HPKO Tank Replacement

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Abstract *— The HPKO (Hydrogenated Palm Kernel Oil) is utilized for the manufacturing of Product X at Alsina Inc. Oil raw material was originally stored in a tank made of carbon steel which is located in the company's premises. Because of the type of material, time in service, and inappropriate maintenance, the tanks became rusty readily. This situation generated flakes on the tank's roof that fell into the oil material and consequently, into the product mix. DMAIC was used as part of the project evaluation and solution proposal. After the evaluation process to compare the three alternatives, we can resume that Alt Tank looks to be the best alternative. This alternative provides a reasonable implementation cost and reduces the actual process impact, including logistic, pumping system and applicable procedures. Safety concerns due to hot water usage to melt the kernel oil using hoses to connect the reheat water to the truck tank water jacket and the usage of a portable ladder to have access to the top of the tank for kernel oil truck tank level verification are reduced.*

Key Terms *— DMAIC, HPKO, Quality, Tank.*

PROJECT STATEMENT

Alsina Inc. currently receives HPKO (Hydrogenated Palm Kernel Oil) in tank trucks from Supplier. HPKO is a raw material for the Chocolate manufacturing process. Then, it is stored in a carbon steel tank. The tank has rust, and this rust could have fallen down into the HPKO. This problem increases a manufacturing cost and create a quality and safety constrain, that urges the replacement of tank. For this reason, the company change for instance to a provisional rented tank truck.

Research Description

This project describes the analysis of space availability, energy savings, planning and logistics of HPKO (Hydrogenated Palm Kernel Oil) oil supply and storage. The analysis technique selected to solve the problem is DMAIC (Define, Measure, Analyze, Improve, and Control).

Research Objectives

The project objectives are the following:

- Propose a Quality Compliance System.
- Avoid observations from regulatory agencies.
- Reduce energy consumption.

Research Contributions

After the project implementation of the recommended solution the company will reach the goal to have a replaced HPKO storage and transfer GMP Compliance system improving product quality and avoiding potential product recalls due to foreign matters on product causing contamination. At the same time, will keep required customer service levels and reduce energy consumption.

LITERATURE REVIEW

As many other process improvement techniques, DMAIC has been used to provide a structured, organized and systematic way for quality improvement or as part of other process improvement initiatives such as lean.

Alsina Inc., will perform a DMAIC to evaluate potential alternatives to replace existing storage tank and transfer system for the HPKO. The current process in which the HPKO is supplied to the storage tank starts when it is melted inside the portable tank.

To melt the HPKO, it is necessary to use water from the boiler which is heated by kerosene. The water passes through a serpentine in the interior of the mobile tank. Once it is melted, a sample is taken for laboratory analysis, and the HPKO is sent to its final storage in a carbon steel tank. It is kept hot using a serpentine in the interior of the tank. During the manufacturing process, HPKO is transported through the piping to the manufacturing room. Due to the high volume of HPKO inside the tank, it is necessary to maintain the system functioning so that it can be utilized whenever it is needed. Once the HPKO reaches a temperature between 96°-104°F it is ready to be transported through a piping system that will take the HPKO to the manufacturing room. Given the long stretch that is necessary to transport the product to the manufacturing room, it is necessary to maintain the pipes heated at all times using heat tracing. Once the HPKO reaches the manufacturing room, the product is poured and measured in kilos. After this, the HPKO can be used in the manufacturing process.

With the temporary alternative tank, it is necessary to make an additional process whereby the HPKO is carried out of the tank and into the manufacturing room. For this process, two mechanics are required to make a connection to the HPKO pump line using two sterilized hoses. The hoses are connected from the HPKO tank truck to the main pipe and then pumped to the manufacturing room. After a large quantity is manufactured, the HPKO filter is replaced. This operation can take approximately 45 minutes.

The HPKO is used in the manufacture of Mexico and US market lots. The annual lots produced are approximately 30 lots for each market, using 988 kg of HPKO. The material is received in a tank truck with 10,300 kg of oil at exterior temperature, this mean that it comes solidified (melting temperature is 96°-104°F). Once in the facilities, it is connected to the hot water supply for approximately 3 days or until melted entirely. At this point, a fatty acid sample is collected to measure the free fatty acid content.

There are two alternatives for replacing the provisional method of HPKO supply that are under consideration. The first alternative is to replace the outside tanks and their respective instruments. This is the ALT Tank. The second one is to introduce a new design of supply that comes in totes with a smaller storage capacity. It is called ALT Totes. The assessment of the current process was performed in conjunction with the warehouse, planning, manufacturing and maintenance personnel via personal discussions and process observation.

DMAIC process that will be used to evaluate alternatives to replace is a data-driven quality strategy used to improve processes. DMAIC is an acronym for the five phases that make up the process:

- Define the problem, improvement activity, opportunity for improvement, the project goals, and customer (internal and external) requirements.
- Measure process performance.
- Analyze the process to determine root causes of variation, poor performance (defects).
- Improve process performance by addressing and eliminating the root causes.
- Control the improved process and future process performance [1].

METHODOLOGY

For this project, DMAIC was the selected methodology to evaluate options to achieve project goals.

The first phase is to Define the problem, a project charter will be created as a formal document that recognizes the existence of the project and defines the high-level requirements. It includes the problem statement, business case, key stakeholders, goals, scope, members of the core team, milestones, and metrics. Project Charted will be followed by the Voice of Customer (VOC) which is a term used to describe the act of collecting customers' feedback. It takes into consideration the needs, wants and expectations that the customer has for the project. The Critical to Quality Tree and the KANO Diagram will be used to illustrate the customers' feedback [2].

Second phase of the DMAIC methodology is to Measure. During this phase, it is expected to gather data from the current process. This data will be analyzed in the next phase which will help identify which system should be implemented.

The third phase of the DMAIC methodology is Analyze. During this phase, the potential storage system to be implemented as a replacement of the current system is evaluated. Findings, constraints and customer needs are taken into consideration when evaluating such systems. The two alternatives that will be taken into consideration are the replacement of the tank or a modern storage system using HPKO Totes.

The fourth phase of the DMAIC methodology is Improve. During this phase the final proposed solution is selected, implemented and tested. A risk assessment is performed and a pilot of the solution is executed. This proposed solution has to satisfy the Goals that where established during the first phase.

Fifth phase of the DMAIC methodology is to Control. In this phase, it will be presented the actions required to maintain the proposed system solution in control. Engineering controls will be recommended to warrant the operation and reliability of the proposed solution and reduce the possibility of reoccurrence.

RESULTS AND DISCUSSION

In this section of the article will be presented all information regarding project following DMAIC methodology.

Define Phase

In this phase, we are going to start with the Project Charter which establish the beginning of the project, see figure 1 [3].

Business Case
The HPKO is utilized for the manufacturing of Product X. Oil raw material was originally stored in a tank mad e of carbon steel which is located in the company 's premises. Because of the type of material, time in service, and inappropriate maintenance, the tanks became rusty readily. This situation generated flakes on the tanks roof that f ell into the oil material and consequently , into the product mix.

Goals
- Propose a Quality Compliance System
- Avoid observations from regulatory agencies.
- Reduce energy consumption

Scope
Improvements to HPKO supply system

Business Priorities
Propose a Quality Compliance HPKO Supply System to replace actual one and assure continue product market presence.

Core Team
Project Manager
Maintenance Leader
Maint. Supervisor
Project Engineer
Mechanic A
Process Engineer
Production Supervisor

Frequency
Working Section
Thursday 10:00am – 11:00am

Stakeholders
Production Department
Engineering/Maintenance Department
QA Department
MS&T Department

Milestones
Kick off meeting
Define Phase
Measure Phase
Analyze Phase
Improvements Phase
Control Phase

Metrics
1. Energy Cost
2. Product Quality Compliance
3. Final Product Cost

Figure 1
Project Charter

Now, will define the problem which trigger the need of this project. The HPKO is utilized for the manufacturing of Product X. Oil raw material was originally stored in a tank made of carbon steel located in the company's premises. Because of the type of material, time in service, and inappropriate maintenance, the tanks became rusty readily. This situation generated flakes on the tank's roof and steel fell into the oil material and consequently, into the product mix.

The process in which the HPKO is supplied to the storage tank starts when it is melted inside the portable tank. To melt the HPKO, it is necessary to use water from the boiler which is heated by kerosene. The water passes through a serpentine in the interior of the mobile tank. Once it is melted, a sample is taken for laboratory analysis, and the HPKO is sent to its final storage in a carbon steel tank. It is kept hot using a serpentine in the interior of the tank. During the manufacturing process, HPKO is transported through the piping to the manufacturing room. Due to the high volume of HPKO inside the tank, it is necessary to maintain the system functioning so that it can be utilized whenever it is needed. Once the HPKO reaches a temperature between 96°-104°F it is ready to be transported through a piping system that will take the HPKO to the manufacturing room. Given the long stretch that is necessary to transport the product to the manufacturing room, it is necessary to maintain the pipes heated at all times using heat tracing. Once the HPKO reaches the manufacturing room, the product is poured and measured in kilos. After this, the HPKO can be used in the manufacturing process.

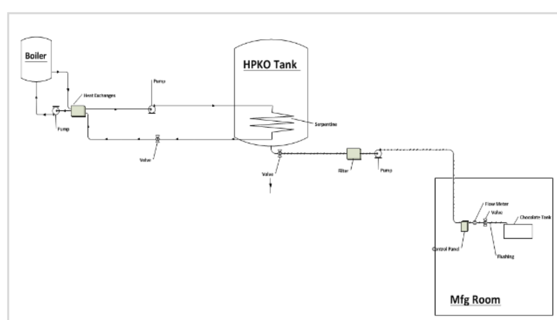

Figure 2
HPKO Process Flow

With the temporary alternative tank, it is necessary to make an additional process whereby the HPKO is carried out of the tank and into the manufacturing room. For this process, two mechanics are required to make a connection to the HPKO pump line using two sterilized hoses. The hoses are connected from the HPKO tank truck to the main pipe and then pumped to the manufacturing room. After a large quantity is manufactured, the HPKO filter is replaced. This operation can take approximately 45 minutes [4].

The HPKO is used in the manufacture of Mexico and US market lots. The annual lots produced are approximately 30 lots for each market, using 988 kg of HPKO. The material is received in a tank truck with 10,300 kg of oil at exterior temperature, this mean that it comes solidified (melting temperature is 96°-104°F). Once in the facilities, it is connected to the hot water supply for approximately 3 days or until melted entirely. At this point, a fatty acid sample is collected to measure the free fatty acid content.

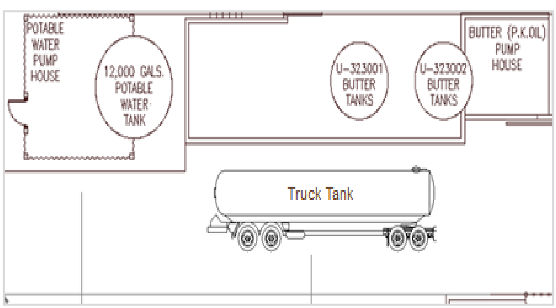

Figure 3
Existing Tanks Layout

This caused the company to look for a temporary solution. The temporary solution had to comply with the requirements and regulations for a pharmaceutical process. The temporary solution that was implemented consisted of a stainless steel tank truck, thus, keeping the process very similar to the original system operation. The company is regulated by the Food and Drug Administration (FDA) that requires robust processes and procedures in every manufacturing process. The situation is a safety and regulatory issue that affects the quality of the final product and increases HPKO cost. The original carbon steel tanks were placed out of service and a new temporary supply alternative was implemented to avoid supply shortages and assure product delivery.

The company now needs to evaluate at least two alternatives to replace the temporary method and select the best alternative. The temporary method consists of the use of a truck tank that is now connected to the oil supply line using flexible hoses. One of the methods will be ultimately implemented as a long term solution of the problem.

Voice of the customer was used to collect the feedback of the customers. A KANO Model and a Critical to Quality Tree will be used to document the VOC. The purpose of KANO analysis is to better understand what value the customer places on the features of product X, which can reduce the risk of providing products that over emphasize features of little importance and that miss critical to quality features or attributes. Figure No. 4 represents a KANO Model that was designed accordingly to the requirements of the client.

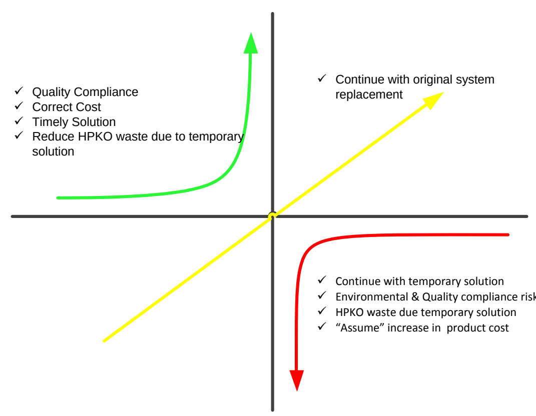

Figure 4
KANO Model

On the other hand, the Critical to Quality (CTQ) Tree is a tool used to define the improvement requirements based on the Quality Drivers. This keeps the core team moving in the same direction.

On figure No. 5, a CTQ Tree demonstrates the client's needs.

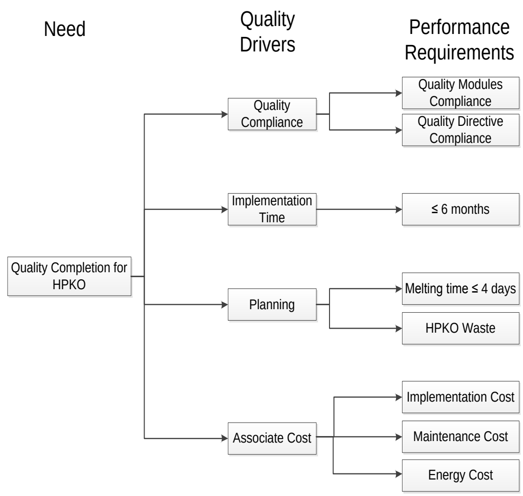

Figure 5
Critical to Quality Tree

Measure Phase

Measure is the second phase of the DMAIC methodology. During this phase, we are going to take a look at energy cost associated to hot water heating on boilers, HPKO pumping and resistances to keep oil hot during transfer process. In addition, will take a look at maintenance plan process.

Table 1
Hot Water Heating Energy Cost Calculations

Delta T	Flow (GPM)	MBTU	BTU/Gallon	Annual Gallons of Kerosene	Average Cost of Kerosene	Annual Cost of Kerosene Ideal Conditions	Annual Cost of Kerosene Actual Conditions
19.15	15	143,602.85	135,000.00	559.09	$4.00	$2,236.38	$ 2,795.47

Table 2
Pumping System Energy Cost Calculations

Description	Qty.	KW	Time	Year (hrs.)	KWh	Cost of KWh	Total Cost of Energy
Pump	1	2.076	0.5	25	51.90	$0.25	$ 12.98

Table 3
Resistance System Energy Cost Calculations

Description	Qty.	KW	Year (hrs.)	KWh	Cost of KWh	Total Cost of Energy
Chromalox	3	0.3	8760	1,314.00	$0.25	$ 328.50
Henry Electric	1	6.925	8760	30,331.50	$ 0.25	$ 7,582.88

The total energy cost for the current HPKO storage system is $10,719. As part of documentation collection, a formal preventive maintenance work order for the actual HPKO storage tanks was not found. A nondestructive test was performed to the storage tanks every 5 years to estimate remaining useful life. Those tests consist of ultrasound test and visual inspection by external inspection company.

Analyze Phase

The third phase of the DMAIC methodology is Analyze. During this phase, the potential storage system to be implemented as a replacement of the current system is evaluated. Findings, constraints and customer needs are taken into consideration when evaluating such systems. The two alternatives that will be taken into consideration are the replacement of the tank (ALT Tank) or a modern storage system using HPKO Totes (ALT Totes).

Figure 6
Storage Tank Replacement

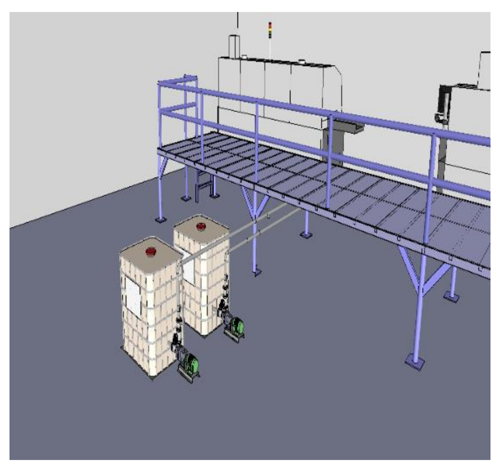

Figure 7
HPKO Totes

ALT Tank solution includes the HPKO tank replacement (carbon steel) for a new stainless steel tank (Figure No. 6). The rest of the process will remain the same. The Stainless steel does not corrode, rust or stain with water as ordinary steel does, but despite the name it is not fully stain proof, most notably under low oxygen, high salinity, or poor circulation environments. There are different grades and surface finishes of stainless steel to suit the environment the alloy must endure. Stainless steel is used where both the properties of steel and resistance to corrosion are required. In addition, stainless steel is a non-reactive material with HPKO.

The recommended maintenance plan for this system is a visual inspection and an ultrasonic thickness inspection. This type of storage requires that it be evaluated annually in order to make sure that the system is working in optimal conditions.

As part of the replacement tank design, an access door should be considered for maintenance purposes. In addition, a vent filter will be required to avoid tank to collapse.

It is recommended to install one (1) tank, which will be used to store the HPKO when it arrives as raw material. Once the appropriate sample tests are made to this product and it is approved for use it then proceeds to be used for Product X.

Table 4
Estimated Replacement Cost for a Tank Replacement

Description	Cost
HPKO Tank	$ 93,500.00
Test Materials	$ 33,000.00
Shipping Costs	$ 30,000.00
Validation	$ 93,000.00
Installation	$ 32,725.00
Project Management	$ 60,000.00
Disposal of current tanks	$ 20,000.00
Total	**$362,225.00**

This system will avoid corrosion issues in the future. Storage Tank replacement estimated cost is approximately $362,225.00. The current process will remain intact avoiding the implementation process complexity and timeline.

Stainless Steel differs from carbon steel by the amount of chromium present. Unprotected carbon steel rusts readily when exposed to air and moisture. This iron oxide film (the rust) is active and accelerates corrosion by forming more iron oxide, and due to the greater volume of the iron oxide this tends to flake and fall away. Stainless Steels contain sufficient chromium to form a passive film of chromium oxide, which prevents further surface corrosion by blocking oxygen diffusion to the steel surface and blocks corrosion from spreading into the metal's internal structure, and due to the similar size of the steel and oxide ions they bond very strongly and remain attached to the surface.

One of the disadvantages of the tank replacement solution is that the hoses will be exposed to outside environment during HPKO Tank Truck material transfer to final storage tank. This causes quality concerns regarding viable and nonviable particle that can enter the hose during the connection process. This outside environment exposition process can result in material contamination. To reduce that exposition possible impact, a quantity of material equivalent to transfer pipe storage capacity is discarded.

Another disadvantage is that as part of the HPKO melting process in the Tank Truck, during rainy days, melting process has taken up to fourteen (14) days. This situation has impacted production schedule and customer service. During regular sunny days, melting process can take up to four (4) days.

If this alternative is implemented, heat tracing for the transfer pipe should be replaced due to system aging. The heat tracing temperature of up to 150□ F represent a safety issue, due to the fact that tracing is exposed at some points across the transfer pipe.

A second alternative being evaluated is the Carbon Steel replacement for a Tote System. In this system, the solidified HPKO will come in a regular polyethylene plastic bin over a wood pallet. Before the HPKO is required for the manufacturing process it will be melted with a heating blanket located under the plastic bin. This melting process could take 24 hours. HPKO will be transferred to the manufacturing kettle using a pump system that will be located in the manufacturing room. Tote system will reduce the quality concerns because all process will be managed inside a clean manufacturing room. No equipment will be exposed to outside environment.

Table 5
Estimate Cost of Proposed Tote System

Description	Cost
HPKO pump system	$ 107,000.00
Test Materials	$ 33,000.00
Shipping Costs	$ 15,000.00
Validation	$ 147,750.00
Installation	$ 42,800.00
Project Management	$ 60,000.00
Fire System	$ 200,000.00
Disposal of current tanks	$ 20,000.00
Total	**$ 625,550.00**

One advantage of the tote system is that HPKO will be melted only when needed, reducing the energy consumption of the system. Another advantage is that tote system reduces the quality concerns and product contamination risks.

Proposed HPKO Totes pallets can be located at the Raw Material Warehouse. HPKO totes are sent by supplier over a wood pallet and covered with cardboard. Cardboard needs to be removed and wood pallet changed to a plastic pallet before send the tote to the manufacturing room. One (1) and a half HPKO totes will be required to manufacture one (1) product lot. HPKO totes will be melted with a heating blanket once they are located at the manufacturing room, where they will be used. HPKO temperature is required to be at 96°F - 104°F to be used in the manufacturing process. A pump system will be required to send the HPKO to the manufacturing kettle; totes will be used one (1) at a time.

Following energy cost calculations of Totes system:

Table 6
Heating Blankets Resistances

Qty of Blankets	KW	*Time*	Year *(hrs.)*	KWh	Cost of *KWh*	Total Cost of Energy
2	1.2	36	1800	4,320	$ 0.25	$ 1,080.00

Table 7
New Pumps

Qty of Pumps	KW	*Time*	Year *(hrs.)*	KWh	Cost of *KWh*	Total Cost of Energy
1	2.1	0.5	25	51.90	$ 0.25	$ 12.98

As part of the evaluation of this new system safety has to be taken into consideration. Palm Kernel Oil is an insoluble vegetable fat used in the product X production. This is a combustible Class III B, which means that have a flash point at or above 200°F. There are three recommended extinguished media:

1. Foam - its role is to cool the fire and to coat the fuel, preventing its contact with oxygen, resulting in suppression of the combustion.
2. Carbon dioxide – it's a thermo physical mechanism in which reacting gases are prevented from achieving a temperature high enough to maintain the free radical population necessary for sustaining the flame chemistry.
3. Dry chemical - consists of a hand-held cylindrical pressure vessel containing an agent which can be discharged to extinguish a fire.

As part of the storage requirements, Safety department asked for a fire suppression system. Three options were evaluated to comply with this requirement. Option one (1) is the carbon dioxide, but this one could create physical damage to the employees. Option two (2) is the chemical system; this one (1) needs rigorous cleaning procedures after it is used. Option three (3) is a foam suppression system. The form suppression system is the one recommended by Health Safety & Environmental (HSE) department where the totes are going to be stored. The suppression system needs to be located in a closed area with a containment dike. A quotation for the foam system was requested and resumed in the estimates cost of proposed system.

HPKO system using totes will increase the regulatory compliance of the process. In addition, will generate energy savings and will reduce waiting time for HPKO melting process.

Improve Phase

The fourth phase of the DMAIC methodology is Improve. During this phase the final proposed solution is selected, implemented and tested. A risk assessment is performed and a pilot of the solution is executed. This proposed solution has to satisfy the Goals that where established during the first phase.

Table 8
Temporary Tank Truck Advantages and Disadvantages

	Advantages	Disadvantages
Temporary Solution Tank Truck	· No changes to actual supplier, does not requires Supplier Qualification. · Reduces the potential of tank corrosion to contaminate kernel oil. · No implementation cost.	· Increases operational costs due to truck tank monthly rental and required man power hours. · Safety concerns due to kernel oil transfer process. · Possible product quality impact due to hose exposure to the outside environment. · Continue to receive and transfer kernel oil at the yard area. · Obstacles the backyard entrance. · Disposal of kernel oil every 4 months, to avoid fatty acids test failure · Kernel oil waste during manufacturing process (at beginning and end). · Increases waste due to pumping process (cavitation process).

Table 9
Alt Tank Advantages and Disadvantages

	Advantages	Disadvantages
Alt Tank	· Replace existing two carbon Steel tanks for a stainless steel tank. · No changes to actual supplier, does not requires supplier qualification. · Control the potential of corrosion tank to contaminate kernel oil. · Lowest implementation cost option. · Short time implementation.	· Safety concerns due to kernel oil transfer process · Possible product quality impact due to hose exposure to the outside environment. · Continue to receive and transfer kernel oil at the yard area. · Disposal of kernel oil every 4 months, to avoid fatty acids test failure.

Table 10
Alt Totes Advantages and Disadvantages

	Advantages	Disadvantages
Alt Totes	· Eliminates the product contamination impact because oil transfer process will be conducted at controlled environment. · Eliminates the potential of corrosion tank to contaminate kernel oil. · Eliminate safety risk during manufacturing process.	· Requires additional raw material locations for totes storage. · Requires new supplier certification. · New fire suppression system is required due to new plastic totes storage at the raw material warehouse. · Increases product cost due to higher kernel oil cost and tote disposition cost. · Highest implementation cost. · Requires new process validation. · Longest implementation timeline.

After the evaluation process to compare the three alternatives, we can resume that Alt Tank looks to be the best alternative. This alternative provides a reasonable implementation cost and reduces the actual process impact, including logistic, pumping system and applicable procedures. Safety concerns due to hot water usage to melt the kernel oil using hoses to connect the reheat water to the truck tank water jacket and the usage of a portable ladder to have access to the top of the tank for kernel oil truck tank level verification are reduced. With this option a truck tank will be received once every quarter instead of having it parked at the backyard the whole year. The Alt Tank, kernel oil from tank truck will be transferred once every quarter, reducing the hoses exposition to outside environment during connection process, and the risk of possible product quality impact. This option does not require supplier certification because supplier will remain the same, this will reduce the project implementation timeline. The other hand, Stainless Steel tank replacement, corrosion contamination is almost eliminated; an appropriate maintenance plan must be created and implemented for the new tank. The selection of this alternative actual space for tank location at the backyard can be reused, no additional warehouse space will be required for raw material storage and planning/buying process will remain the same. For the implementation of this alternative, at the right cost, easy implementation process, and short implementation timeline we are going to reduce the possibility to impact the quality of the product and customer service level.

Control Phase

During the Improve Phase, ALT Tank was the selected alternative as the solution to the problem. Now, it will be presented the actions required to maintain the proposed system solution in control. Engineering controls will be recommended to warrant the operation and reliability of the proposed solution and reduce the possibility of reoccurrence.

To avoid the corrosion, a Stainless Steel Tank will be purchased and installed. In addition to material, tank size and structure, the cleaning procedure and processes should be evaluated. As part of the storage tank life cycle, an appropriate visual and ultrasonic inspection should be included as part of the equipment maintenance program to avoid any future possible product impact. This type of storage tank requires that at least be evaluated annually in order to make sure that the system is working in optimal conditions. Maintenance Team will be in charge of this inspection process execution and to correct any identified gap.

PROJECT RACI MATRIX R = Responsible A = Accountable C = Consult I = Inform

	Activities	Customer	Engineering					Finance	HSE	MS&T	QA/QC	Purchase	Materials		L&D	HR	Adm	MFG/Pack
			Project Manager	Project Engineer	Main	Automation	IT						Planning	WH			Com	
Initiation	Fill the DPR and Submit to PM	R																
	Receive DPR, evaluate and assign a PE		R															
	Create Conceptual Design	C	A	R					C	C	C							
	Approve Conceptual Design	C	A	R					C	C	C							
	Create a Project Charters	C	A	R			I	C	C	C	C		I					
	Identify Stakeholders	C	R	A			I	I	I	I	I		I					
Planning	Develop a Project Plan	C	A	R				C	C	C	C							
	Collect Requirements (UPR)	C	A	R				C	C	C	C							
	Define Scope	C	A	R				C	C	C	C							
	Define Activities	C	A	R				C	C	C	C							
	Define Project Resources	C	A	R				C	C	C	C							
	Define Project Duration	C	A	R				C	C	C	C							
	Develop Schedule	C	A	R				C	C	C	C							
	Develop Cost Estimate	C	A	R				C	C	C	C							
	Determine Budget	C	A	R				C	C	C	C							
	Prepare CAR	C	A	R				C	C	C	C							
	Develop Quality Plan	C	A	R				C	C	C	C							
	Develop HR plan	C	A	R				C	C	C	C					C		
	Develop Communication Plan	C	A	R					C		C		I	I		I	A	
	Plan Risk Management Plan	C	A	R	I	I	I	C	C	C	C	I	I	I	I	I	I	I
	Procurement Plan	C	A	R				C				C		I				
	Present and Endorse Project Plan to SC	I	A	R	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Execution & Control	Direct and Manage Project Execution Plan	C	A	R				I	I	I	I							
	Perform Project Quality Control	I	A	R														
	Acquire Project Team	I	A	R														
	Develop Project team	I	A	R														
	Manage Project team	I	A	R														
	Distribute Information	I	A	R													C	
	Manage Stakeholders Expectations	I	A	R														
	Conduct Procurement	I	A	R								A						
	Monitoring and Control Project		A	R														
	Perform Integrated Change Control		A	R														
	Verify Scope		A	R														
	Control Scope		A	R														
	Control Schedule		A	R														
	Control Cost		A	R														
	Performance Quality Control		A	R														
	Monitor Performance		A	R														
	Monitoring and Control Risks		A	R														
	Administer Procurement		A	R														
	Estimate the Impact of the Change Request (CR)		A	R														
	Determine if the CR impact the baseline of the project		A	R														
	Accept or Reject CR		A	R			A	A	A	A	A							
	Update Work Plan		A	R														
	Review Project Variance		A	R														
Close	Create Punch List	A	A	R	A		A	A	A	A	A							
	Close Punch List	A	A	R			A	A	A	A	A							
	Close Validation		A	R							A							
	Close Change Control		A	R							A							
	Submit Turn Over Package		A	R														
	Project Capitalization		A	R				A										

Table 11
RACI Matrix

CONCLUSION

After the investigation process, the Tank replacement is the alternative that appears to be the most convenient. With Alt Tank, changes to existing procedures, suppliers and processes are minimum. This reduces the risks and implementation time of the project.

There is still investigation work to do for the Project decision on the system to be implemented, for example the evaluation of product cost impact due to the implementation of the selected solution. The final project costs, including the product cost, will be determined once the design phase is completed and real quotes can be obtained with the required level of detail.

The product quality, integrity, purity, potency and safety of the product are the fundamental areas to be evaluated against any possible impact due to the project execution. Quality department active participation and support will be very important for the project success.

A RACI Matrix was developed to be used as part of the overall project execution. The matrix establishes the roles and responsibilities for the Project Team to assure a successful project execution and clarify any doubt about the expected support required from the team members.

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