

LEVEL 4 ASSESSMENT SPECIFICATION

Student name:	<i>Rhys Rackley</i>	Student ID number:	<i>131831</i>
Programme:	HNC Process Operations Engineering		
Module:	Environmental Protection and Sustainable Manufacturing Systems		
Module code:	PCPO4003	Contribution to Overall Module Assessment (%):	100%
Lecturer:	Richard Wray	Internal Verifier:	Lance Rutherford
Assignment Title:	Research Report	Word count (or equivalent):	2000
Submission deadline:	15/05/19	Return date of provisional marks & written feedback:	29/05/19
Submission method:	All written assessments, where practical and possible, must be submitted via Turnitin unless otherwise instructed by the Lecturer. (Please DO NOT put this assessment specification into Turnitin or it will match many similarities with other students' submissions.) Alternative submission method (if applicable): Late submission of the assessment will result in a late penalty mark. Penalties for late submission: Up to one week late, maximum mark of 40%. Over one week late, 0%. Only the Extenuating Circumstances Panel may approve a change to submission dates.		
Academic honesty / referencing:	Academic honesty is required. In the main body of your submission you must give credit to authors on whose research and ideas your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have used, cited or quoted in order to complete this assessment.		

Module Learning Outcomes (from module syllabus)
LO1, LO2.

TASK DESCRIPTION

Investigative report

There are many examples of industrial manufacturing plant, equipment and process that pose a potential risk to the environment and/or where operations may meet or fall short of the requirements for sustainable manufacturing.

For this assignment you are required to analyse a chosen industrial process at your place of work with respect to environmental protection and sustainable manufacturing systems.

Research Guidance

- Fully research the industrial plant, equipment and manufacturing process design and operation
- Evaluate specific aspects associated with meeting environmental protection, legal requirements and best practice
- Evaluate specific aspects associated with ensuring sustainable manufacture can be achieved through efficient equipment, plant and process operation
- Develop conclusions and recommendations on how the process could be improved with respect to environmental protection and manufacturing sustainability

Note: When choosing a work based plant, equipment or process please ensure you have your employers permission to use relevant information in your assignment. Do not include names of personnel or commercially sensitive information.

Research evaluation

You will produce the written report in a clearly structured and professional manner. The report should evaluate the findings of your research and present logical arguments and conclusions. It is expected that you will organize your report following a pattern to that suggested below:

- A brief abstract
- An introductory section outlining the background, the scope and intended readership
- A clear statement of the aim and objectives of the report
- Central sections, explaining any findings, arguments and outcomes
- A suitably structured conclusion that draws together the findings of your research and any recommendations you are making

When writing your report make sure that you:

- Use acceptable academic language and tone
- Check spelling and grammar
- Show that you can evaluate evidence from reference sources and use this material to make a logical and consistent argument
- Make sure that you analyse and evaluate arguments and evidence in a way that meets your stated outcomes and objectives

Report structure

The report document must be constructed in a formal and professional manner using an appropriate word-processed program. The completed report should contain the following sections:

- A cover page or document title page
- A table of contents page
- Sections or paragraph headings related to each aspect of the report
- Headers on each page with the title of your report
- Paragraphs should be spaced using '1.5 line spacing'
- Footers on each page with the author's name on the right hand side and 'Page ... of ...' on the left
- A references page and bibliography as appropriate
- Appendices where appropriate for larger quantities of data
- Diagrams, charts or tables, suitably incorporated and labelled
- The text format should be Times New Roman or Ariel with a font size of 12
- A word count of 2000 words ($\pm 10\%$)

GUIDANCE FOR STUDENTS IN THE COMPLETION OF TASKS

NOTE: The guidance offered below is linked to the five generic assessment criteria overleaf.

1. Engagement with Literature Skills

Your work must be informed and supported by scholarly material that is *relevant* to and *focused* on the task(s) set. You should provide evidence that you have accessed an appropriate *range* of sources, which may be academic, governmental and industrial; these sources may include academic journal articles, textbooks, current news articles, organisational documents, and websites. You should consider the *credibility* of your sources; academic journals are normally highly credible sources while websites require careful consideration/selection and should be used sparingly. Any sources you use should be current and up-to-date, mostly published within the last five years or so, though seminal/important works in the field may be older. You must provide *evidence* of your research/own reading throughout your work, using a suitable referencing system, including in-text citations in the main body of your work and a reference list at the end of your work.

Guidance specific to this assessment: You must provide evidence of individual research with respect to the area of study and provide relevant referencing.

2. Knowledge and Understanding Skills

At level 4, you should be able to demonstrate knowledge of the underlying concepts and principles associated with your area(s) of study. *Knowledge* relates to the facts, information and skills you have acquired through your learning. You demonstrate your *understanding* by interpreting the meaning of the facts and information (knowledge). This means that you need to select and include in your work the concepts, techniques, models, theories, etc. appropriate to the task(s) set. You should be able to explain the theories, concepts, etc. to show your understanding. Your mark/grade will also depend upon the *extent* to which you demonstrate your knowledge and understanding.

Guidance specific to this assessment: Your report should show you gained knowledge of the subject area.

3. Cognitive and Intellectual Skills

You should be able to present, evaluate and interpret qualitative and quantitative data, in order to develop lines of argument and make sound judgements in accordance with basic theories and concepts of your subject(s) of study. You should be able to evaluate the appropriateness of different approaches to solving problems related to your area(s) of study and/or work. Your work must contain evidence of logical, analytical thinking. For example, to examine and break information down into parts, make inferences, compile, compare and contrast information. This means not just describing what! But also justifying: Why? How? When? Who? Where? At what cost? You should provide justification for your arguments and judgements using evidence that you have reflected upon the ideas of others within the subject area and that you are able to make sound judgements and arguments using data and concepts. Where relevant, alternative solutions and recommendations may be proposed.

Guidance specific to this assessment: The report should show analysis of the research.

4. Practical Skills

At level 4, you should be able to apply the basic underlying concepts and principles to evaluate and interpret these within the context of your area of study. You should be able to demonstrate how the subject-related concepts and ideas relate to real world situations and/or a particular context. How do they work in practice? You will deploy models, methods, techniques, and/or theories, in that context, to assess current situations, perhaps to formulate plans or solutions to solve problems, or to create artefacts. This is likely to

STUDENT FEEDBACK FORM

This section details the *extent* to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Name: Rhys Rackley

Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills		
Good: Engagement with an appropriate range of literature, including sources retrieved independently. Some over-reliance on texts rather than other sources. Referencing may show minor inaccuracies or inconsistencies.	25	14
2. Knowledge and Understanding Skills		
Very good: Competent knowledge of the basic underlying concepts and principles. Exhibits very good understanding.	25	15
3. Cognitive and Intellectual Skills		
Good: Good evaluation of the underlying concepts and principles. Can interpret qualitative and quantitative data, with minor errors. An emerging ability to use evidence to support the argument. Mostly valid arguments and logical judgements.	30	15
4. Practical Application Skills		
Good: A good and appropriate application of basic methods, materials, tools and/or techniques. Clear appreciation of the context of the application. Good evidence of different approaches to problem-solving in particular contexts and proposes mostly appropriate solutions.	10	5
5. Transferable Skills for Life and Professional Practice		
Very good: Work is accurate, coherent, fluent, well-structured and organised. Can work effectively independently and/or as part of a team, with very good contribution to group activities. Demonstrates very good skills for employment requiring the exercise of some personal responsibility, with just occasional minor weakness. Please see additional comments in assignment text.	10	6

Assessment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)	Late Submission Penalties (tick if appropriate)		55%
	Up to 1 week late (40% Max)		
	Over 1 week late (0%)		

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	Up to 1 week late (40% Max)		
	Over 1 week late (0%)		

involve, for instance, the use of real world artefacts, examples and cases, the application of a model within an organisation and/or benchmarking one theory or organisation against others based on stated criteria.

Guidance specific to this assessment: The report indicates a level of research with respect to the application and deployment of the equipment, materials or processes that form the basis of the area of study.

5. Transferable Skills for Life and Professional Practice

Your work must provide evidence of the qualities and transferable skills necessary for employment requiring the exercise of some personal responsibility. This includes demonstrating: that you can communicate the results of your study/work accurately and reliably, and with structured and coherent arguments; that you can initiate and complete tasks and procedures, whether individually and/or collaboratively; fluency of expression; clarity and effectiveness in presentation and organisation. Work should be coherent and well-structured in presentation and organisation.

Guidance specific to this assessment: Your work should be well organised and presented in a professional manner.

GENERIC ASSESSMENT CRITERIA

Level 4

In accordance with the Framework for Higher Education Qualifications, at the end of Level 4 students will be expected to have demonstrated knowledge of the basic underlying concepts and principles of a subject, and an ability to evaluate and interpret these within the context of that area of study. They should be able to present, evaluate and interpret qualitative and quantitative data in order to develop lines of argument and make sound judgements in accordance with basic theories and concepts of their subject(s) of study. They will have learned how to evaluate different approaches to solving problems, and will be able to communicate the results of their study/work accurately and reliably, and with structured and coherent arguments. They will be able to undertake further training and develop new skills within a structured and managed environment and will have the qualities and transferable skills necessary for employment requiring the exercise of some personal responsibility.

Level 4	Category	FAIL	MARGINAL FAIL	SATISFACTORY (3 rd / Pass)	GOOD (2.2 / Pass)	VERY GOOD (2.1 / Merit)	EXCELLENT (1 st / Distinction)	EXCEPTIONAL (1 st / Distinction)
	Engagement with literature (including reading, referencing, academic conventions and academic honesty)	Little or no evidence of reading and/or reliance on inappropriate sources. Views and findings mostly unsupported and non-authoritative. Referencing conventions used incoherently or largely absent.	Poor engagement with essential reading. No evidence of wider reading. Reliance on inappropriate sources, and/or indiscriminate use of sources. Heavily reliant on information gained through class contact. Inconsistent and weak use of referencing.	Engagement with a limited range of mostly relevant and credible sources but with some reliance on information gained through class contact. Some omissions and minor errors. Referencing conventions evident though not always applied accurately or consistently.	Engagement with an appropriate range of literature, including sources retrieved independently. Some over-reliance on texts rather than other sources. Referencing may show minor inaccuracies or inconsistencies.	Engagement with a wide range of literature, including sources retrieved independently. Selection of relevant and credible sources. Generally sound referencing, with no/very few inaccuracies or inconsistencies.	Engagement with an extensive range of relevant and credible literature. Consistently accurate application of referencing.	Exceptional engagement with an extensive range of relevant and credible literature. High-level referencing skills consistently applied.

Level 4	FAIL	MARGINAL FAIL	SATISFACTORY (3 rd / Pass)	GOOD (2.2 / Pass)	VERY GOOD (2.1 / Merit)	EXCELLENT (1 st / Distinction)	EXCEPTIONAL (1 st / Distinction)
Category	0-29%	30-39%	40-49%	50-59%	60-69%	70-84%	85-100%
Knowledge and understanding (Knowledge of the basic underlying concepts and principles of a subject.)	Major gaps in knowledge and understanding of the basic underlying concepts and principles of the subject matter. Inclusion of irrelevant material. Substantial inaccuracies.	Gaps in knowledge of the basic underlying concepts and principles, with flawed or superficial understanding. Some significant inaccuracies and/or irrelevant material.	Limited knowledge and understanding of the basic underlying concepts and principles within the subject area. Some elements may be missing.	Knowledge of the basic underlying concepts and principles is accurate with a good understanding of the field of study but lacks depth and/or breadth.	Competent knowledge of the basic underlying concepts and principles. Exhibits very good understanding.	Excellent knowledge and understanding of the basic underlying concepts and principles of the subject.	Exceptional, detailed knowledge and understanding of the basic underlying concepts and principles
Cognitive and intellectual skills (Evaluate underlying concepts and principles of a subject and interpret qualitative and quantitative data in order to develop lines of argument and make sound judgements.)	Wholly or almost wholly descriptive work. Little or no evaluation of the underlying concepts and principles. Failure to develop arguments, leading to illogical or invalid judgements. Minimal or no use of evidence to back up views.	Largely descriptive work, with superficial evaluation of the underlying concepts and principles. Weak interpretation of data, flawed development of arguments and judgements. Information accepted uncritically, uses generalised statements made with scant evidence and unsubstantiated opinions. Ideas sometimes illogical and contradictory.	Limited attempt at evaluation of the underlying concepts and principles, tending towards description. Can interpret qualitative and quantitative data but with some errors. Some evidence to support emerging arguments but judgements are underdeveloped or with a little inconsistency / mis-interpretation.	Good evaluation of the underlying concepts and principles. Can interpret qualitative and quantitative data, with minor errors. An emerging ability to use evidence to support the argument. Mostly valid arguments and logical judgements.	Sound evaluation of the underlying concepts and principles. Can interpret qualitative and quantitative data accurately. Ability to devise arguments using evidence to make mostly appropriate and valid judgements.	Excellent evaluation of the underlying concepts and principles. Can interpret qualitative and quantitative data accurately and with some insight. Excellent ability to devise arguments using evidence and make appropriate and valid judgements.	Exceptional evaluation of the underlying concepts and principles based on evidence. Outstanding interpretation of qualitative and quantitative data. Exceptional ability to devise arguments using evidence and make wholly appropriate and valid judgements.

Level 4	FAIL	MARGINAL FAIL	SATISFACTORY (3 rd / Pass)	GOOD (2.2 / Pass)	VERY GOOD (2.1 / Merit)	EXCELLENT (1 st / Distinction)	EXCEPTIONAL (1 st / Distinction)
Category	0-29%	30-39%	40-49%	50-59%	60-69%	70-84%	85-100%
Practical skills (Different approaches to solving problems in particular contexts.)	Limited or no use of taught, basic methods, materials, tools and/or techniques. Little or no appreciation of the context of the application. Very weak evidence of different approaches to problem-solving in particular contexts.	Rudimentary application of taught, basic methods, materials, tools and/or techniques but without consideration and competence. Flawed appreciation of the context of the application. Weak evidence of different approaches to problem-solving in particular contexts.	An adequate awareness and mostly appropriate application of basic methods, materials, tools and/or techniques. Basic appreciation of the context of the application. Can identify problems in particular contexts and propose basic alternative approaches or solutions though there may be errors.	A good and appropriate application of basic methods, materials, tools and/or techniques. Clear appreciation of the context of the application. Good evidence of different approaches to problem-solving in particular contexts and proposes mostly appropriate solutions.	A very good application of a range of basic methods, materials, tools and/or techniques. Very good consideration of the context of the application. Very good evidence of different approaches to problem-solving in particular contexts and proposes appropriate solutions.	An advanced application of a range of taught, basic methods, materials, tools and/or techniques. The context of the application is well considered, and insightful. Excellent evidence of different approaches to problem-solving in particular contexts and proposes appropriate solutions.	Exceptional levels of application and deployment skills in particular practical contexts. Outstanding identification of problems in particular contexts and formulation of wholly appropriate, thoughtful solutions / different approaches.

Level 4	Category	FAIL 0-29%	MARGINAL FAIL 30-39%	SATISFACTORY (3 rd / Pass)	GOOD (2.2 / Pass)	VERY GOOD (2.1 / Merit)	EXCELLENT (1 st / Distinction)	EXCEPTIONAL (1 st / Distinction)
	Transferable skills for life and professional practice (Communicate the results of their study/work accurately and reliably, and with structured and coherent arguments; the qualities needed for employment requiring the exercise of some personal responsibility within a structured and managed environment.)	Work is poorly structured, disorganised, inaccurate and/or confusingly expressed. Very weak use of language and/or very inappropriate style. Failure to work effectively individual or as part of a group. Little or no evidence of the skills for employment requiring the exercise of some personal responsibility.	Work is poorly presented in a disjointed manner. It is loosely, and at times incoherently, structured, with information and ideas often poorly expressed. Weak use of language and/or inappropriate style. Flawed approach to individual or group work, meeting only partial obligations to others. Limited evidence of the skills for employment requiring the exercise of some personal responsibility.	Mostly ordered presentation and structure in which relevant ideas / concepts are reasonably expressed. Work may lack coherence and/or accuracy in places. Can work as part of a group, meeting most obligations to others but perhaps with limited involvement in group activities. Demonstrates the basic skills for employment requiring the exercise of some personal responsibility, with some areas of strength and some of minor weakness.	Mostly coherent, organised work, in accurate work, in a suitable structure and is for the most part clearly expressed. Can work effectively independently and/or as part of a team, with very good contribution to group activities. Demonstrates very good skills for employment requiring the exercise of some personal responsibility, with just occasional minor weakness.	Work is accurate, coherent, fluent, well-structured and organised. Can work effectively independently and/or as part of a team, with very good contribution to group activities. Demonstrates very good skills for employment requiring the exercise of some personal responsibility, with just occasional minor weakness.	Work is coherent, very fluent and is presented professionally. Can work effectively independently and/or as part of a team, with an excellent contribution to group activities. Demonstrates excellent skills for employment requiring the exercise of some personal responsibility with an appetite for further development.	Work is accurate, exceptionally coherent, very fluent and presented well. Can work effectively independently and/or as part of a team, with an exceptional contribution to group activities. Demonstrates exceptional skills for employment requiring the exercise of some personal responsibility with an appetite for further development.

THIS DOCUMENT IS ALSO AVAILABLE IN WELSH



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Rhys Rackley

HNC Process Operations Engineering

Environmental Protection and Sustainable Manufacturing Systems

Assignment 1 of 1

Lecturer: Richard Wray

Investigative Report

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Introduction

The purpose of this research document is to highlight potential improvements to environmental factors that can be made to a process within the industry that I am training and working in. In this document I have decided to focus on the Waste Water Treatment Plant (WWTP) at Valero's Pembroke Refinery and look at the environmental factors, processes and systems that can be improved upon. The WWTP is a critical part of the refineries process as a number of the process units create waste water that must be treated by the plant before the effluent can be discharged, any of these process units can cause a shock to the plant which must be dealt with in order to meet standards set by the governing body. The following report will describe the process of the WWTP, associated equipment, the link to environmental issues and also the recommendations regarding the control of environmental factors that are present. *who?*

This research was carried out during my time spent on site whilst work with the instruments department, alongside operations and also through research into procedures and equipment on the site.

The desire is to complete this task and create a report that allows the knowledge of the reader to be increased and allow them to understand the importance of the plant in the process of a refinery. This task's conclusion will also identify issues and possible solutions to the way in which the plant is operated and equipment that is used. Evaluating the aspects of environmental protection and set legal standards for effluent discharge. ✓

What is effluent water?

That is a lot of messing
The industrial plant that I am going to talk about in relation to the effects on the environment is the Waste Water Treatment Plant (WWTP), this operation at the Pembroke Plant deals with around 3 million gallons per day with this contaminated water having to be effectively treated in order to bring the quality into the required standards required by the Environment agency *now NRW* (EA) before it can be discharged into the Milford Haven Waterway.

There are a number of different water streams that feed into the WWTP such as;

- Ballast Water – discharged from ships on arrival to enable them to load products.
- Process Water – water that is used in the Refinery process which have become contaminated. ✓

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- Surface Water – mostly rainwater collected in the Refinery storm drains along with water pumped from the West Reservoir.
- Product Tankage – any water drawn off the product tanks located in the Refinery tank farm area.
- Sanitary system – waste from toilet facilities within the Refinery complex.

The waste water treatment plant delivers effluent to Milford Haven waterway, the composition of the effluent delivered must be in line with the conditions set by the EA.

Flow through the plant

Flow through this plant consists of the main basins using gravity, pumps are provided where necessary to aid or direct the flow of the effluent through the plant when this is required, with manual Ph neutralisation application to ensure that the biological system is not shocked. The WWTP can be considered as two processes where the primary process is the API separators where heavy solids and oil are separated from the main influent and then secondly a biological system is used to further refine the effluent further so this reaches the EA pumping regulations.

Below is the simplified overview of the WWTP;

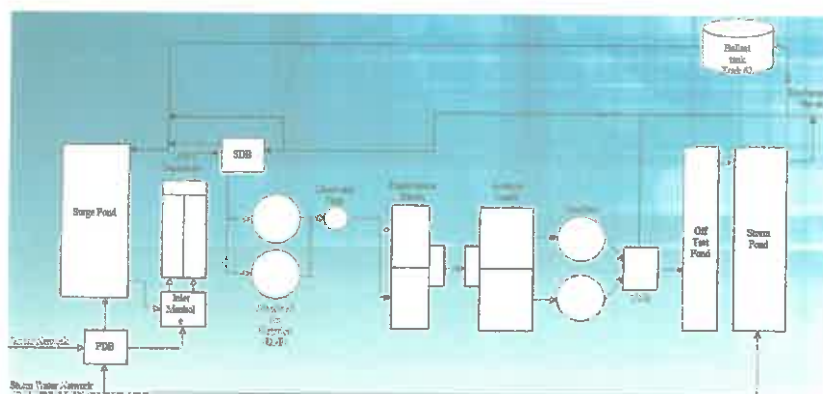


Figure 1: The Waste Water Treatment Plant genera; layout at Pembroke Refinery

Surge pond – this pond is used to collect any excess influent water from the plant that cannot be treated immediately in the WWTP, this can also be used as an emergency sink that can be used to receive the off-spec water from the site. This basin has a capacity of around 20,000 cubic meters.

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API Separators – in the WWTP there are two API separators which are both fed by the inlet manhole, these separators are divided into a Forebay and a Mainbay basin which allows for either of these to be taken out of service to undergo maintenance and enables the plant to continue running. The Forebay is where the initial separation takes place where the sludge and lighter hydrocarbons are carried out using a skimmer/scrapper.

Dissolved Air Flotation Units (DAF) – this part of the process clarifies the effluent by removing suspended solids, the removal of these solids is achieved by dissolving air in the effluent under pressure and then releasing this air at atmospheric pressure in a floatation tank. These air particles raise to the surface of the wastewater containing the suspended solids and then allowing these to be removed from the system using a skimming device. A chemical called polyelectrolyte is added using a dosing system which makes this process more efficient.

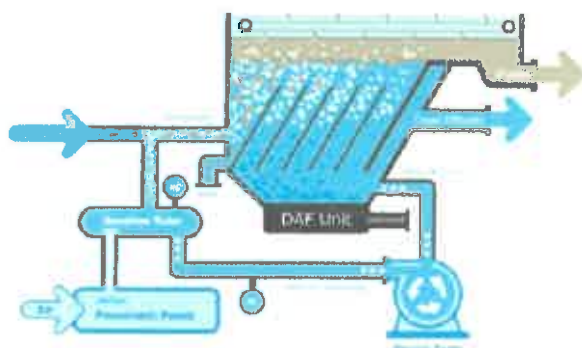


Figure 2: general operation of a DAF tank.

Equalization basins – these basins on Valero WWTP have a capacity of 5,150 m³, with a retention time of 18 hours which targets the objective of creating a smooth water influent flow to prevent any shock loads on the down stream biological section and also the last stage of oil removal from the effluent. This is done with the use of skimmers which are located on the outer walls of the basins and will remove any remaining oil from the waters' surface aided by the use of aerators to assist with the mixing of the influent water.

Biological section – this treatment process is used to reduce the biological oxygen demand (B.O.D.5) and suspended solids in the influent, the below table shows the concentrations both before and after this and the aeration process;

Parameter	Aeration Inlet	Aeration Outlet
Suspended solids	100/150 mg/L	30mg/L
B.O.D.5.	145 mg/L	20 mg/L
Total Hydrocarbons	30 mg/L	10/15 mg/L
Temperature	38 °C Max	29°C Max
PH Value	7 to 8.5	5 to 8.5

Figure 3: effect that aeration has on the effluent within the process.

Before these microorganisms can be activated a minimum temperature must be achieved using the heated sump pump which preheats the influent to between 27 °C and 35 °C to allow for the biological activity to be effective.

Aeration basin – these aeration basins with a capacity of 2,553m³ and a 9-hour residence time which are fed using gravity from the nutrient sump. Manual penstock valves are used to maintain a level within these basins with regards to the influent flow rates through the WWTP. This process uses compressed air to increase the aerobic microorganism bio-degradation efficiency by ensuring that the biodegradable effluents come into contact with the microorganisms that have been starved of oxygen and therefore use the oxygen within these effluents organic material to survive and grow.

Clarifier process – these clarifiers are supplied by the aeration basin with a capacity of 1450m³ the outside of this basin has a collection channel where the scum and micro-organisms are removed using the bridge scraper. Any micro-organisms that are removed from the clarifier basin are pumped back to the aeration basin where these are reused to replicate the process. The sludge in the clarifier is taken off of the bottom and pumped away to be discarded in the correct way.

The treated water that leaves this sump is then pumped into a surge pond which is tested before this is discharged into the waterway, if the water is off specification then this must be pumped back into the process and re-treated to meet environmental standards.

Evaluation of environmental protection, legal requirements and best practice

When it comes to the discharge of effluents understanding environmental protection, legal requirements and best practice that are adhered to by the refinery in this process, it is vital that the where these standards defined and how these must be implemented.

Regarding the limits of the effluent discharge contents that are set the below table shows what these are;

Table 3-1. Discharge Permit Limits				
Parameter	Units	Limit	Averaging Period	Monitoring Frequency
Flow	m ³ /day	25,000	weekly	daily
Temperature	°C	35	daily	continuous
pH		6-9	daily	daily
Oil*	mg/L	2.5	annual	daily
Oil	mg/L	17	daily	daily
Ammonia-Nitrogen	mg/L	20	daily	daily
Total Nitrogen*	mg/L	25	annual	daily
COD*	mg/L	125	annual	daily
COD	mg/L	270	daily	daily
Phenols	mg/L	3	daily	daily
Phenol Index*				monthly
Suspended Solids*	mg/L	25	annual	daily
Suspended Solids	mg/L	85	weekly	daily
Sulphides	mg/L	1	weekly	daily
Fluoride	mg/L	15	weekly	daily
Fluoride	tonnes	5.3	monthly	weekly

Figure 4: Discharge limits set in the IPPC permit.

Pembroke refinery must adhere to the standards set by both the European Union and the UK, the plant must be registered and comply with the Integrated pollution prevention and control (IPPC) permit which specifies the content this discharge effluent. The discharge content of the effluent is monitored, recorded and adjusted before it can be put into the waterway. With the use of the onsite lab all of the recordings are saved for future reference if any discrepancies are noticed these results are sent to Natural Resources Wales and an independent lab to be verified. (DEFRA 2013)

Within the IPPC permit it specifies that the site must adhere to the requirements set based on the Best Available Techniques (BATs), these techniques on this plant include the monitoring of unit effluent before it reaches the WWTP. Samples of effluent discharge from each unit is

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taken and sent to the lab each morning, these samples are tested and the results are monitored so that there is no shock to the WWTP system and therefore allows the plant to run efficiently.

Another new test that is done by the onsite lab of the discharge effluent is the nitrogen/nitrate contents of the discharge, the nitrogen in the effluent from the plant must be removed due to 'too much nitrogen and phosphorus in the water causes algae to grow faster than ecosystems can handle. Significant increases in algae harm water quality, food resources and habitats, and decrease the oxygen that fish and other aquatic life need to survive. Large growths of algae are called algal blooms and they can severely reduce or eliminate oxygen in the water, leading to illnesses in fish and the death of large numbers of fish'. Denitrification requires the nitrogen to be converted into nitrate, this nitrified effluent is then exposed to an oxygen free environment and therefore use the nitrate as an electron acceptor and release nitrogen into the atmosphere.

Aspects associated with ensuring sustainable manufacture that can be achieved through efficient equipment, plant and process operation

Taken from a number of standards set by the IPPC permit and from the BATs legislation there are precautions put in place to ensure the sustainable manufacturing of this product can be achieved.

In the development of new systems within this plant BATs legislation states that all pipework where possible must be above ground so that the detection of leaks and the completion of maintenance on the system is easier. (Waste Treatment Industrial Emissions Directive 2010/75/EU, 2017, P.g. 261)

The creation of a sustainable and reliable system to ensure that this effluent is cleaned to an acceptable level is vital, this is because without this process in working order the refinery cannot continue to function and will therefore shutdown. The WWTP at Pembroke Refinery is a duplicated system which means that it can run even when there is maintenance being carried out on certain parts of the system and therefore making it a sustainable manufacturing process.

The upgrading of the aeration basins in the WWTP has allowed the plant to reduce the COD (Chemical Oxygen Demand) of the water being discharged by the plant, this means that the microorganisms that have been introduced into the plant can work to a higher efficiency and

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therefore create a cleaner and healthier discharge effluent. The microorganisms that are then in turn removed from the clarifiers at the end of the process can be rejuvenated back into the aerators, if there are issues with this pumping system and the bugs cannot be placed back into the aerator then the plant will stop running.

Another way that this sustainable manufacture is achieved is with the use of the maintenance team at the plant who are on hand 24/7 to perform any maintenance tasks and also the operations team who carry out level one maintenance which allows the continuous running of the plant.

Conclusion

The Waste Water Treatment Plant at Pembroke Plant currently removes contaminants from the effluent to meet the standards given by both the UK and European government as to the composition of the discharge. Even though the WWTP plant is in a state that is sustainable there are improvements that can be made to ensure that in the future that this process can continue to be efficient.

The addition of a backup pump from the clarifiers to the aeration basin could be installed which would mean that when the single pump that is currently doing this job will have a spare when maintenance is required and will therefore mean that the plant will continue to run.

This could have been a recommendation.

The introduction of manual systems both in the addition of chemicals to the process and to the flow throughout the plant will remove the probability of human error being a factor. For example, the Ph dosing system could be upgraded to be automatic this would allow for the effluent to be constantly monitored and adjusted so that the downstream microorganisms will not be killed by either high or low Ph. Another example of this would be the use of manual valves to maintain levels within all of the different sections of the plant.

A good point.

On completion of this report on the WWTP I have discovered that the company are already complying with all laws in regards to the discharge of effluent into the waterways. The company are currently investing in the plant due to the age with pumps, tanks and equipment all being replaced and upgraded meaning that the quality of the effluent discharged by the plant will continue to be of the standard set by the governing body.

You could have proposed more improvements to the process.

Investigative Report

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