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OPTIMIZATION OF FILLING PROCESSES FOR BIG DRUMS IN A MULTINATIONAL INTEGRATED OIL AND GAS COMPANY

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Abstract: *The use of process optimization techniques, in nowadays industrial processes are one of the new trends in design and improving the production chains. The paper presents improving the process, performance and the overall equipment effectiveness on the filling line for big packaging in an oil and gas company. The first part of the paper presents a series of information about the optimization of industrial process. In addition, presents several aspects related to the beginning of the optimizing process and the start-up rules. The second part of the paper presents the beginning of the research process and the research methodology. The third part of the paper presents the research process by putting together the operators' activities, the time used for the activities done on the filling line and the actual dosing time that is necessary for filling each drum according to the viscosities of the different kind of oil. The fourth part of the paper presents the result after the optimization process.*
Key words: *optimization, machine time, setup time, OEE, industrial oil, dosing parameter.*

1. INTRODUCTION

In a total amalgam of new business trends, the chances of confusing process optimization, automatization and management are extremely high. Thus, the clarification of these concepts, whether old or new, is a necessary one, especially in such a dynamic field as multinational business [1].

The ever-increasing technology affects all aspects of life and it also affects the production and logistics processes. Production and logistics are becoming increasingly complex. Nowadays customers' needs orders with the lowest price but the highest quality and to be delivered in the shortest possible production time, too.

To meet these requirements the challenges are associated with huge competition in almost every industry, increasingly high standards related to production standards. According with these facts, we get a picture of the situation that requires the optimization of production processes and logistics, just so that companies can operate efficiently [2].

Many of the industrial processes are also based on the principles of the circular economy because it helps the companies to have a better quality of the products delivered, reducing environmental risks, improving the quality management system and the best advantage that the circular economy has is improving the performance of the industrial enterprises [1].

1.1. Optimization of the production processes

The faster expansion of the technologies, the change of the products and the requirements determine the fact that the technologies and engineers are more and mor busy, considering these aspects. Optimization of the production processes is indicated when there is no reason to speculate whether the system would certainly use its potential and whether it could be more efficient and effective.

Furthermore, optimization is also a good solution in a situation where production requires too much time or higher costs. The process of optimizing production processes will be most efficient when it is preceded by a proper analysis. Due to an in-depth analysis of the production system, we can specify exactly what needs to be corrected [2].

The main reasons why the process optimization is necessary in industry are: streamlining processes, cost reduction, quality assurance, consistency in results, efficient use of working resources, improving the overall equipment effectiveness and risk reduction [3].

The optimization of the processes does not follow a certain guideline because every enterprise has different processes and needs. Although, there are some main rules to start to optimize a process like the following [4]:

- Identify inefficient and repetitive processes;
- Defining and structuring the whole process;
- Analysis of the process components and search for solutions to improve it;
- Optimization, either by restricting it or by applying an automation technology.

One of the most important benefits of the optimization process is the reduction of production costs, mainly due to the reduction of its production time. Optimization is also an opportunity to gain more complete and better control over the production process, to reduce the number of defective products and to use the full production potential more efficiently [2].

2. THE RESEARCH METHODOLOGY (METHODS AND TOOLS)

2.1 The research process

The research activities took place in TotalEnergies Marketing Romania S.A. which is a French multinational integrated oil and gas company and one of the seven „supermajor" oil companies. The research time took place on a period of three weeks [5].

First, the research started with the key performance indicators (KPI) and Overall Equipment Effectiveness (OEE) on the filling line for big drums analysis. After the analysis, it could be seen that both indicators on that filling line were not as good as the indicators from the filling line for small packaging.

Second, the research continued with putting together all the activities made by the operators in one shift to understand what means machine time (Table 1) and setup time (Table 2).

The setup time refers to the period that is required to prepare a machine for its next run after it has completed producing the last part of the previous run or in our case, the setup time is the time allocated to labels printing, production reports manifold activities etc. and all the activities from Tabel 2 takes 56 percent from the total time to be done in one shift.

Table 1

The machine time.

No.	Operation	Measurement unit.	Time [%]	Simultaneous Activity		
				Yes	No	Time /drum [%]
1	Drums depalletization	%/1 drum	30%	x		
2	Positioning the drums on the line	%/1 drum	6%	x		
3	Cap unscrewing	%/1 drum	10%	x		
4	First labelling	%/1 drum	10%	x		
5	Filling	%/1 drum	12%		x	24%
6	Cap screwing	%/1 drum	1%	x		
7	Sealing	%/1 drum	8%	x		
8	Cleaning the drum	%/1 drum	10%	x		
9	Second labelling	%/1 drum	9%	x		
10	Full drum moving	%/1 drum	40%		x	10%
11	Full drums palletization	%/1 drum	80%		x	20%
	TOTAL					**44%**

PRODUCT	QUANTITY	VISCOSITY	VISCOSITY LIMITS	INITIAL PRESSURE	INITIAL DOSING TIME/DRUM	UPDATED PRESSURE	UPDATED DOSIGN TIME/DRUM
PRODUCT 1	208L	13.9-14.7	13.4-14.7	high flow=0.5 low flow=0.2	1.23 min	high flow=1.2 low flow=0.5	1.00 min
PRODUCT 2	208L	13.9-14.7					
PRODUCT 3	208L	13.4-14.2					
PRODUCT 4	208L	13.4-14.2					
PRODUCT 5	208L	13.6-14.4					
PRODUCT 6	208L	13.6-14.4					
PRODUCT 7	208L	13.6-14.4					
PRODUCT 8	208L	13.6-14.4					
PRODUCT 9	208L	13.6-14.4					
PRODUCT 10	208L	13.6-14.4					
PRODUCT 11	208L	13.85-14.7					
PRODUCT 12	208L	14.4-15.5	14.3-15.5	high flow=0.5 low flow=0.2	1.17 min	high flow=1.3 low flow=0.5	1.00 min
PRODUCT 13	208L	14.4-15.5					
PRODUCT 14	208L	14.4-15.5					
PRODUCT 15	208L	14.4-15.5					
PRODUCT 16	208L	14.4-15.5					
PRODUCT 17	208L	14.4-15.5					
PRODUCT 18	208L	14.3-15.2					
PRODUCT 19	208L	14.3-15.2					
PRODUCT 20	208L	14.3-15.2					
PRODUCT 21	208L	14.3-15.2					
PRODUCT 22	208L	14.3-15.2					
PRODUCT 23	208L	14.3-15.2					
PRODUCT 24	208L	9.4-10.1	9.38-12.48	high flow=0.5 low flow=0.2	1.23 min	high flow=1.1 low flow=0.5	1.10 min
PRODUCT 25	208L	9.4-10.1					
PRODUCT 26	208L	9.4-10.1					
PRODUCT 27	208L	9,38-12.48					
PRODUCT 28	208L	612-748	612-748	high flow=0.8 low flow=0.3	2.00 min	high flow=2.0 low flow=1.0	1.21 min
PRODUCT 29	208L	612-748					
PRODUCT 30	208L	30.4-33.6	30.4-33.6	high flow=0.2 low flow=0.3	2.10 min	high flow=1.2 low flow=0.3	1.17 min
PRODUCT 31	208L	30.4-33.6					
PRODUCT 32	208L	43.7-48.3	43.7-48.3	high flow=0.2 low flow=0.3	3.10 min	high flow=1.1 low flow=0.5	1.26 min
PRODUCT 33	208L	43.7-48.3					
PRODUCT 34	208L	43.7-48.3					
PRODUCT 35	208L	43.7-48.3		high flow=0.5 low flow=0.3	3.00 min	high flow= 1.2 low flow=0.7	1.45 min
PRODUCT 36	208L	16.5-18.0	16.5-18.0	high flow=0.8 low flow=0.3	1.47 min	high flow=1.6 low flow=0.5	1.22 min
PRODUCT 37	208L	95-105	95-105	high flow=0.6 low flow=0.3	2.00 min	high flow=1.6 low flow=0.5	1.20 min
PRODUCT 39	208L	12.7-13.5	12.7-13.5	high flow=0.5 low flow=0.2	1.35 min	high flow=1.2 low flow=0.5	1.12 min
PRODUCT 40	20L	43.7-48.3	43.7-48.3	high flow=0.2 low flow=0.3	0.23 min	high flow=1.1 low flow=0.3	0.17 min
PRODUCT 41	20L						
PRODUCT 42	20L						
PRODUCT 43	20L	67.2-50.6	67.2-50.6	high flow=0.5 low flow=0.3	0.21 min	high flow=1.0 low flow=0.5	0.13 min
PRODUCT 44	20L	16.5-18.0	16.5-18.0	high flow=0.5 low flow=0.3	0.22 min	high flow 1.5 low flow=0.5	0.16 min

Fig. 1. Products classification with initial dosing time and updated dosing time (a capture).

Table 2

Setup time.

No.	Operation	Time [%]
1	Internal production reports	4%
2	Product labels printing	8%
3	Back labels printing	7%
4	Release order	1%
5	Manifold opening	10%
6	Flow quality check list	1%
7	Release packing line	12%
8	Register left-over drums	2%
9	Manifold closing	8%
10	Internal production reports	1%
11	Shift ending report	2%
	TOTAL	**56%**

Third, the research continued with an analysis over the dosing parameters that were used by the operator to fill each drum and if they can be changed. The dosing parameters referred to high flow pressure and low flow pressure.

After understanding what dosing pressure means and how it can be changed, the research was to do a classification of oils according to their type and to group them in viscosity classes (Figure 1). With that classification we made some tests by changing the dosing parameters little by little until we reached the most suitable which increased the dosing time of one drum and not soiling the drum.

The initial dosing time represents an average between five consecutive dosing drums and the updated dosing time represents an average between ten consecutive dosing drums.

3. RESULTS

After one month and a half of changing the dosing parameters following the data from image no. 1, we have seen some good changes like decreasing the dosing time per one drum (Figure 2), increasing the number of drums filled in one hour and increasing the OEE value compared to the last OEE value (Tabel 3) before starting the optimization project (Figure 4).

In Table 3 it can be seen the changes of availability, performance and quality during one year on that filling line.

PRODUCT	QUANTITY	VISCOSITY	VISCOSITY LIMITS	INITIAL PRESSURE	INITIAL DOSING TIME/DRUM	UPDATED PRESSURE	UPDATED DOSIGN TIME/DRUM	DECREASED DOSIGN TIME
PRODUCT 1	208L	13.9-14.7	13.4-14.7	high flow=0.5 low flow=0.2	1.23 min	high flow=1.2 low flow=0.5	1.00 min	-19%
PRODUCT 2	208L	13.9-14.7						
PRODUCT 3	208L	13.4-14.2						
PRODUCT 4	208L	13.4-14.2						
PRODUCT 5	208L	13.6-14.4						
PRODUCT 6	208L	13.6-14.4						
PRODUCT 7	208L	13.6-14.4						
PRODUCT 8	208L	13.6-14.4						
PRODUCT 9	208L	13.6-14.4						
PRODUCT 10	208L	13.6-14.4						
PRODUCT 11	208L	13.85-14.7						
PRODUCT 12	208L	14.4-15.5	14.3-15.5	high flow=0.5 low flow=0.2	1.17 min	high flow=1.3 low flow=0.5	1.00 min	-15%
PRODUCT 13	208L	14.4-15.5						
PRODUCT 14	208L	14.4-15.5						
PRODUCT 15	208L	14.4-15.5						
PRODUCT 16	208L	14.4-15.5						
PRODUCT 17	208L	14.4-15.5						
PRODUCT 18	208L	14.3-15.2						
PRODUCT 19	208L	14.3-15.2						
PRODUCT 20	208L	14.3-15.2						
PRODUCT 21	208L	14.3-15.2						
PRODUCT 22	208L	14.3-15.2						
PRODUCT 23	208L	14.3-15.2						
PRODUCT 24	208L	9.4-10.1	9.38-12.48	high flow=0.5 low flow=0.2	1.23 min	high flow=1.1 low flow=0.5	1.10 min	-11%
PRODUCT 25	208L	9.4-10.1						
PRODUCT 26	208L	9.4-10.1						
PRODUCT 27	208L	9.38-12.48						
PRODUCT 28	208L	612-748	612-748	high flow=0.8 low flow=0.3	2.00 min	high flow=2.0 low flow=1.0	1.21 min	-40%
PRODUCT 29	208L	612-748						
PRODUCT 30	208L	30.4-33.6	30.4-33.6	high flow=0.2 low flow=0.3	2.10 min	high flow=1.2 low flow=0.3	1.17 min	-44%
PRODUCT 31	208L	30.4-33.6						
PRODUCT 32	208L	43.7-48.3	43.7-48.3	high flow=0.2 low flow=0.3	3.10 min	high flow=1.1 low flow=0.5	1.26 min	-59%
PRODUCT 33	208L	43.7-48.3						
PRODUCT 34	208L	43.7-48.3						
PRODUCT 35	208L	43.7-48.3		high flow=0.5 low flow=0.3	3.00 min	high flow= 1.2 low flow=0.7	1.45 min	
PRODUCT 36	208L	16.5-18.0	16.5-18.0	high flow=0.8 low flow=0.3	1.47 min	high flow=1.6 low flow=0.5	1.22 min	-17%
PRODUCT 37	208L	95-105	95-105	high flow=0.6 low flow=0.3	2.00 min	high flow=1.6 low flow=0.5	1.20 min	-40%
PRODUCT 39	208L	12.7-13.5	12.7-13.5	high flow=0.5 low flow=0.2	1.35 min	high flow=1.2 low flow=0.5	1.12 min	-17%
PRODUCT 40	20L	43.7-48.3	43.7-48.3	high flow=0.2 low flow=0.3	0.23 min	high flow=1.1 low flow=0.3	0.17 min	-26%
PRODUCT 41	20L							
PRODUCT 42	20L							
PRODUCT 43	20L	67.2-50.6	67.2-50.6	high flow=0.5 low flow=0.3	0.21 min	high flow=1.0 low flow=0.5	0.13 min	-38%
PRODUCT 44	20L	16.5-18.0	16.5-18.0	high flow=0.5 low flow=0.3	0.22 min	high flow 1.5 low flow=0.5	0.16 min	-27%
PRODUCT 45	20L	12.5-16.3	12.5-16.3	high flow=0.6 low flow=0.3	0.40 min	high flow=1.2 low flow=0.5	0.15 min	-63%

Fig. 1. Decreased dosing time per type of oil.

Table 3

OEE values on each month from 2021

Work Center	**OEE Factors**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**
Big packs filling line	Availability	81.2%	82.2%	77.4%	78.5%	71.1%	77.3%
	Performance	76.3%	93.9%	95.9%	92.0%	95.8%	87.0%
	Quality	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	OEE	**61.9%**	**77.2%**	**74.3%**	**72.2%**	**68.1%**	**67.2%**
Work Center	**OEE Factors**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Big packs filling line	Availability	74.1%	82.5%	85.6%	81.1%	80.9%	80.1%
	Performance	96.4%	91.0%	91.0%	93.3%	86.4%	89.6%
	Quality	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	OEE	**71.5%**	**75.1%**	**77.9%**	**75.6%**	**69.9%**	**71.8%**

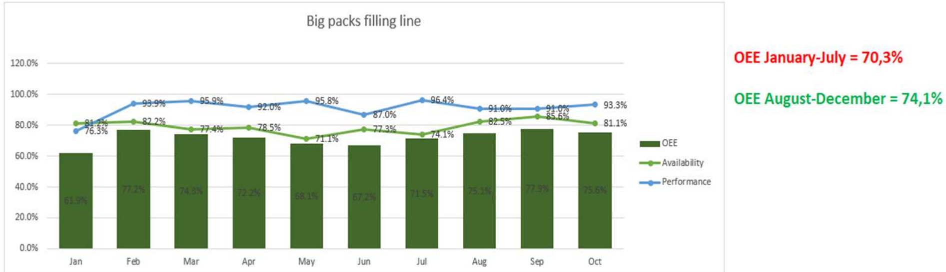

Fig. 3. The graphic representation of OEE values.

4. CONCLUSIONS

The research was made by following the DMAIC approach steps which means define, measure, analyze, improve and control and is a data-driven quality strategy used to improve processes.

The primary scope of this research was to find a method of optimization which can help increasing the performance, the output, KPIs and OEE on the big drums filling line.

The secondary scope of this research was putting together all the activities made by the operators, identify inefficient and repetitive processes, defining and structuring the whole process, analyzing the dosing parameters and implement a new work instruction (e.g., considering an extended training system as presented in [6, 7]). The optimization in an industrial process is important because it helps to define the processes and to improve them by eliminating unnecessary activities and improves the customer satisfaction, the production indicators and the lead time, too.

Future research will be developed in the contractual framework of university-industry collaboration [8] and having a positive impact on the companies' quality and performance management [9-11].

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Optimizarea proceselor de umplere a rezervoarelor mari într-o companie multinaţională de petrol şi gaze

În present, utilizarea tehnicilor de optimizare a proceselor industriale reprezintă o prioritate în demersal de proiectare și îmbunătățire a acestora. Lucrarea prezintă îmbunătățirea procesului, a performanței și a eficienței generale a echipamentelor în cazul proceselor de umplere a rezervorelor mari într-o companie de petrol și gaze. Prima parte a lucrării prezintă o serie de informații despre optimizarea procesului industrial. De asemenea, se prezintă o serie de aspecte legate de demararea procesului de optimizare și regulile ce se aplică. A doua parte a lucrării prezintă procesul de cercetare și metodologia cercetării. Cea de-a treia parte prezintă procesul de cercetare considerând activitățile operatorilor, timpul alocat pentru activitățile desfășurate pe linia de umplere și timpul efectiv de dozare necesar umplerii fiecărui rezervor (butoai) în funcție de vâscozitățile diferitelor tipuri de fluide ed umplere (uleiuri). A patra parte a lucrării prezintă rezultatele procesului de optimizare și concluzii.

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