (global location systems), satellite receivers, radio frequency data processors and network communication systems.

It is important to note that within these production departments, there is a process in which attention is paid to the importance of the final product. According to the company's plating manual, electroplating is the chemical process where a layer of metal is deposited by applying electricity to a metal. An internal and / or external layer is deposited to said material and it is according to the material to be processed. In this area metals such as silver and nickel are deposited through an internal process in which the filters that are manufactured internally are placed. Components-based metals are aluminum, brass and steel to be coated with a specified thickness. These specifications are indicated on the traveling or work instructions sheets, following the QQN290 standards for nickel, QQS365 for silver and ASTM-B700 for silver. This electroplating process generates various properties and characteristics in the coated materials. To do this, an electrochemical process is followed that includes a series of steps to meet the manufacturing specifications and achieve the plating requested in the product. In this particular case it is an Aluminum Housing, which is presented in Figure 1. The products are plated to protect them from environmental corrosion and give them certain electrical properties. This is because they are metal parts of aluminum and a copper derivative called brass (copper and zinc alloy).

According to the plating manual, the department is made up of a process engineer, a production supervisor, a material preparer and a plainer. Employees belonging to this department must have knowledge of the dangerous chemicals that are handled there. This is important for personal safety; Therefore,