Sudan University of Science and Technology

College of Petroleum Engineering and Technology

Department of Transportation and Refining Engineering

DESIGN OF PRODUCED WATER SKIM TANK

A Project is presented to In Partial Fulfillment of the Requirement for the Degree of Bachelor of Science transportation And Refining Engineering

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OCTOBER 2016

DEDICATION

I dedicate this to my mother Soul to my father to my brothers Abdul-Aziz and Sami to my lovely wife Nada and All my friend who all stand and support me and to souls of my field brother Muhammad Mustafa Saad & Mohamed Sheikh.

Mohamed Sidahmed

I dedicate this modest work to my mother, father, my brothers and sisters, all my kinsmen and all my classmates

Mohamed Alamin

I dedicate this to my parents, my family and my all beloved ones that support me to finish this research.

Osman Moawia

ACKNOWLEDGMENTS

بسم الله الرحمن الرحيم

﴿ يسألونك عن الروح قل الروح من أمر ربي وما أوتيتم من العلم إلا قليلاً ﴾

صدق الله العظيم

سورة الإسراء الآية ﴿ 85 ﴾

First of all praise be to Allah almighty for his welfare, kindness and great mercy.

We are pleased to seize this opportunity to express our gratitude to everyone who supported us throughout this BCS Graduation project. We would like to express our acknowledgment to Sudan University for science and technology for giving us an opportunity to do this research.

We would like to express our deepest gratitude to our advisor Dr. Sumia Abdelmoneam for her support and inspiring guidance throughout the research. We express our warm thanks to Mr. Mohamed zain & Mohamed Abu elgasim we would like also to thank Petro energy E&P at Baleela Field for giving us any data and the chance to use their Facilities and Mr. Mohamed Khalid for giving us the laboratory test. I'm grateful also to all my friends who have supported us especially Mr. Musab Ibrahim Magzoub (Qatar university).and no words can ever express our sincere gratitude to our Families who always stood by our side and gave us the courage to complete our degree.

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LIST OF ABBREVIATIONS

TDS	Total Dissolved Solid
SAR	Sodium Adsorption Ratio
PW	Produced water
PAH	Polycyclic Aromatic Hydrocarbon
NORM	Natural occurring Radioactive Material
NPDES	National Pollution Discharge Elimination system
API	American Petroleum institute
T	Shell thickness
ST	Hydrostatic Test
Htr	Height Of Transported Width Of The Course
CA	Corrosion Allowance
Tb	Annular Bottom Plate Thickness
V	Wind Velocity
μ	Maximum Allowable Sliding Friction
OPEX	Operation Expenditure
CAPEX	Capital Expenditure
EPA	Environmental Protection Agency

ABSTRACT

Water produced during oil and gas extraction operations constitutes the industry's most important waste stream on the basis of volume. Our project about design Produce water Skim tank which is treated Water from associated oil as a primary treatment unit and also by explain operation process inside tank Define designing factors such as retention time, volume, capacity, and flow rate. , so for design we use API650 to design tank(shell ,bottom ,roof, Wind load, wind girders and seismic design by using Excel sheet to design suitable design and after design we make a laboratory test approved that efficiency of unit is dependable.

ملخص الرسالة

المياه المنتجة خلال عمليات إنتاج النفط والغاز تشكل أهمية عالية في الصناعة فكان لا بد من التركيز عليها والأستفادة منها بعد معالجتها من المحتوي الهيدروكربوني ويتلخص مشروعنا حول تصميم واحدة من الوحدات التي يتم فيها معالجة المياه المصاحبة للنفط بتسليط الضوءعليها وتصنف علي انها من ضمن وحدات المعالجة الأولية، وشرح وتوضيح الألية التي تعمل بها والتركيز علي بعض العوامل المؤثرة مثل السريان ووقت البقاء، ومعدل التدفق. ، وذلك بأستخدام تصميم نستخدم API650 لتصميم الخزانات (الهيكل، ألقاعدة، السقف، تأثير الرياح ،عوارض الرياح والتصميم الزلزالي باستخدام ورقة اكسل لتصميم التصميم المثالي ثم اجراء تحليل معملي لتحديد كفاءة الوحدة وأثبات انها وحدة يمكن الاعتماد عليها لمعالجة المياة .

CHAPTER 1

INTRODUCTION

1.1 Introduction:

Water produced during oil and gas extraction operations constitutes the industry's most important waste stream on the basis of volume. The oil and gas industry produces approximately 14 billion bbls of water annually(Reynolds 2003)**.** The water varies greatly in quality and quantity and in some cases the water can be a useful by-product or even a salable commodity. Produced water is most often considered a waste, but the industry is beginning to consider this material as a potential profit stream. Whether waste or commodity, produced water has management costs that need to be kept in-line with each specific production project and region or it could adversely affect the life of the well, thereby leaving substantial recoverable reserves in the ground. Produced water handling practices must also be environmentally protective or the operator could face regulatory action. Produced water handling methodology depends on the composition of produced water, location, quantity and the availability of resources**.**

In subsurface formations, naturally occurring rocks are generally permeated with fluids such as water, oil, or gas (or some combination of these fluids). It is believed that the rock in most oil-bearing formations was completely saturated with water prior to the invasion and trapping of petroleum(Amyx, Bass et al. 1960) .The less dense hydrocarbons migrated to trap locations, displacing some of the water from the formation in becoming hydrocarbon reservoirs. Thus, reservoir rocks normally contain both petroleum hydrocarbons (liquid and gas) and water. Sources of this water may include flow from above or below the hydrocarbon zone, flow from within the hydrocarbon zone, or flow from injected fluids and additives resulting from production activities. This water is frequently referred to as "connate water" or "formation water" and becomes produced water when the reservoir is produced and these fluids are brought to the surface.

Produced water is any water that is present in a reservoir with the hydrocarbon resource and is produced to the surface with the crude oil or natural gas .

Produced Water Characteristics**:** Produced water is not a single commodity. The physical and chemical properties of produced water vary considerably depending on the geographic location of the field, the geological formation with which the produced water has been in contact for thousands of years, and the type of hydrocarbon product being produced. Produced water properties and volume can even vary throughout the lifetime of a reservoir. If water flooding operations are conducted, these properties and volumes may vary even more dramatically as additional water is injected into the formation.

Major Components of Produced Water: Knowledge of the constituents of specific produced waters is needed for regulatory compliance and for selecting management/disposal options such as secondary recovery and disposal. Oil and grease are the constituents of produced water that receive the most attention in both onshore and offshore operations, while salt content (expressed as salinity, conductivity, or TDS) is a primary constituent of concern in onshore operations(Breit, Klett et al. 1998). In addition, produced water contains many organic and inorganic compounds. These vary greatly from location to location and even over time in the same well.

Impacts of Produced Water Discharges: The previous sections outline the many chemical constituents found in produced water. These chemicals, either individually or collectively, when present in high concentrations, can present a threat to aquatic life when they are discharged or to crops when the water is used for irrigation. Produced water can have different potential impacts depending on where it is discharged. For example, discharges to small streams are likely to have a larger environmental impact than discharges made to the open ocean by virtue of the dilution that takes place following discharge. Numerous variables determine the actual impacts of produced water discharge. These include the physical and chemical properties of the constituents, temperature, content of dissolved organic material, humic acids, presence of other organic contaminants, and internal factors such as metabolism, fat content, reproductive state, and feeding behavior(Frost, Johnsen et al. 1998) .The following sections discuss the potential impact based on where the discharges occur and the type of produced water.

Produced water usually represents a waste product in the petroleum industry; it is more often than not only a cost that must be controlled to enhance project economics. Water management and cost control can be done by choosing appropriate water disposal options or by finding an appropriate beneficial use for the water. Waste options and beneficial uses are, however, highly dependent upon water quality and may require water treatment prior to disposal or use. Treatment of produced water may be required in order to meet pre-disposal regulatory limits or to meet beneficial use specifications. If the oil and gas operator aims to utilize a low-cost disposal option such as discharge to surface waters, the produced water must meet or exceed limits set by regulators for key parameters. The parameters might be specific constituents of concern such as ammonia or barium that can be toxic to sensitive animal and plant-life. Or the parameters may be more broadly-based such as Total Dissolved Solids (TDS) or Sodium Adsorption Ratio (SAR) that can affect several aspects of the environment. The regulatory community may make these limits seasonal so that spring run-off water is more carefully protected. In that case treatment options may also be seasonal.

The objectives of oil and gas produced water treatment include meeting discharge regulations (local, state and federal), reusing treated produced water in oil and gas operations, developing agricultural water uses, rangeland restoration, cattle and animal drinking water, water for human consumption, and meeting water quality requirements for miscellaneous beneficial uses. Current produced water technologies and their successful applications have advantages and disadvantages and can be ranked on the basis of those factors (Arthur, Langhus et al. 2005).

The general objectives for operators when they plan produced water treatment are:

De-oiling – Removal of free and dispersed oil and grease present in produced water.

Soluble organics removal – Removal of dissolved organics. Disinfection – Removal of bacteria, microorganisms, algae, etc., suspended solids removal – Removal of suspended particles, sand, turbidity, etc. Dissolved gas removal – Removal of light hydrocarbon gases, carbon dioxide, hydrogen sulfide, etc., Desalination or demineralization – Removal of dissolved salts, sulfates, nitrates, contaminants, scaling agents, etc., Softening – Removal of excess water hardness., Sodium Adsorption Ratio (SAR) adjustment – Addition of calcium or magnesium ions into the produced water to adjust sodicity levels prior to irrigation. And Miscellaneous – Naturally occurring radioactive materials (NORM) removal.

Some of the options available to the oil and gas operator for managing produced water might include the following:

- Avoid production of water onto the surface – Using polymer gels that block water contributing fissures or fractures or Downhole Water Separators which separate water from oil or gas streams downhole and reinject it into suitable formations. This option eliminates waste water and is one of the more elegant solutions, but is not always possible.
- Inject produced water – Inject the produced water into the same formation or another suitable formation; involves transportation of produced water from the producing to the injection site. Treatment of the injectate to reduce fouling and scaling agents and bacteria might be necessary. While waste water is generated in this option, the waste is emplaced back underground.
- Discharge produced water – Treat the produced water to meet onshore or offshore discharge regulations. In some cases the treatment of produced water might not be necessary.
- Reuse in oil and gas operations – Treat the produced water to meet the quality required to use it for drilling, stimulation, and workover operations.
- Consume in beneficial use – In some cases, significant treatment of produced water is required to meet the quality required for beneficial uses such as irrigation, rangeland restoration, cattle and animal consumption, and drinking water for private use or in public water systems.

Water Process:

Water flows inside tank through jumper and rise up and distributing by distribution point connected in the top of jumper that help to separate oil drops from water by force of the collision in the first place. Then, by gravity force (Density) oil rises to the top and water to the bottom after that, water gets inside collector which connected in the bottom of riser which rises water to top and sends it out of tank by pipe. The oil in the top get inside wear made in the top of tank and flow out by three top point to Skimmed oil tank show in Figure -1.

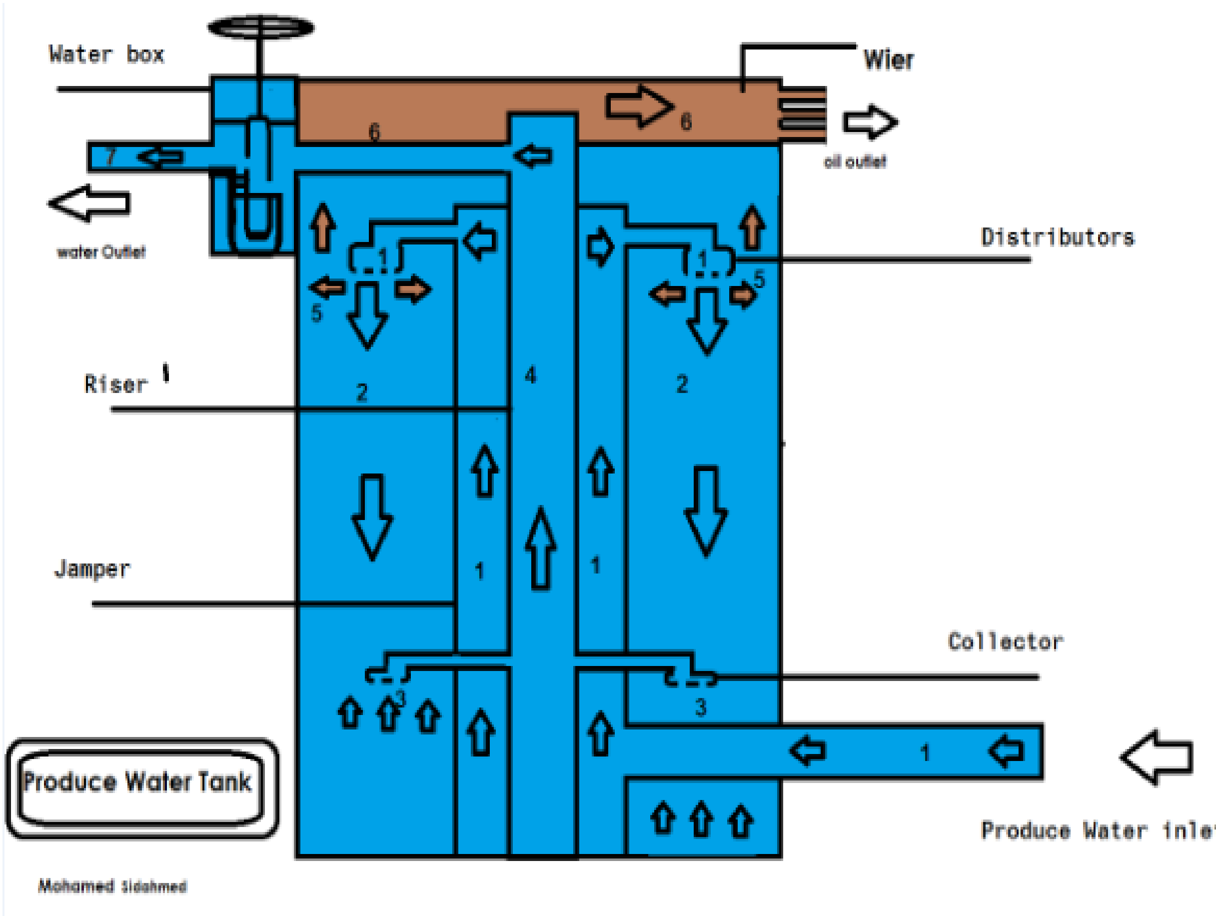


Figure 1 Produce Water Skim Tank

1.2 Statement of the Problem:

Due to importance of produce water in petroleum industry as by product that contain toxic content that effect in surrounding environment and also uses sometimes in many industrial application.

1.3 Objectives:

To Design primary produced water treatment device and process with water skim tank to satisfy

- Increase process separation efficiency.
- Define designing factors such as retention time, volume, capacity, and flow rate.
- Calculate parameters of mechanical and process elements for proper separation such as shell design, roof, bottom, wind girders, seismic and wind load.

CHAPTER 2

LITERATURE REVIEW

2.1 Origin of Produced Water (PW):

Naturally occurring rocks found in subsurface formations are generally permeated with fluids such as water and oil, or gas or mixtures of these substances. There is hypotheses that the rocks that constitute most oil-bearing formations (Adebambo 2011)were filled with water prior to the deposit and accumulation of petroleum Gradually and over time, hydrocarbons migrated to cracks and trap locations, displacing some of the water from the formation in becoming hydrocarbon reservoirs. Hence, reservoir rocks normally contain both petroleum hydrocarbons (liquid and gas) and water. Sources of this water may include flow from above or below the hydrocarbon zone, flow from within the hydrocarbon zone, or flow from injected fluids and additives resulting from production activities . This water is frequently referred to as “connate water “or “formation water” and becomes produced water when the reservoir is produced and these fluids are brought to the surface.

Crude oil has a lower density (between 790 – 873kgandm3) than water (1000kg/m (Simetric, 2007) and as such, floats above the natural water layer/formation water.

In addition to the large volumes of water these reservoirs contain, more water is Injected to help force the oil to the surface and achieve maximum oil recovery.

When hydrocarbons are extracted, they are brought to the surface as a mixture of Produced fluids. The composition of this produced fluid is largely dependent on whether crude oil or natural gas is being extracted and generally includes a mixture Of either liquid or gaseous hydrocarbons, produced water, dissolved or suspended solids, produced solids such as sand or silt, and injected fluids and additives that may have been placed in the formation as a result of exploration and production

Activities.

At the surface, PW is separated from the hydrocarbons, treated to remove as much oil as possible, and then either discharged into water bodies or injected back into The wells. After treatment, PW still contains traces of oil, dissolved organics (including hydrocarbons), organic acids, phenols, production chemicals and inorganic compounds such as varying amounts of chlorides, sulfides, Bicarbonates, ammonia,hydrocarbons, phenolic compounds, metals, and suspended Solids.

2.2 Global PW Production:

Produced water is by far the largest volume by product or waste stream associated With oil and gas exploration and production. Approximately 21 billion bbl (barrels; 1 bbl = 42 U.S. gallons) of PW are generated each year in the United States from nearly a million wells. This represents about 57 million bbl/day, 2.4 billion gallons/day, or 913,000 m3/day (Veil, Puder et al. 2004). More than 50 billion bbl. of PW are generated each year at thousands of wells in other countries with global PW production estimated at around 250 million barrels per day comparedWith around 80 millionBarr els per day of oil it should be noted that PW volumeVaries primarily with age of the oil fi eld and management methods employed during Extraction.(Fakhru'l-Razi, Pendashteh et al. 2009).

Significant PW Constituents and Toxicity:

This section describes constituents typically found in PW, and, to the extent that Information is available, why they are of concern.

2.3 Dispersed & Dissolved Oil:

This term refers to organic material that is either dispersed or dissolved in P When discharged. Dispersed oil consists of small discrete droplets suspended in Water while soluble oil is present in a dissolved state.

2.3.1 Dispersed Oil:

Oil is an important discharge contaminant, primarily because of potentially toxic effects around the discharge point. Dispersed oil consists of small droplets Suspended in the aqueous phase. When discharged along with PW, dispersed oil may accumulate in the floor of the aquatic system, thereby resulting in contamination and accumulation of oil on aquatic sediments, which can potentially affect the benthic community negatively. Dispersed oils that do not reach the bottom may also rise to the surface and spread, causing sheening and Increased biological oxygen demand near the mixing zone, Making hypoxic conditions likely. Volatile components may also evaporate with the more toxic compounds being the most volatile. Factors that affect the concentration of dispersed oil in PW include oil density, interfacial tension between oil and water phases, type and efficiency of chemical treatment, and type, size, and efficiency of the physical separation equipment(Adebambo 2011) .

2.3.2 Dissolved or Soluble Organic Components:

Soluble oil differs from dispersed oil in that it is not readily removed from PW and remains present even after treatment . This can invariably increase the polar constitution of PW and subsequently, the amount of dissolved hydrocarbons . Hydrocarbons that are found predominantly in PW Include organic acids, polycyclic aromatic hydrocarbons (PAHs) and phenols. It has been shown that these hydrocarbons are likely contributors to PW toxicity in that they are additively toxic even though individual toxicities may be insignificant .Typically, the concentration of organic compounds in PW increases as the molecular weight of the compound decreases.

However, even though these low molecular weight compounds are present in large concentrations, it does not reflect in the oil and gas measurements because the organic solvent used in oil and grease analysis extracts virtually none of them due to their high solubility .Organic components that are very soluble in PW consist of low molecular weight (C2,C5) carboxylic acids (fatty acids), ketoses, and alcohols. They include acetic and propionic acid, acetone, and methanol and in some PWs, their concentration may be greater than 5000 ppm.

Partially soluble components include medium to higher molecular weight hydrocarbons (C6 to C15) such as aliphatic and aromatic carboxylic acids, phenols, and aliphatic and aromatic hydrocarbons (Veil, Puder et al. 2004). Aromatic hydrocarbons are structured around a benzene ring and made up primarily of carbon and hydrogen. PAHs are hydrocarbon molecules with several cyclic rings and are formed naturally from organic material under high pressure. Naphthalene is the most simple PAH, with two interconnected benzene rings and is normally present in higher concentrations than other PAHs .PAHs may vary based on their solubility from relatively “light” substances with average water solubility to “heavy” substances with high lip solubility and poor water solubility. While contributing to the formation of sheen, the major concern about these compounds centers on toxicity. They increase biological oxygen demand, are highly toxic to aquatic organisms, and can be carcinogenic to man and animals. Some may mutagenic and harmful to reproduction. Heavy PAHs bind strongly to organic matter (e.g., on the seabed) contributing to their persistency (EPA 2003). Aromatic hydrocarbons (including PAHs) and alkylated phenols are perhaps the most Important contributors to toxicity . Alkylated phenols are considered to be endocrine disruptors, and hence have the potential for reproductive effects. However, phenols and alkyl phenols can be readily degraded by bacterial and photo of oxidation in seawater and marine sediments.

2.4 Treatment Chemicals:

Treatment chemicals include biocides, reverse emulsion breakers, and corrosion Inhibitors and pose the greatest concerns for aquatic toxicity. The effects associated with the use of treating chemicals depend almost entirely on the particular chemical and quantity used as well as the treatment application method.

Batch treatment involves the use of a greater volume of chemical than continues treatment mode, and usually concentrations may exceed the toxic level for the Chemical. However, some of these chemicals can be lethal at levels as low as 0.1 ppm even though these substances may undergo reactions that reduce their toxicities before they are discharged or injected . For example, biocides react chemically to lose their toxicity, and some corrosion inhibitors may partition into the oil phase so that they can never reach the final discharge stream .

2.4.1 Heavy Metals:

The concentration of metals in PW is field-specific and importantly related to the age and geology of rock formation from which the oil and gas are (Veil, Puder et al. 2004). Interestingly, there is no correlation between concentrations in the crude and in the water produced with it .Metals commonly found in PWs include zinc, lead, manganese, iron, and barium. Metals concentrations in PW are often higher than those in seawater , although elevated levels of metals have been reported in sediments around producing locations . However studies suggest that potential impacts on aquatic organisms may be low, because dilution reduces the concentration and because the form of the metals adsorbed into sediments is less bioavailable to aquatic animals than metal ions in Solution.

2.4.2 Naturally Occurring Radioactive Material (NORM):

Like heavy metals, NORM originates in geological formations and can be brought to the surface with PW. The most abundant NORM compounds in PW are radium-226 and radium-228, which are derived from the radioactive decay of uranium and thorium associated with certain rocks and clays in the hydrocarbon reservoir .As the water approaches the surface, temperature changes cause radioactive elements to precipitate and the resulting scales and sludge may accumulate in water separation systems. In the North Sea, where ambient concentrations of Ra-226 are 0.027-0.04 Bq/L, measured concentrations in PW range from 0.23 to 14.7 Bq/L . Radium contamination of PW has generated enough concern that some states have placed additional requirements on national Pollution Discharge Elimination System (NPDES) permits that limit the amount of radium that can be discharged. Compounding the NORM concern is that chemical constituents in many PWs can interfere with conventional analytical methods, and, as a result, radium components can be lost, leading to a false negative result for samples that may contain significant amounts of NORM(Adebambo 2011).

2.5 Produce Water Treatment and Management:

2.5.1 Current Beneficial Reuse Options:

1. Livestock Watering

The quality of water for livestock consumption is normally subjected to lower standards than that of human consumption. Livestock can tolerate a range of contaminants in their drinking water. However, at elevated contaminant concentrations, the animals though able to survive may begin to show some impairment .Total dissolved solids (TDS) is the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. The principal constituents are usually calcium, magnesium, sodium, and potassium cations and carbonate, hydroxy carbonate, chloride, sulfate, and nitrate anions . In general, animals can often tolerate a higher degree of TDS if they are gradually acclimated to the elevated levels. Water with TDS less than 1,000 ppm is considered to be excellent source water but water with TDS from 1,000 up to 7,000 ppm can be used for livestock but may cause some diarrhea . Some coal bed methane (CBM) projects on ranch land have created impoundments or watering stations to provide PW as a drinking water source for livestock(Kirby, Bartram et al. 2003) .

2. Wildlife Watering and Habitat:

Artificial PW filled impoundments can be used to provide a source of drinking water for wildlife and offer habitat for fish and waterfowl in an otherwise arid environment Some Rocky Mountain area CBM projects have created impoundments that collect and retain large volumes of produced water. Some of these impoundments have surface areas of at least several acres. However, it is important to make sure that the quality of the impounded water will not create health problems for the wildlife. The impoundments can also provide additional recreational opportunities for hunting, fishing, boating, and bird watching.(Veil, Puder et al. 2004).

3. Aquaculture and Hydroponic Vegetable Culture:

Jackson and Myers (2002) report on greenhouse experiments to raise vegetables and fish using PW or potable water as the water source. The system used a combination of hydroponic plant cultivation (no soil) and aquaculture. Tomatoes grown with produced water were smaller than those grown in potable water. The produced water tank grew a larger weight of tilapia fish (Orechromis niuloticus/aureus), although some of the fish died. None of the fish in the potable water tank died. From the test results above, there is need to apply caution when using PW for such purposes.

4. Irrigation of Crops:

Many parts of the United States and around the world have limited freshwater resources. Crop irrigation is the largest single use of freshwater in the United States, making up 39% of all freshwater withdrawn, or 150 billion gallons per day (USGS 1998). If produced water has low enough TDS and other characteristics, it can be a valuable resource for crop irrigation.

ALL (2003) summarizes crop irrigation water quality requirements, noting that the three most critical parameters are salinity (affects crops), sodicity (affects soil), and toxicity (affects crops). Salinity is expressed as electrical conductivity in units of mmhos/cm or more currently in micro Siemens per cm (μS/cm). Crops have varying susceptibility to salinity; as salinity rises above a species specific salinity threshold, crop yields decrease. Excess sodium can damage soils. Higher SAR (Sodium Absorption Ratio) values lead to soil dispersion and a loss of soil infiltration capability. When sodic soils are wet, they become sticky, and when dry, they form a crusty layer that is nearly impermeable(Paetz and Maloney 2002)describe an approach for treating CBM water to mitigate its salinity and sodicity problems so it can be used in a managed irrigation program. Some trace elements in produced water can cause harmful effects to plants when present in sufficient quantities. suggests that the most common sources of plant toxicity are chloride, sodium, and boron. Another source of information on the effects of applying produced water to soils is a manual developed for the American Petroleum Institute on remediation of soils that had experienced produced water spills (API 1997). The authors of that manual have subsequently taught a series of workshops on the same subject. The manual is a detailed guide with much useful technical information on the impacts of salinity and sodium on soils and vegetation.

Texas A&M University established a program to develop a portable produced water treatment system that can be moved into oil fields to convert produced water to potable or irrigation water. The goal is to produce water suitable for agricultural use (less than 500 mg/L of total dissolved solids and less than 0.05 mg/L of hydrocarbons). Such a system not only augments scarce water supplies in arid regions, but also provides an economic payback to operators that could allow the well to produce longer.

2.5.2 Industrial Uses:

PW may be substituted in various industrial practices in areas where traditional surface and groundwater resources are scarce. This may be subject to treatment before use and in some cases, PW may be used without treatment depending on what it’s being used for in the industrial process and if no risk/harm is posed to workers or surrounding ecosystem.

2.5.3 Dust Control:

In most oil fields, the lease roads are unpaved and can create substantial dust. Some oil and gas regulatory agencies allow operators to spray produced water on dirt roads to control the dust. This practice is generally controlled so that produced water is not applied beyond the road boundaries or within buffer zones around stream crossings and near buildings.

CBM produced water may be generated in areas with active surface coal mining. Surface mining, processing, and hauling are inherently dusty activities. PW can be used for dust suppression at those locations, too, if regulators allow the practice .

2.5.4 Vehicle and Equipment Washing:

ALL (2003) notes that some state and federal agencies recommend that vehicles and equipment leaving production sites be washed to control the possibility of distributing seeds of undesirable weed species.

2.5.5 Oil Field Use:

Describes a program in New Mexico through which produced water is treated to remove hydrogen sulfide and then is used in drilling operations. This Beneficial reuse saves more than 4 million bbl per year of local groundwater.

2.5.6 Power Generation:

In at least one case, produced water is used to supply water to make steam. About 360,000 bpd of produced water from a ChevronTexaco facility in central California is softened and sent to a cogeneration plant as a source of boiler feed water (Dagli, Brost et al. 2002)another potential use of produced water is cooling water. The electric power industry is the second largest user of freshwater in the United States, making up 38% of all freshwater withdrawn, or 150 billion gallons per day. Conventional surface and ground water sources are no longer sufficient to meet increasing power plant needs in many parts of the country. Produced water represents a large- volume source of water that could potentially serve as makeup water for a power plant. In August 2003, DOE/NETL announced that it had awarded a contract to a group of researchers led by the Electric Power Research Institute to study the feasibility of using water produced from CBM production to meet up to 25% of the cooling water needs at the San Juan Generating Station in northwestern New Mexico. The researchers will evaluate the quality, quantity, and location of the produced water. They will also evaluate the existing produced water collection, transportation, and treatment systems for possible use in delivering cooling water to the generating station. The results are expected in about two years. Argonne National Laboratory recently completed a study that evaluates the use of another that study considers underground pools formed in abandoned coal mines, many of the report's discussions concerning water quality, water quantity, and mode of operation are relevant for using produced water as a cooling source.

2.5.7 Fire Control:

Fires often break out during the driest portions of the year and in areas experiencing drought conditions. In many cases, only limited surface and ground water resources are available for firefighting in these areas. Although application of large volumes of saline produced water can have an impact on soils, this impact is far less devastating than a large fire (Veil, Puder et al. 2004).reports that firefighters near Durango, Colorado, used CBM produced water impoundments as sources of water to fill air tankers (helicopters that spray water onto fires) during the summer of 2002.

CHAPTER 3

METHODOLOGY AND EXPERIMENTAL PROCEDURES

3. 1 METHODOLOGY

This chapter discusses the methodology used in designing of the produced water tank. Design tank with specified retention time and flow rate that required high efficiency of separation between oil and water we ought to keep in mind important parts such as shell, roof, bottom, wind girders, seismic design so we will use equations which had been formulated by API STANDARD 650 (Batarilo 2012)by using EXCEL Sheet, and after design a tank take a sample in inlet and outlet of tank to compare and determine efficiency.

3.1.1 SHELL DESIGN:

In this shell we want to calculate it thickness, to calculate the thickness which depends on

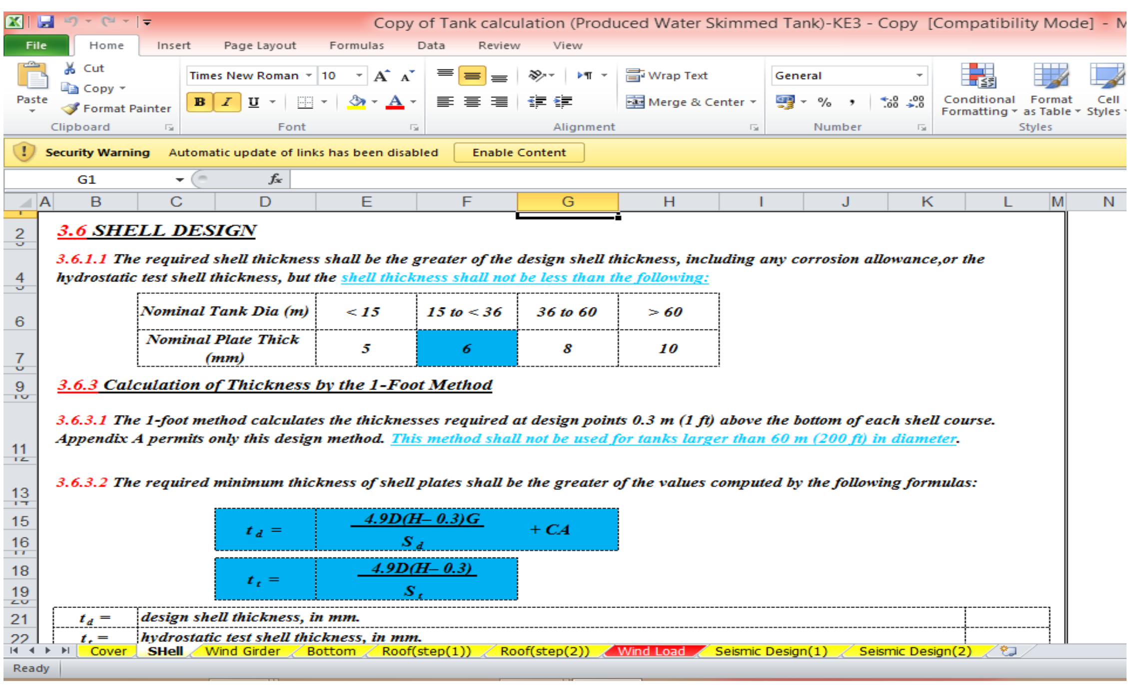


Figure 2 Shell Design Excel Sheet

design specific gravity, corrosion allowance and allowable stress for design condition and for hydrostatic condition by API Code3.6.1. as shown in figure 2.

After calculating actual thickness the minimum thick for each shell plate should be bigger than less actual thickness calculated.

3.1.2 Bottom Design:

All bottom plates shall have a minimum nominal thickness of minimum thickness calculated, exclusive of any corrosion allowance.

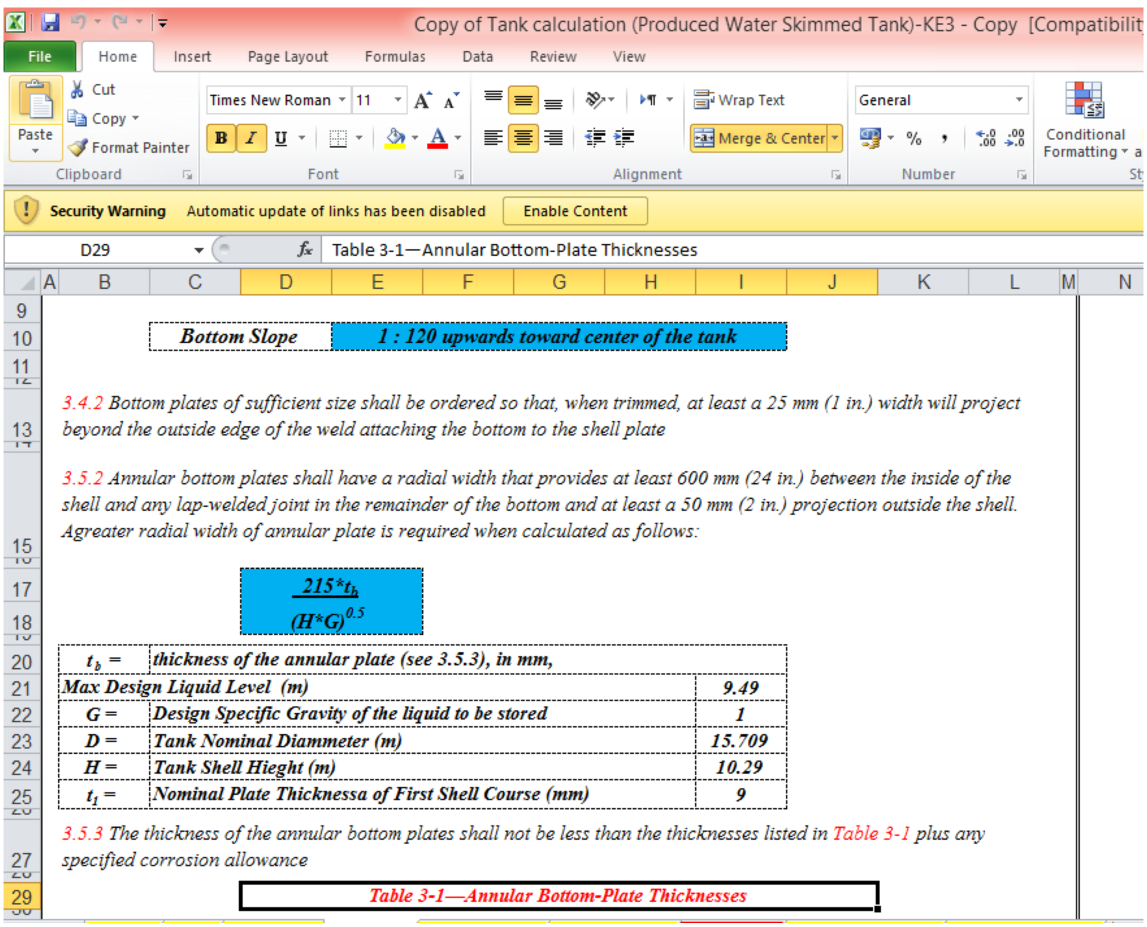


Figure 3 Bottom Plate Design

Here we want calculate the thickness of the annular plates , which depends on several parameters those are the max design level ,tank nominal diameter ,tank shell higher and nominal plate thickness of the first plate and hydrostatic test stress by API Code 3.4 . as shown in figure 3

3.1.3 Roof design:

Calculating the minimum required thickness of roof plate without rip.

The thickness of the roof should not be more than certain value .Its depends on roof spherical surface radius, nominal diameter of tank shell, corrosion allowance and adopted load wich consist of live load and dead load by API Code 3.10.6. as shown in figure 4.

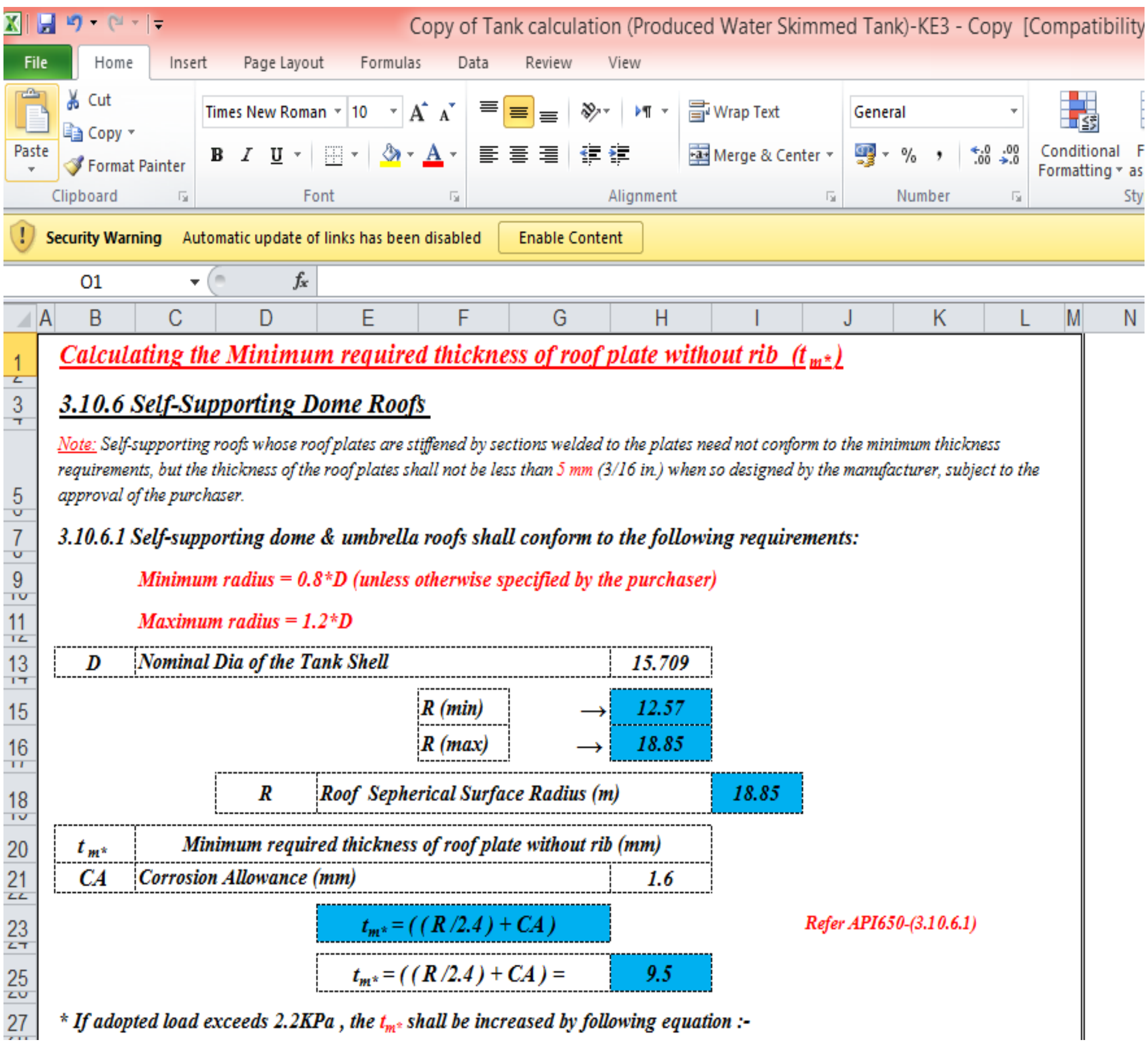


Figure 4 Roof Design

3.1.4 WIND LOAD ON TANKS (OVERTURNING STABILITY):

Here we want to calculate the over turning stability using the givens ,wind velocity ,wind force which depends on affected surface area and wind pressure which leads to calculate the over turning moment by API 3.11.1 as shown in figure 5.

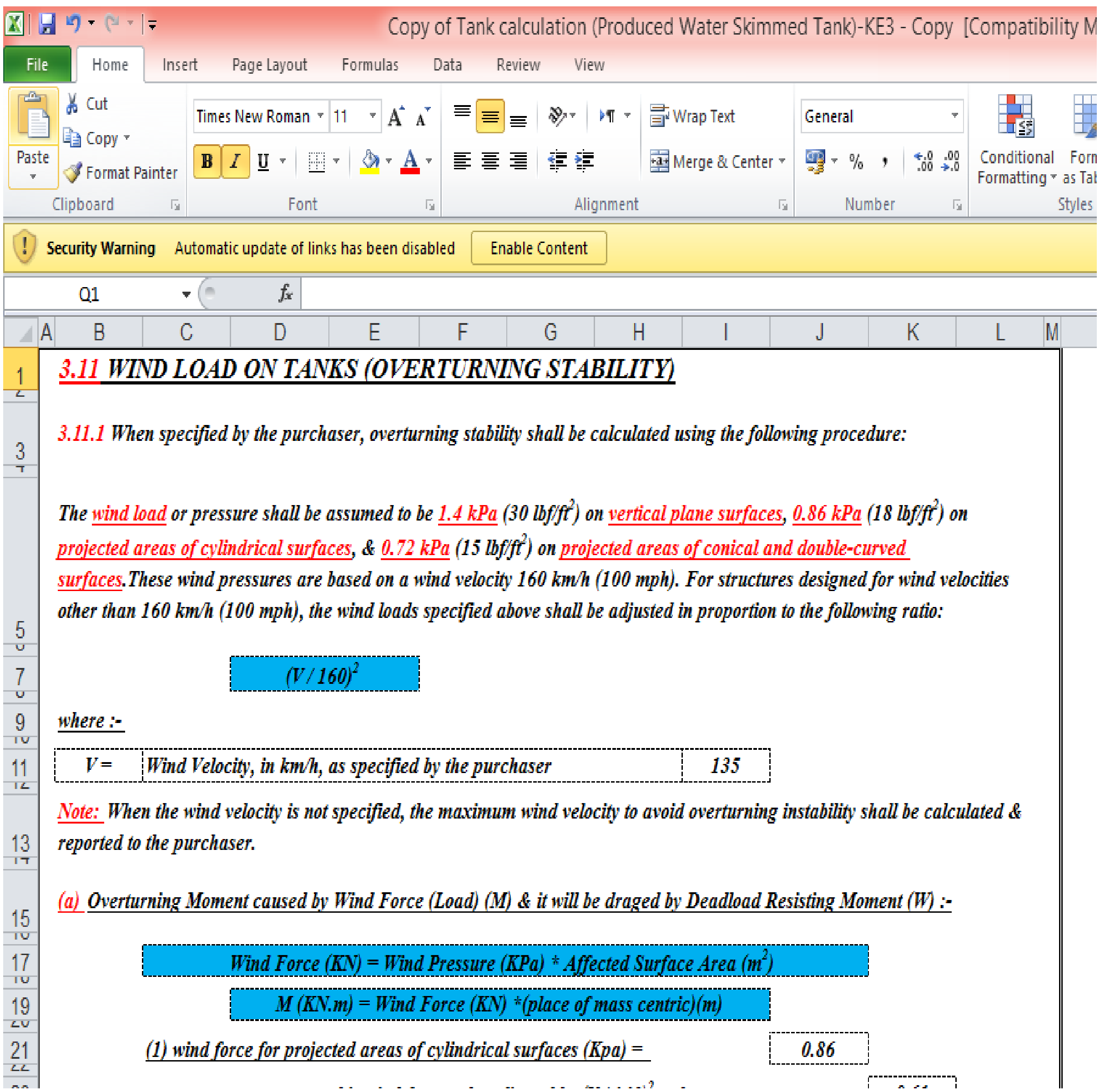
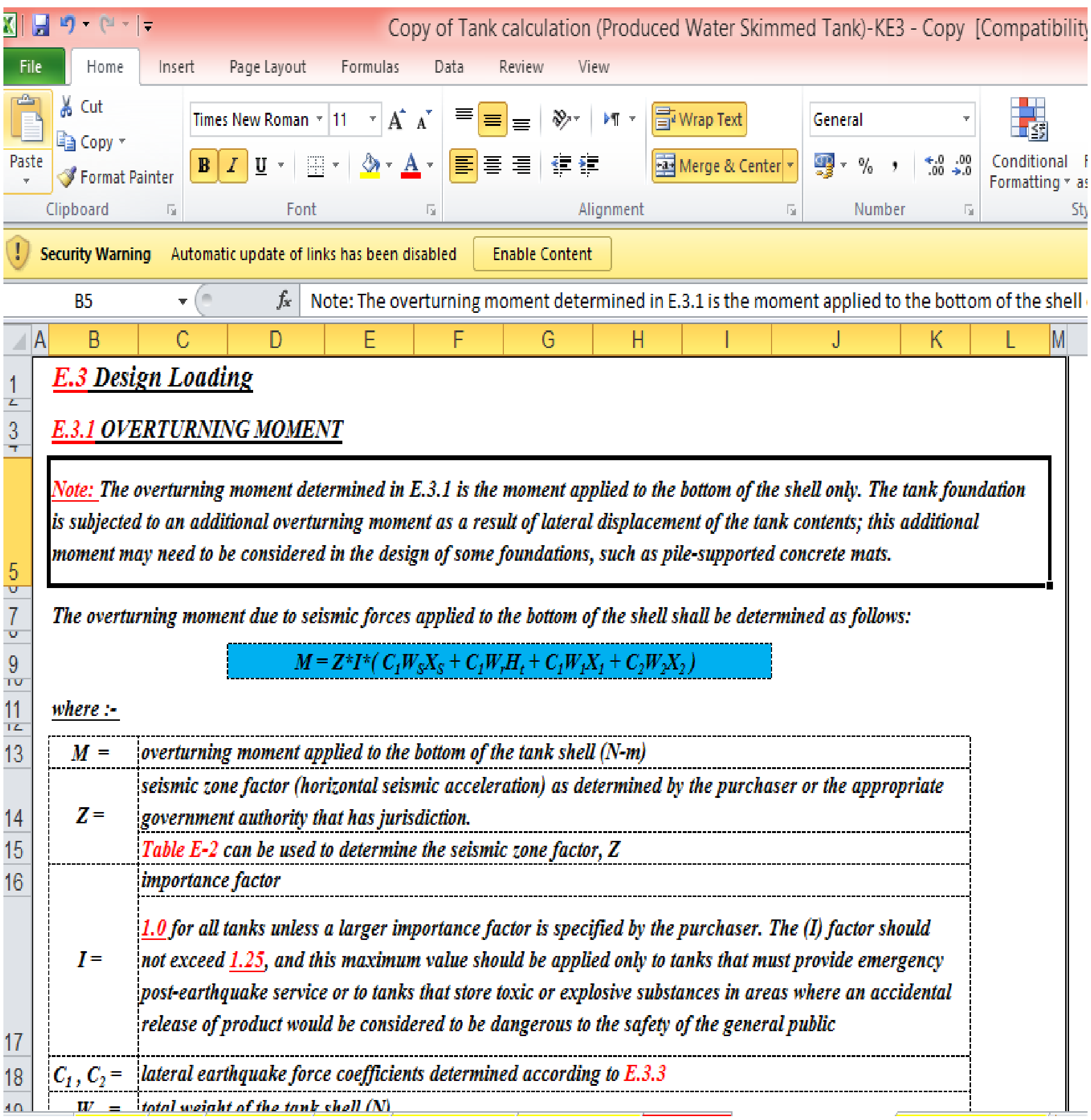


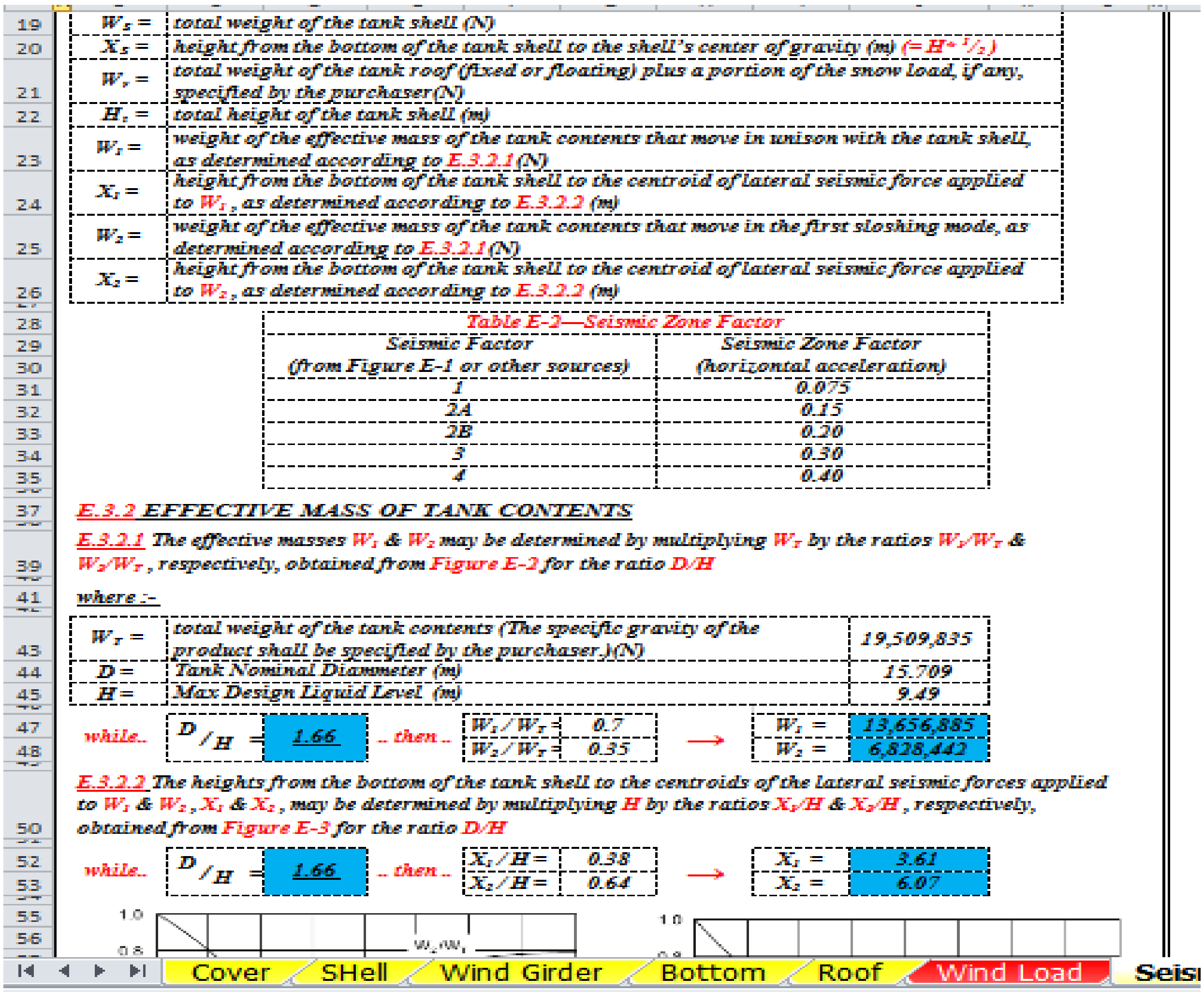
Figure 5 Wind Load on Tanks

3.1.5 Seismic Design:

It's also depends on the over turning moment applied on the bottom of the tank shell which include parameters inside, seismic zone factor, importance factor, total weight of the tank shell, high from the bottom of the tank shell to tank center and the total night of the tank shell, weight of the effective mass of tank contents that move in the first sloshing mode.

The effective mass depends on the tank nominal diameter and max design liquid level as shown in figure 6.





W_s =	total weight of the tank shell (N)
X_s =	height from the bottom of the tank shell to the shell's center of gravity (m) (= H * 1/2)
W_r =	total weight of the tank roof (fixed or floating) plus a portion of the snow load, if any, specified by the purchaser(N)
H_t =	total height of the tank shell (m)
W_1 =	weight of the effective mass of the tank contents that move in unison with the tank shell, as determined according to E.3.2.1 (N)
X_1 =	height from the bottom of the tank shell to the centroid of lateral seismic force applied to W_1, as determined according to E.3.2.2 (m)
W_2 =	weight of the effective mass of the tank contents that move in the first sloshing mode, as determined according to E.3.2.1 (N)
X_2 =	height from the bottom of the tank shell to the centroid of lateral seismic force applied to W_2, as determined according to E.3.2.2 (m)

Table E-2—Seismic Zone Factor

Seismic Factor (from Figure E-1 or other sources)	Seismic Zone Factor (horizontal acceleration)
1	0.075
2A	0.15
2B	0.20
3	0.30
4	0.40

E.3.2 EFFECTIVE MASS OF TANK CONTENTS

E.3.2.1 The effective masses W_1 & W_2 may be determined by multiplying W_T by the ratios W_1/W_T & W_2/W_T, respectively, obtained from Figure E-2 for the ratio D/H

where :-

W_T =	total weight of the tank contents (The specific gravity of the product shall be specified by the purchaser.)(N)	19,509,835
D =	Tank Nominal Diammeter (m)	15.709
H =	Max Design Liquid Level (m)	9.49

while.. D/H = 1.66 .. then .. W_1/W_T = 0.7, W_2/W_T = 0.35 → W_1 = 13,656,885, W_2 = 6,828,442

E.3.2.2 The heights from the bottom of the tank shell to the centroids of the lateral seismic forces applied to W_1 & W_2, X_1 & X_2, may be determined by multiplying H by the ratios X_1/H & X_2/H, respectively, obtained from Figure E-3 for the ratio D/H

while.. D/H = 1.66 .. then .. X_1/H = 0.38, X_2/H = 0.64 → X_1 = 3.61, X_2 = 6.07

Cover | SHell | Wind Girder | Bottom | Roof | Wind Load | Seis

Figure 6 Seismic Design

3.1.6 Wind Girders:

Here we will focus on the intermediate wind girders, specially the maximum high of the unstiffened shell H1 which depends on the order thickness t and nominal tank diameter as shown in figure 7.

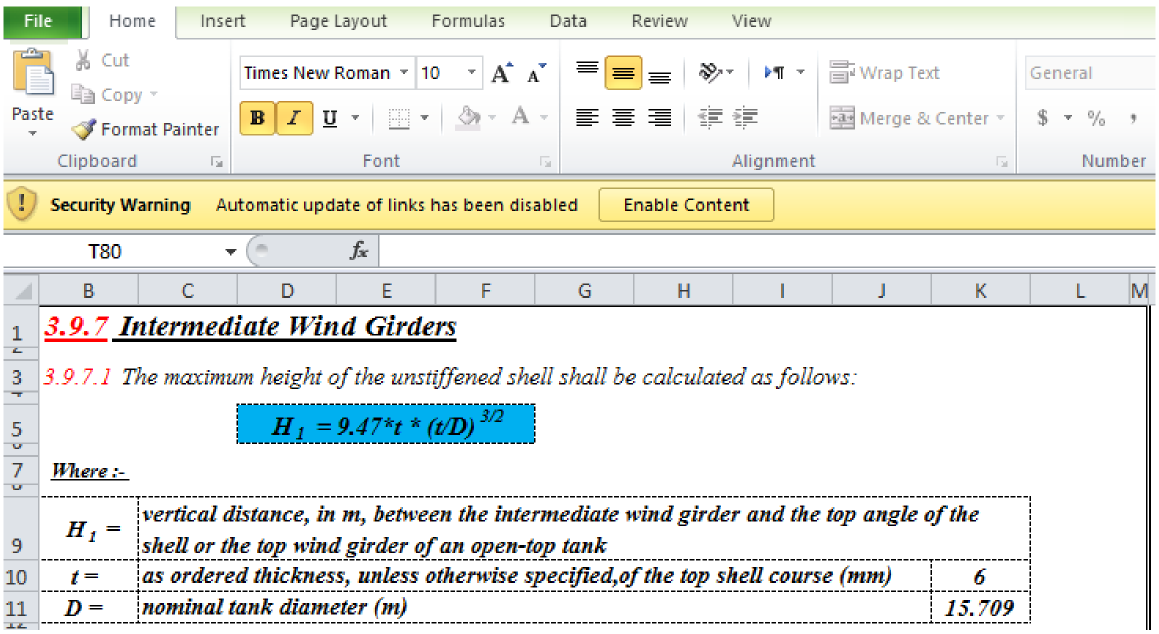


Figure 7 Wind Girders Design

3.2 Experimental Procedures:

Tow samples have been taken from produced water before treatment and after treatment

3.2.1Chemicals Use:

- Hydrochloric acid (1:1)
- Hexane

3.2.2 Tools:

- Spectrophotometer(Figure 9)
- Separator funnel (Figure 8)
- Cells (10 ml)
- Bottles test (100 ml)

h


Figure 8 Separator Funnel

3.2.3 Sampling Procedure:

O&G Extracted by hexane (solvent – solvent extraction) in a 250 ml separator funnel and the extracted solution transferred to 10 ml cell , the cell replaced in spectrophotometer and the absorbed light measured out , finally the concentration (mg / L)of O&G determined from a calibration curve.

Figure 9 Spectrophotometer

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Retention time:

The oil concentration of the inlet water entering the skim tank ranges from 500 to 10,000 mg/l. A minimum residence time of 10 to 30 minutes should be provided to assure that surges do not upset the system(Stewart and Arnold 2011).in this chapter discuss the results of design a produce water skim tank which capacity 2000 that gives a retention time equals 12 Min which depend on flow rate that equal 160 m3/min, and also discuss the result of water oil content test in two points (inlet, outlet) and discuss the mechanical design.

4.2 Mechanical design:

We take data from X Field that treating water which comes from four Separators each one has average flow rate 160 m3/min, so the total flow rate is and for high efficiency we need to design produce water skim tank has retention time at least 12 min that after calculating we found we must design tank by capacity **2000** m3 to give requirement retention time, and the data as below

4.2.1 Codes & Standards:

API 650 , tenth edition - Welded Steel Tanks for Oil Storage
API 2000 , fifth edition - Venting Atmospheric & Low-Pressure Storage Tanks
GEN-SPC-MEQ-4110 Rev.B-ATM Storage Tanks
SH 3046- Petrochemical Design Specification for Vertical Cylindrical Steel Welded Storage Tanks

4.2.2 Basis Design Data:

Roof Type	Supporting Fixed Dome Roof
Process Fluid	Produced Water
Liquid Density (kg/m3) (max/min)	992.4
Operating Temperature (max/nor/min) ºC	70/65/10
Operating Pressure (nor/min)	ATM
Design Temperature (max/min) ºC	93/10
Design Pressure (Int/vacuum)	100/-50mm WC
Internal Design Pressure (Kpa) - P	0.9798
External Design Pressure (Kpa)	0.4899
Test Pressure mm WC	As per code
Filling Rate m3/h	150
Withdrawal Rate m3/h	200
Blanketing Gas Pressure(Kpa(g))	
Flash Point ºC	
Normal Capacity (m3)	2000
Effective Capacity (m3)	1837
Bottom Slope	1:120 Cone-up
Roof Slope	1.2D
Reid Vapour Pressure (RVP) (psi)	11
Design Wind Speed (V) (km/hr)	135
Pickling & Passivation	N/A
Insulation Shell Material / Thickness (mm)	Calcium Silicate (lagging) + Corrugated Aluminum (cladding) / 50
Insulation Roof Material / Thickness (mm)	Calcium Silicate (lagging) + Corrugated Aluminum (cladding) / 50
Internal Painting	GEN-SPC-MEQ-8300
External Painting	GEN-SPC-MEQ-8300
Joint Efficiency	As per code
Site Amplification Factor	1.5
Wind Velocity, in km/h, as specified by the purchaser - V	135
Angle between the roof & a horizontal plane at the roof to shell junction (degrees) - Ɵ	24.56
tan Ɵ	0.457
sin Ɵ	0.416
Design Specific Gravity of the liquid to be stored – G	1
Tank Nominal Diameter (m) – D	15.709
Max Design Liquid Level (m)	9.49

Tank Shell Height (m) – H	10.29
Tank Height (Total) (m)	11.994
Corrosion Allowance (mm) – CA	1.6
Seismic Zone Factor , Zone "1" , Z	0 0.075
Importance Factor , I	1

Table 1 Basis Design Data

4.2.3 Fitting and accessories:-

Bottom (Anular / Sketch) Plate , Shell Plate , Roof (Plate / Structure / Central ring) , Top Angle , Clean Out Door , Wind Girder , Cleats , Stiffeners , Anchors	A 36
Pipes	A 106 Gr.B
Flanges	A 105
Bolts / Nuts (External)	A193-B7 / A194-2H
Bolts / Nuts (Internal)	SS 316 L
Gasket	Compressed Aramide Fiber
Internal , Welded	A36 / A106 Gr.B
Internal , Removable	N/A

Table 2 Fittings and Accessories

4.2.4 Calculation OF Shell Design:

API 4.2.1.1 the 1-foot method calculates the thicknesses of shell required at design points 0.3 m (1 ft) above the bottom of each shell course. This method shall not be used for tanks larger than 60 m (200 ft) in diameter:

Nominal Tank Dia (m)	< 15	15 to < 36	36 to 60	> 60
Nominal Plate Thick (mm)	5	6	8	10

Table 3 API Nominal Thickness

4.2.4.1 Calculation of shell Thickness by using the 1-Foot Method:

3.6o8h.3.1 The 1-foot method calculates the thicknesses required at design points 0.3 m (1 ft) above the bottom of each shell course(Batarilo 2012)

3.6.3.2(Batarilo 2012) The required minimum thickness of shell plates shall be the greater of the values computed by the following formulas:

$$t_d = \frac{4.9D(H-0.3)}{St} + CA$$

$$t_{tl} = \frac{4.9D(H-0.3)}{St}$$

			Calculated		
Course No	H_d	H_t	t_d	t_t	Actual thick
1	10.29	10.29	6.41	4.50	9
2	8.49	8.49	5.54	3.69	8
3	6.69	6.69	4.67	2.88	7
4	4.89	4.89	3.81	2.07	7
5	3.09	3.09	2.94	1.26	6
6	1.29	1.29	2.08	0.45	6

* While you refer to table mention in clause 3.6.1.1(Batarilo 2012) the min thick for each shell plate should be bigger than (6mm) (due to tank dia > 15m & < 36m), & consequently all calculated td had been approximated.

from table 4-2 in API 360:

Calculated					
Plate Specification	Grade	Minimum Yield Strength MPa (psi)	Minimum Tensile Strength MPa (psi)	Product Design Stress Sd MPa (psi)	Hydrostatic Test Stress St MPa (psi)
A 36M (A 36)	—	250	400	160	171

Table 4 Table 3-2 in API 360

The maximum allowable product design stress, Sd, shall be as shown in Table 3-2. The net plate thicknesses—the actual thicknesses less any corrosion allowance—shall be used in the calculation. The design stress basis, Sd, shall be either two-thirds the yield strength or two-fifths the tensile strength, whichever is less.

$$St \begin{cases} = \frac{2}{3} * yeild\ strenght \\ = \frac{2}{5} * tensile\, strenght \end{cases} \text{ whichever is less}$$

=160

3.6.2.2(Batarilo 2012) The maximum allowable hydrostatic test stress, St, shall be as shown in Table 3-2. The gross plate thicknesses, including any corrosion allowance, shall be used in the calculation.

$$St \begin{cases} = \frac{3}{4} * yield\ strenght \\ = \frac{3}{7} * tensile\ strength \end{cases}$$

=171

4.2.5 Calculation of Bottom Plates:

3.4.1 (Batarilo 2012) All bottom plates shall have a minimum nominal thickness of 6 mm [70 kPa (see 2.2.1.2)], exclusive of any corrosion allowance specified by the purchaser for the bottom plates. Unless otherwise agreed to by the purchaser, all rectangular and sketch plates (bottom plates on which the shell rests that have one end rectangular) shall have a minimum nominal width of 1800 mm.

Sketch bottom plates thickness = 6mm + (CA)	7.6	8mm
All rectangular & sketch bottom plates nominal width ≥ 1800 mm		2000mm

Bottom Slope	1 : 120 upwards toward center of the tank

4.2.6 Calculation of Roof:

Calculating the Minimum required thickness of roof plate without rib (tm*)

3.10.6(Batarilo 2012) Self-Supporting Dome Roofs

Note: Self-supporting roofs whose roof plates are stiffened by sections welded to the plates need not conform to the minimum thickness requirements, but the thickness of the roof plates shall not be less than 5 mm (3/16 in.) when so designed by the manufacturer.

3.10.6.1 (Batarilo 2012) Self-supporting dome & umbrella roofs shall conform to the following requirements:

Minimum radius = 0.8*D (unless otherwise specified by the purchaser)

Maximum radius = 1.2*D

R (min)	→	*12.57*
R (max)	→	*18.85*

R	Roof Spherical Surface Radius (m)	18.85

$$t_m = \left(\frac{R}{2.4} + CA \right) = \underline{9.5}$$

* If adopted load exceeds 2.2KPa, the tm* shall be increased by following equation:-

$$\left(\frac{Adopted\,load}{2.2} \right)^{0.5}$$ Refer API650-(3.10.6.1)

Adopted Load = Live Load + Dead Load

Live Load = Uniform Overload + External Pressure

Dead Load = Roof Self weigh

Uniform Overload (Kpa)=	1.2
External Pressure (Kpa)=	0.49

ReferAPI650-(3.10.2.1)

Live Load (Kpa)=	1.69

Dead Load (Roof Self weight) (Kpa) =	0.76

Adopted Load (Kpa) =	2.45

Adopted load exceeds 2.2KPa , then tm* will be as follow :-

$$\left(\left(\frac{R}{2.4}\right)+CA*\left(\frac{Adopted\,load}{2.2}\right)^{0.5}\right) = \underline{9.98}$$

*Roof plate thickness is 7mm (material is A36) & rib is flat bar 50mm X 8mm (material is A36).

tm	Nominal roof thickness (mm) =	7
CA	Corrosion Allowance (mm)	1.6
t_e	Effective Thickness = ((plate Thickness) - (CA))=	5.4
h_1	Width of Longitudinal Ribs (mm)	40
h_2	Width of Circumferential Ribs (mm)	40
b_1	Thickness of Longtitudinal Ribs (mm)	8
b_2	Thickness of Circumferential Ribs (mm)	8
L_1	Space of Longtitudinal Ribs along Circumference (mm)	2090

L_2	Space of Circumferential Ribs along Latitude (mm)	1100
n_1	Circumferential Area Conversion Coefficient for Longitudinal Ribs & Top Plate	
n_2	Area Conversion Coefficient of Circumferential Ribs & Top Plate along Latitude	
e_1	Distance from Central Point (O) of Combined Section of Longitudinal Ribs & Top Plate Along Circumferential to Center of Top Plate	
e_2	Distance from Central Point (O) of Combined Section of Circumferential Ribs & Top Plate along Latitude to Center of Top Plate	

In revert to SH 3046, Calculating the Conversion Thickness of Spherical Shell with Ribs (tm):

For self-supporting roof uses the plate-ribbing structure is designed, the material & size of plate & rib selected as follows:

*Roof plate thickness is 7mm (material is A36) & rib is flat bar 50mm X 8mm (material is A36).

$n_1 =$	$1 + ((h_1 * b_1) / (t_e * L_1)) =$	**1.03**
$n_2 =$	$1 + ((h_2 * b_2) / (t_e * L_2)) =$	**1.05**
$e_1 =$	$[((t_e * L_1) + (0.5 * b_1 * h_1 * (h_1 + t_e)) / ((t_e * L_1) + (b_1 * h_1))] =$	**1.60**
$e_2 =$	$[((t_e * L_2) + (0.5 * b_2 * h_2 * (h_2 + t_e)) / ((t_e * L_2) + (b_2 * h_2))] =$	**2.11**

$t_{1m}^3 =$	*1,178.96*

Abidance's

$t_{2m}^3 =$	*2,117.92*

tm = [(t1m3 + 2 te3 + t2m3) / 4] (1/3) = 9.67

P	Allowable External Pressure of Spherical Shell with Ribs (Pa)

R	Roof Spherical Surface Radius (m)	18.85
E	Modulus of Elasticity for Roof Plate Material (Mpa)-Table P-1	198,800

$P = 0.1 * E * (t_m / R)^2 * (t_e / t_m)^{½}$	3,906	3.91

This pressure (P) supposed to be greater than Adopted Load

P > Adopted Load

….Forethat design is safe ….

Design Temperature		Modulus of Elasticity MPa (lbf/in.^{2})	Thermal Expansion Coefficient[a]
°C	°F	E	[mm × 10^{-6}/(mm-°C)] (inches × 10^{-6} per inch-°F)
20	70	203,000 (29,500,000)	—
90	200	199,000 (28,800,000)	12.0 (6.67)
150	300	195,000 (28,300,000)	12.4 (6.87)
200	400	191,000 (27,700,000)	12.7 (7.07)
260	500	188,000 (27,300,000)	13.1 (7.25)

[a]Mean coefficient of thermal expansion, going from 20°C (70°F) to the temperature indicated.

Note: Linear interpolation may be applied for intermediate values.

Figure 10 Modulus of Elasticity and thermal Expansion Coefficient At The Design temperture

4.2.7 Intermediate Wind Girders:

3.9.7.1 (Batarilo 2012) The maximum height of the unstiffened shell shall be calculated as follows:

$$\mathbf{H1} = 9.47 * t * \frac{t}{D}^{\frac{3}{2}}$$

$$= 9.47 * t * \frac{t}{D}^{\frac{3}{2}} * \left(\frac{Vr}{V}\right)^2$$

H1=**18.840**

3.9.7.2(Batarilo 2012) After the maximum height of the unstiffened shell,H1, has been determined, the height of the transformed shell shall be calculated as follows:

- With the following equation, change the actual width of each shell course into a transposed width of each shell course having the top shell thickness:

$$Wtr = W * \left(\frac{t_{uniform}}{t_{actual}}\right)^{\frac{5}{2}}$$

Course No	t_{actual}	$t_{uniform}$	W	W_{tr}
1	9	6	1800	653.20
2	8	6	1800	876.85
3	7	6	1800	1224.35
4	7	6	1800	1224.35
5	6	6	1800	1800
6	6	6	1250	1250

- Add the transposed widths of the courses. The sum of the transposed widths of the courses will give the height of the transformed shell.

		mm	M
H_{tr} =	***Height of transposed widths of the courses***	***7,028.75***	***7.03***

3.9.7.3 If the height of the transformed shell is greater than the maximum height H1 , an intermediate wind girder is required.

$H_1 > H_{tr}$ **….. then intermediate wind girder not required**

3.9.7.4(Batarilo 2012) If half the height of the transformed shell exceeds the maximum height H1 , a second intermediate girder shall be used to reduce the height of unstiffened shell to a height less than the maximum.

half the height of the transformed shell =	3.51	< H1

…. then second intermediate girder not required

4.2.8 Calculation of Wind Load on Tanks (Overturning Stability):

← wind force = 0.72 kpa * (V / 160)2

← wind force = 0.86 kpa * (V / 160)2

Figure 11 Wind Load on Tanks

The wind load or pressure shall be assumed to be 1.4 kPa (30 lbf/ft2) on vertical plane surfaces, 0.86 kPa (18 lbf/ft2) on projected areas of cylindrical surfaces, & 0.72 kPa (15 lbf/ft2) on projected areas of conical and double-curved surfaces. These wind pressures are based on a wind velocity 160 km/h (100 mph). For structures designed for wind velocities other than 160 km/h (100 mph), the wind loads specified above shall be adjusted in proportion to the following ratio:

$$= \left(\frac{V}{160}\right)^2$$

V =	Wind Velocity, in km/h, as specified by the purchaser	135

Note: When the wind velocity is not specified, the maximum wind velocity to avoid overturning in(a) Overturning Moment caused by Wind Force (Load) (M) & it will be dragged by Dead load Resisting Moment (W) :-

Stability shall be calculated & reported to the purchaser.

Wind Force (KN) = Wind Pressure (KPa) * Affected Surface Area (m2)

M (KN.m) = Wind Force (KN) *(place of mass centric)(m)

(1) wind force for projected areas of cylindrical surfaces (Kpa) =	0.86

Cylinder (affected) surface area (m2) = 2*Л*r*h =is

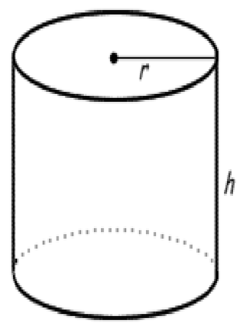


Figure 12 wind force for projected areas of cylindrical surfaces

This wind force to be adjusted by (V / 160)2 to be =0.61

Cylinder (affected) surface area (m2) = 2*Л*r*h =507.57

Wind Force (KN) =310.76

Overturning wind moment (M1) (KN.m) = Wind Force (KN) * (½ * cylinder height) =1,598.84

(2) Wind force for projected areas of double-curved surfaces (Kpa) =0.72

This wind force to be adjusted by (V / 160)2 to be = 0.51

(1/2) Sphere (affected) surface area (m2)= 2*Π*r2 =387.43

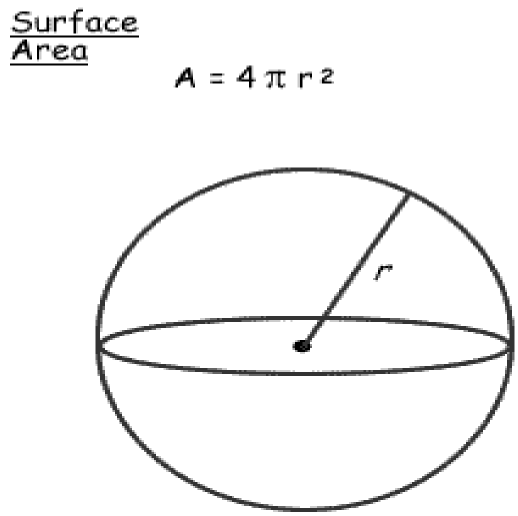


Figure 13 Wind force for projected areas of double-curved surfaces

Wind Force (KN) =198.59

Overturning wind moment (M2) (KN.m) = Wind Force (KN) * (½ * (½ Sphere height)) =169.20

Then combining of both overturning moments (M1 &M2) will lead to obtain M (KN.m) =1,768.04

3.11.2(Batarilo 2012) For an unanchored tank, the overturning moment from wind pressure shall not exceed two-thirds of the deadload resisting moment , excluding any tank contents, & shall be calculated as follows:

$$M \leq 2/3 * (W*D / 2)$$

$$W = W1 + W2 + W3 – Wup$$

$$Wup (KN) = Internal Pressure (KPa)* Roof Surface Area (m2)$$

Internal Pressure (KPa) =	0.9798

Roof Surface Area = ½ Sphere (affected) surface area (m2) = 2*Π*r2 =387.43

Wup (KN) =	379.61
W (KN) =	-52.27
2/3 * (W*D / 2) =	-273.69

M =	1,768.04	> 2/3 * (W*D/2) =	-273.69

*Therefore this tank needs to be anchored

4.2.9 Calculation of Seismic Load:

4.2.9.1 Design Loading:

OVERTURNING MOMENT:

Note: The overturning moment determined in E.3.1 is the moment applied to the bottom of the shell only. The tank foundation is subjected to an additional overturning moment as a result of lateral displacement of the tank contents; this additional moment may need to be considered in the design of some foundations, such as pile-supported concrete mats.

The overturning moment due to seismic forces applied to the bottom of the shell shall be determined as follows:

M = Z*I*(C1WSXS + C1WrHt + C1W1X1 + C2W2X2)

Seismic Factor	Seismic Zone Factor
(from Figure E-1 or other sources)	(horizontal acceleration)
1	0.075
2A	0.15
2B	0.20

3	0.30
4	0.40

Table 5bSeismic Zone Factor

4.2.9.2 Effective Mass of Tank Contents:

E.3.2.1 the effective masses W1 & W2 may be determined by multiplying WT by the ratios W1/WT & W2/WT , respectively, obtained from Figure E-2 for the ratio D/H

while..	***D/H =***	***1.66***	***.. then ..***	***W_1 / W_T***	***0.7***	→	***W_1 =***	***13,656,885***
				W_2 / W_T	***0.35***		***W_2 =***	***6,828,442***

E.3.2.2 The heights from the bottom of the tank shell to the centroids of the lateral seismic forces applied to W1 & W2, X1 & X2, may be determined by multiplying H by the ratios X1/H & X2/H , respectively, obtained from Figure E-3 for the ratio D/H

while..	***D/H =***	***1.66***	***.. then ..***	***X_1 / H =***	***0.38***	→	***X_1 =***	***3.61***
				X_2 / H =	***0.64***		***X_2 =***	***6.07***

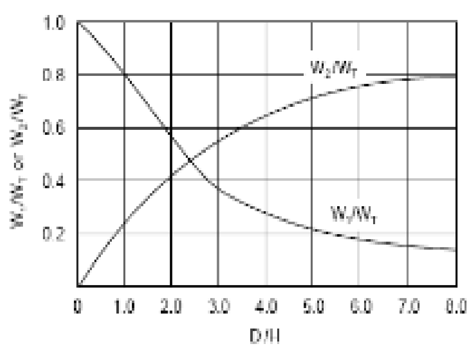


Figure 14 Effective Masses

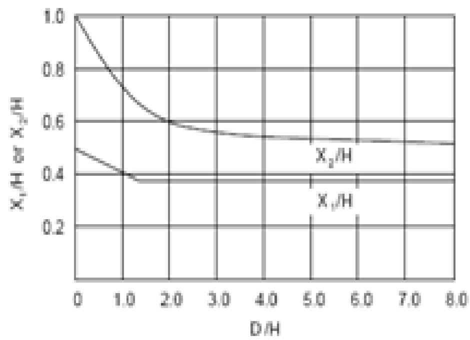


Figure 15 Centoides of Seismic Forces

4.2.9.3 Lateral Force Coefficient:

E.3.3.1 the lateral force coefficient C1 shall be 0.60 unless the product of ZIC1 & the product of ZIC2 are determined as outlined in E.3.3.3.

E.3.3.2 The lateral force coefficient C2 shall be determined as a function of the natural period of the first sloshing mode, T, & the soil conditions at the tank site unless otherwise determined by the method given in E.3.3.3.

When $T \le 4.5$, → $C_2 = \dfrac{0.75*S}{T}$

When $T > 4.5$, → $C_2 = \dfrac{3.375*S}{T^2}$

S =	Site Coefficient (selected as S3 , from Table E-3),	1.5
T =	Natural period of the first sloshing mode, in seconds.	

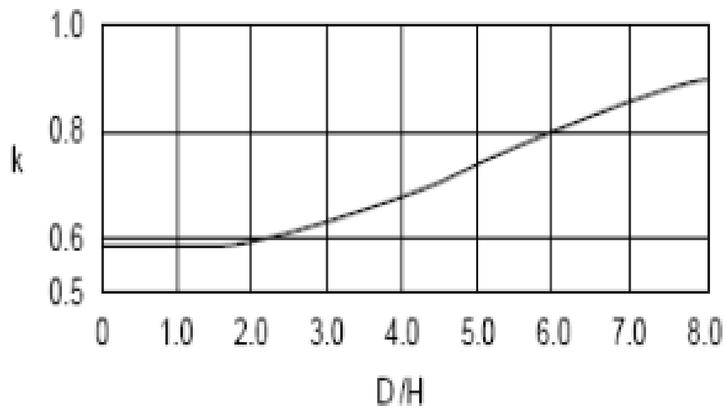


Figure 16 Factor K

$T = 1.81 * k * D^{0.5}$

K= Factor selected from Figure 14 by D/H ratio=0.58

T=4.16
C2=0.270

M (N.m) =	***3,151,335.47***

4.2.9.5 Resistance to Overturning:

E.4.1 Resistance to the overturning moment at the bottom of the shell may be provided by the weight of the tank shell & by the anchorage of the tank shell or, for unanchored tanks, the weight of a portion of the tank contents adjacent to the shell. For unanchored tanks, the portion of the contents that may be used to resist overturning depends on the width of the bottom plate under the shell that lifts off the foundation & may be determined as follows:

$$w_L = 99 * t_b \, (F_{by} * G * H)^{0.5}$$

w_L (N.m) =	***48,221***

And …..

(196*G*H*D) =	***29,219***

Now …..

w_L > (196*G*H*D)

So ….

w_L (N.m) =	***29,219***

E.4.2 The thickness of the bottom plate under the shell may be greater than or equal to tb , but the thickness, tb , used to calculate wL shall not exceed the larger of 6 mm (1/4 in.) or the first shell course thickness less the shell corrosion allowance, nor shall tb exceed the actual thickness of the bottom plate under the shell less the corrosion allowance for the bottom plate. Where the bottom plate under the shell is thicker than the remainder of the bottom, the width of the thicker plate under the shell shall be equal to or greater than:

$$0.1745 * 10^{-3} * w_L /G*H \quad (m)$$

0.8867 m ***or ..*** ***887 mm***

4.3 Determination of oil and grease (O&G) in produced water:

To ensure the efficiency of produce Water skim tank we make a test in inlet in Figure 14 and outlet in Figure 15 by take two samples before and after tank and a test as below:

4.3.1 Result:

Table below Table 7 show that the big difference in Oil content before and after treatment.

Sample	Conc (mg/L)
Before treatment	2154
After treatment	73

Table 6 Test Result

Figure 16 below show in the differnce between two samples that took in the inlet of tank and Outlet

Figure 17 Inlet sample.

Figure 18 Outlet Sample

Figure 19 Two Samples

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

By using the calculative methods suggested in this study to design Produce water skim tank and calculating all important respects, mechanical by calculating important factors that correspond with surrounding environment related to regulation of API ,operation by explain and definite the water process of from source to discharged and efficiency which correspond with objectives of oil and gas produced water treatment include meeting discharge regulations (local, state and federal) and is proofed to be an efficient and quick method to design produced water tank.

Produce water tank can be optimal unit for treating oil that associated with water as a primary method, and all material to design this tank is available, we all know that we pass a petroleum crisis in economically dire need to reduce the exchange to ensure continued production and we know water treatment not a basically process We do not need High-Exchange in it.

5.1 Conclusions:

Based on the investigations carried out and the results and discussion presented in this Study the flowing conclusions can be drawn:

1. Produce water skim tank is optimal unit can use for treating water that produce associated with production oil as Primary method that has high efficiency.
2. Produce water skim tank good in Economics term (OPEX, CAPEX).
3. The parameters calculated are as follow:

   Mechanical design:

   - Shell design

- Roof design
- Bottom design
- Wind Girders
- Seismic design
- Operation Process limits
- Efficiency

4. Size of Produce water Skim tank depends in Flow rate of water that we want to treat and also in optimum retention time.

5.2 Recommendation:

Based on this study the following recommendations are suggested:

- More study about how we can treat water by simple way without cost.
- Implicating PWST in all production field and supporting by chemical adding for more efficiency.
- Prepare a feasibility study and compare with other methods as a hydro cycle.
- Try to improve Efficiency of produce water by adding another unit working as secondary treatment unit.
- Since the Produce water Skim tank has a low efficiency with emulsion further investigations should be carried out to improve treating emulsion content.

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