POPSIG IChemE 2017

Re-engineering Current Palm Oil Degumming Process

27 February 2017

RISE

Sime Darby Plantation

Table of Contents
(Degumming Project)

Company Background

Sime Darby Group

RISE Sime Darby Plantation

This project is a collaboration between Downstream Operation and Research and Development

Company Background

Sime Darby Plantation R&D Centres

The Netherlands
- Innovation Centre Europe (Sime Darby Unimills)

Malaysia
- Sime Darby R&D Centre, Banting, Selangor
- Sime Darby R&D Centre, Carey Island, Selangor
- Sime Darby Biotech Laboratory, Lukut, Negeri Sembilan
- Sime Darby R&D Office, Sabah
- Sime Darby R&D Office, Sarawak
- Sime Darby Technology Centre, Serdang, Selangor
- Innovation Centre Asia (Sime Darby Kempas Sdn Bhd), Kempas, Johor

South Africa
- Innovation Centre Africa (Sime Darby Hudson & Knight)

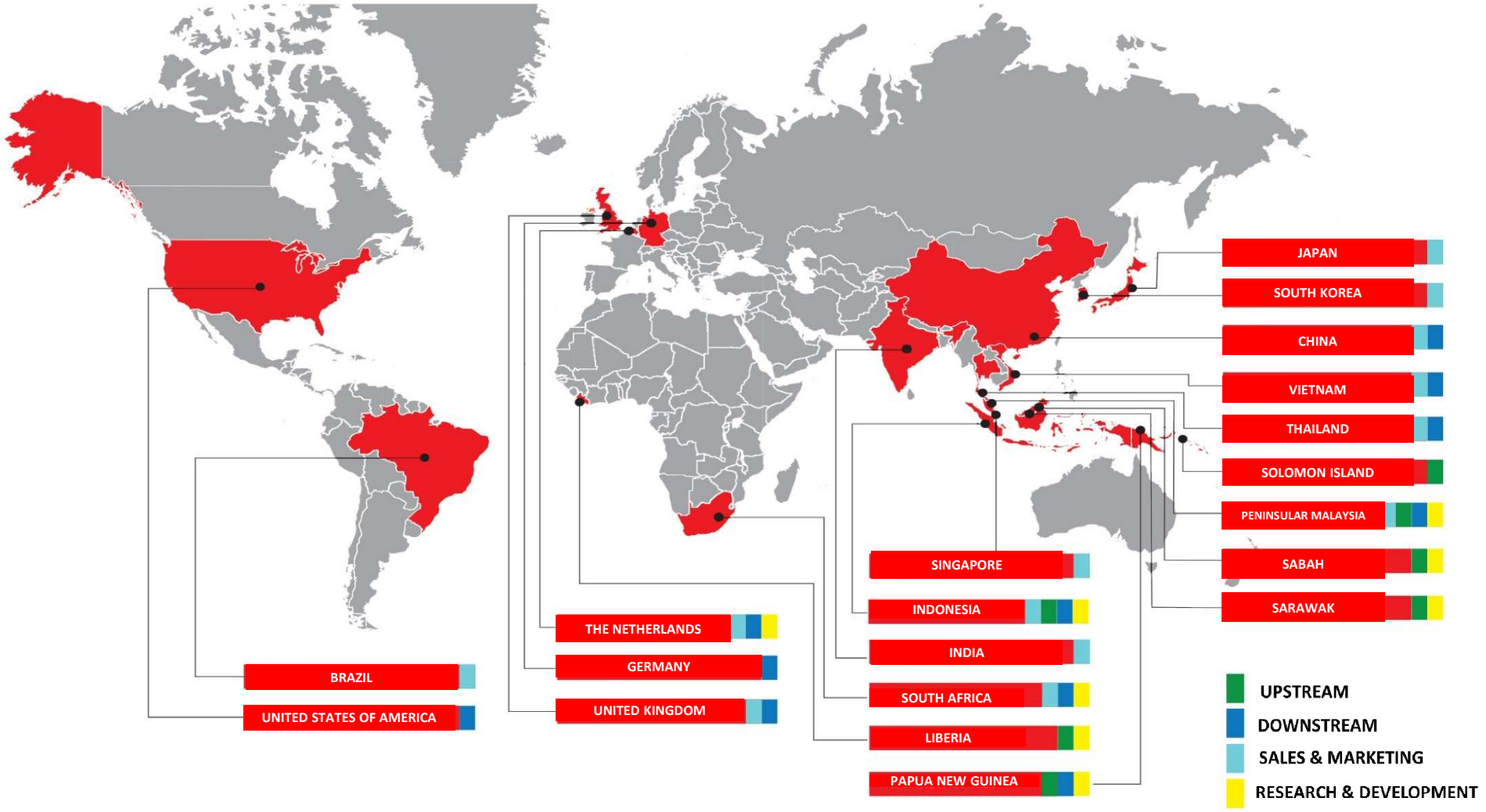
Indonesia
- Minamas Research Centre, Sumatera

SIME DARBY RESEARCH SDN BHD
Sime Darby Research Centre,
Lot 2664, Jalan Pulau Carey,
42960 Carey Island,
Selangor, Malaysia

Sime Darby Research **(SDR)** comprises of **an internationally multi-located network** of R&D and Innovation Centres in **Malaysia, Indonesia, South Africa, and Netherlands**.

Company Background

Plantation Division
Downstream Geographical Coverage



All About Palm Oil

RISE Sime Darby Plantation

SUPPLY CHAIN

Upstream – R&D

R&D capability/
Seed Production

Upstream

Cultivation &
Harvesting

Upstream

Mills/ CPO and PK production
(Biomass and POME by products)

Downstream

Refining/ PK crushing/
Oleochemicals/
Biodiesel processing

PRODUCTS

EDIBLE PRODUCTS

NON EDIBLE PRODUCTS

CUSTOMER

McDonald's

Mondelēz International

TESCO

A&W

KFC

Kellogg's

Nestlé

Unilever

Upstream Processing

Palm Oil Harvesting

Oil Palm Plantation

Palm Oil Fruits

Crude Palm Oil (CPO)

Midstream Processing

Problem Statement and Aim

Approved Project Charter

Project Approvals

Action	Approval Name	Stage	Step	Assigned to	Title	Contact	Status
Edit	A-131161	Project	1	Saiful Nidzam Ismail	Project Leader(PL)		New
Edit	A-131160	Project	2	Mohd Asngari Saion	Project Champion		New
Edit	A-131159	Project	3	Abdul Hakim Wahab	Finance Rep		New
Edit	A-131158	Project	4	Siong Ming Ting	Process Owner		New
Edit	A-131157	Project	5	Abdul Hakim Ismail	Master Black Belt/ Black Belt /LSS Rep		New
Edit	A-130691	Project Charter	1	Saiful Nidzam Ismail	Project Leader(PL)		Approved
Edit	A-130690	Project Charter	2	Mohd Asngari Saion	Project Champion		Approved
Edit	A-130689	Project Charter	3	Abdul Hakim Wahab	Finance Rep		Approved
Edit	A-130688	Project Charter	4	Siong Ming Ting	Process Owner		Approved
Edit	A-130687	Project Charter	5	Abdul Hakim Ismail	Master Black Belt/ Black Belt /LSS Rep		Approved

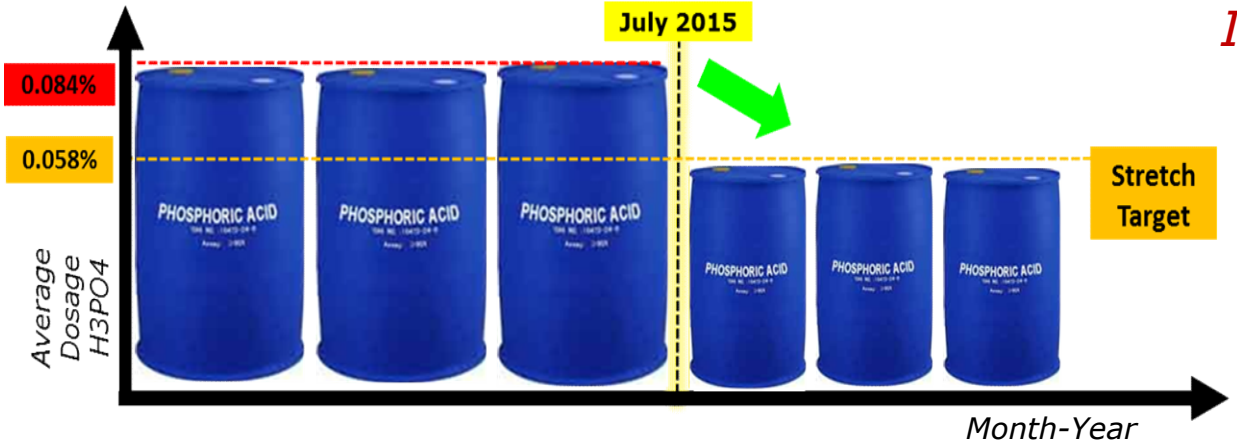
Problem Statement

Phosphoric Acid is the degumming agent used by all SD Refineries. The **Dosage** for **Phosphoric Acid** on **Monthly Average** is at **0.084%** at Sime Darby Austral vs target 0.06% as per industrial standard. This process will determine the final quality of the refined oil produced. Tuning the dosage of the Phosphoric Acid will help to reduce the processing cost and boost up the quality of the Refined Bleached deodorized Palm Oil (RBDPO).

***Replication** to other **13 SD Refineries** will be subjected to the success of this project.*

Our Ultimate Aim
(Project Title)

"To reduce the Monthly Average consumption of Phosphoric Acid in Degumming Process at SD Austral from baseline 0.084% to 0.058% through process optimization by July 2015"



Initial Potential Benefits

RM 290,000

Following is the example to calculate for the saving of 1 SD Refineries:

SD Austral
SAVING = [(Total forecast acid volume for SD Austral) x (The average FY13/14 acid price for SD Austral)] - [(Total forecast of new acid volume for SD Austral) x (The new acid price for SD Austral)]

Average consumption of Phosphoric Acid
at **0.058%** was set as the **TARGET** for this project as agreed by the management.

Refining ---→ WHY

Customer Expectation
- Improve flavor and colour
- Odor elimination

Nutrition Requirement
- Remove harmful impurities
- Retains valuable vitamins

Improve Shelf Life
- Increase oxidative stability

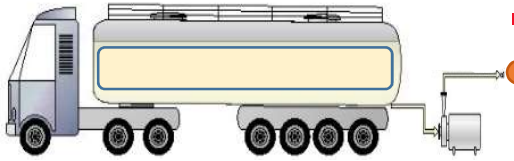
Improve Performance
- Improve frying performance
- Reduce darkening and foaming

Refining....What is it?

Gap Area

RISE

Sime Darby Plantation

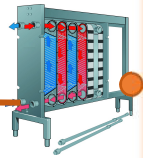


CPO RECEPTION

Buffer Tank

Phosphoric Acid

Heat Exchanger

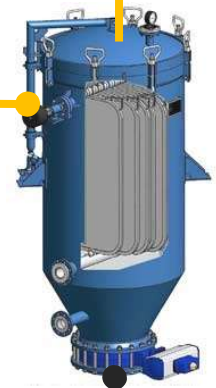


Degumming

Bleaching

Bleaching Earth

Vertical Pressure Leaf Filter



Abbreviation

CPO: *Crude Palm Oil*

RBDPO: *Refined Bleached Deodorized Palm Oil*

By Product

PFAD STORAGE TANK

DEODORIZATION

Product

RBDPO STORAGE TANK

Spent Bleaching Earth

Degumming Process Overview

PORAM Standard Specifications for Processed Palm Oil

"It was concluded in studies, the higher the concentration of phosphoric acid, the lower the iron content in the RBDPO. The degumming process really important as the stability of the oil affected by the traces of metals and phosphorous left in it "

[Siew & Cheah 2007]

Note: Siew Wai Lin and Cheah Kein yoo, 2007, Optimizing of degumming with attapulgite and acid activated clays in refining palm oil. MPOB

Schematic

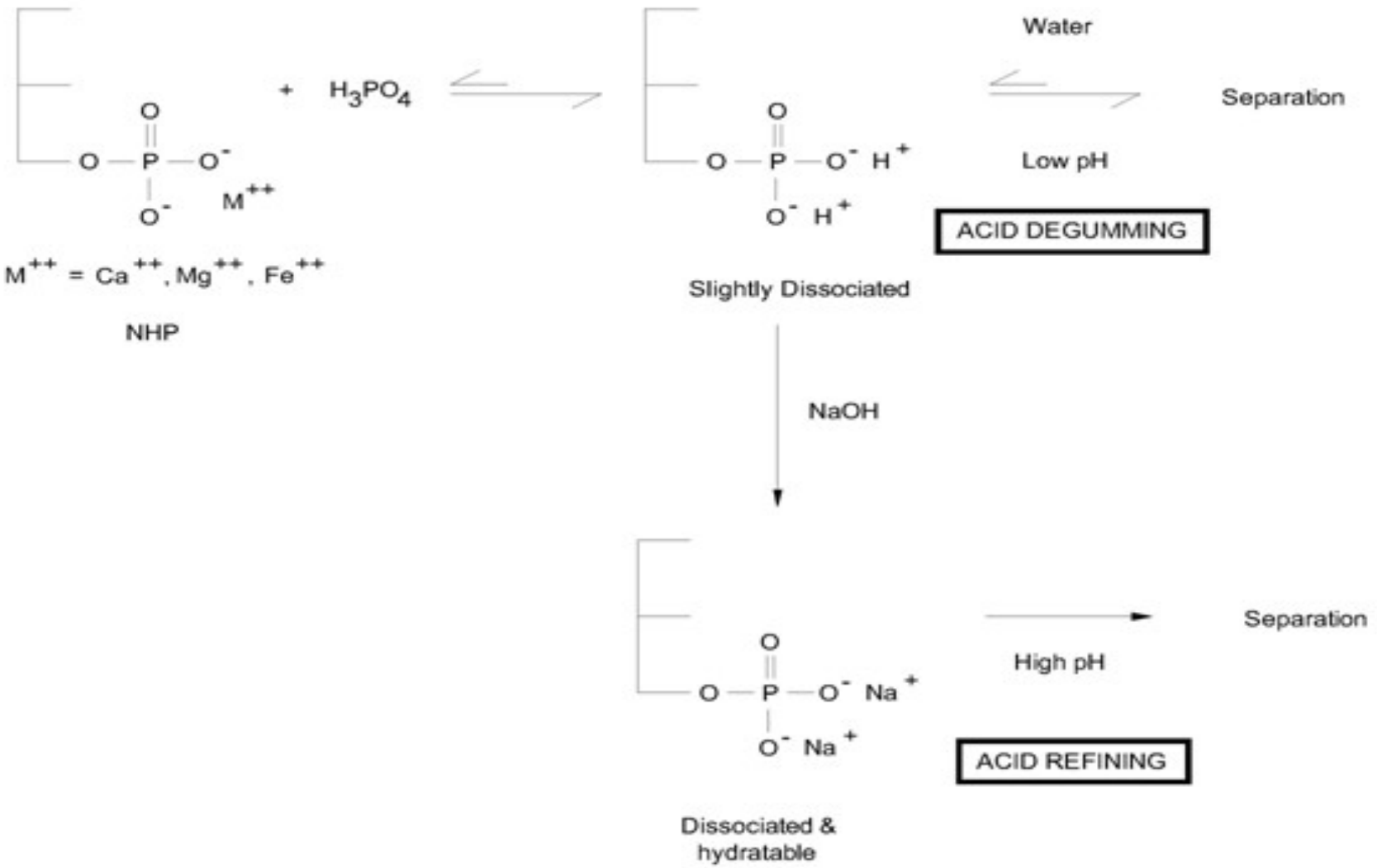

+ H_3PO_4
M^{++}
M^{++} = Ca^{++}, Mg^{++}, Fe^{++}
NHP
Water
Separation
Low pH
ACID DEGUMMING
Slightly Dissociated
NaOH
Separation
High pH
ACID REFINING
Dissociated & hydratable

Table of Contents
(Degumming Project)

CONTENT

Palm Oil Processing

Challenging the Boundaries

Project Selection

Can we do better? → R&D Research Works → R&D Oils & Fats Team → Innovation

Palm Oil Refining Process

Optimization of degumming with attapulgite and acid activated clays in refining palm 0il: Siew Wai Lin and Cheah Kien Yoo

Discussion and brainstorming was conducted among the Oil & Fats team

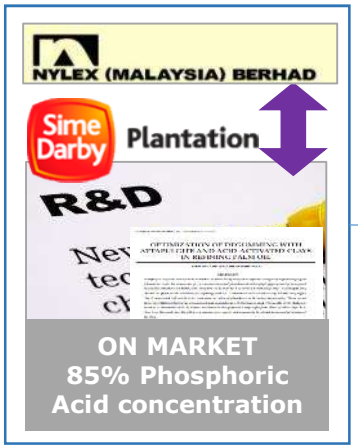
R&D Senior Management → SD Refinery → R&D Technology Transfer to Refinery

After a long and details **discussion** with **all participants member**. The project was **SELECTED AND APPROVED.**

The journey of our **breakthrough achievement.**

RISE

Sime Darby Plantation



ON MARKET
85% Phosphoric Acid concentration

R&D Prototype – 90% and 95% Phosphoric Acid

R&D LAB Test
85% vs 90% vs 95% concentration

90% Phosphoric Acid Optimum

Result Analysis

R&D Senior Management

PASS

SD Austral – 90% Phosphoric Acid Plant Trial

INNOVATION

90% Phosphoric Acid – Big Production

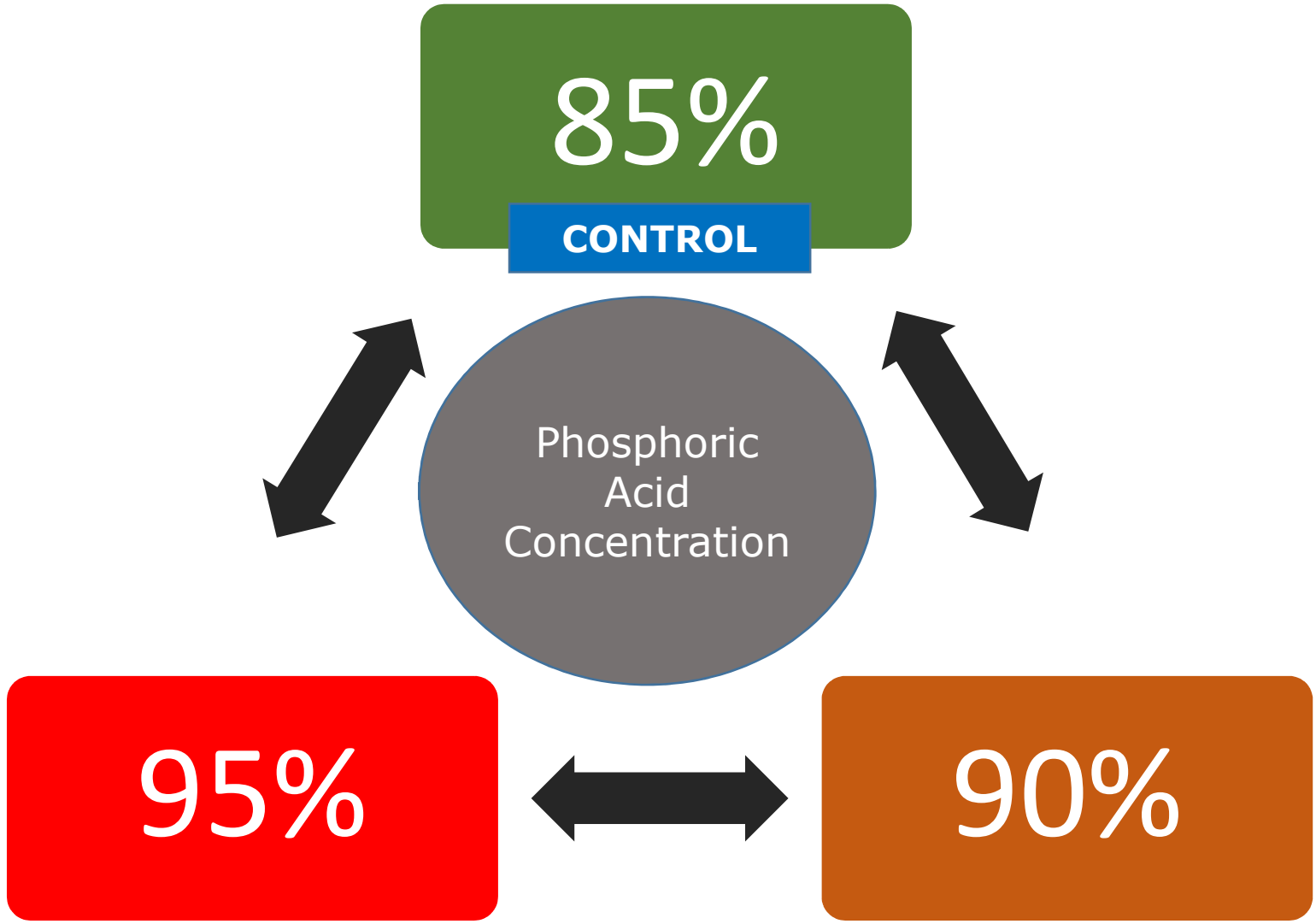
BREAKTHROUGH RESULT

PROJECT REPLICATION

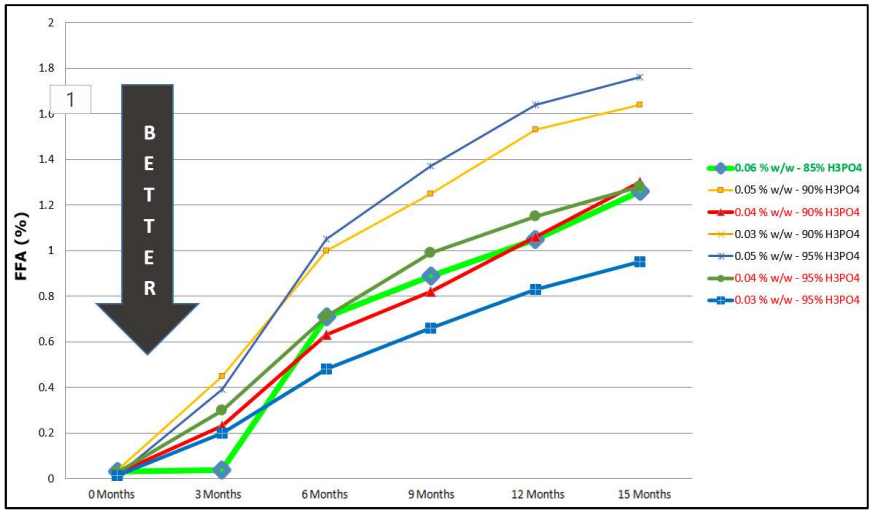
This marks as a new **INNOVATION** when 90% Phosphoric Acid have been used for the **first time in refining palm oil**.

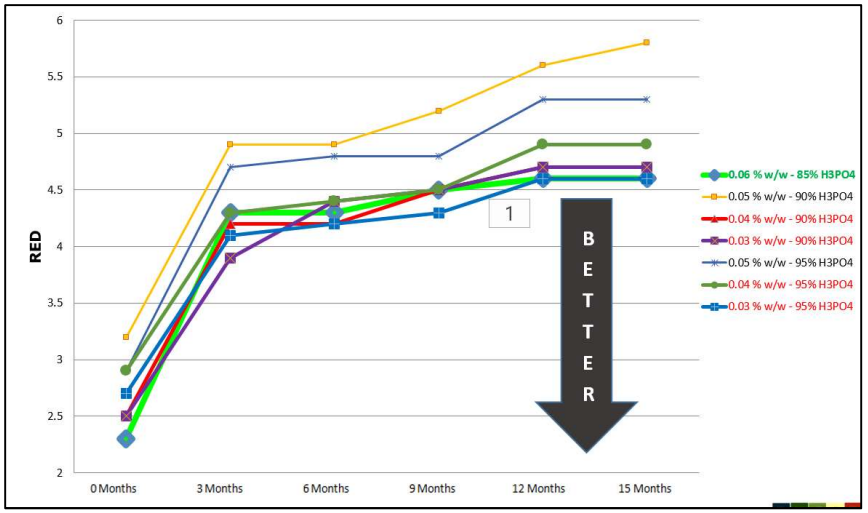
Stakeholder Buy In Obtained

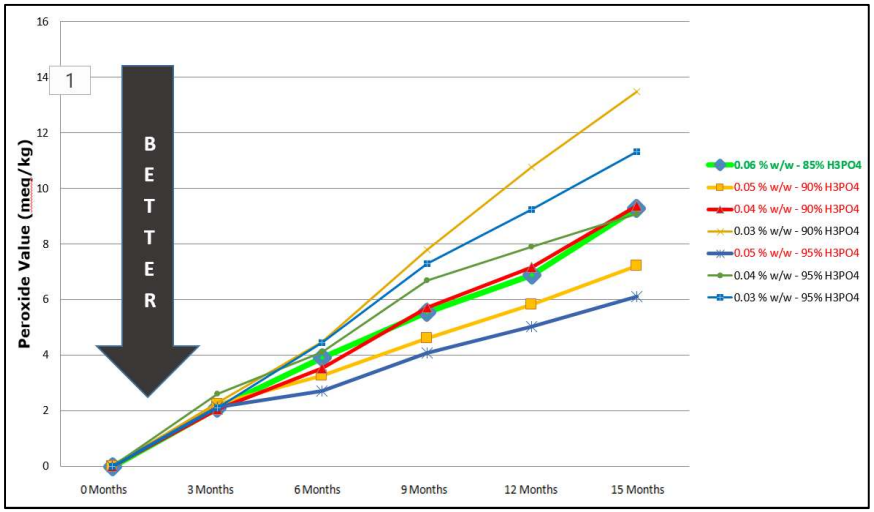
Research Overview

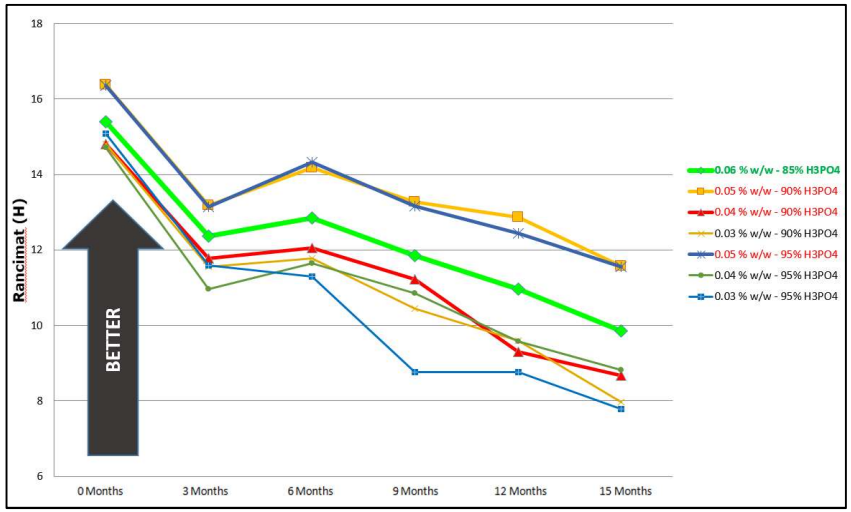


Stability Test - Free Fatty Acid (FFA)









Stability Test - Free Fatty Acid (FFA)

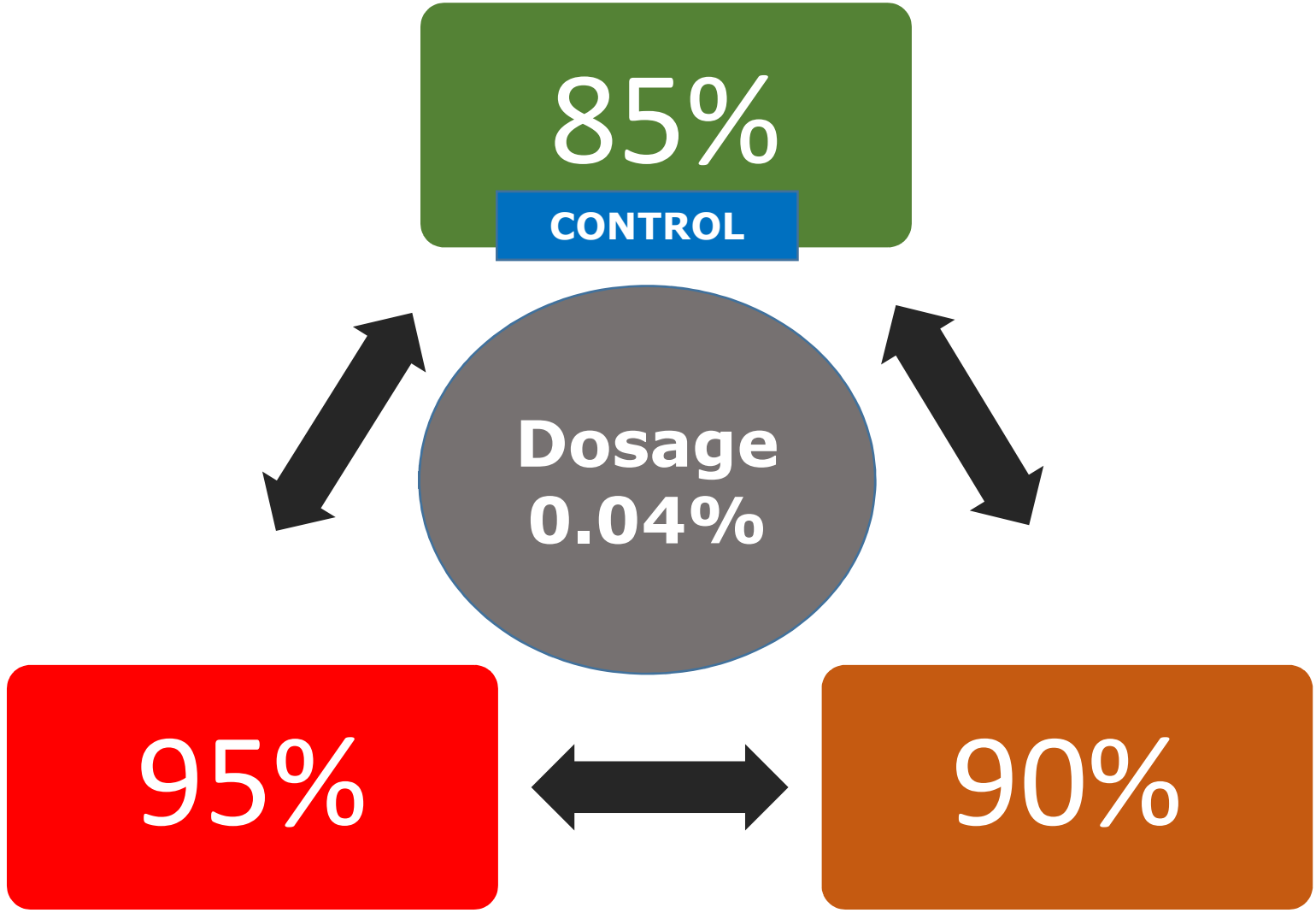
CONTENT

Palm Oil Processing

Validation

LOADING...

Phosphoric Acid



Validation of Results

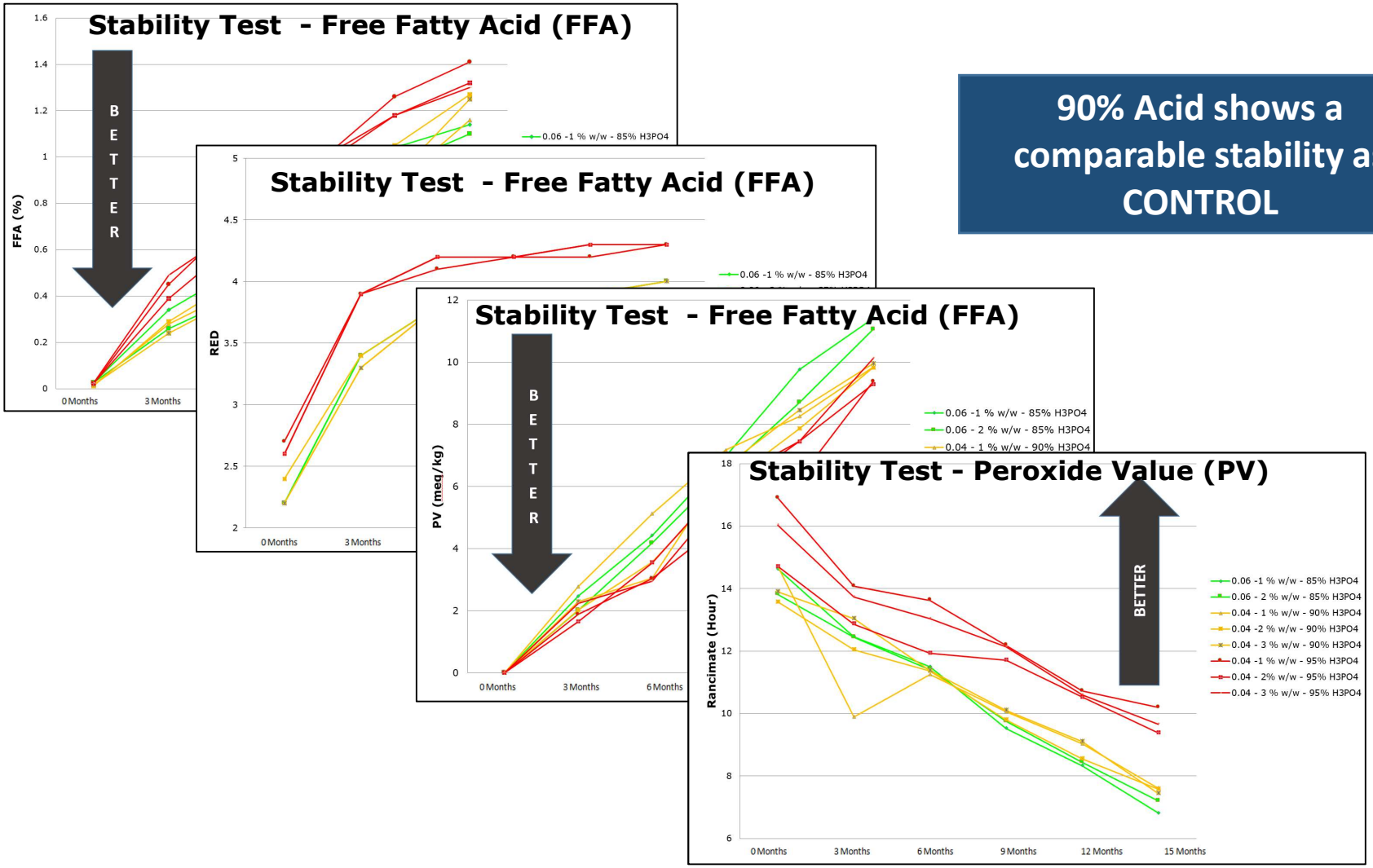
85% Phosphoric Acid Dosage (% w/w) (RBDPO) CONTROL	PV (meq/kg)	FFA (%)	Colour (Red)
0.06-1	Nil	0.028	2.2R 22Y
0.06-2	Nil	0.027	2.2R 22Y

90 % Phosphoric Acid Dosage (% w/w) (RBDPO)	PV (meq/kg)	FFA (%)	Colour (Red)
0.04 -1	Nil	0.018	2.2R 22Y
0.04 -2	Nil	0.012	2.4R 24Y
0.04 -3	Nil	0.018	2.2R 22Y

95 % Phosphoric Acid Dosage (% w/w) (RBDPO)	PV (meq/kg)	FFA (%)	Colour (Red)
0.04-1	Nil	0.021	2.7R 27Y
0.04-2	Nil	0.021	2.6R 26Y
0.04-3	Nil	0.023	2.6R 26Y

REJECTED!

Stability Test - 0.04% - H3PO4 85%,90% & 95%



90% Acid shows a comparable stability as CONTROL

Table of Contents
(Degumming Project)

Commercialization "Plant Trial"

Team Selection and Preparation

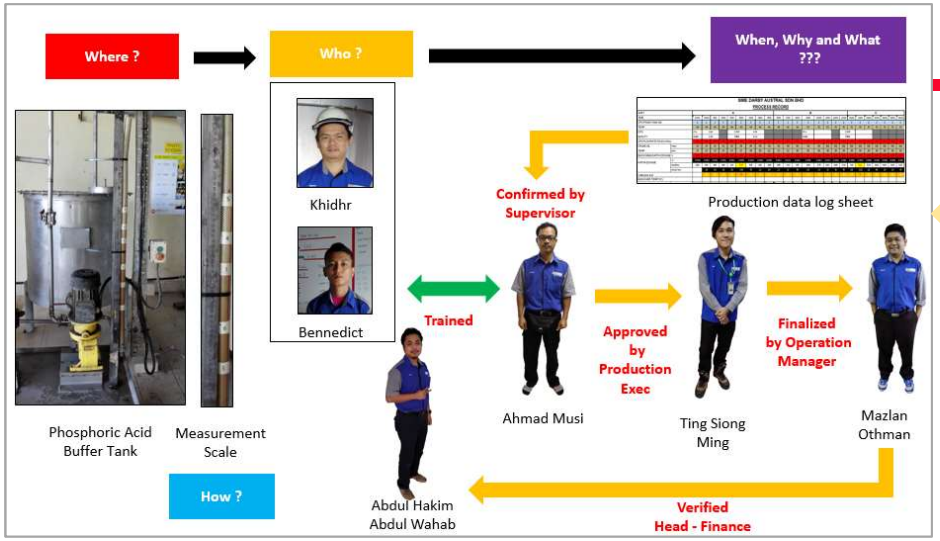
RISE Sime Darby Plantation

Process Team

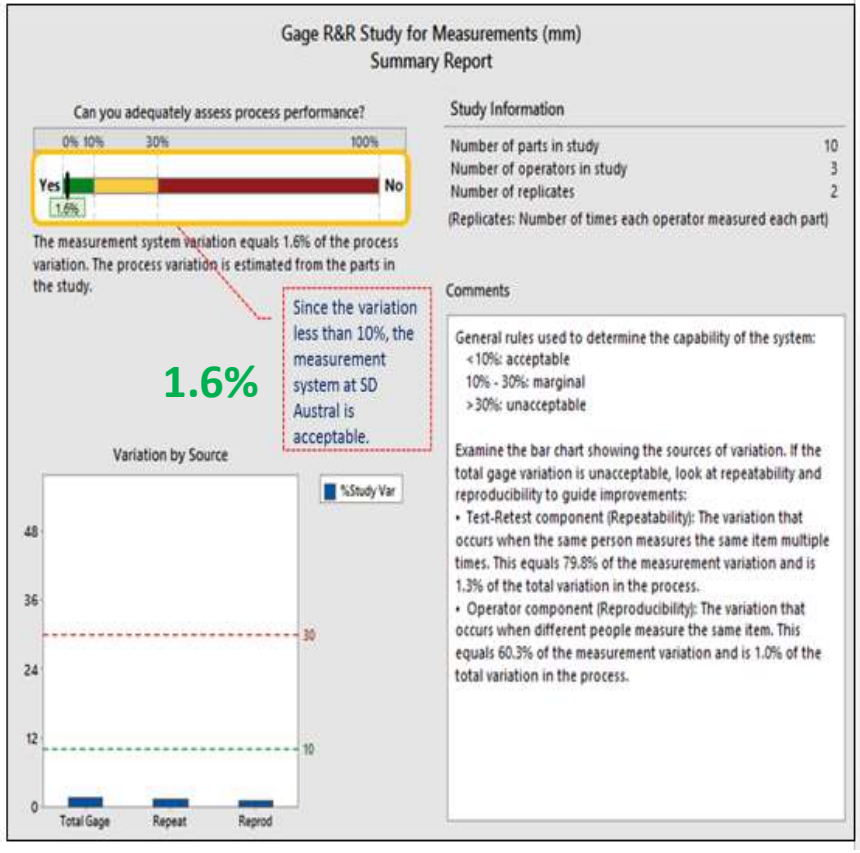
Support Team

Team members were chosen from **various departments** with **different skills** and **supported** by ***Head of Company, Finance representative and experience ASQ Black Belt Coaches.***

Data Collection and Measurement System Analysis

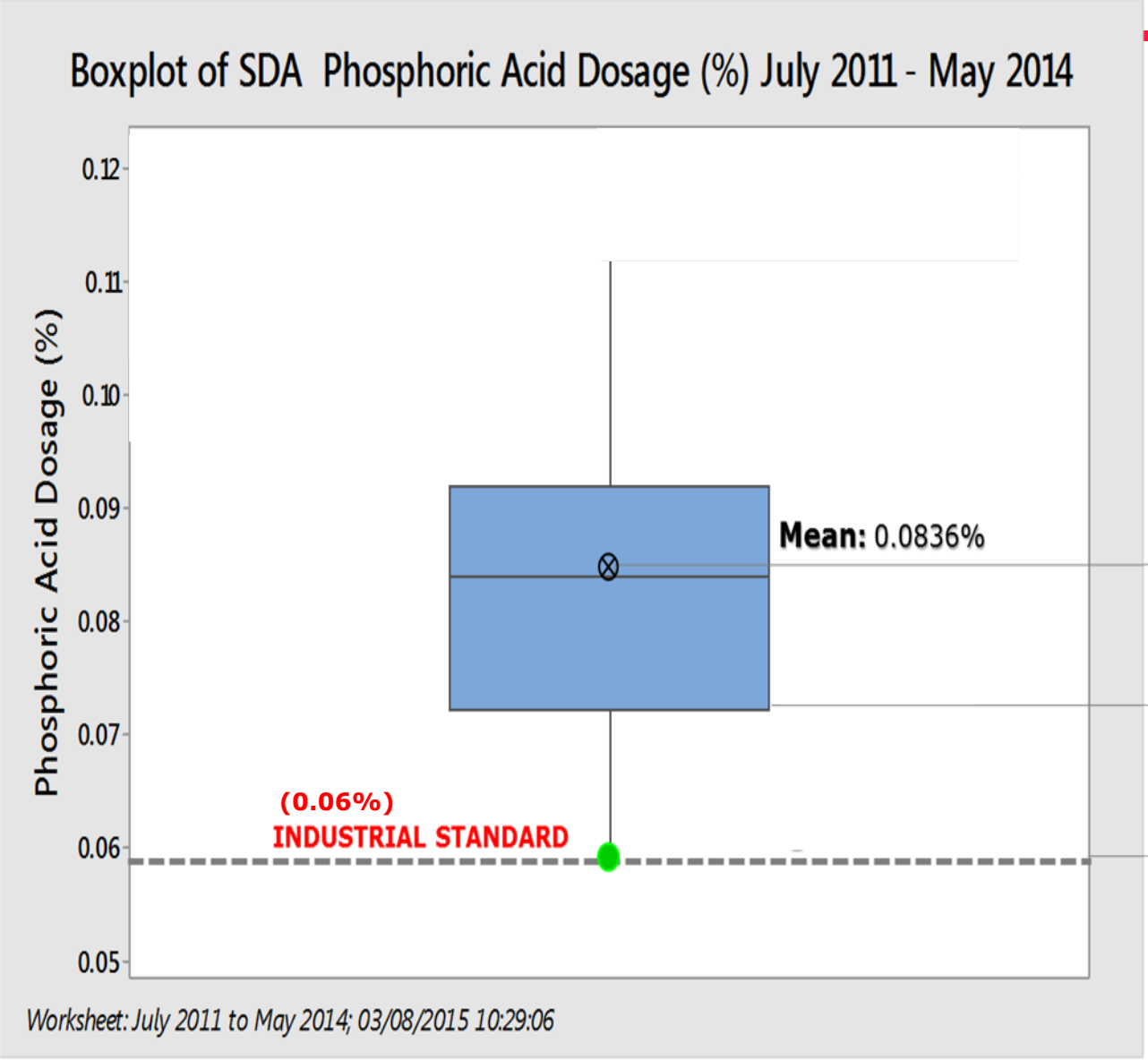


To ensure our measurement system is reliable and precise, we conduct **MSA ASSESMENT (Gage R&R)** to verify the operator's competency.



The precision of the measurement is addressed by **GAGE R&R STUDY** meanwhile the accuracy of the measurement is governed by the **CALIBRATED** gage by a **THIRD PARTY**.

Project Specific Goal



Management aiming for **the STRECH TARGET** based on the potential showed in the preliminary study conducted by R&D.

Process Performance, Mean: **0.084%** — BASELINE

Immediate target, 1st Quartile : **0.072%**

Specific Goals

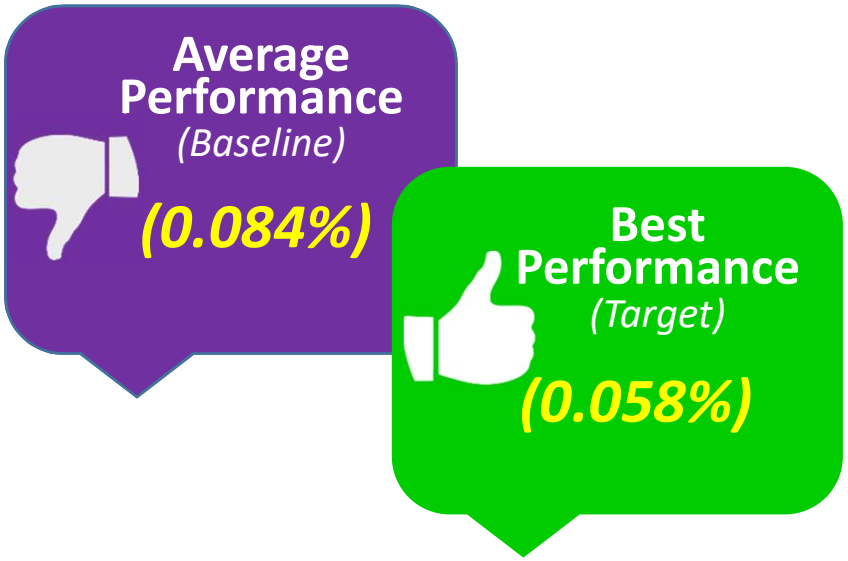
Stretch target is Minimum : **0.058 %** — GOAL

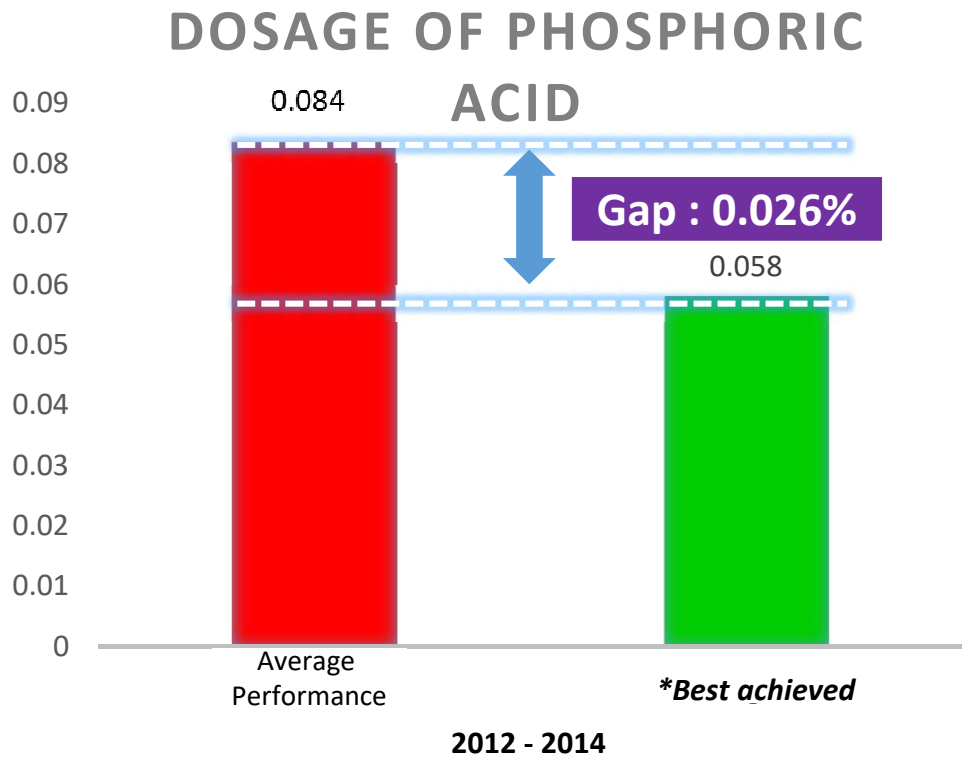
Gap and Improvement Area

*1.2 Describe what, **WHY** & how the project was selected.*

What is the Gap?

Since 2012, the *monthly average dosage* of phosphoric acid in degumming process at Austral is at **0.084%**.





There is a **GAP of 0.026%** between the **average performance compared to the best performance** achieved in previous years.

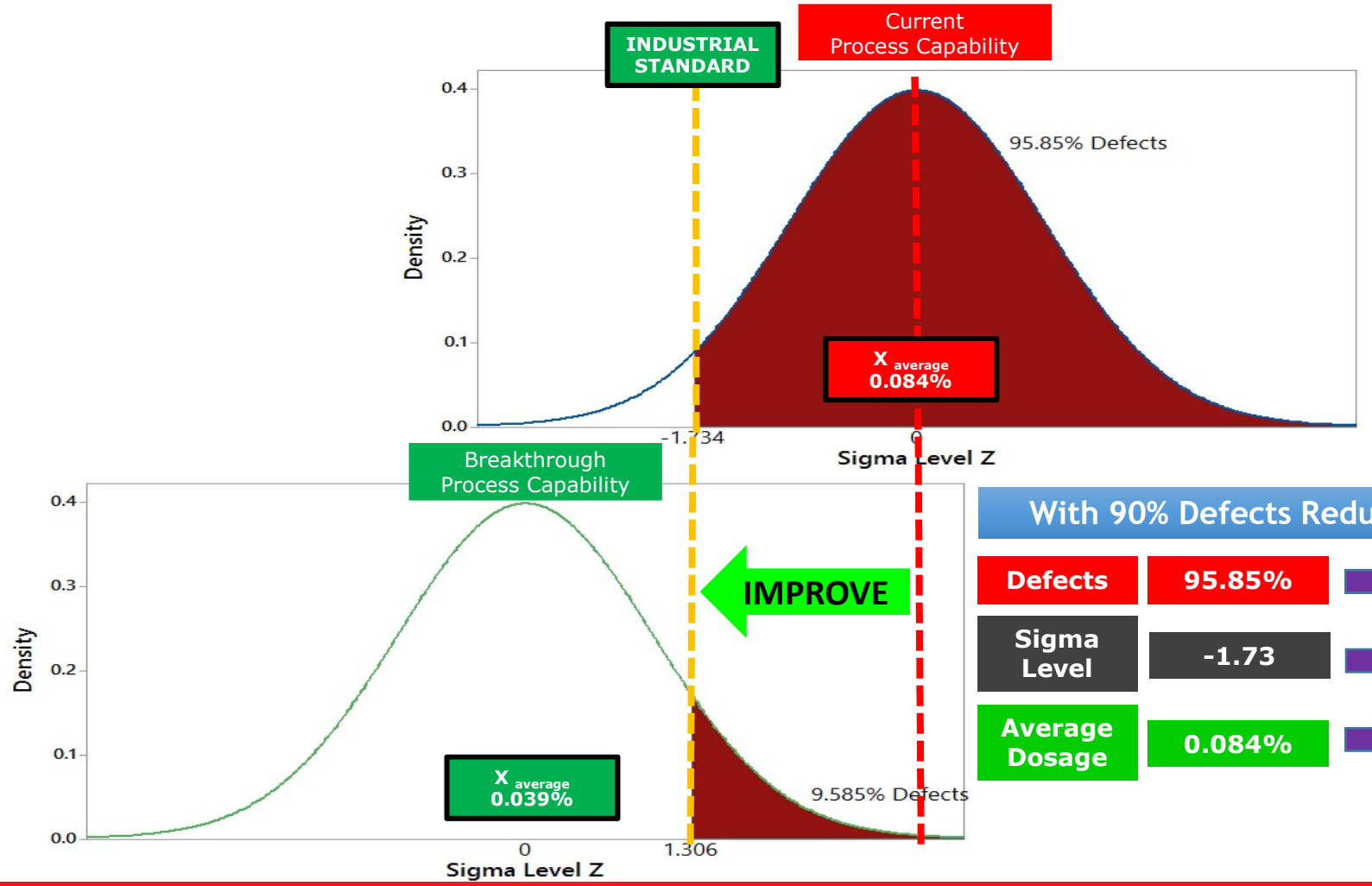
Project Specific Goal

1.4 Describe specific goals and measures based on appropriate analysis or benchmark data/ information.

90:50 Guideline Rule

1) 90% Improvement when current **Sigma Level (Z) < 3** Sigma Level
2) 50% Improvement when current **Sigma Level (Z) ≥ 3** Sigma Level

Breakthrough Target



With 90% Defects Reduction

Defects	95.85%	→	9.59%
Sigma Level	-1.73	→	1.31
Average Dosage	0.084%	→	0.039%

Project Selection

1.5 Explain how the project supports/aligns with the organization's goal, performance measures, and/or strategies

Alignment to **SUSTAINABILITY GOALS**

SIME DARBY BUSINESS BLUEPRINT
Approved by Group COO
Target RM775 million of saving

DIVISION BLUEPRINT
(SIME DARBY PLANTATION SDN BHD)
Approved by Division CEO
Target RM245 million of saving

SIME DARBY RESEARCH SDN BHD BLUEPRINT
Approved by Head of Sime Darby Research Sdn Bhd
Target RM5 million of saving

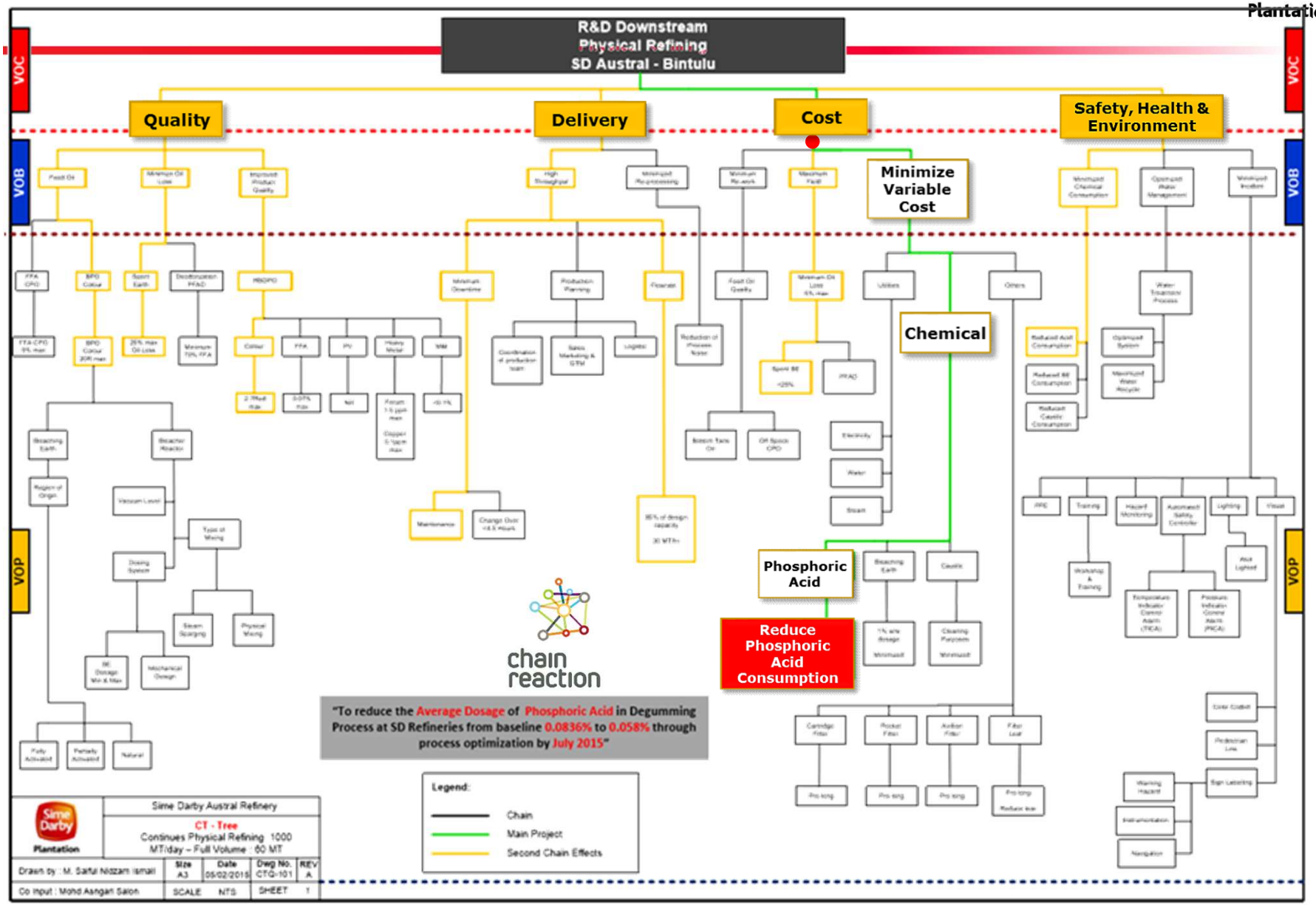
R&D DEPARTMENT PROJECT MINING
- ALIGNMENT WITH 3 R&D STRATEGIC THRUST
(HOD / EXECUTIVES / BLACK BELT)
Brainstorming of innovative ideas for refining process improvement

Alignment to **BUSINESS BLUEPRINT**

This project is align with Sime Darby **Sustainability Goals** and **LSS Business Blueprint** due to its **financial and environmental impacts**.

Project Support/ Alignments – CT Tree

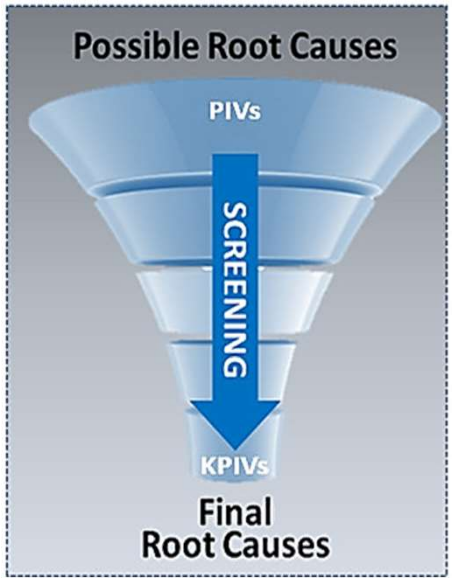
1.5 Explain how the project supports/aligns with the organization's goal, performance measures, and/or strategies



Strategy in Identifying Significant Root Causes

CONCEPTUAL TOOLS

Set of **quick and useful** tools used in LSS methodology by leveraging team's **knowledge and experience**



1st Step
To Brainstorm Possible Root Causes
Tools: **Cause & Effect Diagram**

2nd Step
To Screen Possible Root Causes and Final Root Causes Identification
Tools: **Cause & Effect Matrix**

3rd Step
To Screen Possible Root Causes and Final Root Causes Identification
Tools: **Failure Mode & Effect Analysis (FMEA)**

4th Step
To Integrate Final Root Causes
Tools: **Root Cause Integration**

STATISTICAL TOOLS

Set of statistical tools used to **collect, summarize, analyze, and interpret variable data** to support claim

5th Step
Validating Final Root Causes
Tools: **Statistical Tools**

The team used **conceptual tools** to leverage on the team expertise and to speed up screening process. Finally, we used **statistical tools** to validate the significant root causes.

Root Cause Identification

CONCEPTUAL TOOLS

Tools | **Why those Tools?** | **Team Preparation**

Tools/ Method	Diagram	Why	Result	How Team was prepared
Cause & Effect Matrix		*To weigh each identified potential root cause with customers needs for the 1st screening process*	**13** *Possible causes*	Training attended; **1) LSS Greenbelt Workshop** **2) Process Familiarization**
Failure Mode and Effect Analysis (FMEA)		*2nd and final screening to rate potential root causes according to severity, occurrence and detectability of failure*	**11 final** *Root causes*	
Root Cause Integration		*To group the final root causes with similar type*	**5 final** *Root causes*	

Final Root Cause Verification

2.2 Identify & verify final root causes using various methods/ tools & data gathered

RISE Sime Darby Plantation

5th Step

R1

OBJECTIVE

To study the effects of **various CPO Feed Flow rate *(Throughput)*** towards the Dosage of Phosphoric Acid induced in the process.

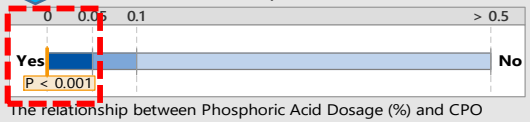
Findings:
From correlation analysis, **P-value = 0.001**, thus **REJECT** the Null hypothesis.

Correlation & Regression

Regression for Phosphoric Acid Dosage (%) vs CPO FLowarte OCT 2014 (MT/hr)
Summary Report

Significant Difference

Is there a relationship between Y and X?

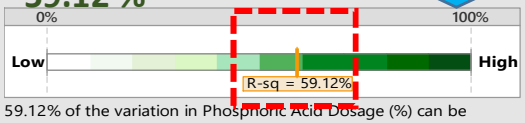


The relationship between Phosphoric Acid Dosage (%) and CPO FLowarte OCT 2014 (MT/hr) is statistically significant (p < 0.05).

R-Square = 59.12 %

Strong Correlation

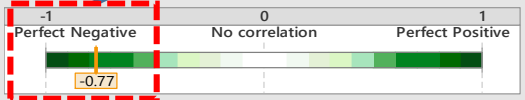
% of variation explained by the model



59.12% of the variation in Phosphoric Acid Dosage (%) can be explained by the regression model.

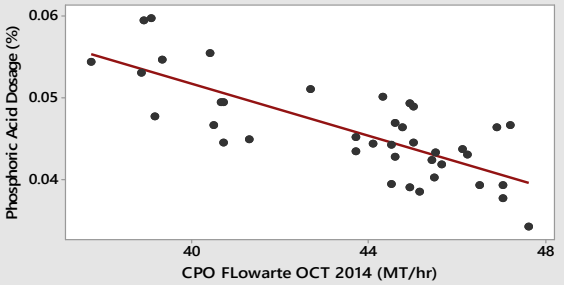
Negative Correlation

Correlation between Y and X



The negative correlation (r = -0.77) indicates that when CPO FLowarte OCT 2014 (MT/hr) increases, Phosphoric Acid Dosage (%) tends to decrease.

Fitted Line Plot for Linear Model
Y = 0.1157 - 0.001599 X



Comments

The fitted equation for the linear model that describes the relationship between Y and X is:
Y = 0.1157 - 0.001599 X
If the model fits the data well, this equation can be used to predict Phosphoric Acid Dosage (%) for a value of CPO FLowarte OCT 2014 (MT/hr), or find the settings for CPO FLowarte OCT 2014 (MT/hr) that correspond to a desired value or range of values for Phosphoric Acid Dosage (%).

A statistically significant relationship does not imply that X causes Y.

Conclusion

At **CPO Feed Flow rate increase**, the dosage of **phosphoric acid reduce.**

Final Root Cause Verification

2.2 Identify & verify final root causes using various methods/ tools & data gathered

RISE Sime Darby Plantation

5th Step

R2

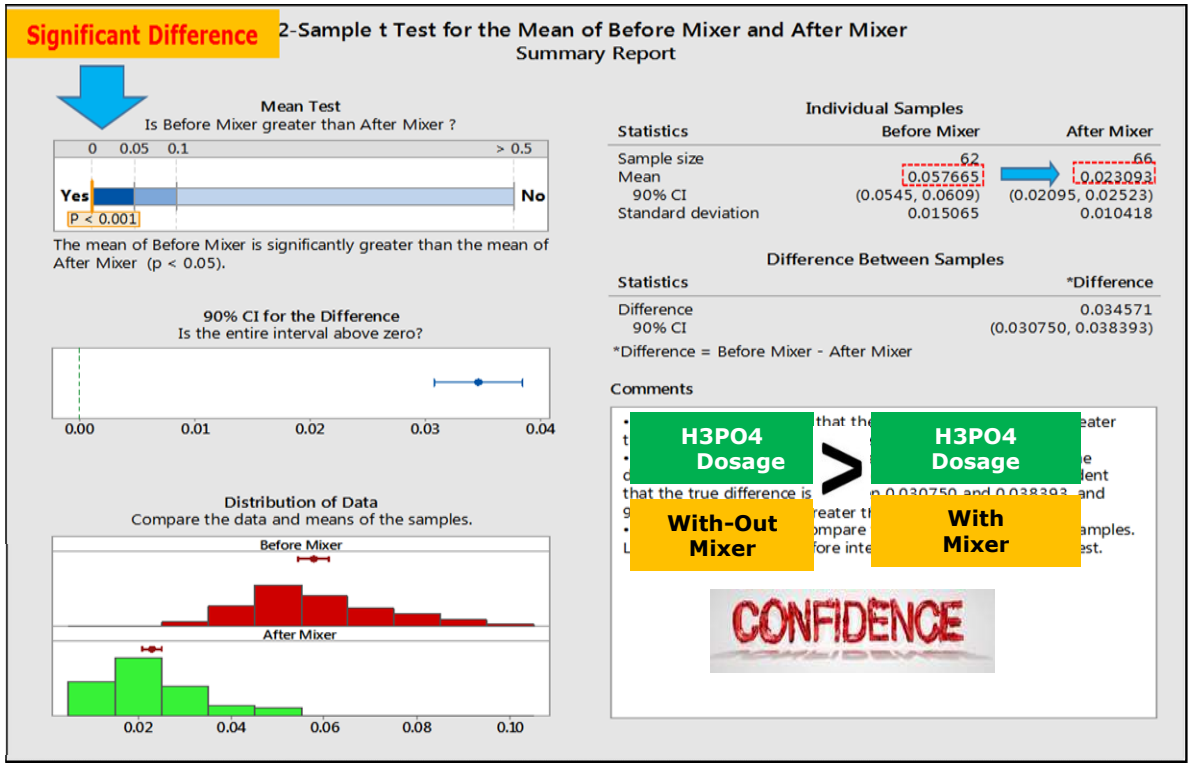
OBJECTIVE

To study the **effects of mixer** towards the phosphoric acid dosage induced in the process

Findings:
From the 2 sample T-test, the **P-Value = 0.001**.
REJECT the null hypothesis

Comparative Method

Significant Difference



Conclusion

Dosage of Phosphoric Acid was **reduced** with **introduction of mixer** will **increase reaction rate**.

Final Root Cause Verification

2.2 Identify & verify final root causes using various methods/ tools & data gathered

RISE Sime Darby Plantation

5th Step

R3

OBJECTIVE

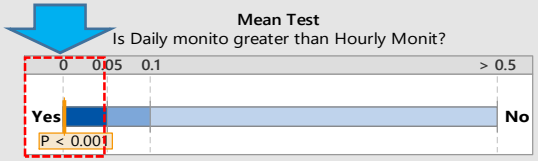
To study the **effects** of the *Daily vs Hourly monitoring* towards the *phosphoric acid dosing*.

Findings:
From the 2 sample T-test, the **P-Value = 0.001**. **REJECT** the null hypothesis.

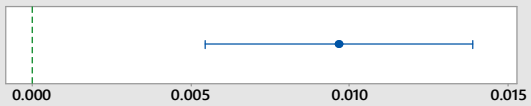
Comparative Method

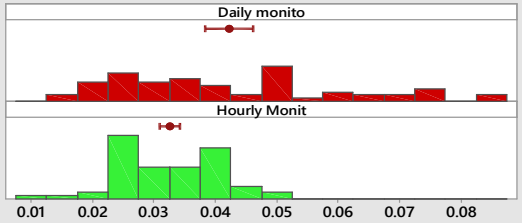
Significant Difference

2-Sample t Test for the Mean of Daily monito and Hourly Monit
Summary Report



The mean of Daily monito is significantly greater than the mean of Hourly Monit ($p < 0.05$).





Individual Samples

Statistics	Daily monito	Hourly Monit
Sample size	62	66
Mean	0.042257	0.032581
90% CI	(0.0383, 0.0462)	(0.03097, 0.03419)
Standard deviation	0.018440	0.0078430

Difference Between Samples

Statistics	*Difference
Difference	0.0096766
90% CI	(0.0054619, 0.013891)

*Difference = Daily monito - Hourly Monit

Comments

- Test: You can conclude that the mean of Daily monito is greater than Hourly Monit at the 0.05 level of significance.
- CI: Quantifies the uncertainty associated with estimating the difference in means from sample data. You can be 90% confident that the true difference is between 0.0054619 and 0.013891, and 95% confident that it is greater than 0.0054619.
- Distribution of Data: Compare the location and means of samples. Look for unusual data before interpreting the results of the test.

H3PO4 Average Dosage (Daily Monitoring) **>** **H3PO4 Average Dosage** (Hourly Monitoring)

Conclusion

Dosage of Phosphoric Acid was **reduced** with **introduction of hourly monitoring** due to increase of adjustment frequent.

Final Root Cause Verification

2.2 Identify & verify final root causes using various methods/ tools & data gathered

5th Step

R4

OBJECTIVE

To evaluate how **Phosphoric Acid Concentration** *(80%, 90% & 95%)* affects the Dosage of Phosphoric Acid and RBDPO Colour (*Quality*)

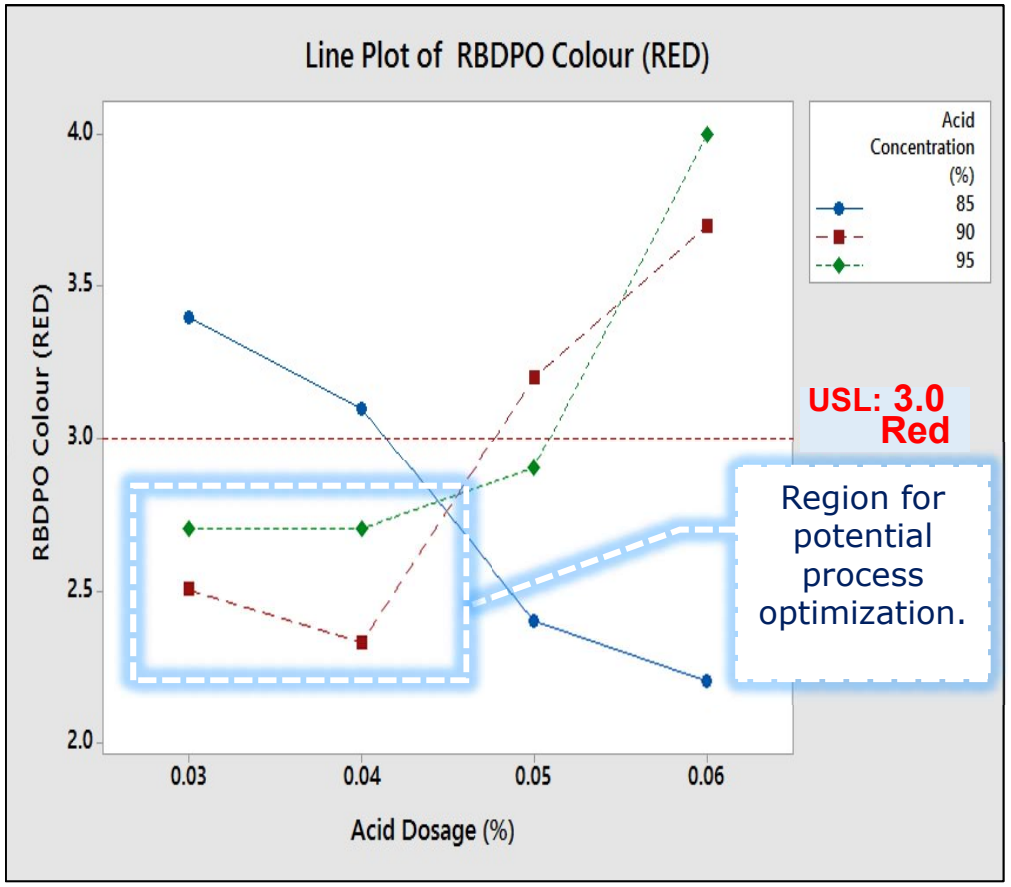
H3PO4	vs	H3PO4	vs	H3PO4
85% Acid Concentration		90% Acid Concentration		95% Acid Concentration

H3PO4 Dosage	→	H3PO4 Dosage
0.06%		0.03%

RBDPO Colour
< 3.0 Red

Findings:
90% phosphoric acid concentration gives the **lowest dosage** with **lowest RBDPO colour.**

Interaction Plot



Conclusion

90% phosphoric acid concentration is the **most suitable concentration**, compared to current 85% concentration.

Final Root Cause Verification

2.2 Identify & verify final root causes using various methods/ tools & data gathered

RISE Sime Darby Plantation

5th Step

R4

Comparative Method

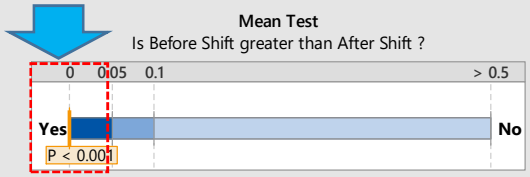
OBJECTIVE

To compare the effects of the 85% and 90% **Phosphoric Acid Concentration** towards the Dosage of Phosphoric Acid.

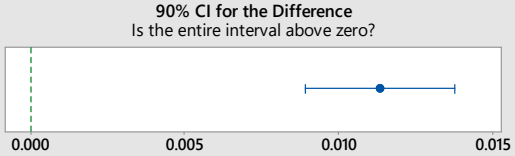
Findings:
From the 2 sample T-test, the **P-Value = 0.001**. **REJECT** the null hypothesis.

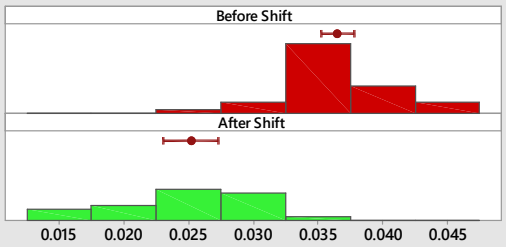
Significant Difference

2-Sample t Test for the Mean of Before Shift and After Shift
Summary Report



The mean of Before Shift is significantly greater than the mean of After Shift ($p < 0.05$).





Individual Samples

Statistics	Before Shift	After Shift
Sample size	32	23
Mean	0.0365	0.025174
90% CI	(0.0352, 0.0378)	(0.02307, 0.02728)
Standard deviation	0.0042955	0.0058748

Difference Between Samples

Statistics	*Difference
Difference	0.011326
90% CI	(0.0088962, 0.013756)

*Difference = Before Shift - After Shift

Comments

- Test: You can conclude that the mean of Before Shift is greater than After Shift at the 0.05 level of significance.
- CI: Quantifies the uncertainty associated with estimating the difference in means from sample data. You can be 90% confident that the true difference is between 0.0088962 and 0.013756, and 95% confident that it is greater than 0.0088962.
- Distribution of Data: Compare the location and means of samples. Look for unusual data before interpreting the results of the test.

H3PO4 Dosage 85% concentration **>** **H3PO4 Dosage** 90% concentration

CONFIDENCE

Conclusion

Dosage of Phosphoric Acid was **reduced** with new **introduction of 90% phosphoric acid** concentration.

Final Root Cause Verification

2.2 Identify & verify final root causes using various methods/ tools & data gathered

5th Step

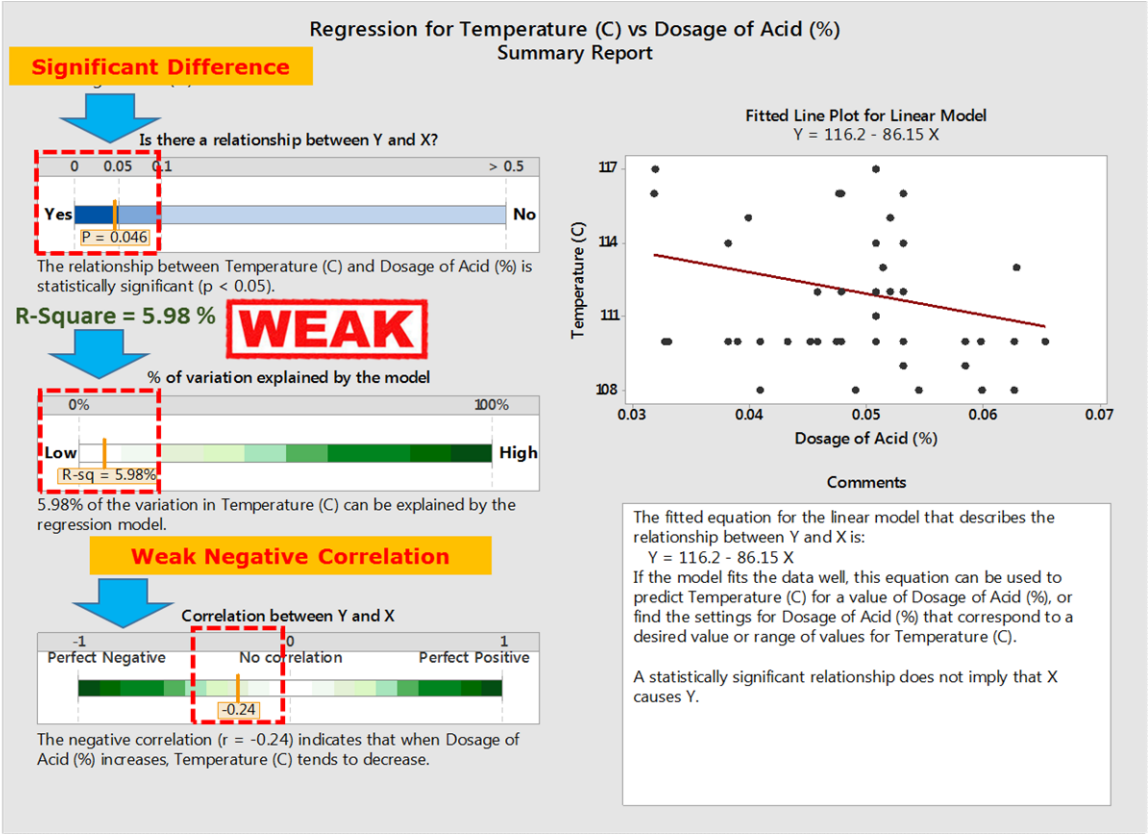
R5

Correlation & Regression

OBJECTIVE

To study the effects of **Degumming Temperature** towards the Dosage of Phosphoric Acid.

Findings:
From the correlation analysis, the **P-Value = 0.046.**
However, the correlation between the factors are very weak with R-Square of **5.98%.**



Conclusion

Dosage of Phosphoric Acid **was reduced** with **higher Temperature of degumming process.**

Root Cause Validation

STTISTICAL TOOLS

Summary Of Final Root Causes Analysis

Pro.	Final Root Cause/ Improvement Opportunities	Validation method	Evidence
R1	Low feed flow rate	Correlation & Regression	**P-Value = 0.001**, R-Square of **59.12%.**
R2	Low reaction rate	Comparative Method	**P-Value = 0.001.**
R3	Low frequency of monitoring	1. Comparative Method 2. Correlation & Regression	**P-Value = 0.001.**
R4	Low concentration of phosphoric acid	Comparative method	**P-Value = 0.001.**
R5	Inconsistent temperature	Correlation & Regression	R-Square of **5.98%.**

Root Cause Validation Evidence

Validated

Root cause Analysis	Symbol	Statistical Method	Summary	KPIV Validation
Feed flowrate	R1	Correlation & Regression	• From the Regression Analysis, the P-Value = 0.001. Significant Difference Strong Relationship • However, the correlation between the factors are very Strong with R-Square of 59.12%.	VALIDATED STRONG
Reaction rate @ Mixing rate	R2	Comparative Method	• From the 2 sample T-test, the P-Value = 0.001. Significant Difference	VALIDATED
Design of Phosphoric Dosing system Frequency of monitoring Daily vs Hourly	R3	Comparative Method	• From Control Chart (IMR Chart) there are region for the variance have been reduce by changing the monitoring from daily to hourly. • From the 2 sample T-test, the P-Value = 0.001. Significant Difference	VALIDATED
Concentration of Phosphoric Acid 85%. 90% and 95%	R4	Interactional Plot Comparative Method	• From the Interactional Plot there are region for potential process optimization. • From the 2 sample T-test, the P-Value = 0.001. Significant Difference	VALIDATED
Temperature	R5	Correlation & Regression	• From the Regression Analysis, the P-Value = 0.046. Significant Difference Weak Relationship • However, the correlation between the factors are very weak with R-Square of 5.98%.	VALIDATED WEAK

The first 5 root causes have significant impact on the phosphoric acid consumption.

Improvement & Optimization

Possible Solutions or Improvements

5 Validated Root Causes

Using **Brainstorming**, **12 ideas** were generated as **potentia** for the next step (Prioritisation).

What Data Generated

Brainstorming & Affinity Diagram

Root Cause 1	Root Cause 2	Root Cause 3	Root Cause 4	Root Cause 5	
Low CPO Feed throughput	**Low optimization of reaction rate**	**Inconsistent degumming temperature**	**Manual dosing adjustment**	**Low concentration of phosphoric acid**	
To improve coordination between estate and mill	To have efficient mixing before degumming tank	Replace positioner for regulating valve	To create study on optimization DOE	Establish measurement calibration	Increase acid concentration
To get good quality crop from estate	Extra support for degumming tray	Repair positioner for regulating valve	Establish SOP	To verify supplier reputation	To have acid tank with cone shape bottom

12 ideas generated from Brainstorming were based on the team members experience and knowledge in the related field. Data were **analyzed using Affinity Diagram** and **Benchmarking activities**.

Possible Solutions or Improvements

What Data Were Generated (Example)?

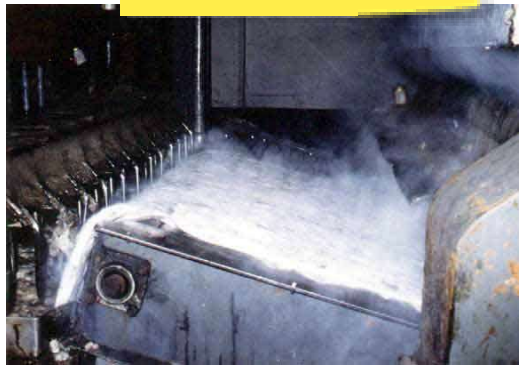
Root Cause 2

Low optimization of reaction rate

To have efficient mixing before degumming tank

Extra support for degumming tray

What Data Generated



Facts

Comparison with other Refineries (Benchmarking) found that low reaction rate between the Phosphoric Acid and Gums cause the high consumption of acid in Sime Darby Austral.

Roots Cause

In sufficient mixing and collapsed degumming tray inside the reactor.

How is Data Analyzed?

Tools

"Brainstorming & Affinity Diagram"
"Benchmarking"
"Expert Opinion"

Improvement Idea

Install High Sheer Mixer Rectification Degumming Reactor

High Shear In-Line Mixers

Silverson High Shear In-Line mixers are supremely efficient and rapid in operation and are capable of reducing mixing times by up to 90%. The action of any Silverson In-Line mixer can be modified with the use of rapidly interchangeable workheads. This enables any machine to mix, emulsify, homogenize, solubilize, suspend, disperse and disintegrate solids.

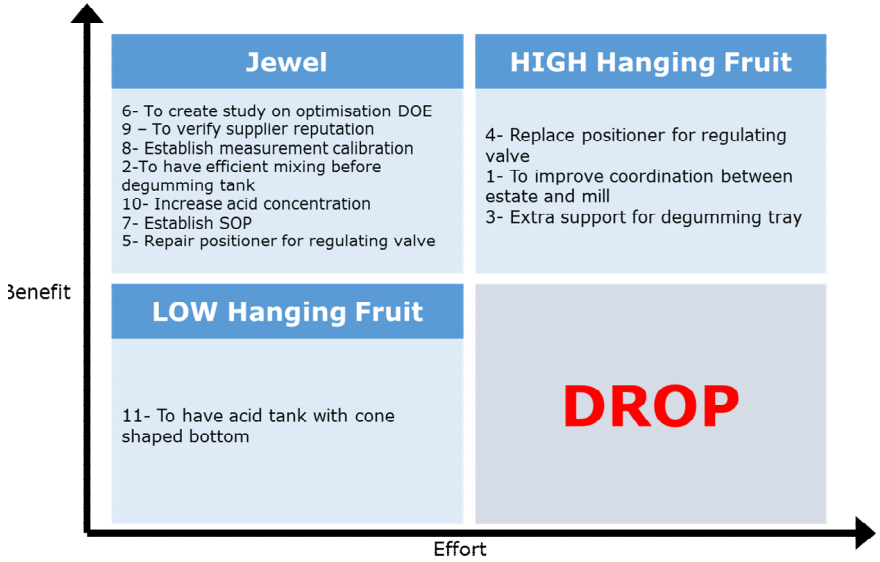
Features:

- Aeration free
- Self-pumping
- No bypassing
- Interchangeable workheads
- Sanitary construction
- Easy maintenance
- Lower power requirements
- Eliminates agglomerates and fish eyes
- Creates stable emulsions and suspensions
- Reduces particle size
- Rapidly dissolves solids
- Accelerates reactions

Final Solutions or Improvements

Method/Tool: SOLUTION MATRIX

Idea No	Possible Solutions	Benefit/ Impact				Effort			Degree of Impact vs. Effort	Best Solution Rank
		Sigma Impact	Time Impact	Cost Benefit Impact	Score (S1)	Investment	Resources	Score (S2)		
	Weightage	10	8	7		10	8			
1	To improve coordination between estate and mill	7	6	6	160	4	8	104	160/104	High Hanging Fruit
2	To have efficient mixing before degumming tank	8	8	8	200	2	3	44	200/44	Jewel
3	Extra support for degumming tray	6	7	7	165	6	4	92	165/92	High Hanging Fruit
4	Replace positioner for regulating valve	8	7	9	199	6	3	84	199/84	High Hanging Fruit
5	Repair positioner for regulating valve	8	7	9	199	2	3	22	199/22	Jewel
6	To create study on optimization	8	8	8	200	3	2	46	200/46	Jewel
7	Establish SOP	7	7	8	182	2	3	44	182/44	Jewel
8	Establish measurement calibration	7	8	8	190	2	3	44	190/44	Jewel
9	To verify supplier reputation	7	8	7	183	2	2	36	183/36	Jewel
10	Increase acid concentration	8	8	8	200	3	2	46	200/46	Jewel
11	To have acid tank with cone shape bottom	6	6	7	157	3	2	46	157/46	Low Hanging Fruit



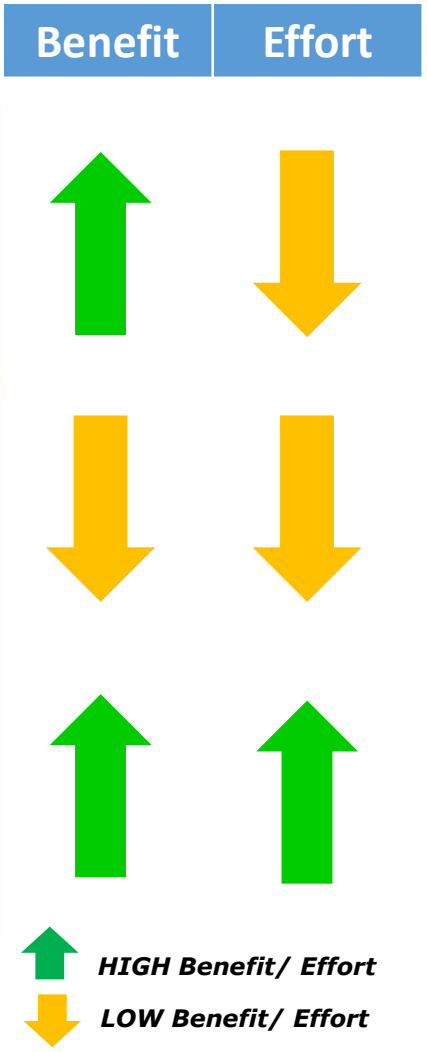
Final Solutions

11 Final Solutions

1st Implementation JEWEL
7 Solutions

2nd Implementation LOW Hanging Fruit
1 Solution

3rd Implementation HIGH Hanging Fruit
3 Solutions



Final Solutions or Improvements
"DOE" Design of Experiment

RISE Sime Darby Plantation

Objective

Phosphoric Acid Optimization in Degumming process (DOE)

Y = f(x)

DOE

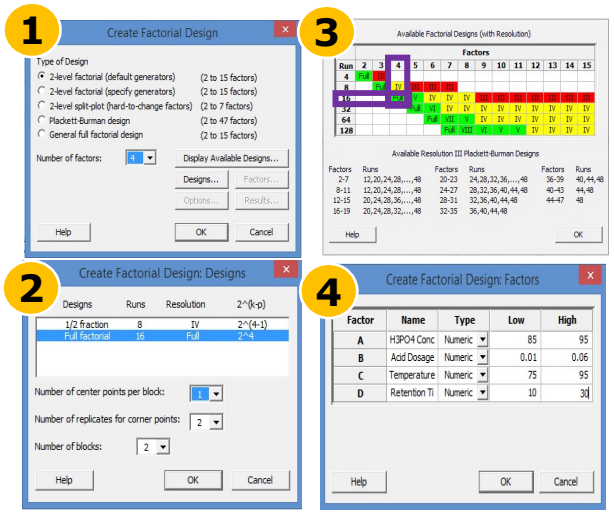
Full Factorial Design with Two Replicates, Two Center Points and Blocking

Minitab 17

Input Variables (Xs)	Response variable (Y)
Acid Concentration	Refined Oil Color
Dosage of Acid	
Temperature	
Retention Time	
Incoming Product Quality	

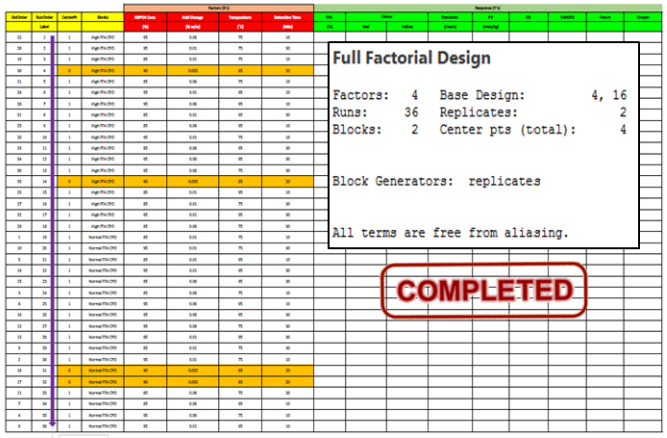
Final Solution Validation

Factorial Design Resolution



Full Factorial Design

Phosphoric Acid optimization in Degumming process (DOE)



Total Run :
(No. of Treatment per Experiment × No. of Replication) + (No. of Centre Point per Blocks × No. of Replication)

Total Run = (2^4 × 2) + (2 × 2) =

36 Runs

2 Level Full factorial design (DOE) has been constructed **for optimization**

1) Acid Concentration,

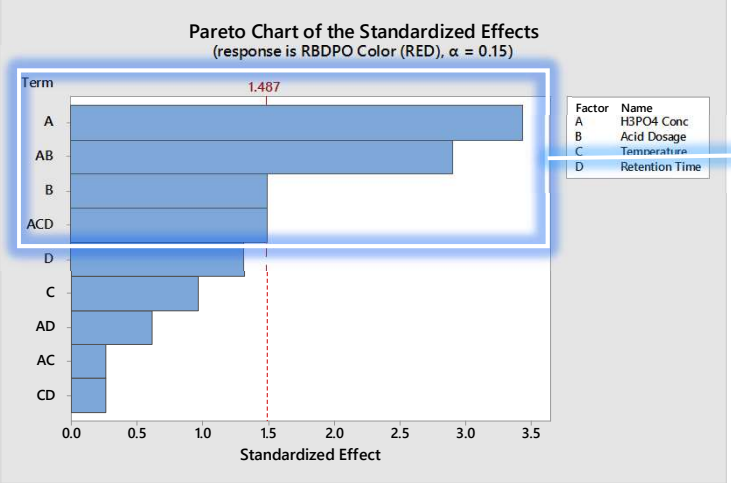
2) Dosage of Acid, 3) Temperature, 4) Retention Time; with blocking of Incoming Product Quality.

Final Solutions or Improvements

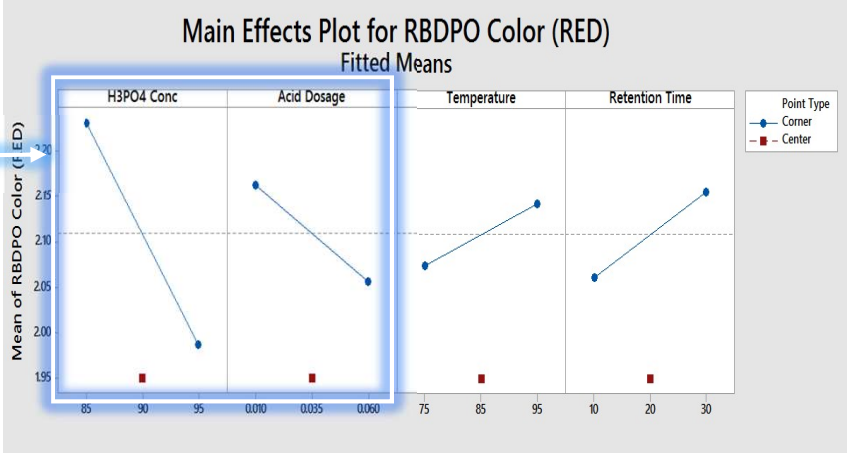
Phosphoric Acid optimization in Degumming process

Final Solution Validation

Pareto Chart Standardized Effect

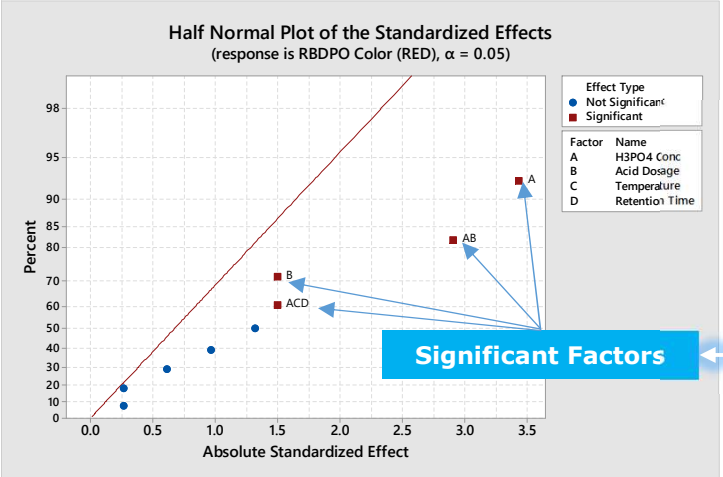


Main Effect Plot



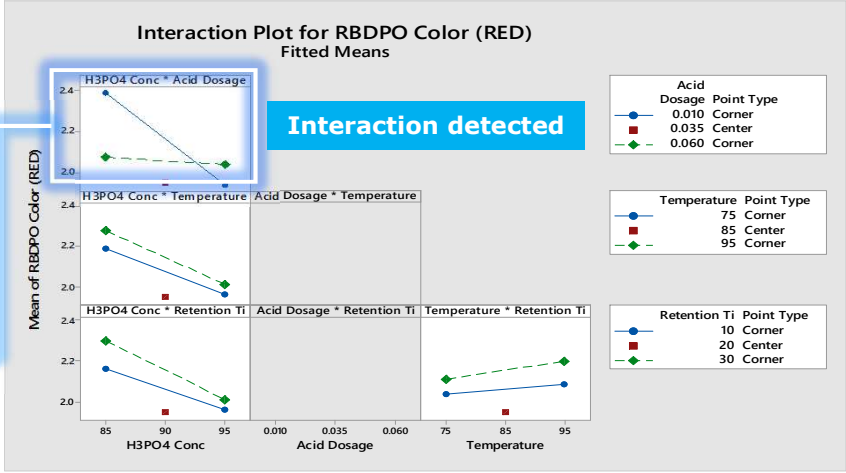
Design of Experiment (DOE) RESULT

Half Normal Plot of the Standardized Effects



Significant Factors

2 Way Interaction Plot

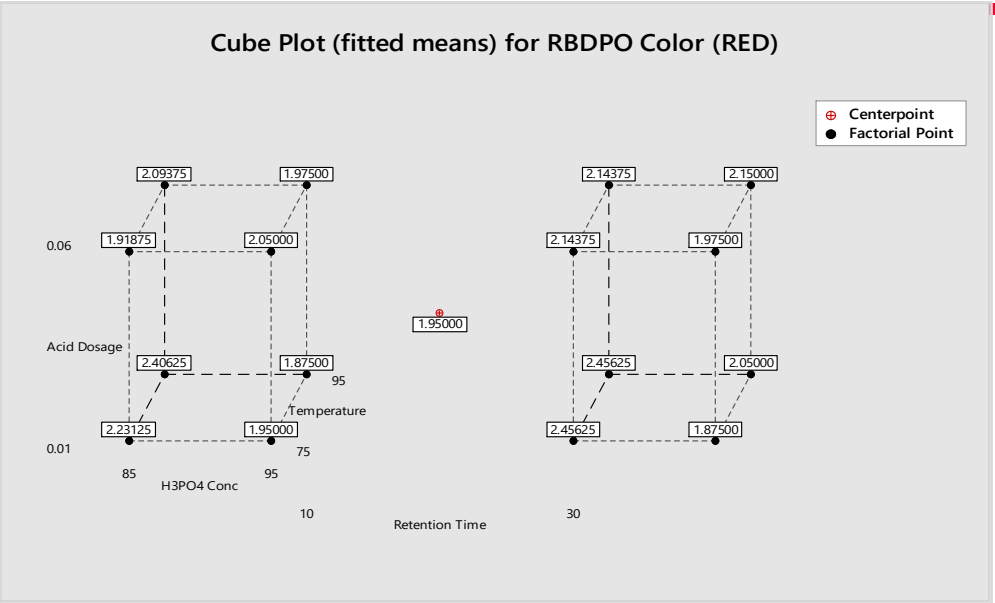


Interaction detected

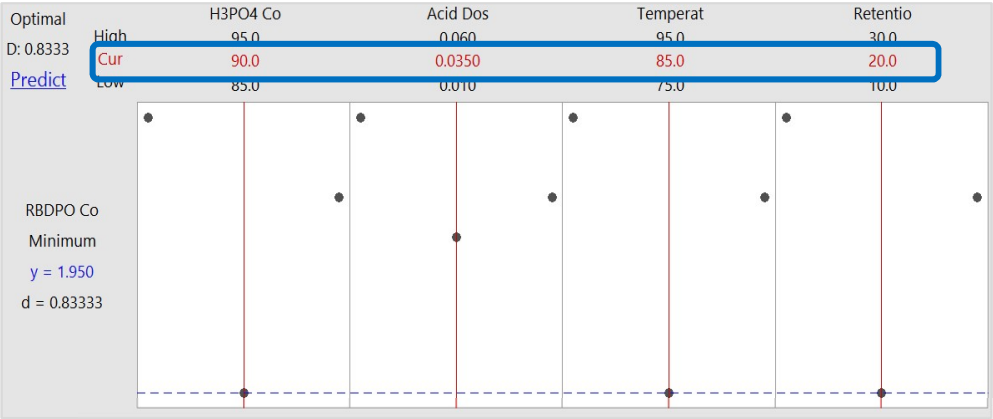
The output from analysis of the results from the **factorial experiment shows** that **concentration and dosage** of phosphoric acid have **significant impact** to the RBDPO color.

Final Solutions or Improvements

Phosphoric Acid optimization in Degumming process



Response Optimizer



Final Solution Validation

Factor (Xs)	Best Setting	Respond RBDPO Colour
H3PO4 Concentration %	***90***	***1.95 RED*** *(USL 3 RED)*
H3PO4 Acid Dosage %	***0.0350***	
Temperature, ^0C	***85***	
Retention Time, *min*	***20***	

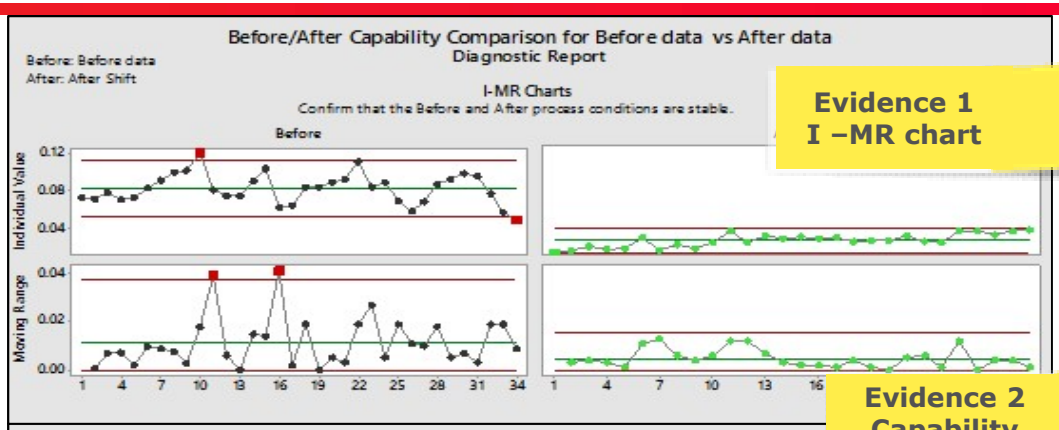
Design of Experiment (DOE)
Optimized setting to be tested

Refined Oil Colour
R-Squared : 82.29%
R-Squared (Adj) : 70.48%

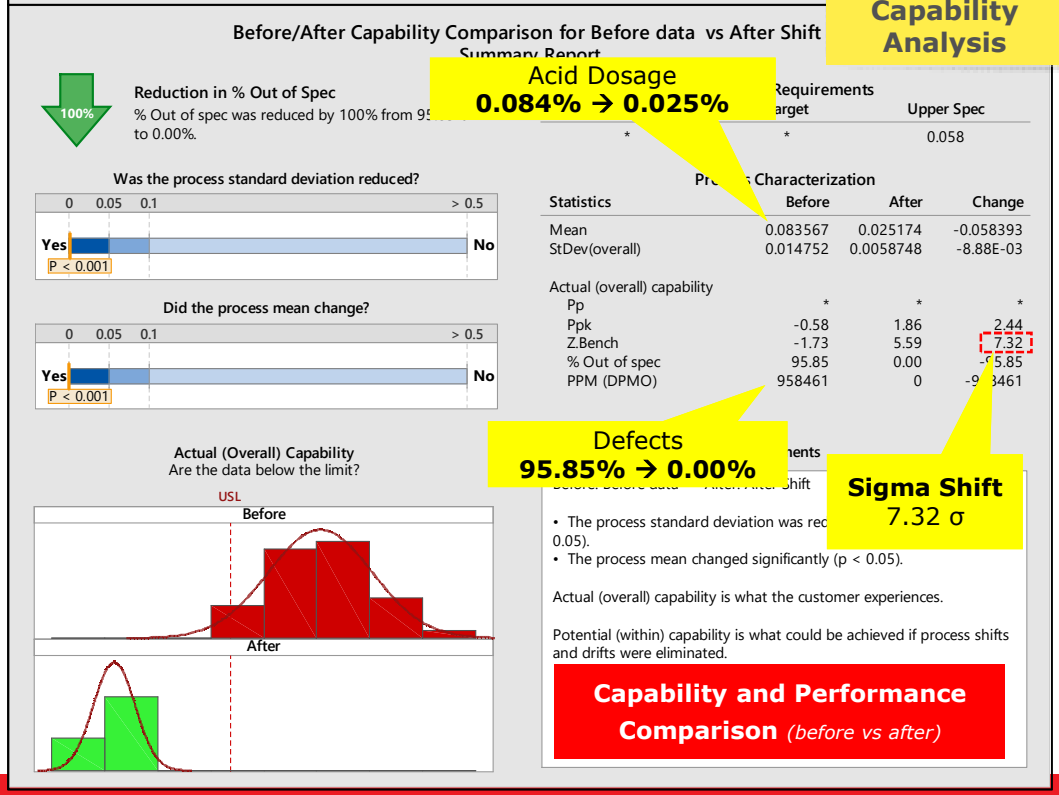
Based on **DOE result**, the **best setting** have been **communicated to the stakeholders** and to be tested at **plant trial**.

Final Solutions – The Plant Trials

Pilot Plant was conducted at SD Austral – Validation



Evidence 1
I –MR chart



Evidence 2
Capability Analysis

Acid Dosage
0.084% → 0.025%

Defects
95.85% → 0.00%

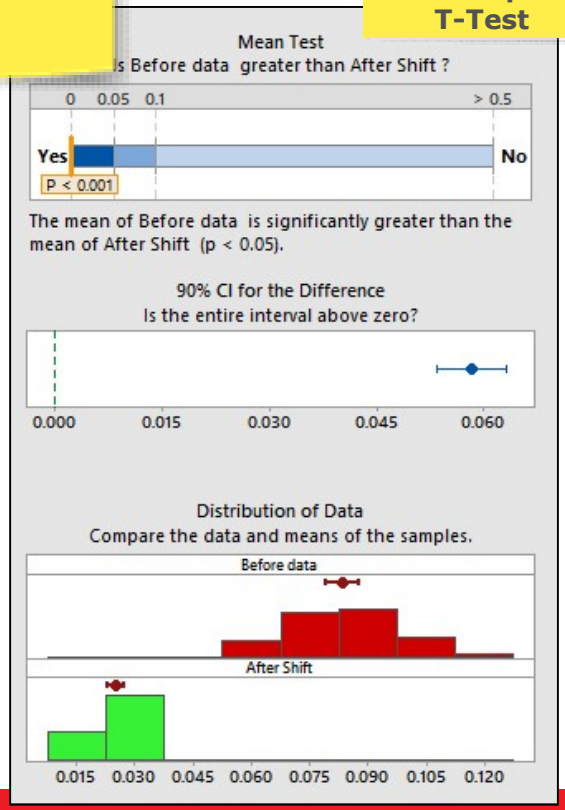
Sigma Shift
7.32 σ

Capability and Performance Comparison *(before vs after)*

The final improvement was validated during Pilot Plant Trial at SD Austral using following tools:

- **2 Sample T-Test**
- **Before/After Capability Comparison Diagnostic**

Evidence 3
2 Sample T-Test



Final Solutions or Improvements

Additional Potential Benefits

Additional Benefits Anticipated

Additional Benefits	Additional Potential Benefits Anticipated
Better RBDPO Quality	• Improve End Product Quality (Olein and Stearin) • Improve Rework Process (Refine process) • Improve End Product Stability • Reduce Processing Cost (Consumption of Bleaching Earth)
Lower Oil Loss in Spent Bleaching Earth (SBE)	• Reduce Environmental Impact • Reduce Oil Loss • Improve Cleanliness in SBE area
Lower Waste Generation Spent Bleaching Earth (SBE)	• Reduce Environmental Impact • Reduce Spent Bleaching Earth Disposal Cost
Higher Plant Throughput	• Increase Company Revenue
Minimize Downtime (fully degummed oil)	• Reduce un-panned downtime • Reduce Maintenance Cost (Unplanned Downtime) • Require Less Monitoring • Minimize Re-planning activity due to Un-planned Downtime

These are the potential benefits anticipated after we conducted pilot trial

Implementation
&
Result Verification

Solution/Improvement Implementation

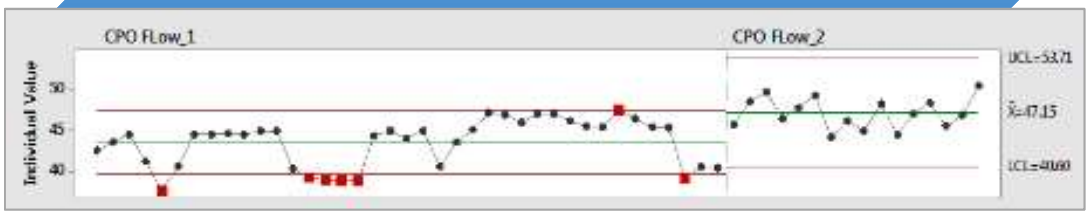
Process (P) / System (S)	Before	Changes prior to solution	After
P - Increase mixing rate	Static Mixer 		Dynamic Mixer 
S - Phosphoric acid dosing system	Inconsistent calibration 		Calibration SOP Established, MSA study every 6 months, Integration Log Sheet 
S - Phosphoric acid data collection measurement	2 decimal points		3 decimal points
S - Pump monitoring frequency	Daily monitoring		Hourly monitoring
P - Degumming piping elbow thickness	SCH 40 		SCH 80 

Solution/Improvement Implementation

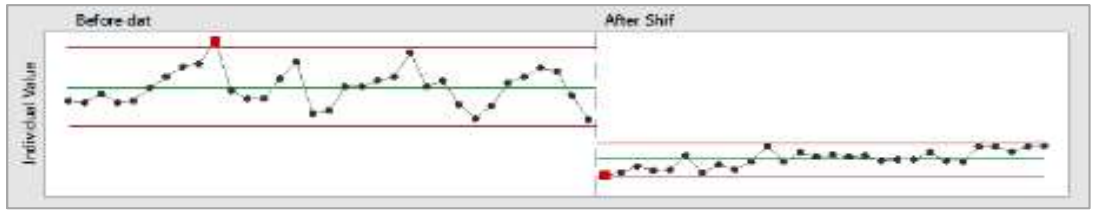
	Performance Indicator
1	Refinery Plant Throughput
2	Phosphoric Acid Dosage
3	Bleaching Earth Dosage
4	Colour: Olein & RBDPO (Refined Oil)

Performance Monitoring Management

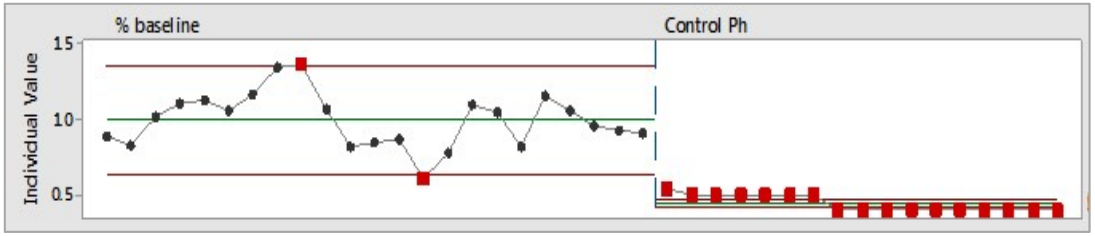
Flow rate



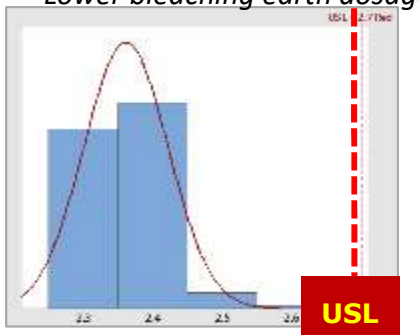
Dosage



Dosage



Lower bleaching earth dosage produced reduce oil loss in spent bleaching earth



Refined oil colour below Upper Spec Limit of 3.0 Red max.

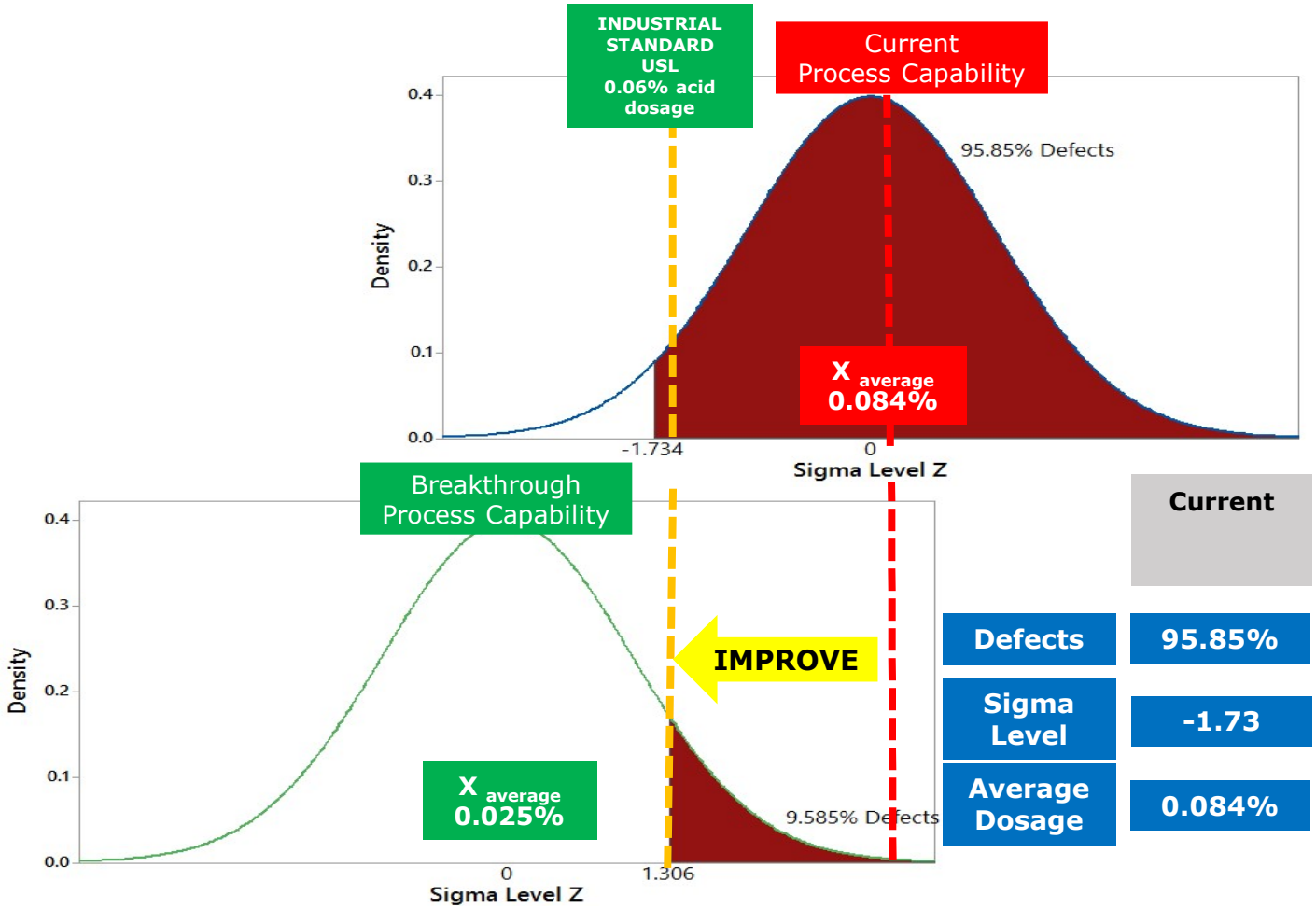
System change

Project Results

90:50 Guideline Rule

1) 90% Improvement when current **Sigma Level (Z) < 3** Sigma Level
2) 50% Improvement when current **Sigma Level (Z) ≥ 3** Sigma Level

Breakthrough Target



BREAK THE BREAKTHROUGH TARGET

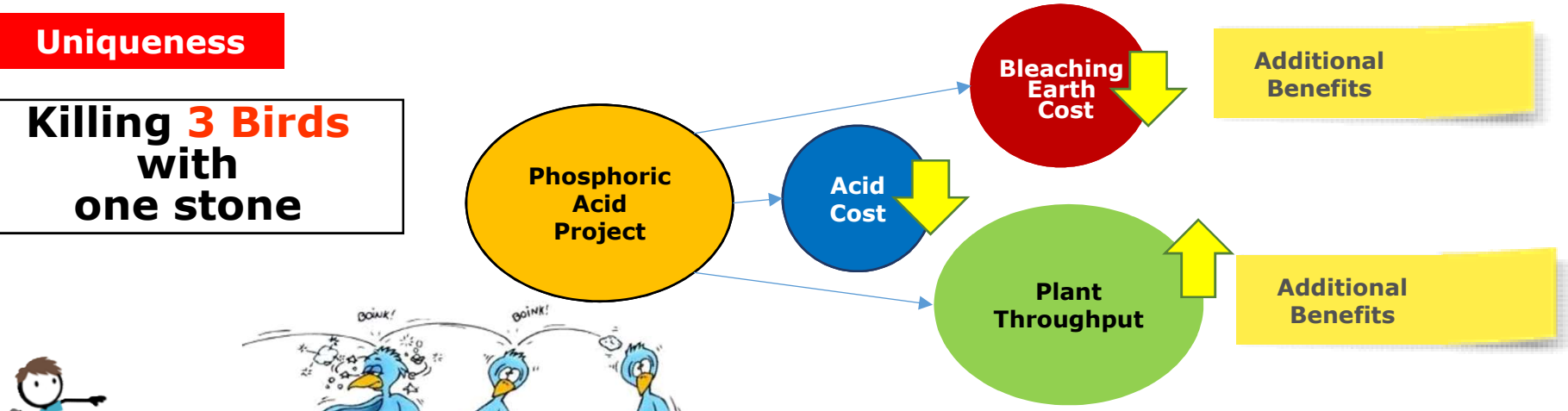
	Current	Break Through Target	Actual
Defects	95.85%	9.59%	0.00%
Sigma Level	-1.73	1.31	5.59
Average Dosage	0.084%	0.039%	0.025%

Mean reduced from **0.084% to 0.025%**, **Standard Deviation** reduced from **0.0148 to 0.0059.**
Sigma Level increased from **-1.73 to 5.59 (increment of 7.32).**
Out of spec reduced from **95.85% to 0%.**

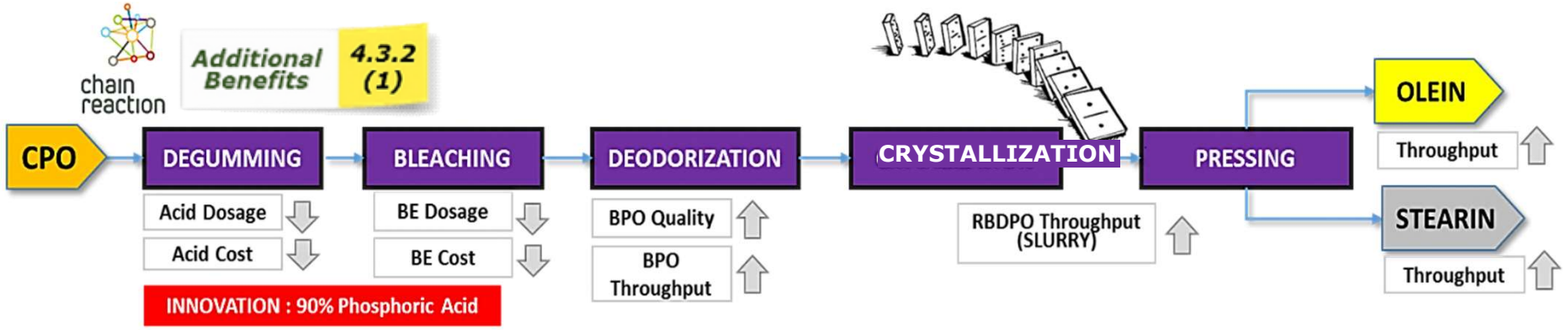
Project Results

Uniqueness

Killing 3 Birds with one stone



Chain Reaction Observed



Team Selection and Preparation

PROJECT GANTT CHART

What deadlines & deliverables?

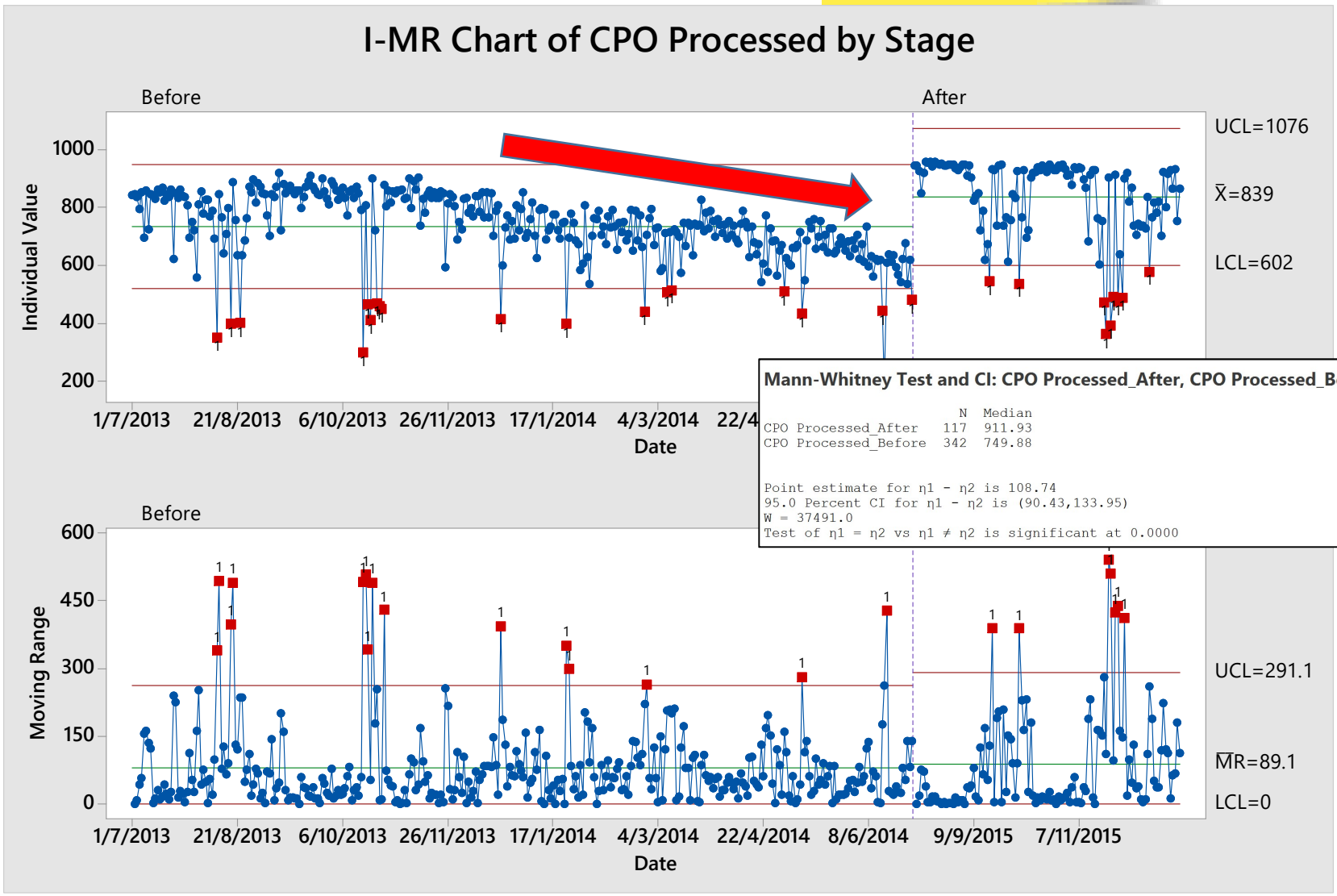
Deliverables	Oct 2014	Nov 2014	Dec 2014	Jan 2015	Feb 2015	Mar 2015	Apr 2015	May 2015	Jun 2015	July 2015	Aug 2015	Sept 2015	Oct 2015
D01: Define opportunity													
D02: Create project charter													
D03: Financial impact reconciliation												Planned	
D04: Project Communication												On Going	
M01: Conduct Dosing System Study												Completed	
M02: Verify process normality & capability													
TGR01: Tollgate review by BB#1													
A01: identify, Screen & verify KPIV through statistic test													
TGR02: Tollgate review by BB#2													
I02: Generate implementation plan													
I03: Conduct the improvement implementation													
C01: Verify the improvement & comparison													
C02: Establish control plan													
C03: Project handover, closure & handover													

TOTAL MAN DAY = 300 Days
Planned = 330 Days
No Of Meetings = 14 Meetings

The project has been conducted according to the **planned time schedule** and currently on track with the designated time frame

SD Austral Throughput Performance

What deadlines & deliverables?



Both Austral and GTM have recorded increase

Sime Darby Austral Processing Layout
Harvesting benefits calculation

Harvesting?

Phosphoric Acid

Reduction of Phosphoric Acid consumption :

= Daily SAP CPO Processed x (Current average Monthly dosage – Baseline dosage) x (Phosphoric acid price per tonne)

= Daily SAP CPO Processed x (Current average Monthly dosage – **0.0835%**) x (**RM 3600 per tonne**)

Additional Profit Margin

Additional Olein :

= (Daily SAP CPO Processed – Baseline SAP CPO processed Apr, May & June 14) x (Minimum Refinery Efficiency) x (Monthly average performance fractionation F1 & F2 combined) x (Minimum Fractionation Yield) x (GTM Olein sales price – (Average CPO price for the months + SDA Processing Cost)

= (Daily SAP CPO Processed – **749.88 MT/Day**)x (**94.886%**) x (Monthly average performance fractionation F1 & F2 combined) x (**75.254%**) x (GTM Olein sales price – (Average CPO price for the months + **RM 135**)

Additional Stearin :

= (Daily SAP CPO Processed – Baseline SAP CPO processed Apr, May & June 14) x (Minimum Refinery Efficiency) x (Monthly average performance fractionation F1 & F2 combined) x (1- Minimum Fractionation Yield) x (GTM Stearin sales price – (Average CPO price for the months + SDA Processing Cost)

= (Daily SAP CPO Processed – **749.88 MT/Day**)x (**94.886%**) x (Monthly average performance fractionation F1 & F2 combined) x (1-**75.254%**) x (GTM Stearin sales price – (Average CPO price for the months + **RM 135**)

The calculation have been discussed and agreed by **SD Austral, PSQM , GSQM, GTM and R&D.**

Project Result

Tangible

Indicator	Baseline	Target	COMPARE	Result	Potential Benefit at Closure
Acid Dosage	0.084%	0.058%	→	0.035%	RM527,903 /year
Bleaching Earth Dosage	1.014%	0.800%	→	0.70%	RM862,368 /year
Throughput *(Profit Margin)*	749.88 tonne/day	850.00 tonne/day	→	911.93 tonne/day	RM2,234,548 /year

Intangible

- Satisfied & delighted customers and stakeholders
- Greener products and better image of company
- Enculturation of improvement & performance oriented

Total LSS Benefit **RM 3,624,819/year**

Total Profit **RM1,153,346** up to Jan 16

VALIDATED

Conclusion:
Based on **results obtained at closure**, the **Potential Benefits at Closure has increased significantly** *(compared to Potential Benefits at Initial).*

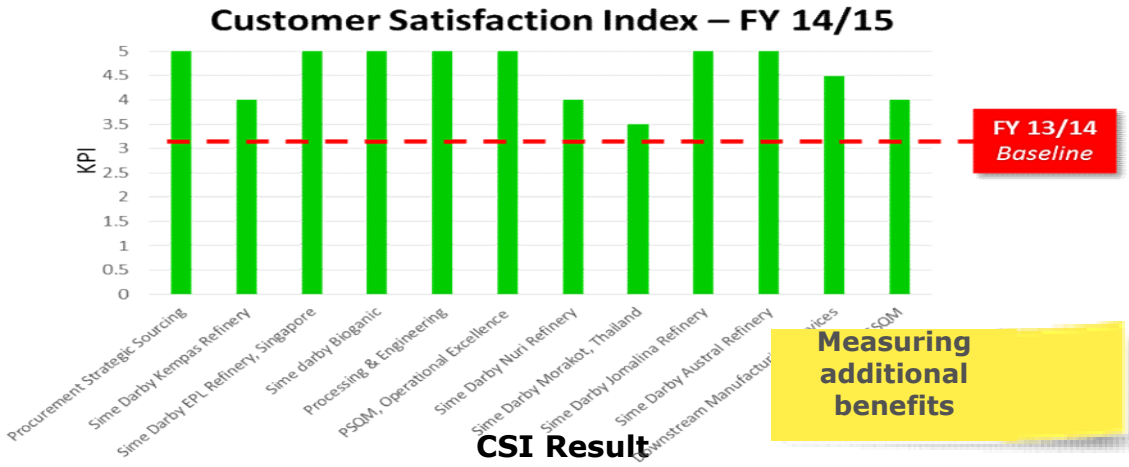
Project Results
"Soft Benefits"

ADDITIONAL POTENTIAL SOFT BENEFITS

- Customer Satisfaction Improvement
- Better RBDPO quality
- Minimize Downtime – Fully Degummed Oil

CSI Form

Soft benefits were inveterate through positive feedback received from the **CSI Survey** from our Operating Units.



CSI Result

Measuring additional benefits

Sustaining and Communicating Results

Sustaining Results Over Time

Communication to All Relevant Stakeholders
(to create organization's culture)

Evidence of sustaining the changes

Monthly Management Meeting

Monthly Management Meeting
Discussion on the Phosphoric Acid Consumption, monthly production cost and all relevant improvements in relation with this project was become one of the main agenda. Management was closely monitor the impact of this project to the overall production process.

Production Weekly Briefing

Production Weekly Briefing
After all of the improvements implemented, it were communicated to all internal stakeholders.
Weekly meeting become one of the common ground to share all of the progress, conflict and issue in regard with the project.

Communication Board

Communication Board
To make language visible and accessible for all staff, we display all improvements (kaizen sheets) into our information board where all of our staff can refer to and to boost our staff motivation for future improvement.

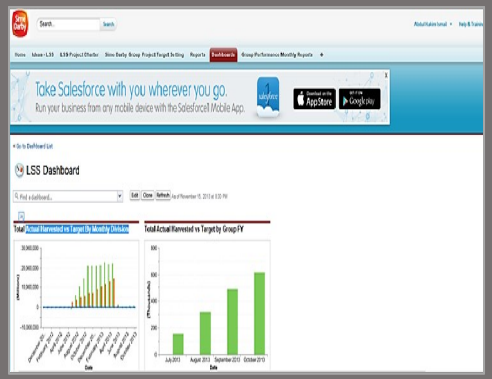
Sustaining Results Over Time

RISE

Sime Darby Plantation

Tools

Sustainability Management System (SMS)



Control Panel Display

Indicators

- Dosage of Phosphoric Acid
- Bleaching Earth Consumption
- Quality of Refined Oil
- % Refinery Utilization
- Niagara Filter Change Over Time

How To Measure?

- Amount of Phosphoric / Total CPO Processed
- Amount of Bleaching Earth/ Total CPO Processed
- FFA Color AV
- PV Phosphorus
- Actual/ Design
- Time in between change of Niagara Filter Leaf

Data Interval
- Daily
- Monthly
- Year To date

How Control

Color Coded Measurement

- Great
- Alert!!
- Alarm!!!

Communication of Results

R&D Technology Transfer Document

Research & Development (R&D) Colloquium

Communication to stakeholder

Champion PNB Quality Competition 2015

R&D Technical Review Committee

Sime Darby World Magazine

Yearly Sustainability Report

Sime Darby Plantation

Sime Darby Research Sdn. Bhd.

STRICTLY CONFIDENTIAL
00001

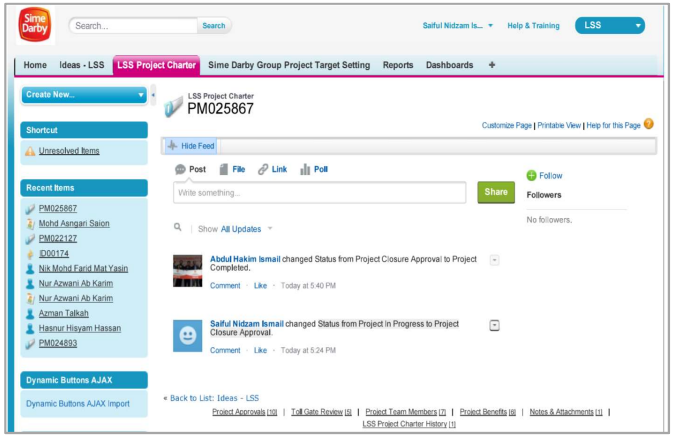
NEW PROCESS OVERVIEW FY14/15

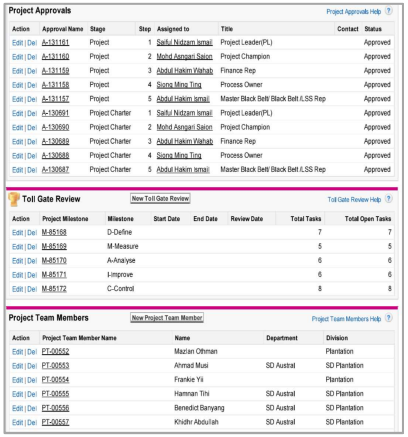
Company:	Sime Darby Plantation – SD Research
Project Owner:	1. Mohammad Saiful Nidzam Ismail – Team Leader 2. Dr. Razam Abd Latip
Project :	**Process Improvement at Refineries - Downstream**
Sub Project:	**Reduction of Phosphoric Acid dosage in degumming process** **To reduce the Monthly Average dosage of Phosphoric Acid in Degumming Process at SD Austral from baseline 0.074% to 0.058% through process optimization by July 2015**

Communication of Results

Sime Darby Group Sustainability Day

Official Project Closure and Handover





Newspaper Publication – Sharing to Public Community

B6 BISNES JUMAAT 15 APRIL 2016 BH

PROGRAM LEAN SIX SIGMA

Sime Darby yakin raih RM775 juta

Razali (enam dari kiri), Mohd Bakke (tujuh dari kiri) dan Azman Shah (lima dari kanan) bersama pasukan Carey Owl Knights selepas

» RM400 juta manfaat terkumpul sejak 3 tahun

Oleh Mahanum Abdul Aziz
mahanum_aziz@bh.com.my

Penjimatan kewangan

Sime Darby Bhd optimis mampu mencapai sasaran untuk meraih jumlah manfaat terkumpul RM775 juta menjelang tahun kewangan 2016/2017 menerusi pelaksanaan program Lean Six Sigma (LSS).

Program yang diperkenalkan konglomerat itu pada 2013 adalah strategi pengurusan perniagaan untuk meningkatkan pendapatan, mengurangkan kos dan meningkatkan kualiti produk menerusi pembuangan sisa, kecacatan dan kesilapan.

Ketua Kecemerlangan Operasi Sime Darby, Azman Shah Mohamed Noor, berkata dalam tempoh tiga tahun pelaksanaan program itu, pihaknya sudah mencatatkan jumlah manfaat lebih RM400 juta.

"Berdasarkan prestasi semasa, kami yakin mampu mencapai sasaran jumlah manfaat terkumpul RM775 juta lebih awal," katanya selepas majlis penyerahan bendera Malaysia kepada Pasukan Sime Darby dikenali Carey Owl Knights di Kuala Lumpur, semalam.

Pasukan itu akan mewakili Malaysia di Pertandingan Anugerah Pasukan Antarabangsa Cemerlang (ITEA) ASQ 2016 yang diadakan sempena Persidangan Dunia mengenai Kualiti dan Kemajuan (WCQI) di Wisconsin, Amerika Syarikat, bermula 16 hingga 18 Mei ini.

Pada majlis itu, turut diadakan penyampaian Anugerah Juara Industri bagi Produktiviti, Syarikat Berkaitan Kerajaan (GLC) kepada Sime Darby oleh Perbadanan Produktiviti Malaysia (MPC) serta penyampaian penghargaan kepada Azman Shah berikutan sumbangan beliau terhadap pembentukan Pelan Hala Tuju Produktiviti Nasional.

Award and Recognitions

American Society for Quality

2016 International Team Excellence Award Finalist

"Organizational Impact"

Sime Darby - RISE

Sime Darby Innovation Award 2016

Institute of Chemical Engineer

Malaysia AWARDS 2016 Finalist
IChemE

Palm Oil Award Finalist
IChemE Malaysia Awards 2016
www.icheme.org/malaysiaawards

Sustainable Technology Award Finalist
IChemE Malaysia Awards 2016
www.icheme.org/malaysiaawards

Sime Darby 3P Policy

Future

SD Sustainability is a company's commitment to operate in an **economically, socially** *and* **environmentally** *sustainable manner whilst balancing the interests of a diverse range of stakeholders – holistic.*

- *Lower chemical consumption*
- *Lower waste generation*
- *Lower CO_2 footprint*
- *Greener product*

- *Better quality oil*
- *Better oil stability*
- *Lower oil contaminant*

- *Higher customer confidence on product*
- *Lower processing cost*
- *Higher profit*
- *Provide product superiority*
- *Sustainable business*

This project also impacted and created value to stakeholders by upholding **Sime Darby's 3P Policy** which displays Sime Darby's **commitment** to operate in an economically, environmentally and socially sustainable manner whilst balancing the interests of a **diverse range of stakeholders**.

The Fun Time

Please sit back, relax and enjoy……

Thank you

"Without data you're just another person with an opinion"

- W. Edwards Deming

RISE

Sime Darby Plantation

Thank you

-THE END-