THE EFFECT OF SEA- WATER,PALM- OIL AND BRINE ON STRESSED AND UNSTRESSED MILD MILD STEEL

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ABSTRACT-An investigation was made on the effect of seawater, brine and palm oil on stressed and unstressed mild steel. Theobjective was to determine the changes in physical and mechanical properties of the mild steel specimens when immersed in the different mediaThree stressed and three unstressed mild steel specimens were used, the specimens were immersed in the three different media for six weeks after which their weights, tensile strength and hardness value were determinedThe results show that the weights and hardness value of the unstressed specimens in the three media after six weeks of immersion did not change.The weights of the stressed specimens did not change but there were slight differences in their hardness value after immersion for six weeks.

Keywords: Effect, Seawater, Palm-oil, Brine, Stressed and unstressed, Mild-Steel

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1.0 INTRODUCTION

In selecting material for purposes such as structural constructions, automobile parts and components, hinges, nuts and bolts, domestic appliances, industrial appliances etc, what readily comes to mind is mild steel because it is cheap and readily available. All the various aspects where mild steel can be useful have effect(s) directly or indirectly on human lives. In structural constructions, when mild steel is used, it is subjected to various stresses and environmental conditions, for example in the construction of bridges it may be in sea water and the movement of vehicles or even human beings may be a form of stress acting on the bridge, under such condition, it is susceptible to pitting corrosion. When mild steel is used in domestic it may be in contact with materials such as palm oil and also under the effect of some stresses. In the industry, it can be in contact with various chemicals or salts, brine is however of interest in this work, carbon steel is sometimes referred to as 'mild steel' or 'plain carbon steel'. The American Iron and Steel Institute defines a carbon steel as having no more than 2 % carbon and no other appreciable alloying element. Carbon steel makes up the largest part of steel production and is used in a vast range of applications. Mild steel has a relatively low tensile strength, but it is cheap and malleable; surface hardness can be increased through carburizing.Plain carbon steels are classified according to their carbon content. The commonest of these is the 'mild steel' with carbon content ranging less than 0.3%. Mild steel may be subdivided into 3parts namely : dead mild steel containing 0.05 to 0.10%C, carburizing steel containing 0.10 to 0.20%C and the constructional steel containing 0.2 to 0.3%C.

Whenever external forces act on a body, deformation occurs due to the fact that most materials are elastic in nature. The molecules of the body therefore tend to resist this deformation. This resistant per unit area to deformation is called stress. These stresses can be of different types, tension, and torsion etc.

Brine is a solution of salt and liquid with extremely high salinity content. It has been used historically in food production as a preservative; since salt inhibits the growth of bacteria Brines are also referred to as 'produced water'. Produced water is extracted along with oil and gas during exploration and production. Brine can include reservoir water, injected water plus

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chemicals added during the production and treatment process. Brine can contain high mineral and salt content, known as formation water

Palm oil is an edible plant oil derived from the fruit of the *Arecaceae* *Elaeis* oil palm.

It is also an important component of many soaps, washing powders and personal care products, is used to treat wounds, and has controversially found a new use as a feedstock for biofuel.

The palm fruit is the source of both palm oil (extracted from palm fruit) and **palm kernel oil** (extracted from the fruit seeds). Palm oil itself is reddish because it contains a high amount of beta-carotene. It is used as cooking oil, to make margarine and is a component of many processed foods. Boiling it for a few minutes destroys the carotenoids and the oil becomes colorless. Palm oil is one of the few vegetable oils relatively high in saturated fats (like coconut oil) and thus semi-solid at room temperature

Sea water contains approximately to a 3.5mass% solution of sodium chloride but also contain significant quantities of other solutes. In sea surface water, the oxygen contents are close to equilibrium with the atmosphere. The PH range is 8.0 to 8.3 and the temperature range is -2 to 30^{0}c. The high concentration of ionic solutes might be expected to influence corrosion rate. It is a good electrolyte.

Pitting and crevice corrosion commonly occur in chloride environment, chloride stress corrosion cracking (SCC) can occur in chloride-containing solutions at elevated temperature, normally above 50 degrees C, when tensile stress is present. These corrosion types mentioned above will most likely occur in seawater since it contains sodium chloride. The objective of this research work is to determine the effect of seawater, brine and palm oil on the

- Mechanical properties
- Physical properties of stressed and unstressed mild steel.

2.0 EXPERIMENTAL

Mild steel was obtained locally and was analyzed for its constituent composition using a spectrometer; the values are shown in table 2

	C	Mn	Si	Ni	Cr	Mb	FeC
%	0.3	0.79	0.5	1.4	1.2	0.3	95.51

Table 2 Composition of mild steel billet

2.1 PREPARATION OF SPECIMEN FOR TEST

The billet was machined into six 30mm guage lengths. A Rockwell hardness testing machine was used to determine the hardness of the billet this was done by measuring the depth to which the cone indents the material under a load, the diameter of the impression was determined and the hardness was read from the chart.

Three of the specimens were subjected to a simple tensile test to yield point using the united tensile strength machine. The load-extension curves for each specimen as shown below. The simple tensile test was carried out by gripping opposite ends of the piece of material and pulling it apart. The loads were adjusted and the readings were taken. The various weights of the stressed and unstressed samples were also determined using the weighing machine.

In order to determine the effect of sea water, palm oil and brine on the stressed and unstressed specimens, concentrated brine was obtained from Lagos State Drug Quality Control Laboratory, Ikeja .9g of brine was dissolved in 1litre of water to make a brine solution.1litre of sea water from Lagos bar Beach was used and 1litre palm oil was obtained from the market .One specimen each of the stressed mild steel was immersed in sea water, brine solution and palm oil..The specimens were left in the media for about six weeks where they were carefully observed, after six weeks the specimens were removed from the media and the weights and hardness were determined.

Fig 2 Unstressed Specimens

Fig 3 Stressed Specimens

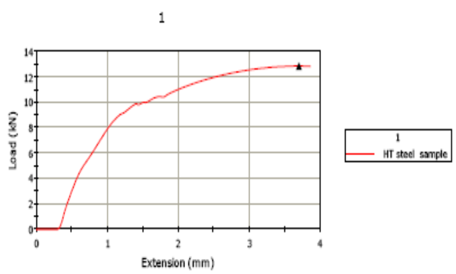
3.0 ANALYSIS OF RESULTS AND DISCUSSION

The results obtained after carrying out the required tests on the specimens are enumerated as follows

3.1 TENSILE TEST

Al Sample

Tensile test of Al samples



	Extension at Yield (Zero Slope) (mm)	Specimen Label	Length (mm)	Diameter (mm)
1	3.70	HT steel sample	30.00	6.00000

	Area (mm^2)	Load at Break (Standard) (kN)	Extension at Break (Standard) (mm)	Tensile stress at Break (Standard) (MPa)
1	28.27	12.81	3.85	453.00

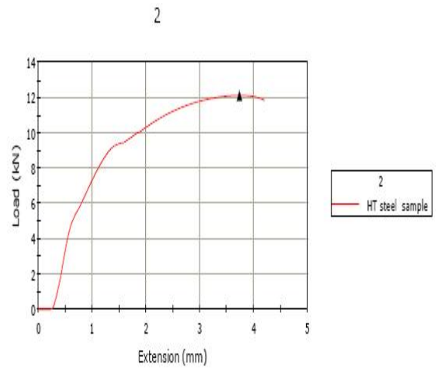
	Tensile strain at Break (Standard) (%)	Tensile stress at Yield (Zero Slope) (MPa)	Modulus (Automatic) (MPa)	Energy at Break (Standard) (J)
1	12.83	453.73	12085.18	35.62

	Energy at Yield (Zero Slope) (J)	Load at Yield (Zero Slope) (kN)	Tensile strain at Yield (Zero Slope) (%)	Poisson's Ratio (Chord)
1	33.69	12.83	12.33	-----

	Energy to X-Intercept at Modulus (Automatic) (J)	Extension at Tensile Strength (mm)	Load at Tensile Strength (kN)	Tensile strain at Tensile Strength (%)
1	0.00	3.45	12.79	11.50

	Tensile stress at Tensile Strength (MPa)	True strain at Yield (Zero Slope) (mm/mm)	True stress at Yield (Zero Slope) (Pa)	Tensile stress at maximum (MPa)
1	452.30	0.12	509686768.18	

Fig 4 Graph of Load-Extension at tensile stress of 453Mpa at yield point



	Extension at Yield (Zero Slope) (mm)	Specimen Label	Length (mm)	Diameter (mm)
1	3.73	HT steel sample	30.00	6.00000

	Area (mm^2)	Load at Break (Standard) (kN)	Extension at Break (Standard) (mm)	Tensile stress at Break (Standard) (MPa)
1	28.27	11.84	4.20	418.67

	Tensile strain at Break (Standard) (%)	Tensile stress at Yield (Zero Slope) (MPa)	Modulus (Automatic) (MPa)	Energy at Break (Standard) (J)
1	14.00	428.44	11762.70	37.96

	Energy at Yield (Zero Slope) (J)	Load at Yield (Zero Slope) (kN)	Tensile strain at Yield (Zero Slope) (%)	Poisson's Ratio (Chord)
1	32.34	12.11	12.44	-----

	Energy to X-Intercept at Modulus (Automatic) (J)	Extension at Tensile Strength (mm)	Load at Tensile Strength (kN)	Tensile strain at Tensile Strength (%)
1	0.00	3.72	12.11	12.39

	Tensile stress at Tensile Strength (MPa)	True strain at Yield (Zero Slope) (mm/mm)	True stress at Yield (Zero Slope) (Pa)	Tensile stress at maximum (MPa)
1	428.37	0.12	481757071.26	

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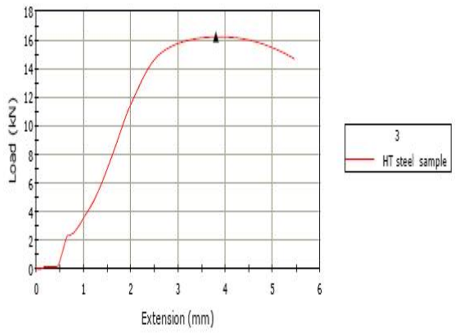
Fig 5 Graph of Load-Extension at tensile stress of 418Mpa at yield point



	Extension at Yield (Zero Slope) (mm)	Specimen Label	Length (mm)	Diameter (mm)
1	3.80	HT steel sample	30.00	6.00000

	Area (mm^2)	Load at Break (Standard) (kN)	Extension at Break (Standard) (mm)	Tensile stress at Break (Standard) (MPa)
1	28.27	14.70	5.45	519.85

	Tensile strain at Break (Standard) (%)	Tensile stress at Yield (Zero Slope) (MPa)	Modulus (Automatic) (MPa)	Energy at Break (Standard) (J)
1	18.17	573.22	9245.65	61.49

	Energy at Yield (Zero Slope) (J)	Load at Yield (Zero Slope) (kN)	Tensile strain at Yield (Zero Slope) (%)	Poisson's Ratio (Chord)
1	35.52	16.21	12.67	-----

	Energy to X-Intercept at Modulus (Automatic) (J)	Extension at Tensile Strength (mm)	Load at Tensile Strength (kN)	Tensile strain at Tensile Strength (%)
1	0.37	3.85	16.21	12.83

	Tensile stress at Tensile Strength (MPa)	True strain at Yield (Zero Slope) (mm/mm)	True stress at Yield (Zero Slope) (Pa)	Tensile stress at maximum (MPa)
1	573.16	0.12	645831063.63	

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Fig6 Graph of Load-Extension at tensile stress of 519Mpa at yield point

From figures 4, 5 and 6, the load, extension, energy and tensile stress at yield point of the samples from the same mild steel billet vary; these differences may have been due to the machining and bench work done on the samples before subjecting them to tensile test.

3.2 WEIGHTS OF SPECIMENS

The weights of the stressed and unstressed specimens before and after immersion are shown in the tables 3 and 4

WEIGHT (grams)	PALM OIL	SEA WATER	BRINE
BEFORE (grams)	30.0	30.0	29.7
AFTER FOR 6 WEEKS	30.0	30.0	29.7

Table 3 Stressed Specimens

WEIGHT (grams)	PALM OIL	SEA WATER	BRINE
BEFORE	28.4	30.0	31.3
AFTER 6WEEKS	28.4	30.0	31.3

Table 4 Unstressed Specimens

3.3 HARDNESS TEST

The results of the hardness test is shown in table 5 and 6

HARDNESS	PALM OIL	SEA WATER	BRI-NE
BEFORE	29 HRC	29 HRC	29 HRC
AFTER	29 HRC	29 HRC	29 HRC

Table 5 Unstressed Specimens

HARDNESS	PALM OIL	SEA WATER	BRI-NE
BEFORE	29 HRC	29 HRC	29 HRC
AFTER	30.2 HRC	29.8 HRC	30.5 HRC

Table 6 Stressed Specimens

4.0 EFFECT OF SEA-WATER, PALM- OIL, BRINE, ON STRESSED AND UNSTRESSED SPECIMEN

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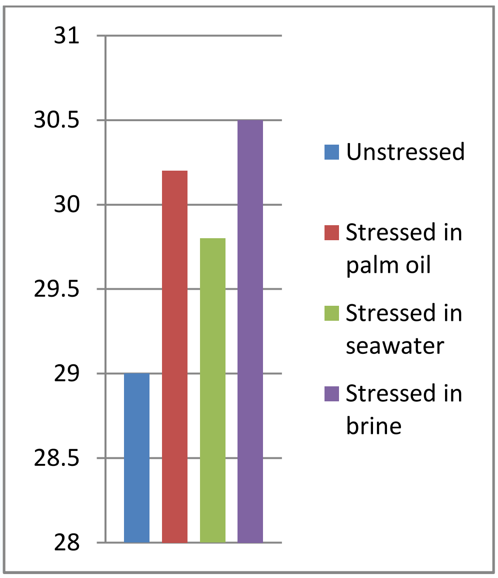

Fig 7 Comparative analysis of hardness for stressed and unstressed specimen after immersion

From fig 7 above, after six weeks there are slight changes in the hardness values of the stressed specimens in the various media but for the unstressed specimens there are no changes in the hardness values in all the media. Conclusively it was observed that hardness value increased in stressed samples and this was highest for the sample immersed in brine.

REFERNCES

1 A Cottrell, An introduction to metallurgy Edward Arnold Publishers Limited, 2nd Edition, London. 1975

2 H Davies, K Oelman The structure properties and heat treatment of metals Pitman Publishing Ltd, New Zealand, 1983.

3 F C Hernandez, J.H Sokolowski, Journal Of Metals p48-52 2005

4 M. G. Fontana, Corrosion Engineering Mcgraw-Hill Singapore 1986

5 A Atkinson, Conditions for the formulation of new oxide films growing on metals, Journal Institution of corrosion science and technology, vol 22 nr 441982

6 P R Roberge, Hand book of corrosion Engineering Mcgraw-Hill China 2005

7 F Trugott, Material science for Engineering Students , Academy Press Ltd, New-Jersey 2008

8 C Williams, Fund. of material science and Engineering, Prentice hall New-Jersey 2008

9 M.T Adem, Factors affecting aqueous corrosion kinematics of mild steel, Mechanical Dept University of Lagos 1983 unpublished

9 A.R Alatishe The effect of environment on coated mild steel Lagos 1998 unpublished

10 R Jefferey, F Melchers, Corrosion tests of mild steel in temperate seawater Newcastle 2001

11 G. Dieter, Mechanical metallurgy McGraw- Hill, New Jersey 1986

12 H.E Davies, G Troxel, E.W.G. Hanck, The testing of engineering materials Edward Arnold publishers Dublin 1982

13 X. Jian, Scripta Materilia,pp893-896 2006

14 Y. Mitzutani, Materials Transactions vol 45 2004

15 R M. Pillai, Journal of Material Processing Technology vol 146 2004