UNIVERSITI TEKNOLOGI MARA

PETRONAS

INDUSTRIAL TRAINING FIELD REPORT

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LI Duration:	22nd March 2021-15th July 2021

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1.0 INTRODUCTION

Industrial training is an important part in engineering study. Theories learnt can be applied into the real working environment in the chemical engineering industries. During the industrial training, I trained to make job applications before stepping into the real working environment. Exposure to working environment is necessary since study and working environment is completely different in every aspect. Industrial training is not focused on application of the knowledge that I learnt; communication skills also important in working field.

There are a few objectives that should be achieved at the end of industrial training. Firstly, students able to identify the types of work that chemical engineers do in real engineering world and appreciate the theoretical knowledge learnt. Next, students can perform engineering basics, including technical writing report, communications with colleagues, handling project and generating proposal for betterment of industries. Other than that, students should be able to have higher level of integrity, ethical and accountability in practicing energy.

During industrial training, students might be participating in equipment design, familiarization with real PID and PFD and production of products related with chemical engineering. Participation in some of the project in company is important. This is the chance for student to apply their knowledge into the company and gain more knowledge by asking to the colleagues. Students should complete minimum 17 weeks of industrial training to earn total 7 credit hours.

I was doing my internship at Regas Terminal Sungai Udang, Melaka. The duration of my internship is started from 22 March 2021 until 15 July 2021. I worked under operations department and my job scope during internship is related with material and energy balance,gas transmission and regasification. My internship was supervised by Encik Muhammad Muhaimin Mohamad who worked as production planner at Regas Terminal Sungai udang.

Figure 1: Board of Directors Petronas Gas Berhad

2.1.2 COMPANY VISION AND MISSION

VISION

A leading gas infrastructure and utilities company

MISSON

- We are a business entity
- Gas infrastructure and utilities is our core business
- We operate safely, reliably and competitively
- We optimise the gas value chain to maximise returns for our stakeholders

2.1.3 NATURE OF BUSINESS

Products manufactured in the regasification terminal is natural gas. Liquefied natural gas will passed through regasification process to produce natural gas and it will be supplied to our client such as Tenaga Nasional Berhad (TNB) and Gas Malaysia Berhad (GMB).

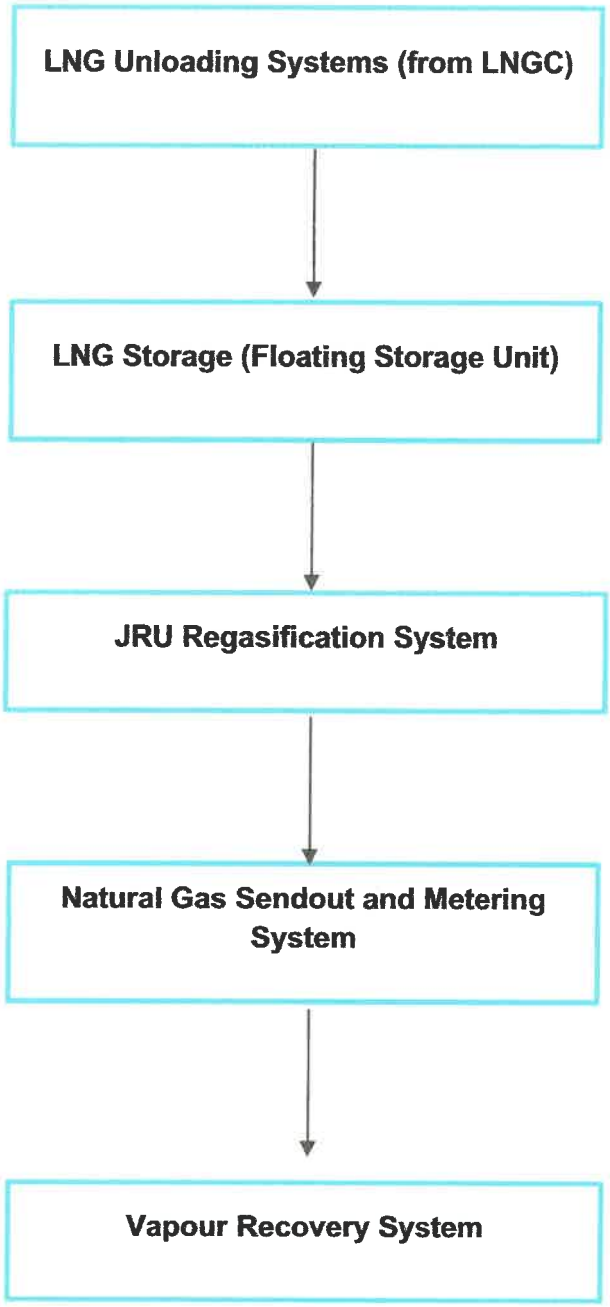
2.1.4 HISTORY OF THE COMPANY

PETRONAS

Petroliam Nasional Berhad which also known as Petronas is a Malaysian oil and gas company. It established in 1974 and fully owned by the Government of Malaysia, the corporation is vested with the entire oil and gas resources in Malaysia. Other than that, it is entrusted with the responsibility of developing and adding value to these resources. The group is engaged in broad spectrum of petroleum activities, including production of oil and gas to downstream oil refining, upstream exploration, gas transmissions pipeline network operations, petrochemical manufacturing, automotive engineering, gas processing and liquefaction and property investment.

Petronas can be divided into a few divisions which are Petronas Dagangan Berhad, Petronas Gas Berhad, MISC Berhad and the else. Regasification Terminal Sungai Udang operated under Petronas Gas Berhad Involved in the provision of gas processing and transmission services to Petronas and its customers as a throughput company. PGB's Gas Transmission and Regasification (GTR) Division operates and maintains our offshore Liquefied Natural Gas (LNG) Regasification Terminal in Sungai Udang, Melaka (RGTSU) and our onshore LNG Regasification Terminal in Pengerang, Johor (RGTP). RGTSU began its commercial operation in the second quarter of 2013, while RGTP began its commercial operation in the fourth quarter of 2017. Vision for PGB is a leading gas infrastructure and utilities company. The facilities receive vessels carrying LNG from around the world and offer a wide range of services including LNG regasification, LNG reloading and gassing up cooling down.

2.2 PROCESS FLOW



2.2.1 LNG Unloading Systems (from LNGC)

LNG unloading system comprises of two 16° liquid LNG loading arms (Z-3520A/B), one 16° vapour return arm (Z-3645) and one 16° hybrid arm (Z-3520C). The hybrid arm acts as a standby arm that can be used for vapour return or LNG unloading. It can be used if that any arm is out of service and the unloading LNG can still be done. Other than that, it also can be used if the unloading rate is greater than 10, 000 m^3/h. In order to switchover Z-3520C from liquid return to vapour return, an appropriate piping connection is provided.

The LNG liquid is pumped to the vaporizers by HP LNG Booster Pumps. These pumps pressurize the LNG to the required gas export pressure. The discharge pressure of the pump is approximately 102 barg in order to cater for the maximum send out pressure of 68.95 barg at the inlet of subsea pipeline. Regasification unit comprises of three trains.Two 50% pumps are located in each regasification skid. Each pump has their own rated capacity which is 221 tons/h. The purpose of regasification unit is to vaporize the liquid LNG to natural gas. A minimum gas temperature must be achieved at the battery limit which is 15°C. For some cases such as leanest LNG and highest BOG, the regasification units are designed to operate over the full range of pressure from 40 barg to 68.95 barg at the design send out rate of 442 tons/hr.

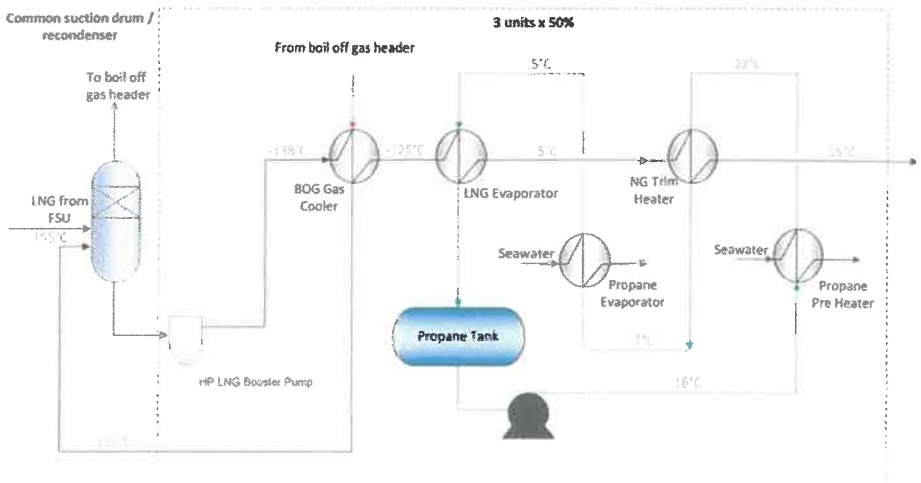


Figure 2: Simplified schematic of regasification unit

The regasification process selected for the facility is Intermediate Fluid Vaporiser (IFV). Propane and seawater is used to heat up LNG and produce natural gas. There are two stage heating and vaporization of LNG that performed by using propane as heating medium. Firstly, LNG is preheated in the LNG/BOG exchanger (BOG Gas Cooler) to -125°C. The BOG gas cooler is one of the parts in Recondenser system.

Then, it will be followed by a LNG/Propane exchanger (LNG evaporator), where LNG is heated by condensing propane. The propane gas enters the PCHE and is condensed. The propane is heated by seawater in a 3-stage plate and frame heat exchangers. In this system, cascade concept is used instead directly heat exchanging with seawater to reduce the risk of freezing the seawater in the heat exchanger. Propane act as secondary medium selected due to its thermodynamic properties with low freezing point.

2.2.4 Natural Gas Sendout and Metering System

Natural gas sendout system receives the natural gas from the regasification unit via a 24° header. The natural gas sendout pressure varies between67.5 barg which is maximum operating pressure down to 40 barg and it depends on the downstream PGU pressure. The metering system consists of two by 100% metering runs one in operation and the other will being as a spare. The function of meter run is to perform the measurement of the quantity and quality of natural gas exported. Each meter run is equipped with one ultrasonic flow meter with pressure and temperature compensation also one gas chromatograph to determine gas composition, calorific value, Wobbe Index, moisture analyzer and dew point analyzer. A receiver is provided to allow pigging of the subsea gas pipeline.

Pigging only be required on initial commissioning and intelligent pig surveys as required by the Regulatory Authority because the export gas is non-corrosive and does not contain liquids. Low low pressure trip is provided to detect low pressure of the gas export pipeline. If the rate of decrease in pressure exceeds a set value, the riser valve will also be closed to minimize hydrocarbon release.

2.2.5 Vapour Recovery System

Boil off gas is generated in the system due to heat input from a few sources such as pressure changes, pump heat of the LNGC pumps, heat leak from atmosphere through insulation into the storage tanks, pump heat of the FSU in-tank pumps and displacement of vapour from FSUs by incoming liquid during LNGC unloading into the FSUs. Boil off gas have been removed and recovered to maintain constant pressure in the FSU's LNG storage tank. There are two modes of operation for the BOG recovery system which are LNG unloading mode with simultaneous send out to regasification and holding mode (normal send out with no LNG loading to the FSU).

The number of operating compressors is depending on the types of operations modes. For holding mode, one BOG compressor will be in operation meanwhile three BOG compressors will be in unloading mode. Some of the BOG generated is used for power generation within the FSU. BOG system is able to accommodate all normal operating modes without flaring.

2.3 WEEKLY ACTIVITIES

WEEK 1: LEARNING ABOUT REGASIFICATION PROCESS

On the first day of internship, supervisor briefed about background of the company and process involved in regasification terminal. I also learnt about Personal Protective Equipment used in the plant.

WEEK 2: LEARNING ABOUT THE APPLICATION OF MATERIAL & ENERGY BALANCE

Supervisor explained about my job scope during internship which related with material and energy balance. I need to fill all the data required for material and energy balance calculation for every month. Supervisor guided me to fill all the data to ensure all the data filled in is correct.

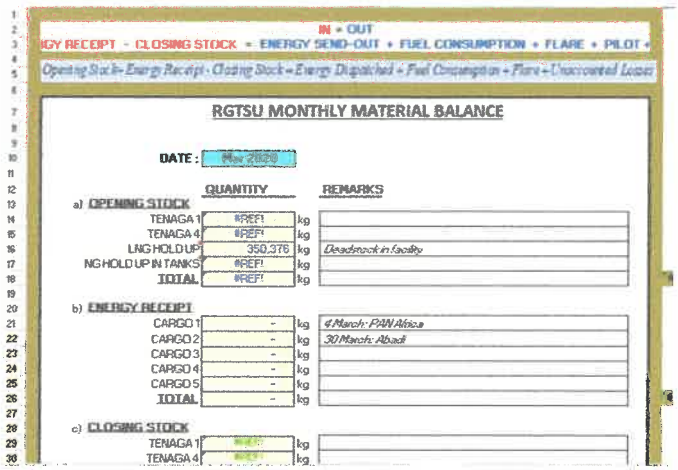


Figure 3: Material & Energy Balance Template

WEEK 3: LEARN AND IDENTIFY EQUATION RELATED WITH MATERIAL & ENERGY BALANCE

Supervisor assigned me to find the relationship between gas law equation and the excel formula for material and energy balance. I presented the relationship between them to my supervisor.

Figure 4: Formula used in Material & Energy Balance for Excel File

WEEK 4: LEARN ABOUT THE GHV AND DENSITY OF LIQUEFIED NATURAL GAS

I learnt about the correlation between GHV, density and cargo source in transferring data for the material and energy balance. GHV and density value are depending on the cargo source. If the LNG came from the same cargo source, the GHV and density value will be being the same.

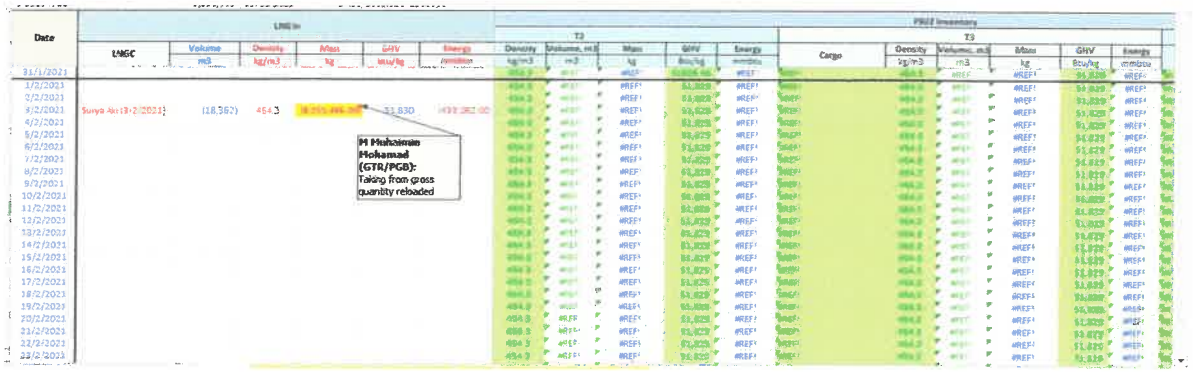


Figure 5: Template for GHV and Density Data

WEEK 5: LEARN ABOUT REGAS MANAGEMENT SYSTEM (RMS)

Joined the meeting handled by the supervisor regarding Regas Management System (RMS). The system is used to transfer all data related with mass and energy balance. For density, I need to do the conversion unit because the unit used in the system is different with the unit used in the Excel file.

WEEK 6: LEARN ABOUT CYCLIC HAZOP FOR RGTSU

Learn about the application of Hazop Table that have been studied. Colleague handled a meeting to discuss about the hazop cyclic for RGTSU in every part of operations or systems.

WEEK 7: UPDATE RGTSU MASS BALANCE APRIL 2021

Transfer all the data from FSU report for April 2021 into input data table. Other than that, transfer the data into the RMS. After completing all the data, submit the updated file to the supervisor.

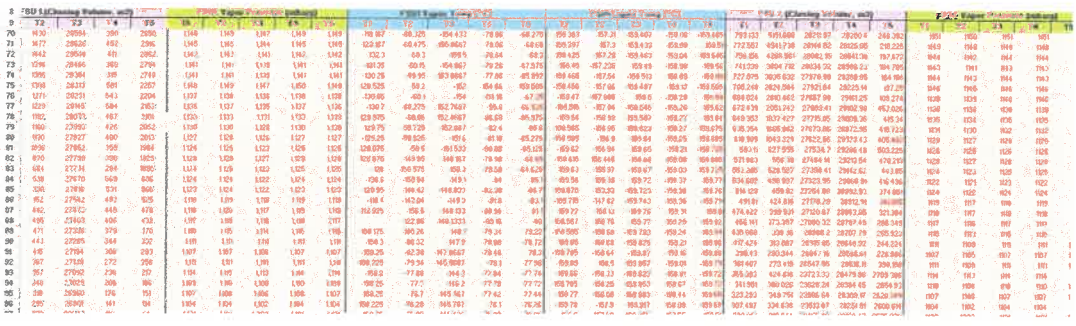


Figure 6: Input Data Table

WEEK 8: LEARN ABOUT REGASIFICATION PROCESS

Study about the operation procedure for regasification process. Regasification process is the main process involved in RGTSU. It is because we can produce our product which is natural gas through regasification.

WEEK 9: UPDATE eLOG TROUBLESHOOTING

I have been assigned to update eLOG Troubleshooting for RGTSU into the system. I joined the meeting to learn about the troubleshooting, which is required for every system such as maintenance, mechanical and electrical. eLOG Troubleshooting is a list of actions that should be taken if there is any incident or event happened.

WEEK 10: IDENTIFY LEVEL CRITICAL & UPDATE CHA RISK ASSESMENT

I have been assigned to identify level of critical for every listed event or incident. I need to update the level of hazardous and criticality for the event. Other than that, I learnt that preparation for any incident or event is important in the plant system.

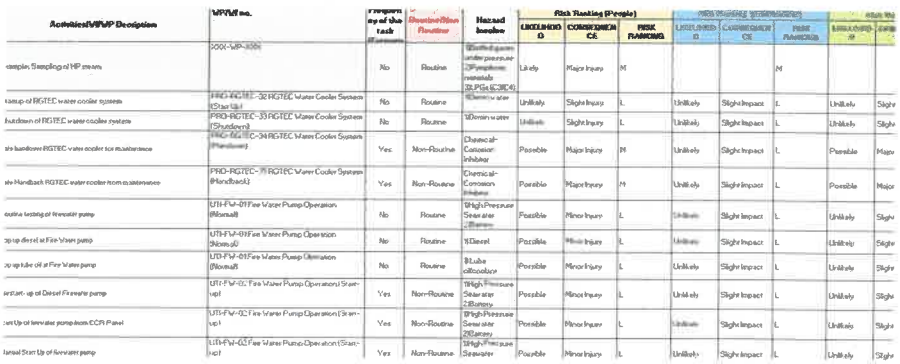


Figure 7: CHA Risk Assesment

WEEK 11: UPDATE OPERATING PROCEDURE

Transfer all the operating procedure into the new template. The operating procedure consist of startup, shutdown, and the process itself. The updated operating procedure is important for further reference.

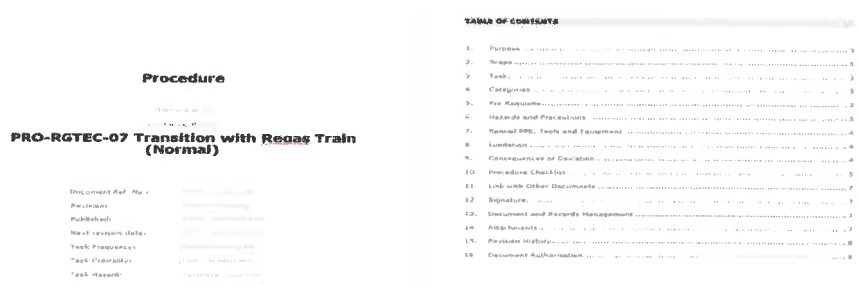


Figure 8: Operating Procedure Template

WEEK 12: SUBMIT NEW TEMPLATE FOR RGTSU MASS ENERGY BALANCE

I have been assigned to prepare the new template for mass energy balance. I have compiled the input data table into the mass energy balance file. It will ease the process of referring data.

WEEK 13: PREPARE SLIDE PRESENTATION EBM FLM COMPLIANCE ANALYSIS

Helped one of the colleagues to prepare slide EBM FLM compliance Analysis from January 2021 to April 2021. There is a few information needed in the slide which are total manhour and cost saving analysis. Total manhour is separated for instrument and mechanical.

WEEK 14: STUDY ABOUT THE PROBLEM STATEMENT OF MINI PROJECT

Identify the problem statement for the mini project. I applied the knowledge of fault tree analysis to understand the roots or causes that leads to the problem statement.

WEEK 15: LEARN ABOUT ELECTROLYZER

Electrolyzer is the equipment used to produce hypochlorite from seawater. The operation procedure electrolyzer same as electrolysis which involved the electrode, cathode, and anode.

WEEK 16: LEARN ABOUT RGTSU HYPOCHLORINATOR PERFORMANCE

I observed RGTSU hypochlorinator performance to study the effect of fouling to the performance. The performance reduces by year from 2013 to 2019 due to the fouling.

WEEK 17: STUDY ABOUT THE SOLUTION PROPOSED TO SOLVE THE PROBLEM

I learn about the solution that have been proposed to reduce the biofouling that occur in electrolyzer. Solution is focused on the type of pipe, maintenance method and material of pipe.

2.4 MINI PROJECT: REDUCTION OF BIOFOULING IN ELECTROLYZER

Figure 9: Electrolyzer

An electrolyzer is a system that have been used to produced hypochlorite from seawater. Hypochlorination is a process of producing hypochlorite by passing electric current through seawater. This process is running in the electrolyzer system. The purposes to produce hypochlorite are for biofouling control as well as for disinfection, bleaching and deodorizing purposes.

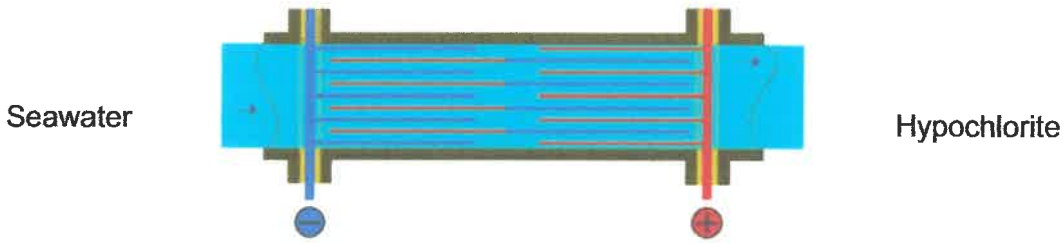


Figure 10: Flow of Elctrolyzer

The chemical equation that has been used for this process is:

$$Salt + Water + Energy = Sodium\ Hypochlorite + Hydrogen$$

$$NaCl + H_2O + 2e = NaClO + H_2$$

Free chlorine from seawater will be generated at the anode.

$$2Cl^- \rightarrow Cl_2 + 2e^-$$

Hydrogen is discharged at cathode with the formation of OH^- ions.

$$2H_2O + 2e^- \rightarrow 2OH^- + H_2$$

OH^- ions moved from the cathode and react with Na^+ and Cl_2 at the anode to produce sodium hypochlorite.

$$2NaOH + Cl_2 \rightarrow NaOCl + NaCl + H_2O$$

Problem Statement

GRVE piping inside torn leading to pipe clog which constraint sodium hypochlorite supply to seawater caissons, resulting to potential repair cost of RM200k

Object : Sodium Hypochlorite injection line to users (SW, USW, FW Pumps)

Defect/issue : Torn inside GRVE piping

Impact : Inability to supply sodium hypochlorite to users leading to potential damage to pumps due to marine growth

Category	Remarks
People	No personnel injury
Environment	No impact
Asset	Repair cost of RM200,000
Reputation	No Impact

Finding

Byproducts

Post-Cleaning

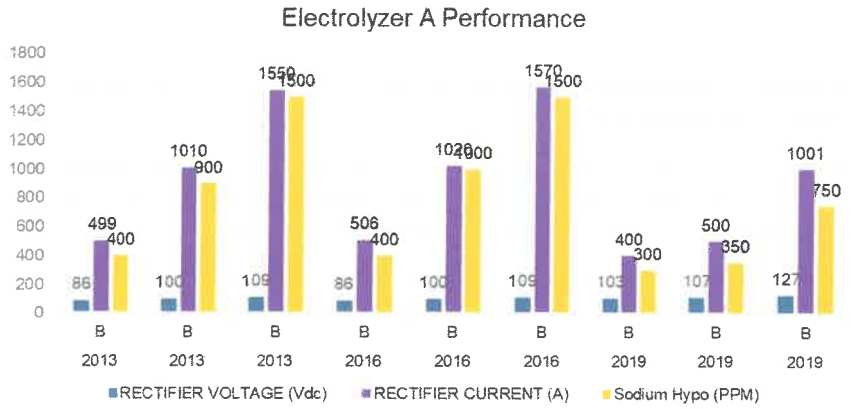


Figure 11: Graph for Electrolyzer A Performance

Electrolyzer A has been replaced in 2019 which last value of current at 1001 amp and producing 750 PPM of sodium hypochlorite. Electrolyzer A has been replaced in 2019 which last value of current at 1001 amp and producing 750 PPM of sodium hypochlorite. The decreasing of performance due to high scaling and deposit at electrocell which create resistance and reduce its surface area.

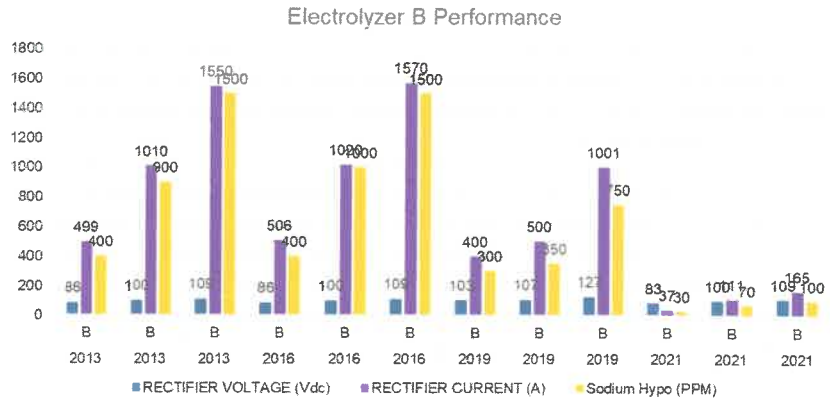


Figure 12: Graph for Electrolyzer B Performance

The efficiency current of the electrolyzer B is decreased about 89.3% causing reduction of sodium hypocloride production about 93.3% from 2013 until 2021.The decreasing of performance due to high scaling, deposition, and depletion of electrocell. The reduction in performance of electrolyzer caused by the fouling occur in the electrolyzer pipeline.

Biofouling is the colonization of submerged surfaces by incrustations and slimes. Incrustation occurs caused by hardshell such as Barnacles and Mussels meanwhile slimes caused by the bacteria and algae. There are a few impacts happened due to the biofouling that occur such as reduce cooling water flow, reduce heat exchanger efficiency, and corrode

condenser pipes.Other than that, low seawater flow also can leads to the fouling. Fouling takes place as soon as electrolysis begin.

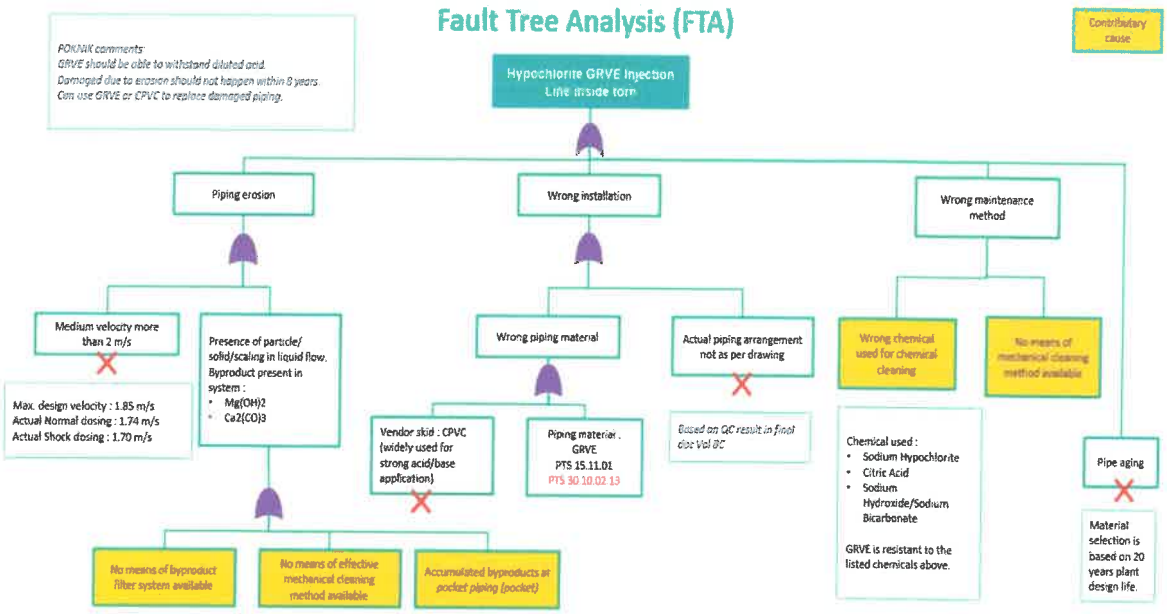


Figure 13: FTA Analysis for Hypochlorite GRVE Injection Line Inside Torn

By referring to the problem statement of the project, we are using Fault Tree Analysis (FTA) to find the solution that can be proposed to solve the problem in the system. As what we know, the main function of FTA is to explore the causes of system level failures and this is the place that we can apply the knowledge that I have been learnt in UiTM for the subject safety and health. From the FTA, there are four causes for the hypochlorite GRVE injection line inside torn. Piping erosion, wrong installation, wrong maintenance method and pipe aging are the main causes that have been identified.

Pipe erosion can be defined as the process by which the internal surface of a pipe deteriorates due to the abrasive action of moving solid particles and gas bubbles present in the sewage flow. These particles are suspended in the flow and the problem can be aggravated if corrosion is already present in the pipe. This can lead to a loss of strength of the pipeline and can lead to failure of the system. In this system, there are two causes that might be led to the piper erosion which are medium velocity more than 2 m/s and presence of particle or solid in liquid flow. The maximum design velocity for the system is 1.85 m/s meanwhile the actual dosing for hypochlorite is 1.74 m/s and actual shock dosing is 1.7 m/s. When the flow exceeds the maximum design velocity, the piping will not be being worked

properly because it does not follow the specifications of the piping design. The presence of particle or solid in liquid flow is because of the electrolysis produced chemical by-products. The chemical by-products that have been produced are Magnesium Hydroxide (Mg (OH_2)) and Calcium Carbonate ($Ca_2(CO_3)$). In this case, we have been identified that the flow can be controlled manually and the presence of solid or particle is the main reason that led to the pipe erosion. Under the presence of solid or particles, there are a few causes which are no byproduct filter system available, no effective mechanical cleaning method available and accumulated byproducts at pocket piping (pocket).

Wrong maintenance method also can lead to the hypochlorite GRVE injection line inside torn. Maintenance is the most important thing that should be done in the system to prevent any event or incident. The method used for maintenance should be suitable for the system. Wrong chemical used for chemical cleaning and no mechanical cleaning method available are the errors that lead to our main problem. The chemicals used for chemical cleaning are Sodium Hypochlorite, Sodium Hydroxide/Sodium Bicarbonate and Citric Acid. All the chemicals used are resistant to GRVE piping and the chemical cleaning process does not be done correctly. Mechanical cleaning method should be provided in the system. It is because we cannot depend on the chemical cleaning method. The maintenance for the piping, pump and others should be provided.

Pipe aging is not included as the main causes that led to the problem statement. It is because GRVE piping can be used over 20 years. After reviewed all the details in the FTA, the solutions that can be proposed to solve the problem are related with the type of piping, removal of by-products and maintenance method.

Solutions

- **Replace GRVE piping material to CPVC as per vendor skid.**
  Type of piping used in the system plays important role to run our system. GRVE piping is glass reinforced vinyl ester which usually used for end-user at marine and petrochemical industry. It is resistant to any corrosive liquids which is good to prevent any corrosion might be occur. From fault tree analysis (FTA), chemicals used for the chemical cleaning method are sodium hypochlorite, sodium bicarbonate/hydroxide and citric acid. All the chemical used for chemical cleaning are resistant with GRVE piping. This sown there will have no effect in chemical cleaning. To improve the cleaning method, replace GRVE piping material to CPVC as per vendor kid is one of the actions that we can made. Chlorinated PolyVinyl Chloride (CPVC) often outperforms metallic systems and is more cost effective over a longer period. CPVC

has smooth inner surface that resists scaling and fouling, which minimizes friction pressure losses in the fluid flow from the beginning. CPVC starts with a C-factor of 150 and maintains that interior surface smoothness throughout its life by resisting the effects of corrosives. This leads to greater efficiency and reduced costs to facilities because smaller pipes, smaller pumps and less energy can be used to move fluids at the same rate. The action of replacing GRVE piping to CPVC is only at vendor part meanwhile the type of piping for ranhill will not being changed to reduce the cost and the fouling occur focused on the electrolyzer.

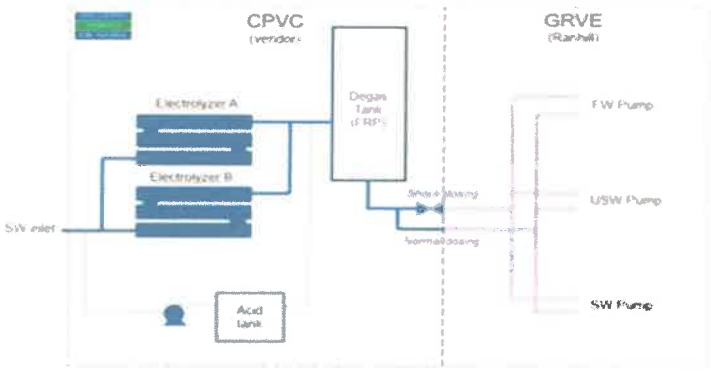


Figure 14: Schematic Diagram for Electrolyzer

- **To remove 'pocket' piping in new replaced line.**

  It is essential to have air-releases valve in designing piping systems. As air pockets accumulate in a system, the air-release valves will vent the pockets. If the pipeline is flat and the inside surface of the pipe is very rough, or if the pipeline slopes downward, the fluid velocity may not be sufficient to keep the bubbles moving. This can cause pockets of air to form at the high points and will begin to affect the liquid flow areas. Liquid flow plays an important role in controlling the reduction of biofouling. One of the causes that lead to the accumulation of by-products is the uneven flow of seawater. Furthermore, pocket piping cannot be applied on random place in the system. There are a few conditions that do not allow the pocket piping to being applied. The examples for the conditions that do not allow pocket piping are line from the condenser to the accumulator, overhead Vapor Lines (from a fractionation Column to the condenser) and all lines up-stream of a vapor Relief valve. Pocket piping is replaced to the suitable line which not involved flow of seawater since the uneven flow of seawater may lead to the biofouling.

Figure 15: Piping system for Electrolyzer

- To install scalling trap and lowest point total allow by-products removal.
  Scalling trap is important for by-products removal. Based on what have been stated, by-products I the main things that need to remove to prevent any impacts that might disturb the system. Scalling trap will being put in the end of electrolyzer to remove the by-products.

Figure 16: Scalling Trap

- To use unions to allow pipe dismantling in case of the need of inner pipe cleaning.
  We choose unions to allow pipe dismantling instead of coupling. It is because it allows future disconnection of the pipes for maintenance. It will ease the process of disconnection in inner pipe cleaning.

3.0 CONCLUSION AND RECOMMENDATIONS

In conclusion, industrial training is an important component. It is because I can gain more knowledge and apply everything that I learnt in real working environment. For example, I learnt how to apply knowledge related with material and energy balance since my job scope during my internship is focused on it. Other than that, I realized that we should lowering our expectation for the internship. The knowledge that we gain during our diploma is not enough to use in engineering working field and a lot of things that we need to study. Communication with the colleague is important to make our works easier and less stress. During my internship, my supervisor guided me to adapt with working environment and give more exposure regarding working environment for engineering field. I have been receiving a few criticism and advice from my colleague in completing my works and I will not repeat same mistakes on other times. Along the internship period, I noticed that if we are studied in engineering field, our future career is not limited to being an engineer only. It is because engineering provides a lot of future career such as production planner, pipeline analyst and others.

For recommendation, students should apply and submit their resume two or three months before the internship started. It is because most of company will receive the resume two or three months before it started. Next, I recommend for the UiTM to allow the students submit their report and logbook in a softcopy due to this Covid-19 pandemic. It is because students not being able to send their report personally at UiTM. As what we know, we can still submit the hardcopy of our report and logbook through postage. Any problem might be happen caused by the courier and by submit our logbook and report in a softcopy only, it will be being much easier.