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Research And Evaluation Of Hair Waste As A Substitute For Absorbent Pad Material

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Abstract — In 2021-2022, there were 37 oil spill incidents recorded in the PT. Pertamina EP Sangasanga Field. The oil spill incident from 2021-2022 resulted in a loss in company operational costs of IDR 626,333,120, of which 50% was used as costs for using oil spill equipment. This research aims to reduce and save costs on using oil spill equipment by replacing it with natural absorbent materials. Natural absorbent materials that are often found in Indonesia include palm fiber, husks, bintaro powder and hair waste. To test absorbent capacity, ASTM (American Society for Testing and Materials) is used as another standard procedure for testing absorption capacity. The test method applied for oil absorption by various absorbent media is ASTM D/483-60 "Oil Absorption of Pigment by Gardner-Coleman Method". The results of testing using the ASTM D/483-60 method showed that the capacity of palm fiber was 79.8%, husk 58.8%, bintaro powder was 42.9%, and hair was 89.3%. Meanwhile, data on the absorption capacity of palm fiber is 22.9%, husk is 25.5%, bintaro powder is 57.2%. Comparison of the factory absorbent pad with the hair absorbent pad after 17 uses, the hair absorbent pad remained stable after 6 presses with an oil recovery of 1.72 liters. Meanwhile, the factory's absorbent pad decreased from the initial 10 squeezes with oil recovery of 1.86 liters, after 17 uses it became 12 squeezes with oil recovery decreasing by 1.60 liters. After implementing the hair absorbent pad, the company can save operational costs of IDR 576,983,120 for the cost of purchasing Oil Spill Equipment

Keywords— Oil Spill, Hair, Absorbent, Oil absorption

I. INTRODUCTION

An oil spill is the release of liquid petroleum hydrocarbons into the environment due to human activities. Oil spills can occur due to the release of crude oil from tankers, offshore platforms, drilling platforms and wells, as well as spills of refined petroleum products and their by-products, heavier fuels used by large ships such as bunker fuel, or spills of oily rubbish or oil waste (Rahman, K. M. M., 2016).

Sangasanga Field is one of the fields in the Pertamina Upstream Zone 9 of Indonesia with three areas namely Samboja, Sangasanga and Anggana (Figure 1.1). In 2021-2022 there were 37 incidents of oil spill in the field of the 9th zone due to unsafe action and unsafe condition as well as asset reliability requiring comprehensive repairs (Figure 1.2). The incident caused the loss of operational costs of the company, such as; the cost of leakage prevention activities, the purchase of equipment for leaks, and the costs of liquidation of waste B3 per capita of Rp.626.333.120. Of these costs, 50% of the cost is the use of oil spill equipment with a nominal Rp. 399.246.160. The cost of use of oil spill equipment obtains the highest weight against the company's losses so it is necessary to make improvements to improve efficiency.

The oil spill incident in the Sangasanga Field Zone 9 resulted in losses to the company's operational costs in the form of; costs for leak prevention activities, costs for purchasing leak equipment, and costs for managing B3 waste costs. The following is data on leakage loss costs for 2021 - 2022.

Table 1.1
Oil Spill Countermeasure Cost in 2021

No	Problems	Cost
1.	Total Usage Cost of Oil Spill Equipment 2021	Rp. 111.600.000
2.	Total Waste Management Cost 2021	Rp. 56.887.840
3.	Total Waste Management Service Cost 2021	Rp. 105.600.000
Total		Rp. 274.087.840

Table 1.2
Oil Spill Countermeasure Cost in 2022

No	Problem	Cost
1.	Total Usage Cost of Oil Spill Equipment 2022	Rp. 31.900.000
2.	Total Waste Management Cost 2022	Rp. 13.458.320
3.	Total Waste Management Service Cost 2022	Rp. 19.800.000
Total		Rp. 65.158.320

Table 1.3
Oil Spill Countermeasure Cost 2021-2022

No	Masalah	Biaya
1.	Total Usage Cost of Oil Spill Equipment 2021-2022	Rp. 143.500.000
2.	Total Waste Management Cost 2021-2022	Rp. 70.346.160
3.	Total Waste Management Service Cost 2021-2022	Rp. 125.400.000
Total		Rp. 339.246.160

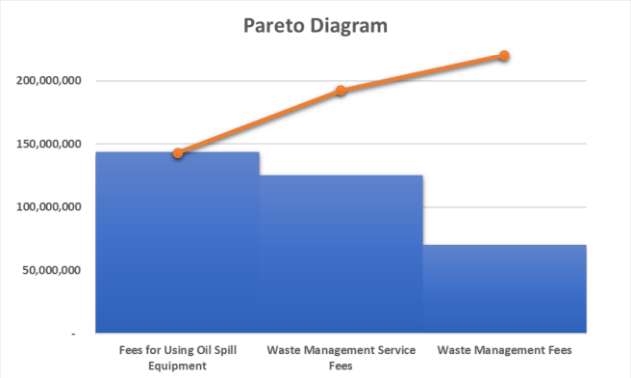

Figure 1.3 Oil Spill Counter measure Pareto Diagram

From the data above, the cost of using Oil Spill Equipment gets the highest weight so improvements need to be made to improve efficiency on Oil Spill handling costs

Table 1.4
Loss Caused by Incident Problems

ID	Process Description	Loss (in Rp.)	Relatif	Cumm
A	Oil Spill	Rp. 339.246.160	82%	82%
B	Property Damage	Rp. 38.000.000	13%	96%
C	First Aid	Rp. 10.400.000	3%	100%

According to the graph data above, Oil Spill is the highest incidence in the Field Sangasanga Zone 9 due to unreliable assets and the problem Oil Spill has the largest potential loss in the company with a cumulative value of 82.6%. The process of repairing assets requires high costs and a long enough time so it is necessary to carry out preventive action to prevent Oil Spill from occurring in the environment. The losses caused by Oil Spill are as follows:

- Purchase of oil spill contingency equipment
- Compensation costs for affected environments
- Repair damaged assets
- LPO

II. LITERATUR REVIEW

Oil spills or oil leaks are an event in which liquid hydrocarbon fuels spill into the living environment, marine ecosystems, human activities or are in a form of pollution. The term usually refers to oil spills at the border, where oil melts into oceans and coastal waters, although spills can also occur on land (Jonathan L, 2017). Therefore, action is needed to counter oil spill and one of them by using the absorbent pad.

Absorbent oil pad is made from Meltblown material. This Meltblown Oil Absorbent Material has high absorption capacity. Most oil absorbent pads are made with polypropylene, a thermoplastic polymer. It is a technical textile and is water repellent and oleophilic. Most of the oleophilic substances used to make these Meltblown Oil Absorbent Pads are relatively new additions to industrial equipment. Good quality oil absorbent pads or mats consist of several layers of polypropylene so they can clean large amounts of oil quickly, because these materials are hydrophobic, the water remains (Park Non Woven, 2023). However, it does not rule out the possibility that it also has several weaknesses that need to overcome, namely that absorbent pads have a limited ability to absorb liquids. Once they reach maximum capacity, they must be replaced or refurbished. This can cause problems if the resulting oil spill is large enough or must be handled continuously. Replacing absorbent pads regularly can be quite expensive, especially if they are used in large quantities or frequently. The use of natural absorbents is considered to be a solution to overcome the weaknesses of the use of absorbent pads. Due to its high efficiency, low cost, can be used repeatedly, environmentally friendly, and also high absorption power. One of the natural absorbers is human hair. The use of hair as a natural absorber of oil spills was pioneered by Philip/McCrory in 1989 during the Exxon Valdez disaster (JanviManish Shah, 2020).

It is produced from the Aren tree after about 5 years and before flowering. The type of palm tree depends on its age and height. The cold is black, and has a diameter up to 0.50 mm. Heat-resistant colds up to 150 °C and has a flame point of about 200 °C. The main advantage of the juice is its durability and good resistance to sea water (Sahari J, 2012). It has a chemical composition of cellulose 52.3%, hemicellulose 13.3%, lignin 31.5%, and ash 4%. (Ishak MR, 2013).

Rice husk is the inedible outer layer of rice seeds and is removed during the rice milling process. Husks contain ingredients such as cellulose, lignin, silica, and other minerals such as phosphorus, potassium, magnesium, and calcium. Rice husk ash contains a high percentage of silica, ranging from 80.26% to 96%. Apart from that, husks also contain water, with a percentage of around 8.9% (H. Aminuddin, 1996).

Bintaro fruit is a drupa fruit (seed fruit) which consists of three layers, namely the epicarp or exocarp (outer skin of the fruit), mesocarp (middle

layer in the form of fiber like coconut fiber), and endocarp (seeds covered with seed coat or testa). Physically, bintaro fruit has fibrous fibers like coconut. The fiber in bintaro fruit is formed from cellulose. The cellulose fiber is a glucose polymer which has β-1,4 glycosidic bonds which are connected together via hydrogen bonds. This β configuration is what makes cellulose hard, difficult to dissolve in water, and not sweet. The β-1,4 glycoside bonds in cellulose fibers can be broken down into glucose monomers by enzymatic hydrolysis. The glycosidic bonds of the glucose monomers in cellulose make the cellulose structure linear and regular. This structural regularity gives rise to intra- and intermolecular hydrogen bonds (Yun et al., 2008)

Human hair has a diameter of between 50-100μm (micrometers) and consists of dead cells consisting of cuticle, water, lipids and 6595% protein. Contains amino acid polymers such as keratin and cysteine, medulla and cortex. The cuticle is very hydrophobic which makes hair water repellent. The cuticle also contains many peptide bonds and CO- and NH-groups that create hydrogen bonds between adjacent molecules on the surface of human organic follicles and the highly porous cortex. It's the hydrophobic and biological absorbent properties that make hair able to bind heavy metals and other contaminants like oil (Janvi Manish Shah., 2020).

ASTM (American Society for Testing and Materials) is a standard procedure for testing absorbent capacity and developed from this test an uncomplicated standard test procedure for use with waste oil. The procedure chosen for determining absorption capacity is absorption that applies to static conditions. One of the most applicable test methods for oil absorption by various absorbent media is ASTM D/483-60 "Oil Absorption of Pigment by Gardner-Coleman Method" (M. Lin., 1983).

Titration is an analytical process in which a volume of a standard solution is added to a solution with the aim of identifying unknown components. A standard solution is a solution whose concentration is known for certain. Based on purity, standard solutions are divided into primary standard solutions and secondary standard solutions. A primary standard solution is a standard solution that is prepared by weighing and dissolving a certain substance with high purity (the concentration is known from the mass - volume of the solution). A secondary standard solution is a standard solution that is prepared by weighing and dissolving a certain substance with relatively low purity so that the concentration is known from the standardization results (Day Underwood, 1999).

The absorption capacity test can be determined using the following equation:

$$\text{Absorbency by volume} = \frac{volume\ of\ liquid\ \ absorbed\ in\ ml}{volume\ of\ absorbent\ in\ ml}$$

Meanwhile, the capacity test is based on the specific gravity of the liquid which can be determined based on the following equation.

$$\text{Absorbency by weight} = \frac{volume\ of\ liquid\ absorbed\ in\ ml\ x\ density\ (g/mL)}{weight\ of\ absorbent\ in\ grams}$$

To obtain data related to the absorption test, other comparative materials are needed. As a comparison, natural absorbent samples are used, namely husks, fibers and bintaro fruit powder.

III. MATERIALS AND TOOLS

The tools required in this study are a container with a capacity of 10 liters, a 1 litre measuring glass, a 20 mL injection capacity, and a scale (Figure 1.3)

The materials used in this study are natural absorbents namely: human hair, palm powder, husks, bintaro powder, crude oil, and water. (Figure 1.4)

DATA COLLECTION

Data collection for this research was carried out at the WOWS workshop of PT Pertamina EP Sangasanga. Testing was carried out in accordance with ASTM D/483-60 which has been obtained, namely:

1. Weight of the sample with a volume of 30 x 30 cm before use
- Hair = 348 gram (Figure 1.5)
- Palm fiber = 184 gram (Figure 1.6)
- Husks = 373 gram (Figure 1.7)
- Bintaro = 110 gram (Figure 1.8)

2. Maximum absorption volume using the titration method. Using a 20 ml syringe.
- Hair = 349 mL (in 19 injections + 14 ml)
- Palm fiber = 86 mL (in 4 injections)
- Husks = 180 mL (in 9 injections)
- Bintaro = 163 mL (in 8 injections + 3 ml)

3. The maximum absorption volume by immersing the material in a container and filling it with liquid oil is 520 mL.

Table 1.5 Comparison of Ingredients with the Method of Immersing the Ingredients in a Container and Filling it with 520 mL of Liquid Oil

No.	Name of Materials	Absorbed Oil (mL)	Unabsorbed Oil (mL)
1.	Hair	352	31
2.	Palm Fiber	47	390
3.	Husks	106	200
4.	Bintaro	70	300

4. Test the ratio of materials with 2 phases of water and crude oil with a ratio of 4 liters of water and 2 liters of crude oil.

Table 1.6 Comparison of Absorption Materials in 2 Phases

No	Name of Materials	Times Squeeze	Recovered Oil (mL)	Water in Absorption (mL)	Details
1.	Hair	6 times	1.720	150	Clean water from oil
2.	Palm Fiber	13 times	1.290	1.670	Squeezing was not continued because oil still exists
3.	Husks	10 times	1.300	490	Squeezing was not continued because oil still exists
4	Bintaro	3 times	210	130	Squeezing was not continued because the maximum absorption limit was already reached

DATA PROCESSING

To determine the absorption capacity of oil in a sample, the following calculations are carried out.

1. Absorbency by Volume calculation (Capacity)
   1. Hair

$$\frac{volume\ of\ liquid\ absorbed\ in\ mL}{volume\ of\ absorbnet\ in\ mL} = \frac{352\ mL}{395\ mL} = 89{,}3\ \%$$

   2. Palm Fiber

$$\frac{volume\ of\ liquid\ absorbed\ in\ mL}{volume\ of\ absorbnet\ in\ mL} = \frac{47\ mL}{86\ mL} = 79{,}8\ \%$$

   3. Husks

$$\frac{volume\ of\ liquid\ absorbed\ in\ mL}{volume\ of\ absorbnet\ in\ mL} = \frac{106\ mL}{180\ mL} = 58{,}8\ \%$$

   4. Bintaro

$$\frac{volume\ of\ liquid\ absorbed\ in\ mL}{volume\ of\ absorbnet\ in\ mL} = \frac{60\ mL}{163\ mL} = 36{,}8\ \%$$

2. Absorbency by Weight calculation (Absorption Capacity)
   1. Hair

$$= \frac{volume\ of\ liquid\ absorbed\ in\ ml\ x\ density\ (g/mL)}{weight\ of\ absorbent\ in\ gram}$$

$$= \frac{352\ ml\ x\ 0{,}9\ g/mL}{348\ gram} = 91\ \%$$

   2. Palm Fiber

$$= \frac{volume\ of\ liquid\ absorbed\ in\ ml\ x\ density\ (g/mL)}{weight\ of\ absorbent\ in\ gram}$$

$$= \frac{47\ ml\ x\ 0{,}9\ g/mL}{184\ gram} = 22{,}9\ \%$$

   3. Husks

$$= \frac{volume\ of\ liquid\ absorbed\ in\ ml\ x\ density\ (g/mL)}{weight\ of\ absorbent\ in\ gram}$$

$$= \frac{106\ ml\ x\ 0{,}9\ g/mL}{373\ gram} = 25{,}5\ \%$$

   4. Bintaro

$$= \frac{volume\ of\ liquid\ absorbed\ in\ ml\ x\ density\ (g/mL)}{weight\ of\ absorbent\ in\ gram}$$

$$= \frac{70\ ml\ x\ 0{,}9\ g/mL}{110\ gram} = 55{,}6\ \%$$

Table 1.7 Comparison of Absorbent Materials

Natural Absorbent	Absorbency	
	Capacity (%)	Absorption Capacity (%)
Hair	89,3 %	91 %
Palm fiber	79,8 %	22,9 %
Husks	58,8 %	25,5 %
Bintaro	42,9 %	55,6 %

The results of the calculation of oil absorption capacity according to ASTM D/483-60 are recorded in Table 1.1 if hair and bintaro have very good reproducibility because the absorbency values are close between absorption by volume (Capacity) and absorption by weight (Absorption Capacity) with comparative values. approaching +-1%. However, from the number of calculations with the same volume of 30x30 cm, hair has the highest absorption capacity value, namely 91.0%. Therefore, in this research hair was used as the main ingredient for a natural absorbent.

After calculating the absorption capacity of each natural absorbent material, it was known, and hair was chosen as a good material as a substitute for absorbent oil. The hair is modified to resemble an Absorbent pad wrapped in cloth. Then a product comparison test was carried out between the manufacturer's absorbent pad and hair absorbent.

1. Comparison between manufacturer's Absorbent Pad and Hair Absorbent in new condition can be seen at table 1.8 in attachment.

2. Comparison between factory Absorbent Pad and Hair Absorbent after 17 uses can be ssen at table 1.9 in attachment

From the experimental results above, the absorption capacity of the Hair Absorbent Pad is more stable than the factory Absorbent Pad even though it has been used 17 times. Meanwhile, in the factory Absorbent Pad, there is a decrease in the absorption capacity, which decreases over time.

RESULT

The results of calculations using ASTM D/483-60 to compare the absorbency of 4 natural absorbent materials, hair, palm fiber, husks, and bintaro, can be concluded that hair can be used as a substitute for manufactured absorbent materials because it has an Absorbency by Volume (Capacity) value of 89 % and the Absorbency by Weight value is 91%. Comparison between absorption capacity: hair capacity is close to -+ 1%

For comparison testing of the hair material that has been modified to the Hair Absorbent Pad with the manufacturer's Absorption Pad, the hair absorbent pad is still effective in terms of absorption even though it has been used 17 times.

ECONOMIC VALUE

In this case, a replacement application of the Absorbent manufacturer is carried out with the use of absorbents made of natural absorbents, i.e. hair waste. This application is expected to squeeze and save expenditure on oil spilling in Sangasanga Field Zone 9.

Table 1.10 Hair Absorbent Pad Manufacturing Cost [per 1 pc]

No.	Material and Service	Size	Cost (Rp.)
1	Fabric	0,2 m²	12.500,00
2	Hair	138 Gram	-
3	Sewing	1 pc	5.000,00
Total			**17.500,00**

To make one Hair Absorbent Pad it only costs IDR. 17,500.00. This price is cheaper compared to manufacturer's Absorbent Pads where it costs Rp. 25,000.00 per pc.

Table 1.11 Financial Verification After Application of Hair Absorbent

No.	Description	Cost (IDR)
A. Revenue		**2021-2022**
1	Pad Absorbent & Oil Boom	453.200.000,00
2	Dispersant	88.000.000,00
3	Wypall cost (Majun fabric)	79.000.000,00
4	Est. Oil Recovery Hair Absorbent	6.133.120,00
Total Revenue		**626.333.120,00**
B. Cost		
1	Cost of Making Hair Absorbent	31.500.000,00
Total Cost		**31.500.000,00**
Value Creation Cost		**626.333.120,00**
		31.500.000,00
Total Value Creation Cost		**594.833.120,00**

The data above is financial verification data after replacing factory absorbent materials with natural absorbent materials, namely hair waste. The use of Hair Absorbent results in a Value Creation Cost of Rp. 594,833,120.00.

CONCLUSION

The following are some conclusions that have been drawn from a series of studies that have been carried out. Among others:

1. The natural absorbent materials that will be used as replacements for factory absorbent products are palm fiber, husks, Bintaro fruit and hair.
2. This research used testing stages using the ASTM D/483-60 method. This method is used as a standardization of the "Oil Absorption of Pigment by Gardner-Coleman Method" (M. Lin., 1983).
3. During the research process, the natural absorbent materials is chosen enter the research process with the stages of finding absorption and capacity values. An absorbent material can be said to be good if the ratio of the absorption and capacity values is close to -+ 1%

1. The results of ASTM D/483-60 testing, the natural absorbent material that meets ASTM D/483-60 standards is hair. Where hair has an absorption capacity of 91% and a capacity of 89.3%.
2. After going through the testing stage according to ASTM D/483-60 standards, the hair is processed to resemble the manufacturer's Absorbent Pad which is named Hair Absorbent Pad.
3. The Hair Absorbent Pad is tested to compare the absorption capacity in 2 phases with the factory Absorbent Pad product. Testing the strength of 2 phase absorption, in a container filled with 4 liters of water mixed with 2 liters of Crude Oil. After testing the absorption capacity in 2 phases, the Hair Absorbent Pad remained stable in absorption from the factory Absorbent Pad even though it had been used 17 times.

Therefore, this research proves that hair waste can be a solution as a substitute for factory Absorbent Pads. The advantage of the Hair Absorbent Pad product is that it can be used repeatedly with stable absorption even though it has been used 17 times.

REFERENCE

[1] ASTM D/483-60, Oil Absorbention of Pigment by Gardner-Coleman Method, 1983. (BNL) United States.

[2] Jadhav, A.S, Dkk, (2011), " Study Of Adsorbtion Of Oil From Oily Water Using Human Hair". Internasional Journal Of Advanced Engineering Technology, Department Of Chemical Engineering Aissms College Of Enginnering, Pune Anad Department Of Chemical Eginnering, TKIET, Warnanagar, Dist Kolhapur, Vol. 2.

[3] M. Lin, D. R. Mackenzie, (1983), “Tests Of Absorbents And Solidification Techniques For Oil Wastes, Brookhaven National Laboratory”, Washington, D.C

[4] Rahayu, Eka , Dkk, (2021), “Optimasi Sintesis Dan Aplikasi Adsorben Dari Limbah Ekstrasi Biosilika Sekam Padi”, Balai Besar Penelitian Dan Pengembangan Pascapanen Pertanian, Jawa Barat, Indonesia. Hal 36.

[5] Shah, Janvi Manish, (2020), “Penggunaan Jaring Rambut Untuk Pengelolaan Tumpahan Minyak, Internasional journal of creative research thoughts (IJCRT), Sekolah Tinggi Teknik Thadomal Shahani, Mumbai, India.

[6] Surya, Adi Silvester, (2015), Pemanfaatan Limbah Rambut Manusia Sebagai Pelampung Adsorben Pencemaran Minyak Di Lautan, Universitas Sebelas Maret, Surakarta.

[7] Silalahi, Isabella Marlinang, Dkk, (2023), “Kombinasi Adsorben Alam Dalam Pengolahan Air Limbah Cucian Pada Bengkel”. Jurnal Kesehatan Lingkungan Indonesia, Kedokteran Gigi Dan Ilmu Kesehatan Universitas Prima, Indonesia, Indonesia

[8] Sinurat, Maya Eria, Dkk, (2016), “Analisis Pola Sebaran Tumpahan Minyak Mentah (Crude Oil) Dengan Pendekatan Model Hidrodinamika Dan Spill Amalysis Di Perairan Balongan, Indramayu, Jawa Barat, Jurusan Ilmu Kelautan, Fakultas Perikanan Dan Ilmu Kelautan, Univertas Dipenogoro, Semarang. Jurnal Oseanografi, Vol. 5, No.2, Hal 218-226.

[9] Sugama, Junio, Dkk, (2012), “Efficacy Of An Improved Absorbent Pad On Incontinence-Associatead Dermatitis In Older Women: Cluster Randomized Controlled Trial”.BMC Geriatrics, Institute Of Medical, Pharmaceutical And Helath Sciences, Kanazzawa University,Ishikawa, Japan.

[10] Shalahuddin , Faris, (2021) , “Reduksi Cemaran Limbah Minyak Dan Lemak Di Pelabuhan Ppi Kamal Muara Menggunakan Variasi Ukuran Dan Massa Limbah Rambut Manusia, Universitas Islam Negeri Syarif Hidayatullah, Jakarta, Indonesia.

[11] Talunoe, Ofelman, Dkk, (2015), “Pemanfaatan Arang Aktif Kulit Kacang Tanah Sebagai Adsorben Besi (Fe) Pada Air Sumur Di Desa Pendolo, Kec. Pamona Selatan, Kab.Poso”, Jurusan Kimia Fakultas MIPA Universitas Tadulako, Indonesia.

[12] Nitilesh Kumar, Anup C Halekote. Hemanth Kumar B. J & Akshay, (2019), “Absorption Of Natural Oil Spills Using Human Hair As Sorbent”, Asian Journal Of Applied Science And Technology (Ajast), Mvjce, Bangalore, Vol.3, Pages 184-188.

ATTACHMENT

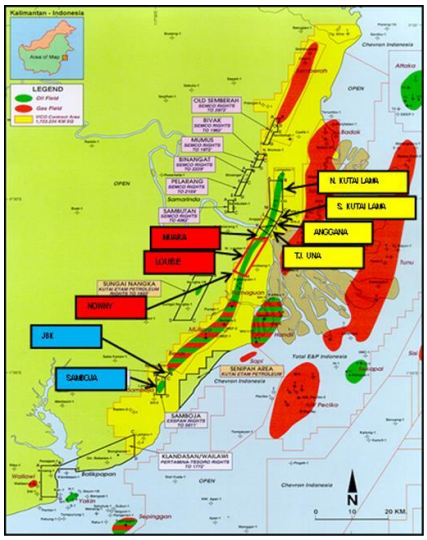

Figure 1.1 Sangasanga Field Map

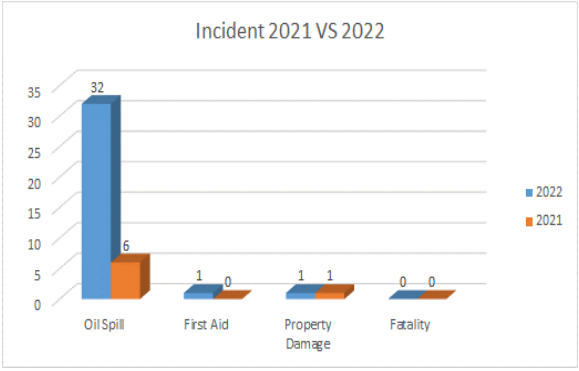

Figure 1.2 Oil Spill Incident Diagram

Figure 1.4 Tools Hair Abosrbent

Figure 1.5 Materials Hair Absorbent Pad

Figure 1.6 Hair Weight

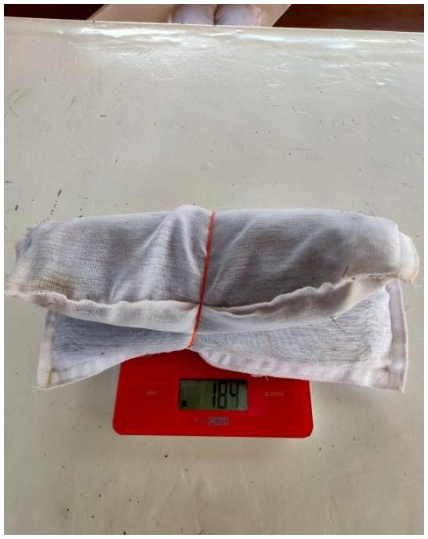

Figure 1.7 Palm Fiber Weight

Figure 1.8 Husks Weight

Figure 1.9 Bintaro Fruit Weight

Table 1.8 Comparison Between Manufacturer's Absorbent Pad and Hair Absorbent in New Condition

Oil Spill Countermeasure Materials					
No.	Criteria	Unit	Manufacturer's Absorbent Pad		Hair Absorbent Pad
1	Material volume	cm	30 x 30		30 x 30
2	Crude oil volume	L	2		2
3	Water Volume	L	4		4
4	Number of Squee	times	10		6
5	Number of Usage	times	17		17
Result					
Recovered Oil		L	1,860		1,720

Table 1.9 Comparison of Factory Absorbent Pad with Hair Absorbent in Condition After 17 Uses

Oil Spill Countermeasure Materials					
No.	Criteria	Unit	Manufacturer's Absorbent Pad		Hair Absorpant Pad 
1	Material volume	cm	30 x 30		30 x 30 
2	Crude oil volume	L	2		2
3	Water Volume	L	4		4
4	Number of Squeeze	times	12		6
5	Number of Usage	times	17		17
Result					
	Recovered Oil	L	1,6		1,720