Control Creation of a RFID to improve productivity and Inventory Control

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Abstract

In this paper, various changes are presented on devices that transmit long-distance electromagnetic frequencies for product location (RFID). This research aims to improve the characteristics of a Tag by changing its coating to ensure that it can tolerate working with higher temperatures than it currently supports (240 ° C). The objective is to introduce these modified Tags in a company dedicated to the pressurized cutting of "foam" by means of presses and dies for the automotive industry. The implementation of RFID in the automotive plant aims to improve the current inventory system, minimize set-up times, which will lead us to minimize process times and company costs.

Keywords
RFID, Tag, Productivity, Inventory control

1. Introduction

In recent years, radio frequency identification (RFID) technology has been characterized with an increasing number of applications involving many RFID readers (eg. supply chain management, traceability management and intelligent transport systems). (tan and Zainol, 2018) RFID is a technology of wireless sensors, based on the detection of electromagnetic signals and radio frequencies, which are used to capture and transmit data from or to a label (Domdouzis et al., 2007). Its ability to store and retrieve item data remotely can be used to replace traditional element identification and data capture approaches. If RFID technology is applied to the logistics industry under a more general environment, a reduction in logistics costs can be expected (Kim and Sohn, 2009). RFID has been used extensively to improve the processes of warehouses and distribution centers, logistics, and the management of inventories through the supply chain (Chongwatpol and Sharda, 2013). Huang et al. (2007) suggest that an approach based on RFID technology can improve the visibility and traceability of shopfloor information in real time in a flexible fixed-line assembly for mobile workers. The main objective of this work is to use RFID technology to control the inventory system in a company that has products in a high temperature system. Currently, the labels used for the RFID process can withstand temperatures below 240 ° C, due to this situation the modification of the TAG encapsulation is sought so that it can withstand temperatures higher than those currently supported by the TAG and that this encapsulation does not interfere in the sending of the information that this TAG has recorded.

2. Theoretical Framework

The radio frequency identification (RFID) brought the automatic detection of the object by electromagnetic waves, without the requirement of physical contact. As the costs of this technology diminish, RFID systems are increasingly implemented in varied environments (Liu et al., 2018). An RFID system is generally composed of three elements, a label placed on the object that wants to be identified, a reader with its antenna that communicates with the label without having to be in direct line and a server equipped with a middleware responsible for the administrarion of the system and the interaction with the information systems of the organization. Tags can be defined as the basic building block of RFID, its main components are: a chip, an antenna and storage capacity (Chiu and Jie 2013). The chip contains the serial number of the label, the antenna allows the chip to transmit the label information to the reader. Next, the reader receives the reflected radiofrequency waves that will be converted to digital information which is encrypted by a computer. Unlike a bar code reader, the reader of the RFID system can perform multiple readings of labels at the same time. (Viceto on 2017). According to (Dass and Om 2016) the labels of the RFID system can be grouped into three types: passive, semi-active and active, according to the way they are powered or not. Some of the tags, in addition to having the ability to transmit data for reading, may also allow rewriting with new data and record them (Velandia et al., 216). According to [9] there are three types of frequencies in which the RFID, low frequency (LH), high frequency (HF) and ultra high frequency (UHF) systems operate. The frequencies are in the range 125-134 kHz for LH, 13-56 MHz for HF, and in the range 866-966 MHz for UHF. It is important to mention that the RFID system is affected in its reading by several factors, such as the radio frequency energy, the speed of the label, size of the TAG, shape, material and surface structure. Among all these factors, researchers have done a lot of research to eliminate their interference and to improve the reading rate of the RFID system (Xie et al., 2017). For their part (Periyasamy and Dhanasekaran 2014) evaluated and analyzed the performance of the RFID system in metal and liquid environments and found that both metal and water affect the reading process in the RFID system. (Qing and Chen 2007) found that due to the effect of the near-field effect of the metal environment, the size and orientation of the metal plate has a significant effect on reading. On the other hand, one of the most significant problems in the management of the supply chain is the control of inventories, since there is the possibility of committing manual operational errors, including manufacturing, distribution, storage and retail. The problem of incorrect placement of inventory is difficult to be completely eliminated, and thus becomes a challenge rather than overcome (Chuang and Olive, 2015). According to (Gjeldum et al., 2018) Industry 4.0 is an important and relevant issue nowadays, which integrates advanced technological systems such as the use of the RFID system. These authors propose to introduce RFID processes in the manufacturing process, by creating a system called manufacturing execution enabled by RFID, thus allowing the identification of the products and the writing of the data in the RFID tag that is attached to the product providing multiple benefits to organizations. Moghaddam talks to us about the integration of the RFID system into fiber-reinforced plastic (FRP) components during the production process and offers many opportunities, such as control of the vacuum infusion process with integrated pressure sensors. In addition to this, it would also be possible to control the internal curing temperature of the resin during the hardening process using temperature sensors. (Brink et al., 2018) Therefore, the data can be read during the lifetime of the FRP, at least for recycling. The integration of RFID into components of fiber-reinforced plastic (FRP) is presented in current research topics (Konstantopoulos et al 2014). Currently one of the biggest problems encountered in any organization and industry is the control of inventories; the industry dedicated to the pressurized cutting of foam (pressurized cutting of "foam") by means of presses and dies, has been observed the constant loss of pieces during the thermal processes that are made to the dies of the presses and pieces of the dies , the thermal processes performed on these parts operate at temperatures higher than those accepted by RFID system labels, for this reason the main objective of our research is to develop a modification in the encapsulation of a new label that supports temperatures above 240°C, with the implementation of RFID in the automotive plant, we intend to have control over the inventory, minimizing configuration times, which will lead us to minimize process times and company costs.

3. Method

There are several RFID equipment, however, for our work we will use the DWE CC USB RF 125 Khz RFID EM4305 T5567 as shown in figure 1. As our objective is to have the design of an encapsulated TAG that supports temperatures of 240 ° C. We will use this simple equipment only to read and write label information. The RFID reader was connected to the computer and the software was loaded with information to the TAG. Once the TAG has information, it is taken inside the oven, like the one shown in figure 2, to analyze its reading and writing behavior after being heated.

The oven was heated to a temperature of 40 ° C and the TAG was introduced into this equipment in a crucible; when the TAG reached the indicated temperature the condition of the TAG was observed and at this temperature it did not suffer damages. Subsequently, different tests were performed with higher temperatures until it was observed that the encapsulation of the TAG only tolerated up to 80 ° C. The encapsulation was broken at a temperature of 100 ° C, however, we did a reading and writing run and the TAG worked in correct form, that is, at this temperature only the encapsulation was damaged and not the TAG as shown in figure 3.

Figure 1. Portable RFID system integrated by a computer, a reader and TAG

Figure 2. Test oven to analyze the characteristics of TAG in high temperatures

Table 1 shows the six runs that were made on the TAG, heating the oven at various temperatures and observing the damage caused to the encapsulation. In each run, the encapsulation was left for a period of 10 minutes inside the oven.

Table 1. Temperature and conditions of each run

RUN	TEMPERATURE	CONDITION
1	40° C	stable
2	50° C	stable
3	60° C	stable
4	70° C	stable
5	80° C	stable
6	90° C	unstable

Figure 3. TAG with damage encapsulation

The encapsulation of the TAG will be carried out with a process similar to crystallized PET (opaque) to obtain better resistance to temperatures up to 240 ° C. The process to produce this PET starts with two basic components, dimethylterephthalate DMT and terephthalic acid TPA. The reaction between these compounds is carried out by esterification DMT or TPA with ethylene glycol to obtain the monomer di-beta-hydroxyethyl-terephthalate, this is subjected to polycondensation, and polymerized forming the PET. These two esterification reactions release water and methanol and in the polycondensation reaction high temperatures have to be used to improve their effectiveness. The ethylene glycol compound is separated and recovered by vacuum to be distilled and reused in the production process (figure 4)

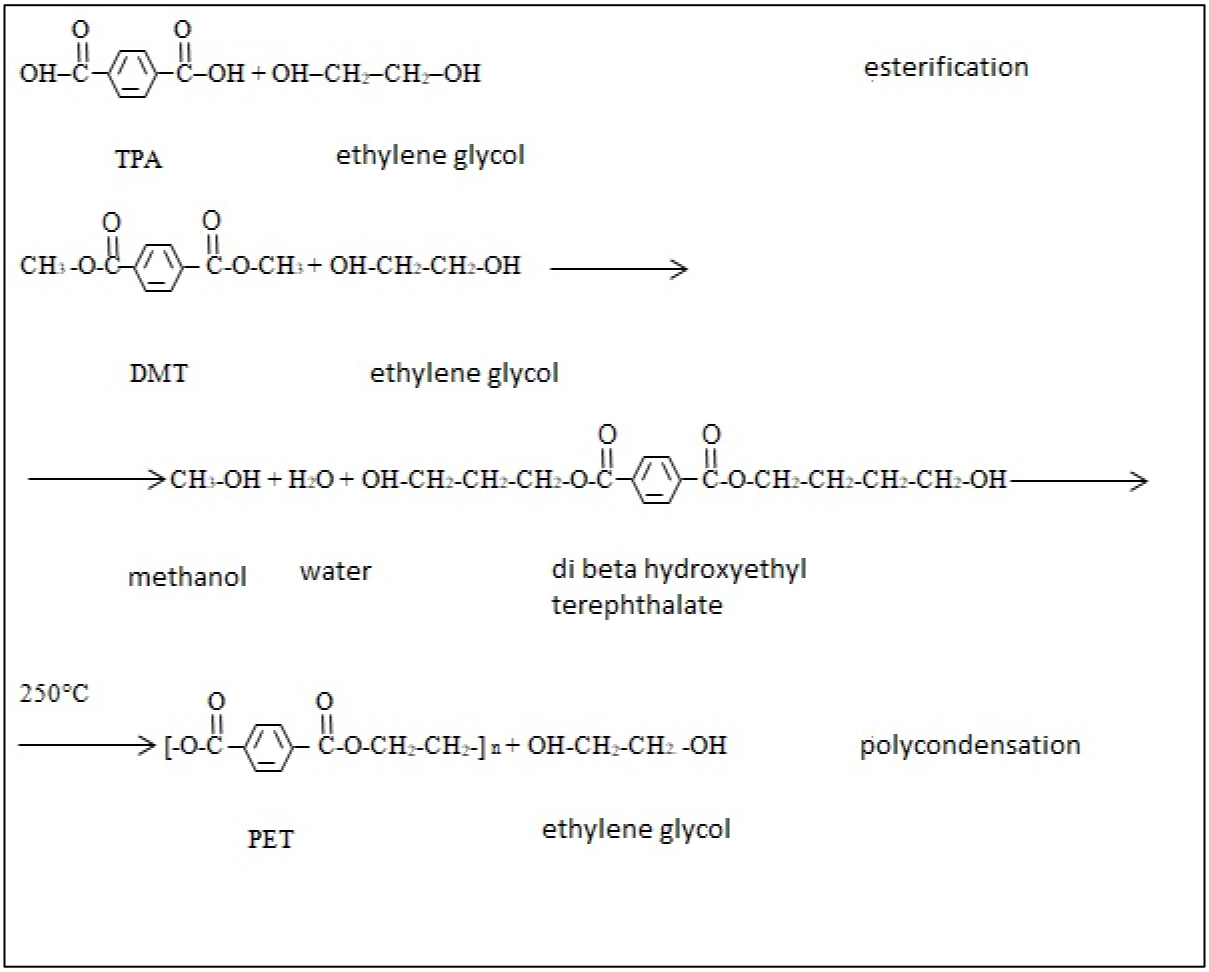

Figure 4. Process to crystallized PET

It is sought to reach a certain viscosity in the polymer and at that moment the vacuum is stopped introducing nitrogen to avoid oxidation. The polymer mass is transformed into yarn and cut into granules to be sieved. The sieving obtained is normally bright and clear because it is amorphous, with low viscosity.

In the crystallization process, the structure of the semi-crystalline polymers is modified, where the macromolecules change from a structure in which their spatial arrangement is amorphous and transparent to light, to a uniform and disordered structure (crystalline structure, opaque to the light) that transfers a whitish color to the resin. This process is carried out with a heating at 130-160 ° C, in a variable period of time while the granule, to avoid its blocking, is kept in constant agitation by the effect of a fluid bed or a mechanical movement. With crystallization, the density of the PET goes from 1.33 g / cm3 of the amorphous to 1.4 of the lens.

4. Conclusion

This paper presented the need to improve inventory control of a company that has several products that are subjected to temperatures higher than 200 ° C. The introduction of RFID systems in inventory control is a competitive advantage since it reduces the operating costs of these processes. The innovation involves designing a plastic encapsulation for the TAG that can tolerate temperatures of 240 ° C. The methodology proposed in this work includes the incorporation of a modified process to what is currently done in PET production. To tolerate high temperatures, it is proposed to crystallize the PET to obtain an opaque crystalline plastic as demonstrated in the chemical equations presented above. The TAG, has behaved stable even with high temperatures and the information that has been assigned is information that has been maintained within the TAG. The instability is lost by the encapsulated plastic of the TAG since previously designing a TAG for high temperatures was not a necessity for any company. The design of the TAG package has been possible from a fundamentally theoretical perspective; the components (raw material) to make the encapsulation are difficult to obtain to be able to experiment, nevertheless, this work concluded its feasibility and its technical viability. With the implementation of the RFID system for the control of inventories, a considerable reduction was observed in the time lost in the search of parts without a specific location. Another important impact was accomplished with the reduction in the stop time for lines with missing tools. All of this was achieved with the development of access to the exact location of the pieces that have the TAG and with its technical description. This article provides an innovative option to allow the TAG of the RFID system to withstand high temperatures. Another advantage of the system is the feasibility of its implementation in parts that undergo treatments or processes with temperatures above 240 ° C without limiting its scope.

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Biographies

Gerardo Espinosa-Garza obtained his Bachelor's in Chemical Engineering, his Master's in Environment Studies and Doctoral degree in engineering in Barcelona, Spain. He is the professor of engineering in the Tecnologico de Monterrey, Mexico. He has been the Construction Projects director for more than 20 years, with responsabilities ranging from management of institutional contracts to engineering, operations, maintenance and construction of instalations. From January 2015 to today, he has published 5 patents and created more than 20 prototypes and published a great number or articles. He belongs to the National System of Researchers of Mexico.

Imelda de Jesús Loera- Hernandez received her Ph.D. degree in Project Engineering from the Universitat Politècnica de Catalunya, Spain in 2006. Since 1999 she is a full-time professor in Industrial Engineering Department in Tecnologico de Monterrey, México. Her areas of interest and research are focused on Project Engineering, Innovation Management and Operational excellence.

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