Article **Journal of Quantitative and Statistical Analysis**
December, 2019 Vol.6 No.18 13-15

Implementation of the RCM methodology in pleating machine

Implementación de la metodología RCM en máquina plisadora

TUDÓN-MARTÍNEZ, Alberto †*, ZUÑIGA-MARTINEZ, Marco Antonio, LERMA-GARCÍA, Miguel Angel and MÉNDEZ-GOVEA, Luis Alberto

Universidad Tecnológica de San Luis Potosí

ID 1st Author: *Alberto, Tudón-Martínez* / **ORC ID:** 0000-0003-1689-1250, **CVU CONACYT ID**: 411753

ID 1st Coauthor: *Marco Antonio, Zúñiga-Martínez* / **ORC ID**: 0000-0003-2736-9177, **CVU CONACYT ID**: 94933

ID 2nd Coauthor: *Miguel Angel, Lerma-García* / **ORC ID**: 0000-0002-7849-4528, **CVU CONACYT ID**: 668648

ID 3rd Coauthor: *Luis Alberto, Méndez-Govea* / **ORC ID**: 0000-0002-9763-2519, **Researcher ID Thomson**: X-7378-2019, **CVU CONACYT ID:** 1014457

DOI: 10.35429/JQSA.2019.19.6.13.15 Received July 10, 2019; Accepted November 28, 2019

Abstract

The objective of this project is to reduce the downtime of a machine that performs the pleating of materials in a company dedicated to the manufacture of automotive parts. The development of this project aims to increase the availability of the machine and contribute to the use of material and humnan resources, achieving an increase in production to ensure permanence and competitiveness in the Market. Reliability Centered Maintenance (RCM) will be the methodology used to achieve the goal. The implementation of this methodology contributes to the updating of maintenance programs to achieve an increase of the MTBF indicator (Average Time Between Failures) and the decrease of the MTTR (Mean Time to Repair). The application of maintenance methodologies that exist today plays an important role within the industrial sector when it is necessary to meet the goals set by companies to meet the needs of customers.

Maintenance, Reliability, Machine

Resumen

El objetivo del presente proyecto es la disminución de los tiempos improductivos de una máquina que realiza el plisado de materiales en una empresa dedicada a la fabricación de piezas automotrices. Con el desarrollo del presente proyecto se pretende incrementar la disponibilidad de la máquina y contribuir al aprovechamiento de los recursos materiales y humnanos, logrando un incremento en la producción para garantizar la permanencia y la competitividad en el mercado. El Mantenimeinto centrado en la confiabilidad (RCM) será la metodología que se utilizara para el logro del objetivo. (Falcon, 2015). Con la implementación de esta metodología se contribuye a la actualización de los programas de mantenimento para lograr un incremente del indicador MTBF (Tiempo promedio entre falla) y el decremento del indicador MTTR Tiempo promedio de reparación). (Villanueva E. D., 2014). La aplicación de las metodologías de mantenimiento existes en la actualidad juegan un papel importante dentro del sector industrial cuando se requiere cumplir con las metas establecidas por las empresas para satisfacer las necesidades de los clientes.

Mantenimiento, Confiabilidad, Máquina

Citación: TUDÓN-MARTÍNEZ, Alberto, ZUÑIGA-MARTINEZ, Marco Antonio, LERMA-GARCÍA, Miguel Angel and MÉNDEZ-GOVEA, Luis Alberto. Implementation of the RCM methodology in pleating machine. Journal of Quantitative and Statistical Analysis. 2019 6-19: 13-16

* Correspondence to Author (email: atudon@utslp.edu.mx)
† Investigador contribuyendo como primer autor.

Introduction

Companies are in constant need of improving the availability of equipment by reducing downtime, contributing to increased productivity and the offering of products at competitive prices in the market.

The increase of unproductive times in the material pleating machine was detected in the second half of 2018, which presented a decrease in availability directly affecting productivity.

The tools used are the RCM methodology (Reliability Centered Maintenance), the analysis of the machine's fault history and the revision of the current state of the preventive, predictive and autonomous maintenance program. (Garcia, 2015)

The project hypothesis is that increasing the MTBF maintenance indicator and reducing the MTTR maintenance indicator will reduce the downtime of the pleating machine and this will contribute to the increase in production.

Method Description

The problem is addressed through the RCM methodology, Reliability Centered Maintenance, based on failure analysis (Martín, 1998).

Both, failures which have already occurred and those which have a certain probability of occurring and carry serious consequences are analyzed. During the analysis process, six key questions must be answered for each of the systems that make up the plant:

1. What are the functions and operating standards in each system?
2. How does each device and each system as a whole fail?
3. What is the cause of each failure?
4. What consequences does each failure have?
5. How can each failure be avoided?
6. What should be done if it is not possible to avoid a failure? (Falcon, 2015)

Methodology development

Figure 1 shows the RCM methodology, which consists of a series of phases for each of the systems that make up the machine.

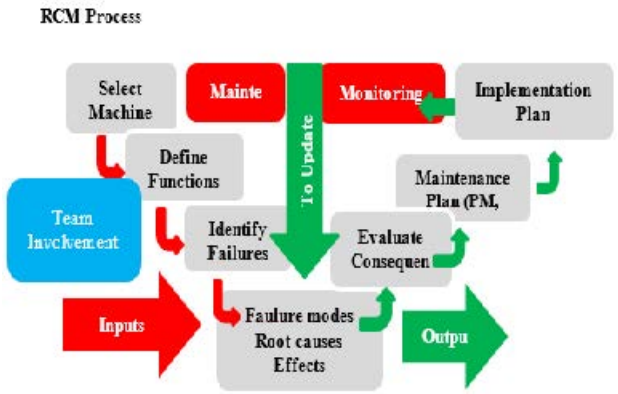


Figure 1 RCM methodology process
Source: Project contribution, unpublished

Phase 0: Coding and listing of all subsystems, equipment and elements that make up the system. Compilation of schemes, functional diagrams, logical diagrams, etc.

No.	System
1	Pleating system
No.	System
2	Unwind system
3	Tension system
4	Heat iron
5	Marking system

Table 1 Subsystem List
Source: Project contribution, unpublished

Phase 1: Detailed study of the system operation. List of system functions as a whole. List of functions of each subsystem and of each significant equipment integrated in each subsystem.

ISSN 2410-3438

No.	System	Main function
1	Pleating system	Pleating paper and mesh
No.	**System**	**Complementary functions**
2	Unwind system.	Unwinding paper and mesh
3	Tension system	Applying tension to paper and mesh
4	Heat iron	Treating glue
5	Marking system	Marking the pleat (red or blue)

Table 2 List of main and complementary functions
Source: Project contribution, unpublished

Phase 2: Determination of functional and potential failures.

Main function	Functional failures
Pleating paper and mesh	1. Does not pleat paper and mesh
	2. Partially pleats paper and mesh
Secondary Functions	**Potential failures**
Unwinding paper and mesh	3. Does not unwind paper and mesh
	4. Partially unwinds paper and mesh
Applying tension to paper and mesh.	5. Does not apply tension topaper and mesh
	6. Partially applies tension to paper and mesh
Treating glue.	7. Does not treat glue.
Marking the pleat.	8. Does not mark the pleat.
	9. Partially marks the pleat.

Table 3 List of functional and potential failures
Source: Project contribution, unpublished

Phase 3: Determination of the failure modes or causes of each of the failures found in the previous phase.

Functional failures.	Mode of Failure	Root Cause
1. Does not pleat paper and mesh.	- The turbine does not start and the andon alarm is fired	Stuck turbine motor bearings
2. Partially pleats paper and mesh		Hit mesh detection sensor
Potential failures.		
3. Does not unwind paper and mesh	- The pleat comes out fluorescent (short and long)	Broken voltage sensor internal sheet
4. Partially unwinds paper and mesh	- Paper comes out without secondary mesh	Hit mesh sensor
5. Does not apply tension topaper and mesh	- The pleat comes out fluorescent (short and long) - Unwind paper and mesh	Broken tension sensor internal sheet
6. Partially applies tension to paper and mesh	- The paper breaks and the sliding rollers skid	Loose transmission serrated band
7. Does not treat glue	- The mesh does not stick to the paper	Open resistors
8. Does not mark the pleat	- It does not have the mark color on the pleat (Red or blue)	Blocked marking gun
9. Partially marks the pleat	- Stains the entire pleat with paint	Worn marking gun seals

Table 4 Failure modes and root cause.
Source: Project contribution, unpublished

Phase 4: Study of the consequences of each failure mode. Classification of failures in critical, important or tolerable according to consequences.

Root Cause	Frequency	Severty	Detection	Security	Cost	Total
Stuck turbine motor bearings	1	1	2	1	2	4
Open fuses.	2	1	4	1	1	8
Damaged emergency brakes (Open)	2	1	4	2	1	16
Hit mesh sensor	2	2	4	1	2	32
Dirty safety curtains	2	1	1	1	1	2
Transducer alignment mechanism stained with glue	2	1	1	1	2	4
Flamed safety relays.	1	1	4	2	2	16
Lack of pressure in rollers	2	2	3	1	1	12

Table 5 Consequence Evaluation
Source: Project contribution, unpublished

Phase 5: Determination of preventive measures that avoid or mitigate the effects of failures

ISSN 2410-3438

Root Cause	Maintenance Activities
Stuck turbine motor bearings	Replace bearings
Open fuses	Replace fuses
Damaged emergency brakes (Open)	Repair emergency brakes or replace them
Hit inductive mesh detection sensor	Replace inductive sensor
Dirty safety curtains	Clean safety curtains
Transducer alignment mechanism stained with glue	Clean the transducer alignment mechanism
Flamed safety relays	Replace relays
Lack of pressure in rollers	Regulate air pressure of the rollers at 22 psi

Table 6 Preventive actions
Source: Project contribution, unpublished

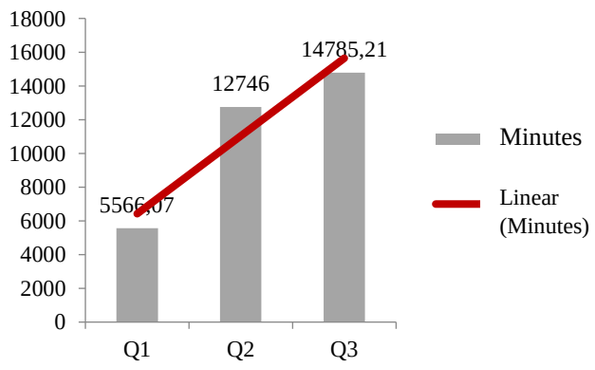
Phase 6: Grouping of preventive measures in their different categories. Preparation of the Maintenance Plan, list of improvements, training plans and operation and maintenance procedures. (Martín, 1998)

Mechanic	Electric
Recover oil level in lubricating vessel of FRL unit	Replace fuses
Clean and lubricate bearing guides	Repair emergency brakes or replace them
Clean the transducer alignment mechanism	Replace inductive sensor
Replace linear bearing guides	Clean safety curtains
Changing guide bearings	Replace relays
Alignment of transmission pulleys	Solder the card or replace voltage sensor

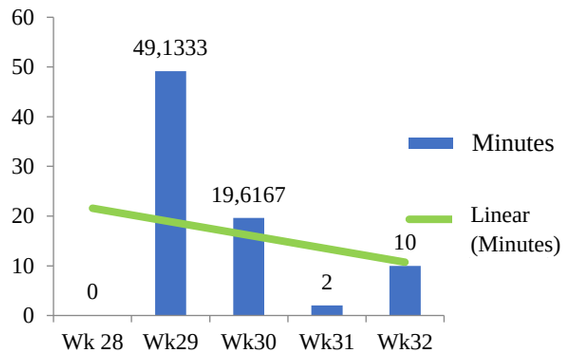
Table 7 Grouping of preventive actions
Source: Project contribution, unpublished

Results

The implementation of the RCM methodology was achieved. It was possible to improve the MTBF and MTTR indicators, contributing to the increased availability of the pleating machine and, as a consequence, the productivity.



Graph 1 MTBF Indicator
Source: Project contribution, unpublished



Graph 2 MTTR Indicator
Source: Project contribution, unpublished

Conclusions

The use of the RCM methodology is important, since it led to the development of a preventive maintenance plan that would contribute to the improvement of the MTBF and MTTR indicators to reduce machine downtime and thus achieve an increase in production.

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ISSN 2410-3438