A Project Submitted to the Department of Chemical Engineering F.U.T Minna in partial fulfillment of the Requirement of the award of Bachelor of Engineering (B. Eng). Degree in Chemical Engineering

DECLARATION

I Okpala .O. Kenneth with registration number 2003/15063EH declare that this research work is my original work and has not been presented somewhere to the best to my knowledge.

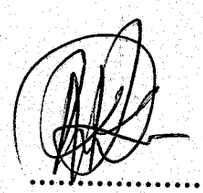
Okpala .O. Kenneth. .....

Name ***Sign/date***

Okpala 7-11-08.

CERTIFICATION

The research project has been examined and certified under the supervision of Engr. Mohammed Alhassan to be Adequate in scope and quality for the partial fulfillment of the requirement for the award of Bachelor of Engr. (B. Engr) in Chemical Engineering.



.....

Engineer. Alhassan Mohammed
Project Supervisor

5/11/08
.....

Date

.....

Dr. Edoga (Head of Department)

.....

Date

.....

External Examiner

.....

Date

DEDICATION

This research project is dedicated to my beloved parent's chief and Mrs P.E. Okpala and my beloved Brothers and Sister for all their support and encouragement during my course of study.

ACKNOWLEDGEMENT

My sincere thanks goes to Almighty God, Jesus Christ who has made it possible for me to conclude these work. I wish to express my appreciation to my supervisor, ENGR. ALHASSAN whose enormous contributions to the success of these work cannot be overlooked and to my Head of Department DR. EDOGA who has encouraged me throughout my course of study.

I appreciate the effort of my father Chief P.E. Okpala whose financial and moral support has sustained me throughout my stay in the University

I am also grateful to all my lectures my brother and Sister for their support and encouragement at the course of my studies and all my friends and classmate in chemical Engineering Department.

TABLE OF CONTENT

CHAPTER SIX

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND INFORMATION

The world is endowed with abundant agricultural produced which often gives rise to wastes. Hence the need to convert some of these waste to some useful materials. Thus, country like ours which have both agricultural produce and mineral resources as the main foreign exchange commodities for her economy, an attempt to convert this readily available wastes for useful materials, especially for the containment of the inevitable oil spillage is a step in the right direction

Agricultural wastes are considered suitable for use as oil adsorbent in case of spillage because of their porous mature (necessary for adsorption) Floatability, cheapness at virtually no cost. (John and Vander Hooven ,1970).

This invention relates to a method for recovery an organic substance, such as oil from materials, such as liquid and loose matter and other earth materials in particular the present invention relates to the removal of catastrophic organic substance such as oil spills from bodies of water and earth materials in an environmentally and ecologically beneficial manner.

The prior art has been a variety of devices proposed to clean up oil from solid surfaces and bodies of water including those substantial oil spills which create ecological disaster. Some prior art devices are designed primarily for foliation and confinement. Other prior art device for cleaning up oil spills scoop with mechanical device and pumps. Other devices comprise adsorbent materials which are usually granular and held by a woven container. However other devices have minimal adsorptive procedures in other that they do not sink.

After oil has been adsorbed by an adsorbent the contaminated mineral adsorbed is removed from the body of water. However a percentage of the mineral materials is not removed from body of water which create an additional pollution or sewage treatment problem.

This present invention is aimed at using compacted wood dust with gum and starch in oil spill removal. This becomes necessary for effective control and cost reduction in the event of oil spillage removal. The aim was achieved via the following objectives.

- Determination of the physical and chemical properties of crude before and after removal.
- Determination of the binding agent, with the highest adsorptivity and retention time.

To a greater extent the aim was achieved.

1.2 SCOPE AND OBJECTIVE OF THIS PROJECT

The aim of this protect is to develop a means of oil removal using agricultural waste (wood dust) from the surface of water.

A comparative study is to be made of these adsorbent using two binding agents. (Gum Arabic and starch) in terms of oil adsorption and retention capacity with view of encouraging the oil industries and government on the use of this cheap and effective method of removing oil spillage.

The scope of this protect is limited to the following:

- To develop an effective means of removing the adsorbent from the body of water after adsorption by the use of different binding agent – also to determine the (binding agent) with the highest adsorbility.
- To recover back the oil adsorbed by the adsorbent using solvent extraction method.

1.3 JUSTIFICATION

The study was carried out to model and simulate crude oil spill removal using wood dust with Arabic Gum and Starch as binding agent to prevent the wood dust from been carried away by wind and water waves during spill removal in large body of water and also to determine the binding agent with the highest adsorptivity and there after to recover the crude back.

There is no doubt that the out come of this research work will not only make available on alternative means of oil spill removal and recovery but will also go along way in saving companies and government enormous amount of money often required to remove crude oil spillage using other mechanized method such as oil skippers, free water knockouts and heaters.

CHAPTER TWO

2.0 LITERATURE REVIEW

Nigeria has experienced a number of oil spillage in resent times in oil producing areas of Nigeria. To this effect the Nigeria National Petroleum Cooperation (NNPC) sponsored a baseline study carried out by the Research Planning Insulate (R.P.I) in partnership with the institute of petroleum studies to obtain data for establishment of control criteria and standard against petroleum related pollution. (Peter and olusegun ,2006)

The development refueled a conviction that the problem of oil spillage must be faced and solved as part of the current general effect to improve the quality of life although crude oil in its many forms is one of the necessities of modern industrial society. It is efficient, versatile and productive but if it is out of control, it can be one of the most devastating substance in the environment inspite of preventive effort there will be spills, either due to human carelessness or to calamities beyond human control, consequently, attention should be given to improve clean up measures. (Brown and Adria, 1992)

However, mere addition of any quantity of substance recognized as pollutant in aquatic ecosystem. Constitute a pollution condition. On studying the effect of petroleum on organism discovered that a very low amount of hydrocarbon could reduce the respiratory rate of aquatic organism and phytoplankton.

2.1.0 CAUSES OF OIL SPILLAGE

An accidental or intentional discharge of oil into water or land is called oil spillage and can be controlled by a number of ways ranging from chemical dispersion, combustion, mechanical containment and adsorption oil spills are caused by a number of factors such as blow outs, sabotage, corrosion, equipment malfuction , natural causes such as wind earth movement etc.(Peter and Olusegun,2006)

2.1.1 LACK OF PROPER MAINTANCE.

Thousand of barrels of oil have been spilt into the environment through our oil pipe lines and tanks in the country. This spillage is as a result of our lack of regular maintenance of the pipe line and storage tanks. Some of these facilities have been in use for decades without replacement about 10,000 barrels of oil spilled into environment through the offshore pipeline in idoko (Peter and Olusegun ,2006)

2.1.2 SABOTAGE

Sabotage is another major cause of oil spillage in the country. Some of the citizens of this country in collaboration with people from other countries engage in oil bunkering. They damage and

destroy oil pipe lines in their effort to steal oil from them SPDC claimed in 1996 that sabotage accounted for more than 60% of all oil spilled at its facilities in Nigeria.(Peter and Olusegun ,2006)

Stating that the percentage has increased over the years both because the number of sabotage incident has increased and because spill due to corrosion have decreased with programs to replace oil pipe line. Pirates are stealing Nigeria crude oil at a phenomenal rate, funneling nearly 300,000 barrels per day from our oil and selling it illegally on the international trade market.

2.1.3 CORROSION

In Nigeria 50% of oil spill is due to corrosion, oil pipeline which are buried both off shore and on shore for very long period of time corrode and there by become very weak and eventually explode due to pressure from the refinery and contact by man or animal and objects of any kind.(Peter and Olusegun, 2006)

2.1.4 VANDALIZATION OF OIL PIPELINE AND TANKS.

Illegal fuel siphoning as a result of the thriving black market for fuel products has increased the number of oil pipeline explosion in recent years . in July 2000, a pipeline explosion outside the city of warri caused the death of 250 people. An explosion in Lagos in December 2000 killed at least 60 people. The NNPC reported 800 cases of pipeline vandalization from January through October 2000. in January 2001, Nigeria lost about 84 billion on oil revenue due to activities of oil vandals on our oil installation. The government estimates that as much as 300,000 bbl/d of Nigeria crude is illegally bunkered out of the country. (Peter and Olusegun, 2006)

2.2.0 EFFECTS OF OIL SPILLS INCIDENTS ON NIGERIA COASTAL AREA AND LAND

Since the discovery of oil in Nigeria in the 1950s, the country has been suffering the negative environmental consequence of oil development. The growth of oil industry combine with a population and a lack of enforcement of environmental regulation has led to a substantial damage to Nigeria's environment especially in the Niger Delta region. When there is an oil spill on the environment spreading immediately takes place. The gaseous and liquid component evaporate. Some get dissolved in order and even oxidize and yet some undergo bacteria changes and eventually sink to the bottom by gravitational action. The soil is them contaminated with a gross effect upon the terrestrial life. As the evaporation of the volatile lower molecular weight component with the resulting emulsified water affect aquatic life.(Peter and Olusegun 2006)

The harmful effects of oil spill on the environment are many, oil kills plant and animals in the estuarine zone. oil settles on beaches and kill organisms that live there, it also settle on ocean

floors and kill bottom dwelling organisms such as crabs. oil poison algae, disrupted major food chains and damage the number of edible crustaceans. It also coats bird imparing their flight or reducing the insulative properties of their feathers oil endangers fish hatcheries in coastal water and as well as containment the flesh of commercially valuable fish. In the Nigeria coastal environment a large area of mangrove ecosystem have been destroyed. The mangrove was once a source of both fuel wood for the indigenous people and a habitat for the areas biodiversity, but is now unable to survive the oil toxicity of its habitat.(Peter and Olusegun, 2006)

2.3.0 CONTROL OF OIL SPILLAGE

Several law and polices have been taken in managing oil spill incidents at the international and national levels. Theses lows and polices are given in the following below.

- The oil pollution act (OPA) of 1990.
- National oil spill Detention and Response Agency.
- The Niger delta Development Commission (NDDC)
- Efforts of the oil companies and non Government Agencies.
- Creating of Awareness.
- Nigerian sat 1

2.4.0 ADSORPTION

Adsorption is defined as a process in which fluid molecules are concentrated on a surface by chemical or physical forces, or by both. Adsorption is also define as the tendency of a solid substance to condense and retain on its surface a layer of a gaseous or liquid substance.

The phenomenon of absorption is expressed by the freundlick equations

$$\frac{(X)^n}{n} = KC \quad \text{-------- (1)}$$

where x = weight of adsorbed material

m = weight of adsorbing material

c = concentration in equilibrium with adsorbed material.

K and n = content to be determined experimentally for each temperature.

2.4.1 THE THEORY OF ADSORPTION

Adsorption involves accumulation of substances at interface. There are five possible types of interface in adsorption process namely. Liquid – liquid gas – liquid, gas – solid, liquid – solid, and gas – liquid. Adsorption is caused by the attractive forces between the molecules of the substance which are in contact. the degree of adsorption depends upon the chemical composition of the adsorbing material which include the exposed surface and other geometric and physical characteristic, the nature of the material being adsorbed the temperature. The solute from the fluid

attached selectively to solid. Highly porous solid with very large internal area per unit volume are usually preferred because accumulation per unit, area is small. The surface of the solid are usually irregular. The material adsorbed is known as the adsorbate and the adsorbing phase is the adsorbent.(Anderson and Rubin,1981)

2.4.2 MECHANISM OF ADSORPTION

In the system of solid surface are liquid the molecule of the liquid will be continually striking the surface and a fraction of these molecules will adhere. But because of their kinetic, vibrational and rotational energy. The more energetic molecules will be leaving the surface continuously. Eventually, an equilibrium will be established such that the rate at which molecules strike the surface, the remain for a time, will be exactly balanced by the rate at which molecules leave the surface.(Anderson and Rubin 1981)

2.4.3 FACTORS INFLUENCING ADSORPTION

The extent of adsorption is proportional to surface area. Surface area, that is available for adsorption per unit adsorbent. This means that the adsorption capacity of a non porous adsorbent should very inversely with the particle diameter while the adsorption capacity of highly porous adsorbents should be almost independent of the particle diameter.

The nature of the adsorbate also influences adsorption in general inverse relationship can be expected between the extent of adsorption of a solute and its solubility in the solvent from which adsorption takes place.

2.4.4 NATURE OF ADSORBENTS

Adsorbent solid are usually used in a granular from varying in size for roughly 12mm diameter to as small as 50pm. The solid mark posses certain properties depending upon the application to which they are put. If they are used in a fixed bed through which a liquid or gas is to flows for example, they must not offer too great a pressure drop for flow nor must they easily be carried away by the flowing stream. They must have adequate strength and hardness

2.4.5 APPLICATION OF ADSORPTION

Experience shows that various adsorbent have a different adsorptivity. But here the adsorbate also plays a substantial role. Consequently, when speaking of the adoptivity of an adsorbent, one must also indicate the adsorbent relative to which it was determined. In order words, the adoptively of the adsorbent is different relative to different adsorbates. This property of adsorbents is called their selectivity.

The relativity of adsorbents is widely employed for reparating complicated mixture into their components in removing impurities from various substance. All these processes are based on the

fact that the components having a high adsorptivity are adsorbed first from a mixture of substance while the component having a lower adsorptive are adsorbed after them or are practically not adsorbed.

2.4.6 COMMERCIAL ADSORBENTS

There are four adsorbents which are widely used or have important potential use on an industrial scale, namely, activated carbon activated alumina, silica gel and molecular sieves. The first three of these are amorphous adsorbent with a non – uniform internal structure, the pores being of various shapes and sizes so far as it is known. Materials of the forth type however, are crystaline and have therefore an internal structure of regularly spaced cavities with interconnecting pores of definite size. (Andersonand Rubin ,1981)

In this project, concentration would be on wood dust as the adsorbent. The adsorptive capacity of a porous material is essentially determined by its specific surface area which its directly proportional to the porosity and inversely proportional to the pore size. There porous material find use in various processes, such as waste water treatment and the purification, separating or removing of oil – water mixture, bleaching of oil and alcoholic fermentation liquid.

2.4.7 RATE OF ADSORPTION

The adsorption process can be divided into three step:

(1) transfer of the adsorbate molecules through the 5/m that surrounds the adsorbent, (2) diffusion through the pores if the adsorbent is porous, and (3) up – take of the adsorbate molecules by the above surfaces including formation of the bonds between the adsorbate and the carbon. Step three is considered to be very rapid, since equilibrium on non porus adsorbents can be accomplished in a matter of minuter. Step one and two are generally held to be rate – limiting. The thickness of the stagnant aqueous film that surrounds the adsorbent depends on the flow regime maintained in the by system. The rate of adsorption then depends on the rate at which the molecules. Move or diffuse in solution or the rate at which the modules can reach the available surface by diffusion through the film and the pores(Rechardson and cursun 4^{th} edition)

2.5.0 MECHANIZED WAYS OF REMOVING CRUDE OIL SPILLS

2.5.1 OIL SKIMMER

This is an equipment used which is suitable for the removal of oil like fuel – oils, kerosene and bunker oil. It consist of polyester best driven continuously by a motor. When submerged partially in the water the belt enters the liquid and floating or stratified oil adhered to it. The recovered oil is then lifted out of the water removed from the belt by steel supported hard rubber wipers (Brown and Adria 1992)

2.5.2 OIL WATER SEPARATION

This is a simple device that basically utilities the force of quality to effect separation of oil – water nature. The separation is based on the fact that most oils float on water. The oil water is allowed to stand and the oils forms a layer on the surface which is then pumped off or allowed to flow off into a holding tank white the water is discharged to the sewer.(Brown and Adria 1992)

2.5.3 FREE WATER KNOCKOUTS

This is another simple device used to separate oil and water mixture the mixture from the well flow into the used through on inlet value and allowed to slow down in the larger setting chamber. In this chamber, any free water mixed with the oil settle to the bottom of the vested and is drain off to the sewer, while the oil is removed through separate line and sent for further processing. The vessel is used to separate or eliminate only water which has rate been emulsified with the oil, (that is, water that is free to separate by itself) and hence the emulsified water cannot be separate by this method, it has to be broken down first. A typical free – water knockout is show in the fig 1. 0.

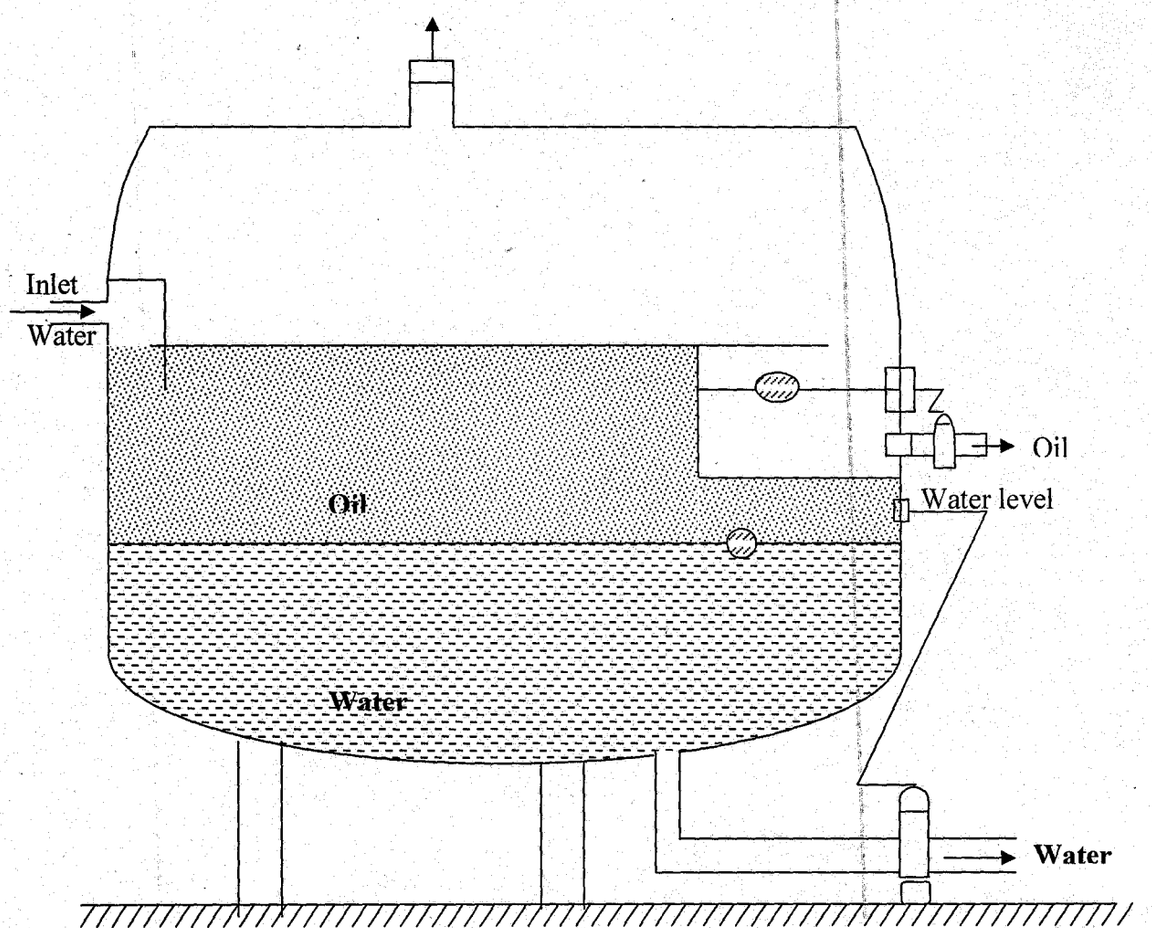


FIG 1.0: FREE WATER

(Brown and Adria 1992)

2.5.4 HEATER TREAKERS

This is also known as emulsion treaters. They are common devices used throughout the world to separate oil and water emulsion. It is similar to the free – water knockout but has heating capacity with fire tube inclusive. This fire tubes extend horizontally into the vested and natural or gas oil is bunk inside to create heat which passes through the fire tubes into the emulsion. The combustion of the gas within the fire tubes heats the oil and water emulsion that is entering the vessel and passing around the outside tubes. As the mixture of oil and water grow hotter, the emulsion breaks and forms into clean oil and water. While the water is removed from the bottom of the vessel and sent to the oil storage tank. Figure 2.0 is a typical heater – treaters.

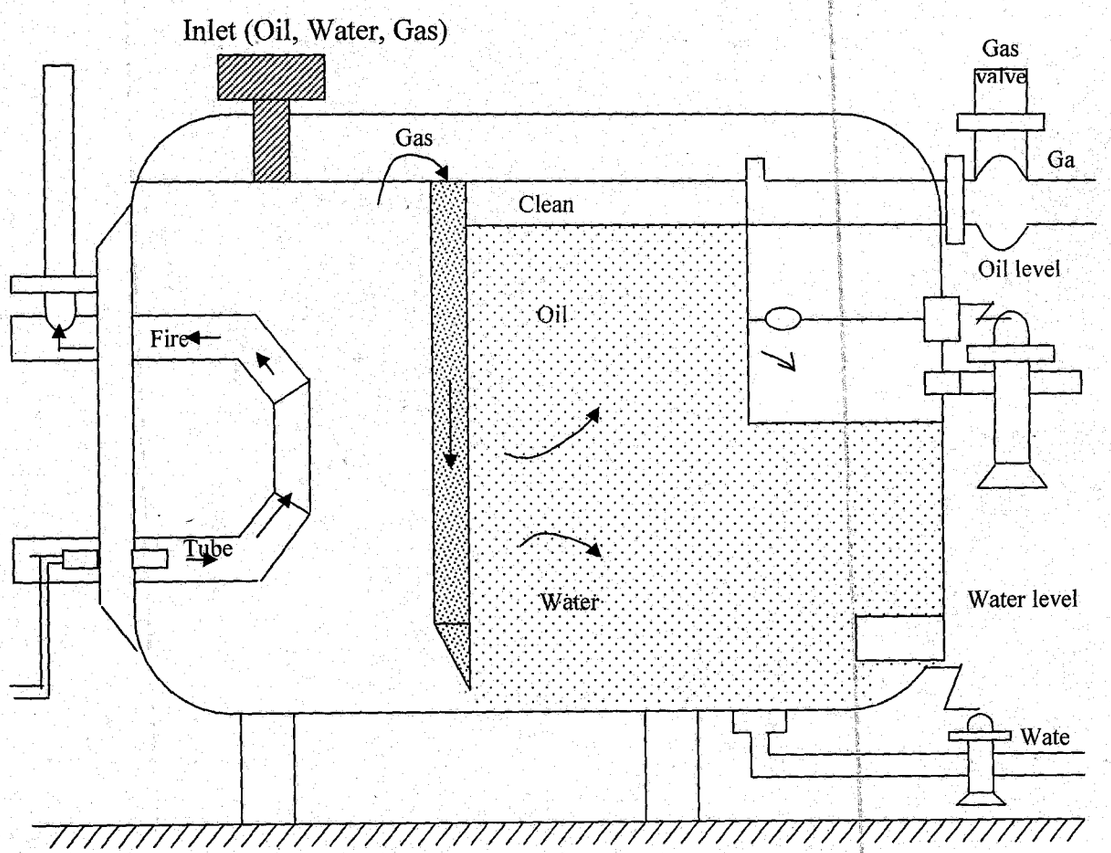


Fig 2: Horizontal Heater Treater (Brown and Adria 1992)

2.5.5 FREE WATER KNOCKOUT AND HEATER TREATER

This is the combination of free – water knockout and heater –treater to treat the fluids produced by a well. Fig 3.0 shows a typical combination of the equipment. The fluid from the well is made up of oil, water and gas this mixture first enters the free – water knockout where any water that would readily and freely separate is extracted from the oil and sent into the sewer while the free gas that separate out of the mixture is drawn off as a separate side stream. The remaining oil and water emulsion is sent to the heater – treater where the mixture is separate as described in the heater – treater equipment.

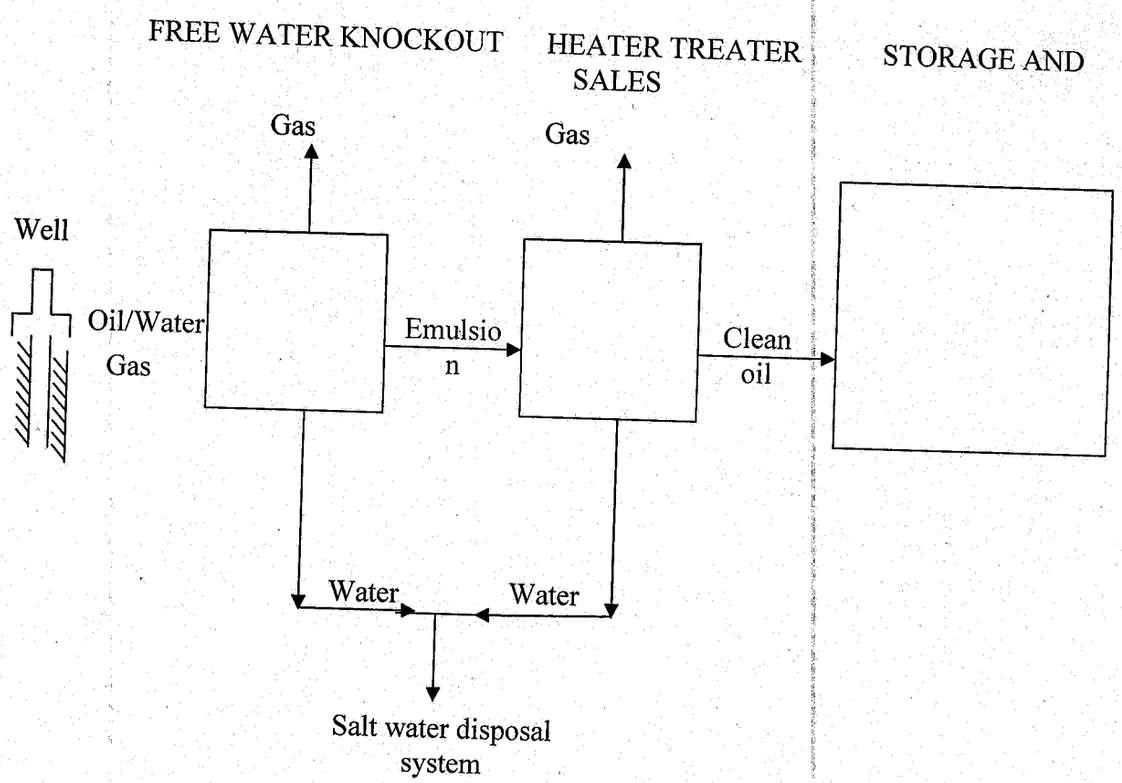


Fig 3.0: Surface facilities for typical oil well. (Brown and Adria ,1992)

2.6.0 SOURCE OF WOOD DUST

Wood dust is a waste from wood. Wood has been used by man from the very earliest time because it is a readily available and easily worked natural material. A large amount of wood is wasted in various processes of conversion. The waste takes a form of wood dust. The wood dust has expectation ally high porosity and hence huge surface area when not grind due to the crystalline porous structure and precise uniformity of the small pores within the wood dust, adsorption phenomena only take place with molecules which are of small enough size to enter the cavities through the pores. Wood dust have an ability to adsorb molecules from a surrounding medium on their surface to a certain degree.

2.6.1 INDUSTRIAL SCALE UP AND ECONOMIC IMPORTANCE OF WOOD DUST

The commercial utilization of wood dust is in the manufacture of particle board, fuel from wood dust, Ash, filler, plastics, mud control, the compression of wood dust together with or without the use of a binder for heating in furnaces, charcoal in which it can be use for embalming purposes and also for the use in filling the paint in wooden ships.

2.7.0 GUM ARABIC

Gum Arabic a natural gum also called gum acacia, and chear gund (in India), the hardened sap taken from two species of the acacia tree acacia Senegal acacia seyal. It is used primarily in the food industry as a stabilizer but has more varied use in the past and in the present, including viscosity control in inks and as binding agent.

Gum Arabic is a complex mixture of saccharides and glycoproteins which give it its most useful property. It is perfectly edible. While historically used for printing, paint production, glue and industrial application, it continues to be used as an ingredient in food stuffs. The substance is havested commercially from wild trees through out the sahel from senegal and sudan.. To Somalia although it has been historically cultivated in Arabia and west asia.(The Encyclopedia of Chemistry, 1966)

2.8.0 CRUDE OIL

Crude oil is a liquid combustible mineral occuring in the earth's sedimentary mantel. It consist of a complicated flow by gravity through an orifice or consideration of specified dimension

the thicker the oil, the longer the time required for its passage. Each of the various methods required its own viscosimeter

Close control of oil temperature is important because the viscosity of any petroleum oil increases when it is cooled and diminishes when it is heated for this same reason, the viscosity valve of an oil must always be accompanied by the temperature at which the viscosity was determined.

2.8.1 COLOUR AND COLOUR STABILITY

The colour of an oil normally is brown or brownish black and no direct indication of its lubricating properties is expected to show the presence of contaminant or to act as guide to the uniformity of product. Colour is sometime used to estimate the degree of deterioration met during storage.

The colour of the crude oil can be observed by either transmitted light (true colour) or reflected light (cast fluorescence, or bloom). The colour scales in common use are all based on measuring transmitted light, using a variety of standard colour glasses or reference.(Mohammed and Jimoh, 2005)

2.8.2 FLASH AND FIRE POINTS

The flash point and fire point of a petroleum – liquid are basically measurements of flammability. Flash point is defined as the minimum temperature at which deficient liquid is vaporized to create a mixture of fuel and air that all easily ignite flame.

2.9.0 MODELING AND SIMULATION

A model is a simplified representation at some particular point in time or space intended to promote understanding of the real system.

While a simulation is the manipulation of a model in a way that it operate on time or space to compress it, thus enabling one to perceive the interaction that would not otherwise be apparent of their separation in time or space.

Modeling and simulation is a discipline for developing a level of understanding of the interaction of the parts of a system and of the system as a whole. The level of understanding which may be developed via this discipline is seldom achievable via any other discipline. Whether a model is a good model or not depends on the extent to which it promotes understanding. Since all models are simplifications of reality there is always a trade off as to what level of detail is included in the model. If too little details is included in the model one runs the risk of missing relevant iteration and the resultant model does not promote understanding. If too little detail is included in the model one runs the risk of missing relevant iteration and the resultant model May become overly complicated and actually precluded in the development of understanding one simply cannot develop all models in the context of the enter universe.

ABSTRACT

The increasing number of marine and land oil spills ask for effective solution for the environment pollution control. The present invention is on the use of wood dust as adsorbent in oil spill removal from water. To achieve this aim two different binding agent where used to hold both the sulphonated and unsulponated particles of wood dust together. The compacted wood dust was then used in the removal of oil spill from water.

Analysis conducted to test the properties of the compacted wood dust before and after the oil spill removal shows that the sulphonated form of the adsorbent has the highest efficiency in terms of the adsorbtion and retention capacity, this was probably due to their large porosity, the Sulphonated sample of the wood dust with Arabic Gum as the binding agent has an appreciable retention capacity at 100% wood dust and 10% while the retention capacity of that of starch was appreciable at 100% wood dust and 40% starch. Primary investigation also shows that gum Arabic do not dissolve in crude oil under room temperature hence can serve as an effective binder in oil spill removal.

A simulation generally refers to a computerized version of the model which is run over time to study the implications of the defined interaction. simulation are generally iterative in there development. One develops a model simulates it learns from the simulation, revise the model and continues until an adequate level of understanding is achieved.

2.9.1 SOFTWARE'S USED

The software used in this experiment is minitab 14. The choice of this software aroused as a result of the various tabulation which aroused from the result of the experiment and minitab been what it is will speeds up the rate of the work because it only requires the input of data's obtained.

Another software used for this research work is the auto cad software for drawing of the various machine stated in the literature review. This particular software made it easier for me draw all the component using the computer without much stress as all the necessary lines and curve's needed to form a component has all been made available.

The other software used is the mat lab, the choice of this particular software arouse as a result of the various calculation which I would be undertaken in the course of these research work.

2.9.2 AMERICAN STANDARD TEST METHOD & FOR PETROLEUM PRODUCT (ASTM)

This standard is issued under the fixed designation D97. this method is intented for use on any petroleum oil after prelimimary heating , the sample is cooled at a specified rate and examined at interval of 50C for flow characteristics. The lowest temperature at which movement of the oil is observed is recorded as the pour point. Add 30C to the temperature recorded and report the result as the point point ASTM D97.

2.9.3 VISCOSITY OF CRUDE OIL

This standard is issued under the fixed deligation D44S. this test method. Covers the determination of the viscosity of liquid petroleum products both transparent and opaque by measuring the time. For a volume of liquid to flow under gravity through a calibrated glass capillary viscometer.

2.9.4 STANDARD TEST METHOD FOR FLASH AND FIRE POINT BY CLEVELAND OPEN CUP.

This standard is issued under the fixed designation. D92 this test method covers determination of the flash and fire point of all petroleum products except fuel oil and those having an open cup flash below 1750C.

The test cup is filled to a specified level with the sample the temperature of the sample is increased rapidly at first and then at a slow constant rate as the flash point is approached at a specified intervals a small test flame is passed across the cup the lowest temperature at which application of the test flame curses the vapour above the surface of the liquid to ignite is taken as the flash point. To determine the fire point the test is continued instill the application of the test flame causes oil to ignite and burn for at least 5s.

CALCULATION

The barometric pressure is observed and recorded at the time of test. When the pressure differs from 760mmHq correct the flash or fire point or both by means of the following equation

Corrected flash or fire point, or both = F + 0.06 (760 – P)

Where F = observed flash or fire point, or both.

2.9.5 THE STANDARD TEST METHOD FOR API GRAVITY AND CRUDE PETROLEUM PRODUCT (HYDROMETER METHOD)

This standard is issued under the fixed designation D287, this method covers the determination by means of a glass hydrometer of the API gravity of crude petroleum and petroleum product. Normally handled in liquids and having a reid vapor pressure of 26 Psi (180 kpa) or less. Graveties are determined at 60F (18.560C). the API gravity is read by observing the freely floating API hydrometer and noting the graduction nearest to the apparent intersection of the horizontal plane surface of the liquid with the vertical scale of the hydronmeter after temperature equilbrium has been reached.

CALCULATION

$$API = \frac{141.5 - 131.5}{S.G\ \frac{60\ F\ \text{of oil}}{60\ f\ \text{of water.}}}$$

CHAPTER THREE

3.0.0 INSTRUMENTTATION /EQUIPMENT

Equipment/Apparatus	Manufacture	Description
Volumetric flash and Beaker		250 – 500ml
Conical Flash		
Glass rod.		
Weighing balance		
Filter paper		
Oven.		
Viscometer		Honillon tube type
Thermometer		
Stop watch.		
Sohxlet		
Colorimeter		
Refactometer		

REAGENTS.

The following are the reagents used in this research.

Sulphuric acid

Benzene.

SAMPLE.

Crude oil

Binding Agent

Starch and

Gum Arabic

3.2.0 METHODOLOGY

A sample of crude oil was obtained along with wood dust. The absorption capacity of the wood dust were analysed. Several analysis which included density determination, uptake test, as well as, determination of retention capacity, percentage crude oil content, specific gravity, refractive index, apparent viscosity and colour were carried out on experimental samples.

3.3.0 SULPHONATING THE WOOD DUST

20ml of concentrated sulphuric acid of 0.5m was refluxed to 1g of the wood dust for 1 hour and then it was washed free of acid with water then oven dried.

To prepare 20ml of 0.5 H2so4.

$$\text{Volume of stock} = \frac{\text{Vol of solvent x mol. Wt x molar cone.}}{\text{\% purily x 100 x sp. Gravity}}$$

3.4.0 EXPERIMENTAL PROCEDURE.

The sulphonated wood dust is mixed with two binding agent which are Gum Arabic and starch at different percentages and then molded with the aid of a 4ml beaker and weighed before dropping in a Petri dish containing 250ml of distilled water and 10ml of crude oil. After which each was left in the dish for 5 minutes and then reweighed.

3.4.1 DETERMINATION OF THE RETENTION CAPACITY

After adsorption the adsorbent was weighed again and the retention capacity was then determined.

Thus uptake test = (weight of sorbent+ adsorbent) – (weight of residue after interacting with oil)

$$\text{Determination of \% crude oil content} = \frac{\text{weight of residue or extracted oil x 100}}{\text{Marginal weight of Dry ground solid}}$$

3.4.2 DETERMINATION OF SPECIFIC GRAVITY.

The specific gravity and density of the petroleum oil was obtained with the aid of 10ml measuring beaker and weight balance. The weight of the empty measuring beaker and the weight of the 10ml measuring beaker of 4ml crude oil which was beaker respectively. The density of the crude oil was found by dividing the mass of the petroleum oil with the volume of the petroleum oil while the specific gravity was obtained by dividing the density of the crude oil with the density of water. Density was also determinate for wood dust, starch, Gum Arabic

3.4.3 REFRACTIVE INDEX DETERMINATION

The refractive index was determined by placing a drop of the crude oil on a glass slab of the refractometer, the crude oil was well spread and the adjustable arms of the refractometer was adjusted to give the reading. The refractive index was taken under room temperature.

3.4.4 APPARENT VISCOSITY DETERMINATION

The viscosity of the crude oil obtained was determined with the help of a viscosimeter. The tube type in particular. The viscosimeter is suspend with the aid of a retort stand in a Petri dish. Filled water. Therefore the crude oil was filled to certain mark in the tube and then allowed to drop. The time it began to flow back was monitored with the aid of stop watch in seconds.

3.4.5 COLOUR DETERMINATION

The colour of the obtained crude oil the adsorbent was determined by the use of a colorimeter. There the cups and the plungers are cleaned before and after use. The scale was tested to zero point then the sups with the crude oil was inserted until they touched the plungers. The instrument was adjusted for equal light intensity on both sides of the cups. The intensity of a colour is proportional to the concentration of the compound.

3.4.6 SOLVENT EXTRACTION.

The process of extraction of a solid – liquid extraction. This is by the use of Benzene as the solvent. A known weight of the adsorbent (wood dust) which has adsorbed some amount of crude oil and water. Benzene was used to extract the oil from these waste (wood dust).

Adequate safety measures was taken to prevent the escape of Benzene vapours, the inhalation of which is harmful.

CHAPTER FOUR

4.0.0 RESULT OF ANALSIS

Scatterplot of Adsorption by A, Adsorption by B vs % composition of

Regression Analysis: Adsorption by A versus % composition of binder

The regression equation is
Adsorption by A = 22.2 + 0.139 % composition of binder

Predictor	Coef	SE Coef	T	P
Constant	22.200	1.955	11.35	0.000
% composition of binder	0.13927	0.03151	4.42	0.002

S = 2.86225 R-Sq = 70.9% R-Sq(adj) = 67.3%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	160.02	160.02	19.53	0.002
Residual Error	8	65.54	8.19		
Total	9	225.56			

TABLE 4.1.0 % COMPOSITION ADSORPTION

Obs	of binder	by A	Fit	SE Fit	Residual	St Resid
1	10	25.500	23.593	1.682	1.907	0.82

2	20	26.800	24.985	1.427	1.815	0.73
3	30	23.700	26.378	1.200	-2.678	-1.03
4	40	27.900	27.771	1.021	0.129	0.05
5	50	25.200	29.164	0.919	-3.964	-1.46
6	60	33.300	30.556	0.919	2.744	1.01
7	70	33.100	31.949	1.021	1.151	0.43
8	80	29.100	33.342	1.200	-4.242	-1.63
9	90	34.900	34.735	1.427	0.165	0.07
10	100	39.100	36.127	1.682	2.973	1.28

Regression Analysis: Adsorption by B versus % composition of binder

The regression equation is

Adsorption by B = 34.8 + 0.0964 % composition of binder

Predictor	Coef	SE Coef	T	P
Constant	34.807	1.785	19.50	0.000
% composition of binder	0.09642	0.02877	3.35	0.010

S = 2.61351 R-Sq = 58.4% R-Sq(adj) = 53.2%

Analysis of Variance

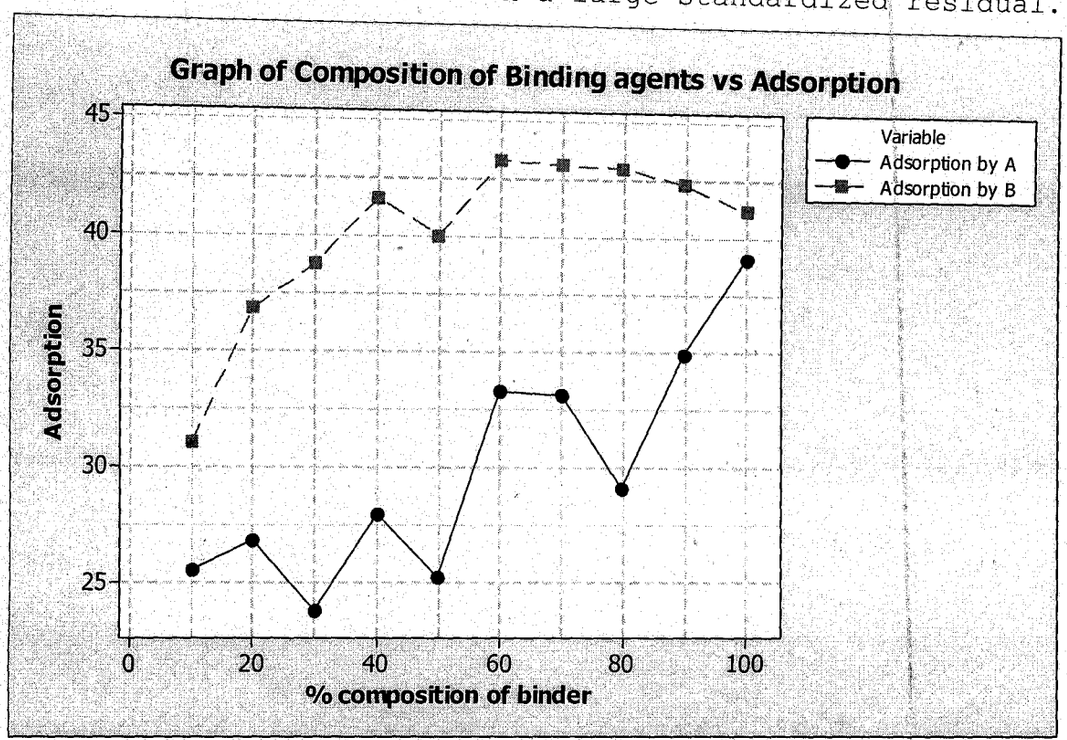
Source	DF	SS	MS	F	P
Regression	1	76.705	76.705	11.23	0.010
Residual Error	8	54.644	6.830		
Total	9	131.349			

TABLE 4.2.0

Obs	% composition of binder	Adsorption by B	Fit	SE Fit	Residual	St Resid
1	10	31.000	35.771	1.536	-4.771	-2.26R
2	20	36.800	36.735	1.303	0.065	0.03
3	30	38.800	37.699	1.096	1.101	0.46
4	40	41.600	38.664	0.932	2.936	1.20
5	50	40.000	39.628	0.839	0.372	0.15
6	60	43.300	40.592	0.839	2.708	1.09

7	70	43.100	41.556	0.932	1.544	0.63
8	80	43.000	42.521	1.096	0.479	0.20
9	90	42.300	43.485	1.303	-1.185	-0.52
10	100	41.200	44.449	1.536	-3.249	-1.54

R denotes an observation with a large standardized residual.



PROPERTIES OF THE CRUDE OIL RECOVERED FROM THE ADSORBENT

Table 4.3.0

Property	Recovered crude oil	Pure crude oil
Specific gravity	8.4650	8.4750
Viscosity at 34°c (centistokes)	9.6531	10. 0531
Colour	Say bolt + 24	Say bolt + 26
Pure point °c	28. 4	30
Refractive index	1. 5330	1. 4300

CHAPTER FIVE

5.0.0 DISCUSSION OF RESULT

The Agricultural waste used in this experiment was wood dust and the two binding agent used were Gum Arabic and starch. From the result obtained it was Discovered that as the percentage of binding agent decreased, the rate of adsorption increased.

The Agricultural waste used in thus experiment was wood dust and the two binding agent used to hold the wood dust together are Gum Arabic and starch. From the result obtained it was discovered that the rate of absorption of the wood dust using Gum Arabic as absorption was higher at 100% wood dust 10% Gum Arabic. While the rate of adsorption when using starch as the binding agent was higher at 100% wood dust and 40% starch.

This suggest that the absorptibilty increased with the decrease in binding agent used.

5.1.0 SULPHONATED WOOD DUST.

The wood dust was sulphonated before adsorption, this was to increase the surface area of wood dust for adsorption. It was discovered that for good removal of the oil spills the adsorbents should be immersed on the oil for sometime so that it can give room for more adsorption to take place.

5.2.0 RETENTION CAPACITY

The retention capacity of the adsorbent with the binding agents increased with decrease in the amount of binding agent used.This is shown from the result at 10% gum Arabic and 100% wood dust and for starch at 40% starch and 100% wood dust. This is shown in table 4.3.0

5.3.0 PERCENTAGE CRUDE OIL CONTENT.

The percentage crude oil content determined was more at the lower amount of the binding agent there was more oil particle with lower amount of binding agent this is shown at the appendix.

5.4.0 SPECIFIC GRAVITY

Specific gravity was found to be 5.4650. This is shown at the Appendix

5.5.0 REFRACTIVE INDEX

Refractive index was determined by win a refractometer at room temperature (34°c) and the refractive index was found to be 1.5330.

5.6.0 APPARENT VISCOSITY

From the result obtained the viscosity of the crude oil under test falls with rise in temperature. The viscosity at (34°c) was 9.6531 .

5.7.0 COLOUR

The colour of the crude oil obtained from the sulphonated wood dust and various binding agent was found to be dirty brown this could be due to the reaction between the concentrated sulphuric acid and the crude oil while the colour of the original crude oil was dark brown.

CHAPTER SIX

6.0.0 CONCLUSION/RECOMMENDATION

6.1.0 CONCLUSION

Analysis have show that the ordinary wood dust binder with Gum Arabic and starch can be used as adsorbent for removal of crude oil spills, with the sulphonated form of these waste and Gum Arabic having the highest efficiency in terms of retention capacity and adsorptive due to increased porosity by increase in their pore volume. Analysis of the recovered crude oil shows negligible difference in properties of the recovered crude oil compared to that of the original crude oil, hence it can be concluded that wood dust and binding agent (Gum Arabic and Starch) are very effective adsorbent for crude oil spill removal.

6.2.0 RECOMMENDATION

From the analysis carried out and the result obtained it would be recommended that the sulphonated wood dust moved with the various binding agent should be allowed to dry be fore adsorption. As this would hold the Particle of wood dust together for a long time.

In order to avoid economical waste, one can recover but the crude oil from the adsorbent. Since the recovered crude oil and the pure crude oil has almost the same physical properties or on the other hand the crude oil can also be left in the adsorbent to enhance combustion for domestic purpose and more so the ash obtained can be use for local soap.

So far in this project with the agricultural waste that has been used it is recommended that other agricultural waste such as coconut husk, groundnut shell and con can be used in clean up. It is also recommended that for effective removal of the adsorbent after adsorption. The adsorbent should be poured in sieve like bags and suspended by trawler boats or post at the two ends in large body of water as this will easy the removal of the adsorbent after adsorption.

It was also discovered that since these adsorbent are good for the removal of the crude oil spillage it can also be applied not in a refinery alone but more so in a mechanical workshop where there are oil spill all over some food processing industries or road side mechanic that throw away oils drained from vehicles into the ditch

REFERENCE

1. Peter C. Nwilo and Olusequn T. Badejo , (2005): Impacts and management of oil spill pollution along the Nigeria coastal areas. Journal on oil spill pollution in Niger, vol. 2, page 1 - 10

2. John and Vander Hooven I, David B. (1971): Removal of oil or oil substance from water and land area using corncob component page 3, 1971

3. Anderson, M. A. and Rubin, A. J. (1981): Adsorption of inorqanic at solid – liquid interface Ann Arbon science Publishers, inc, Michigan. Page 290 - 300

4. Brown, Adria (1992): Method for removing oil spills using a natural recyclable absorbent. www. Freepatentonline. Com. age 4 - 12

5. Mohammed Alhassan and Jimoh Abdul fatai (2005), Journal of chemical engineering conference,. page 62 - 65

APPENDIX

DENSITY DETERMINATION

To determine the density of the various samples, wood dust crude oils and starch.

FOR CURDE

Mass of oil with cylinder = 21.6g

Volume of crude oil with cylinder = 4ml

Mass of empty cylinder = 18. 39

But S = mass = 3. 39 = 0.008475 lcm^3

Volume 0. 4 x 10^3

FOR WOOD DUST

Mass of empty cylinder = 31. 9g

Mass of cylinder with H20 = 69. 7g

Mass of H20 = 69. 7 – 31. 9 = 37. 8g

Using relative density formula R.D = weight of substance

Weight of equal volume of H20

But weight of substance + beaker = 40. 5

Weight of substance = 40. 5 – 31. 9 = 8. 6g

= Y D = 8. 6 x 1000

---

37. 8

= Y Density = 227. 5g lcm^3

FOR SEARCH

Volume of search = 4ml

Weight of search + cylinder = 55. 6g

Weight of cylinder = 31. 9g

Mass of cylinder with H20 = 69. 7g

Weight of H20 = 37. 8g

= Y R.D = weight of substance

Weight of equal volume of H20.

D = 23. 7 x 1000

---

37. 8

D = 629. 9849 lcm^3

Determination of the density of Gum Arabic.

Weight of empty cylinder = 33. 8g

Weight of cylinder + Arabic Gum = 40. 5g

Volume of Arabic Gum = 4ml

Weight of Arabic Gum = 6.7g

But Density = mass

Volume

Density = 6.7g = 16. 75g lcm^3

0.4

Determination of specific gravity of crude oil.

Specific gravity = density of crude oil = 0.00489 = 8.475

Density of water 0.001

TO PREPARE 20ML 0. 5M H2S04

Using the formula

Cc = p x w x 10 where S = wt per ml

M W = % of acid.

Cc = 1. 84 x 98 x 10 M = molecular weight of acid.

---

98. 08

Cc = 18. 38glm.

But dilution formula is given as

$$CcVc = CdVd$$

$$= Y \quad Vc = \frac{CdVd}{Cc}$$

$$Vc = \frac{0.5 \times 500}{18.38} = 13.6ml$$

$$Vc = \frac{0.5 \times 500}{18.38} = 13.6\ ml$$

This implies that 13. 6ml of concentrated acid would be diluted with 500ml of the distilled water

DETERMINATION OF PERCENTAGE CRUDE OIL CONTENT

Percentage crude oil content = $\frac{\text{weight of residue or entreated oil (g)} \times 100}{\text{Marginal weight of dry ground solid}}$

For Gum Arabic:

$\frac{3.8}{35.3} \times 100 = 10.76\%$

$\frac{3.1}{31.8} \times 100 = 9.75\%$

$\frac{2.2}{31.3} \times 100 = 7.03\%$

$\frac{3.6}{20.7} \times 100 = 12.12\%$

$\frac{1.8}{27.0} \times 100 = 6.67\%$

1.9 x 100 = 7. 31%

26

0.9 x100 = 3. 95%

22.8

4.4 x 100 = 19. 6%

22.4

7.6 x 100 = 40.21%

18.9

For search

1.2 x 100 = 2. 83%

42.4

0.7 x 100 = 1. 68%

41.6

1.6 x 100 = 3. 86%

41.4

2.2 x 100 = 5. 38%

40.9

2.8 x 100 = 6. 91%

40.5

0.5 x 100 = 15. 7%

39.5

3.1 x 100 = 8.05%

38.5

0.8 x 100 = 2.08%

38.5

0.2 x 100 = 0.55%

36.5

1.7 x 100 = 5. 8%

29.3

TABLE 1

Result of the analysis carried out using the two binding agents

Table 1:

Using Gum Arabic as Binder all at 5min interval	**Wt before adsorption**	**Wt after adsorption**
100% Wood dust and 100% Binder	3.5.3	3.4.1
100% Wood dust and 90% Binder	31.8	34.9
100% Wood dust and 80% Binder	31.3	29.1
100% Wood dust and 70% Binder	30.8	33.1
100% Wood dust and 60% Binder	29.7	33.3
100% Wood dust and 50% Binder	27.0	25.2
100% Wood dust and 40% Binder	26.0	27.9
100% Wood dust and 30% Binder	22.8	23.7
100% Wood dust and 20% Binder	22.4	26.8
100% Wood dust and 10% Binder	18.9	25.5

Table 2: Using starch as a Binder

Using Starch as Binder all at 5min interval	Wt befor adsorption	Wt after adsorption
100% Wood dust and 100% Binder	42.4	41.2
100% Wood dust and 90% Binder	41.6	42.3
100% Wood dust and 80% Binder	41.4	43.0
100% Wood dust and 70% Binder	40.9	
100% Wood dust and 60% Binder		
100%		

MODELING AND SIMULATION OF OIL SPILL REMOVAL USING WOOD DUST AS ADSORBENT

BY

OKPALA ONYEBUCHI KENNETH
2003/15063EH

DEPARTMENT OF CHEMICAL ENGINEERING
SCHOOL OF ENGINEERING AND ENGINEERING
TECHNOLOGY.
FEDERAL UNIVERSITY OF TECHNOLOGY
MINNA, NIGER STATE NIGERIA.

OCTOBER, 2008

Using Starch as Binder all at 5min interval	Wt befor adsorption	Wt after adsorption
100% Wood dust and 100% Binder	42.4	41.2
100% Wood dust and 90% Binder	41.6	42.3
100% Wood dust and 80% Binder	41.4	43.0
100% Wood dust and 70% Binder	40.9	43.1
100% Wood dust and 60% Binder	40.5	43.3
100% Wood dust and 50% Binder	39.5	40.0
100% Wood dust and 40% Binder	38.5	41.6
100% Wood dust and 30% Binder	38.5	38.8
100% Wood dust and 20% Binder	36.5	36.8
100% Wood dust and 10% Binder	29.3	31.0