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**Berry Global
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Improvement and optimization of emulsions' preparation and cleaning process

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to obtain the Master degree in Chemical Engineering
from the Universitat Rovira i Virgili

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This is a summary of the original project

1. INTRODUCTION

1.1. Contact information

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1.2. Project Description

The present project aims to reduce the amount of aqueous waste generated in the plant. To this end, the processes of emulsions' preparation and cleaning had to be studied, improved and optimised.

First of all, a database of the project has been created by gathering information about surfactants (storage conditions, consumption, the wasted amount annually, the incidents, etc.), emulsions' preparation and the clean-up process.

Then, it has been studied deeply the surfactants used in the plant. It has been found that currently, the storage conditions are not adequate. For that reason, it has been proposed to design a new warehouse according to the requirements and recommendations of suppliers.

At the same time, it has been studied the emulsions' preparation. From this point, it was found that preparation and batches volume was not standardized. Thus, some standards have been suggested to minimize the waste generated from this part.

The other point studied was the clean-up process. It has been found that this was the major responsible for the aqueous waste in the plant. So, here it has been recommended some changes in the current heating system, the design of tanks and operational settings.

Once all problems have been detected and proposed some improvements, it has evaluated its impact, feasibility, cost and application term to be implemented.

Finally, the cost of those proposals that solved key or/and urgent issues have been estimated. Moreover, those proposals that do not require capital inversion have been implemented.

2. OBJECTIVES

This project aims to increase the efficiency of the production process by reducing the aqueous waste generated by emulsions' preparation and clean-up process.

Considering the current problem and the scope of the project the objectives established are the following:

- Create protocols for data collection.
- Study and propose improvements besides surfactants storage.
- Study and propose improvements besides the preparation of surfactants.
- Study and propose improvements besides the clean-up process.

3. CONCLUSIONS

This project has been carried out to reduce the aqueous waste generated in the plant. Therefore, first, it has focused on the two processes from which most of the aqueous waste originates: the preparation of emulsions and the cleaning process.

Accordingly, it has been defined the objectives, the expected results and the boundaries of the project. Since there were no data about how the processes are carried out or in which conditions, the first step was to develop a collection data plan to generate the project baseline. To do so has been created registers to gather data, interviewed employees and all parts that in some way have to deal with the studied processes routinely, suppliers of the raw materials, etc. After four months of data gathering, it has been possible to organize, clear and analyse the data, which allowed to size up the current situation quantitatively and qualitatively.

The analysis of the consumption of surfactants shows that surfactants A, B and C are the ones with the higher consumption, and it is more difficult to achieve the target concentration. So, from this point, it has been figured out that by focusing more on the conservation, preparation and cleaning of these surfactants, a big part of consumption and waste generation will be reduced.

In terms of waste generation, it has been found that 97% of the total waste comes from aqueous solutions.

Regarding storage conditions, it has been found that surfactants are not stored under the conditions recommended by the suppliers, which leads to degradation or loss of some properties of the material, complicating the emulsions' preparation process. To solve this important issue, it has been proposed to design a new warehouse with a climate control system and reinforce safety during the storage period. In addition, it has been proposed as a provisional solution, the repositioning of IBCs on production lines where the specified temperature range is met.

Once the baseline has been defined, it has been analysed all data collected to find the root cause of waste generation. Therefore, the focus was on emulsions' preparation and clean-up processes.

What relates to emulsions' preparation, it has been noticed that there is no standard preparation volume. Currently, the preparation volume varies between 50 and 250 litres. Hence, it was suggested to standardize the preparation volume in 50 litres for the offline preparations; for the online preparations, where it is used the kiss-roll tray to prepare the emulsions, could be used the minimum level required to start the recirculation in the kiss-roll. This would reduce the waste in case of off-spec emulsions as less volume would be thrown away.

Continuing with the volume reduction of emulsions' preparations, it has been proposed to decrease the batches size to 80 litres by a tank, so when switching from one product to another, the amount of emulsion to be disposed of will be smaller.

Furthermore, the cleaning process, which is responsible for 75 % of the aqueous waste generated in the plant, has been studied in-depth and it has been found that the process is not carried out according to the protocols. The main findings were that the temperature settings are not met due to the deficiencies of the current heating system. This is the main responsible for the low effectivity and efficiency in the clean-up process, which implies to increase in the lead time, the amount of water and chemicals used. From this point, it has been suggested to supply water at 60°C from the tank kitchen to the kiss-rolls. In this way the system will operate at the minimum temperature required for the CIP clean-up, moreover, cleaning of tanks and pipes is achieved at the same time. Increasing the clean-up temperature from 30 to 60°C, will reduce the current 1,000 litres of water to 250 litres in the whole clean-up cycle.

The current cleaning system is manual which implies that the frequency and how it is carried each time varies a lot from the regulation, therefore the traceability of the process and its effectiveness are lost. To solve this problem, it has proposed to automatize the clean-up process; by this way, it will be reduced the cycle time by 10%, the reduction in 15-20% the cost of chemicals used as well as it will be reduced by 75% the water used currently.

Also, another aspect that influences negatively to clean-up process was the design flaw in online tanks. This design flaw leads to every product change, at least 20 litres of pure surfactant have to be thrown away to ensure that there is no cross-contamination. To minimize the waste, it has been proposed to fix the design flaw, also use the other available tanks, which are 5 in total. This measure will ensure that each surfactant has a specific tank, so the clean-up frequency will decrease considerably, and the amount of surfactant wasted too.

Regarding economic analysis, as there were proposed more than 12 proposals, it has been needed to create criteria to evaluate their impact, cost, feasibility and term application. Attending the results has been carried the cost estimation. Hence, it was calculated that the warehouse design will cost about €682k with the direct benefits of rejected IBCs reduction; the tanks redesign will cost between €1,000 to 5,500; and finally, the heating exchange system re-modulation will cost about €950.

In the present project, it has been implemented some proposals, like the monitoring of batches size, hence, the surplus material. It is expected that the material reduction will be 43%. It has been supplied the operators with the material needed to take samples easier and ensure the process safety. Also, due to the emergent problem with IBCs storage conditions, it has been relocated in the production lines as had been suggested. Furthermore, it has achieved a better understanding of how processes are carried out.

It has been calculated that just applying some previous proposals (clean-up optimization, monitoring the surplus material and training the employees), will be reduced the amount of waste by 53%, thereby saving €47,000 annually. Moreover, by monitoring and standardizing emulsions' preparation and clean-up, the efficiency of the whole process will increase remarkably.