

FACULTAD DE INGENIERÍA

Escuela Académico Profesional de Ingeniería Mecatrónica

Tesis

**Design of a Control and Monitoring System for
Pollutants in a Handcrafted Footwear Factory**

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Design of a control and monitoring system for pollutants in a handcrafted footwear factory

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Abstract— Autonomous systems provide a new approach to environmental quality control in the labour market, especially in jobs that expose the employee to concentrations of pollutants, which, if constantly exposed, can cause damage to the employee's health and well-being. Therefore, this work presents a system of control and monitoring of pollutants in an independent way for a handmade footwear factory. For the development of the design, the VDI 2206 methodology was used, where the technological information, control design and system integration are presented. All this will allow the system to perform a good collection of information of the main environmental parameters to then be displayed on an HMI screen in real time, also the system has a PLC controller to activate the air conditioning instruments according to the information received in order to maintain the maximum permissible parameters of pollutants, which are a temperature between 30 ° C and 35 ° C, a relative humidity between 30 % and 70 % and an exposure of VOC between 0.50 ppm and 0.70 ppm. In this way, the system prevents the occurrence of diseases caused by unintentional exposure to pollutants.

Keywords— *Temperature, relative humidity, volatile organic compounds, monitoring system, control, handcrafted footwear factory*

I. INTRODUCTION

Diseases related to environmental problems are increasingly relevant in the labor field, the emergence of occupational diseases (EPPP) is the result of accidents and environmental conditions to which the worker is exposed. The latter can lead to long-term occupational diseases and consequently the health of the collaborator is affected, as well as the productivity of the industries [1]. In the footwear industry, it has been seen that they involve many workers due to the fact that the preparation of the product mostly absorbs labor, such as the process of cutting, sewing, gluing and painting [2].

In some of these processes, mainly in bonding, contaminants involving physical and chemical agents are perceived [3,4]. Volatile organic compound (VOC) vapor is one of them and is found in solvents containing toluene and benzene, being this the main component for the realization of an effective gluing at the

time of plant-leather bonding. Another agent that is perceived is temperature (°C), due to the involuntary environmental exposure of the physical nature with the operator, as well as humidity (Hr) [5,6]. Constant exposure to these factors causes long-term occupational diseases such as skin irritation, narcotic syndrome, heat stress, dermatitis, while in the short term, eye irritation, headaches and fatigue are perceived [7].

A previous study developed VOC monitoring by means of a WSN system with the objective of controlling the data reception in real time through a mobile application [8]. Since the sensor network works wirelessly, it is possible to expand the area of VOC monitoring and control [9]. Also, flexible systems have the ability to census in a wide environment thanks to strategically located multiple gas monitoring stations [10].

To achieve an effective control of contaminants by physical or chemical agents, it is necessary to use a controller capable of receiving data and performing programmable operations. Several studies propose systems based on development boards such as Arduino, being this a limitation when it comes to real-time measurements due to certain limitations such as the speed of data processing that this type of controllers offers [11]. In this sense, the design proposed in this study makes use of a PLC because of the benefits of this controller. Also, it is proposed to work with fans for the extraction of these pollutant gases, a previous study proposes a similar extraction system, but the evaluation of the pollutants is given by means of gas cinematography, being this a slower process of VOC evaluation [12].

This study develops a system capable of monitoring and controlling the main pollutants (VOC, Temperature, Relative Humidity) that are perceived in the footwear industry, for this a systemic methodology is used and oriented to mechatronic designs being this the VDI 2206, therefore, it is necessary to implement an HMI interface for monitoring and make use of a programmable logic controller (PLC) to control the pollutants within permissible parameters. In this way it is possible to monitor and visualize the behavior of the physical-chemical agents in real time.