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INVESTIGATION OF THE PROPERTIES OF LOCAL WOODS WITH A VIEW TO USING THEM FOR ELECTRICAL INSULATION ESPECIALLY IN POWER DISTRIBUTION TRANSFORMER

by

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ABSTRACT

This work view wood and its derived products as valuable assets to the power and machines industry. It deals with commonly available wood in the Nigerian forests and market (2).

These woods have been analysed in the fresh state and after heat treatment. The work covers the water and oil absorption capacity of the various samples and the effect of same on the insulation resistance of the samples. It has been established that the sample has a reasonable insulation resistance (greater than 100MΩ at 2.5kV) in the treated state and zero mega-ohm (at 2.5kV) when the samples were immersed in water. In all the samples, the of water absorption was much greater then the rate of oil absorption.

1.0 INTRODUCTION

Woods and products of wood have a high affinity for water (1). The degree of affinity for water affects woods electrical properties (chiefly, the insulation resistance) is the prime objective of this paper. From all indications, it has been shown that the insulation/dielectric ability of wood and it products is greatly affected by the presence of the smallest amount of moisture (1). In the tropics with climatic extremes, any equipment with wood or it product is subject to adverse condition of temperature, moisture and humidity. Work has been done on this types of wood common in Nigerian markets to test the effect of moisture and heat treatment on them. The results are encouraging and have shown that heat treatment improves the insulation /dielectric properties of wood.

Properties of the wood and this treated wood can lend itself to use in the machine industry as clamps, pegs, separators, insulating paper, etc

1.1 METHODS

1.1.1 Preparation of the Samples

Bits of wooden blocks were produced from the Uselu plank shed in Benin City. The block were rectangular with approximately the same surface area to volume ratio. Provisions were made for clip-on electrical terminals for easy access with the megaohmeter. Each sample (Obeche, Black Afara, Obobo, Opepe, Apa, Danta and Ekhimi) was made in a pari. The samples were all labeled. The fresh weights (g) were measured and recorded. The insulation resistance at 500V (100MΩ) measured by the use of a megaohmeter was recorded. The samples were then introduced into an oven preheated at 70°Cand left there for 36 hours. The new weights and insulation resistance were measured and recorded (Tables 1 and 2).

1.1.2 Test procedures

The samples were now introduced into equal volumes of fresh water and a sample of good transformer oil (of break down voltage 30kV). Their weights and insulation resistance were monitored for a period of one month (Tables 3, 4).

The sample in water were removed, heat treated and the weight and insulation resistance of the samples were noted (Tables 5 and 6).
The samples in oil were subjected to a medium of oil-water mixture (artificial contamination of a good sample of oil). Periodically the weight and insulation resistance were measured and recorded (Table 7).

1.2 TEST RESULTS

The results are shown in tables 3 - 7 and figures 1 - 6

1.3 OBSERVATION

(i) The rate of water absorption by the simple is much greater than the rate of oil absorption (about 2:1 or 2.5:1) except for Danta.

(ii) The insulation resistance for the dry sample decreases from 4000MΩ to 0 MΩ at 2.5kv barely a day after being immersed in water.

(iii) The insulation resistance for the simple in oil fluctuates but stay well over 1000MΩ at 2.5kV.

The sample (Obeche) that easily absorbs water (372% absorption rate), readily loses the water on heat treatment.
For the control (oil : water mixture test), the insulation resistance at 2.5kV, decreases sharply with increase in ratio of oil : water mixture with the remarkable effect occurring at a 50 - 50 mixture (table 7b).

1.4 DISCUSSION OF RESULTS:

Because of the distinct cell structure of the samples, rates of absorption vary. For those with porous or loosely bounded cells, water or oil can penetrate quite easily and in the same way their electrical properties are affected. Once the samples (immersed formally in water) are introduced into a heat chambers, the cell startes constricting, thereby forcing the water out. This lead to weight decrease and an increase in the insulation resistance of the samples. By the nature of the samples, some float and some sink. This characteristic is the guide for the control. Naturally oil is lighter than water and the two can not mix. Water pocket therefore settle at the base of an oil: water mixture. Those sample that can sink and rest at the base of the container are those that absorb more water thereby lending to a sharp decrease in their insulation resistance.

1.5 CONCLUSION

Local wood can thus adequately serve the transformer industry as valuable insulation materials. This is a good development since tufnol extensively used as insulation pegs and pads to isolate conducting parts is not, readily available locally and the cost of importation is very high. From the foregoing, various treatment has been given to the various samples of wood in order in ascertain their possible use. The results were positive and are recommended for trial. This recommendation is strengthened by the fact that the average resistance per unit length for the sample is computed to be 53.95G Ω/m for an average voltage stress per meter if 33.53kV/m for an average sample dimension sample dimension of 7.41 x 3.19 x 2.44(Lenght x Width x Thickness)m^3

1.6 REFERENCES

1. Nikulin, N. Fundamental of electrical materials, 1984, Ed. Mir. Publishers.

2. Oluyide, A.O. et al; Fundamental of woodwork practice, 1985, Ed. Published by Evans Brothers (Nigeria Publishers) Limited.

Table1: Original Weight/Volume Of Shared Fresh Samples Of Wood

S/N	Sample Name	Sample Weight (g)		Sample Volume (m^3)	
		Sample A	Sample B	Sample A	Sample B
1	Obeche	18.5	18.0	63.5	60.5
2	Black afara	23.0	25.0	59.7	62.9
3	Obolo	41.0	40.0	60.5	57.6
4	Opepe	41.0	43.0	48.4	53.5
5	Apa	60.0	70.0	70.7	72.0
6	Danta	80.0	80.0	70.7	72.0
7	Ikhimi	50.0	44.5	73.0	64.0

Table 2: Density, Weight & Insulation Resistance For Heat Treated Fresh Samples.

S/N	Sample Name	Density (g/cm_3)	Sample Weight (g)		Insulation Resistance (MΩ) AT 2.5kV	
1	Obeche	0.2810	17.0	17.0	4000	4000
2	Black afara	0.3820	22.0	24.0	4000	4000
3	Obobo	0.6770	39.0	39.0	4000	4000
4	Opepe	0.7660	40.0	41.0	4000	4000
5	Apa	1.208	55.0	65.0	4000	4000
6	Danta	1.111	80.0	80.0	4000	4000
7	Ikhimi	0.6720	49.0	43.0	4000	4000

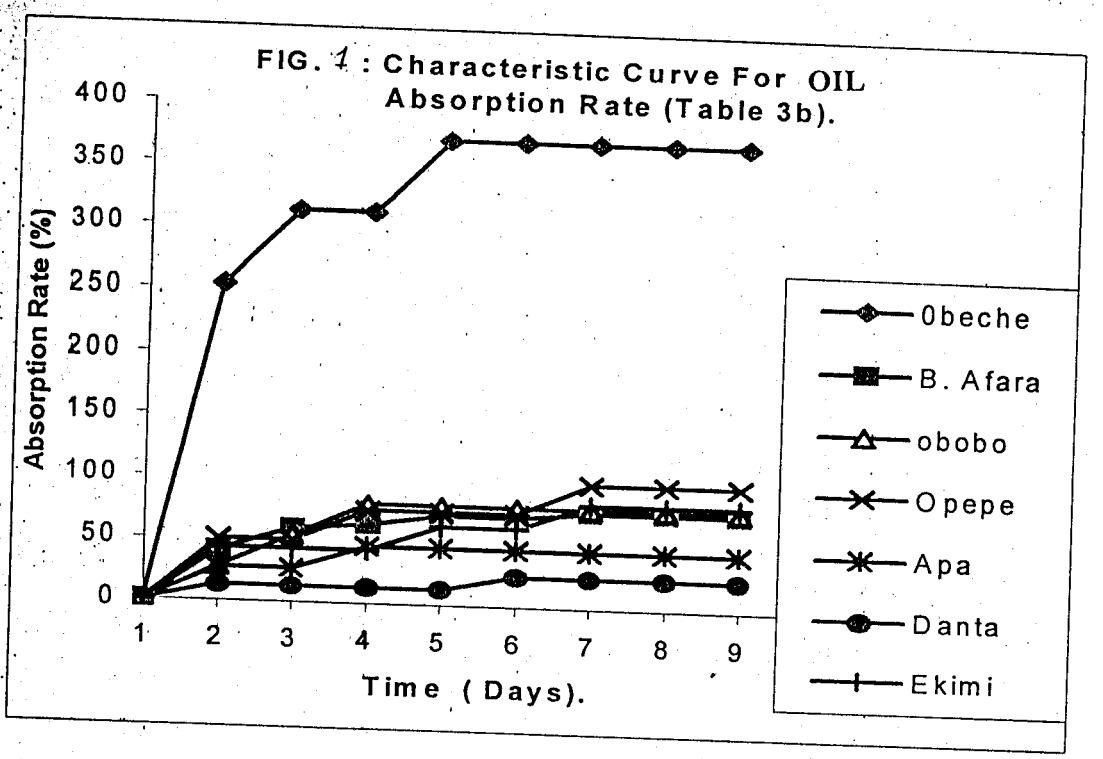

Table 3(a): Variation of Sample Weight(g) in Water & Oil

S/N	Sample Name	Sample Weight in Water and Oil(g)								
1.	Obeche	17	60.0	70.0	80.0	80.0	80.0	80.0	80.0	80.0
		17	34.0	35.0	36.0	36.0	36.0	37.0	37.0	37.0
2.	Black Afara	22	31.0	35.0	36.0	38.0	38.0	39.0	39.0	39.0
		24	28.0	29.0	30.0	31.0	31.0	31.0	31.0	31.0
3.	Obobo	39	50.0	60.0	70.0	70.0	70.0	70.0	70.0	70.0
		39	47.0	48.0	49.0	49.0	49.0	50.0	50.0	50.0
4.	Opepe	40	60.0	60.0	70.0	70.0	70.0	70.0	70.0	70.0
		41.0	45.0	48.0	48.0	48.0	48.0	50.0	60.0	60.0
5.	Apa	55	70.0	70.0	80.0	80.0	80.0	80.0	80.0	80.0
		65.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	80.0
6.	Danta	80.0	90.0	90.0	90.0	90.0	90.0	100.0	100.0	100.0
		80.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
7.	Ekimi	49.0	70.0	70.0	70.0	70.0	80.0	80.0	90.0	90.0
	(Ikhimi)	43.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0

TABLE 3(b): Water & Oil Absorption rate (%)

S/N	Sample Name	State Point	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Water/Oil Ratio For Day I	Water/Oil Raio For Day 8
1.	Obech	0	253.0	312.0	312.0	3711.	371.0	371.0	371.0	371.0	2.5	2.5
		0	100.0	100.0	106.0	112.0	112.0	118.0	118.0	118.0		
2.	Black Afar	0	41.0	59.0	64.0	72.0	7720	77.0	77.0	77.0	2.4	2.7
		0	17.0	21.0	25.0	29.0	29.0	29.0	29.0	29.0		
3.	Obobo	0	28.0	54.0	80.0	80.0	80.0	80.0	80.0	80.0	1.3	2.9
		0	21.0	23.0	26.0	26.0	28.0	28.0	28.0	28.0		
4.	Opepe	0	50.0	50.0	75.0	75.0	75.0	100..0	100.0	100.0	5.0	2.2
		0	10.0	17.0	17.0	17.0	17.0	21.0	46.0	46.0		
5.	Apa	0	27.0	27.0	46.0	46.0	46.0	46.0	46.0	46.0	3.4	2.0
		0	8.0	8.0	8.0	8.0	8.0	8.0	23.0	23.0		
6.	Danta	0	13.0	13.0	13.0	13.0	13.0	25.0	25.0	25.0	0.5	1.0
		0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0		
7.	Ekimi	0	43.0	43.0	43.0	63.0	63.0	84.0	84.0	84.0	1.1	2.1
8.	(Ekhimi)	0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0		
9.												

Key: Water (top)
Oil (bottom)

Table 4: Effect of insulation resistance with water/oil content respectively

S/N	Sample Name	Start	Day 1	Day 2 8	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
1.	Obech	4000	0	.0	0	0	0	0	0	0
			3000	2000	2000	1400	1400	1200	4000	4000
2.	Black Afar	4000	0	0	0	0	0	0	0	0
			3000	2000	2000	1400	1400	1200	3000	4000
3.	Obobo	4000	0	0	0	0	0	0	0	0
			1400	1400	1200	1200	1200	1200	1200	1200
4.	Opepe	4000	0	0	0	0	0	.0	0	0
			2000	2000	1400	1400	1400	1000	4000	4000
5.	Apa	4000	0	0	0	0	0	0	0	0
			2000	2000	1400	1400	1400	1000	4000	4000
6.	Danta	4000	0	0	0	0	0	0	0	0
			1400	1600	1400	1400	1200	1400	4000	1700
7.	Ekimi		0	0	0	0	0	0	0	0
8.	(Ekhimi)		1500	1600	1200	1200	1200	1200	3000	1000

Key: Value in water (top)
Value in oil (bottom)

Table 5(a): Heat treated samples (Samples originally immersed in water) - weight variation

S/N	Sample	Sample Weight (g)								
1.	Obeche	80	60	20	19	19	19	19	19	19
2.	Black afara	44	32	25	24	23	23	23	23	23
3.	Obobo	70	60	45	41	39	39	39	39	39
4.	Opepe	80	60	47	44	43	43	42	42	42
5.	Apa	70	65	60	60	60	55	55	55	55
6.	Danta	90	85	75	75	70	70	70	70	70
7.	Ekimi (Ikhimi)	80	75	60	48	46	45	42	42	42

Table 5(b): Percentage water loss of heat treated samples

S/N	SAMPLE NAME	Start	day1	Day2	Day3	Day4	Day5	Day6	Day7	Day8
1	Obeche	321	215	5	0	0	0	0	0	0
2	Black Afara	91	39	9	4	0	0	0	0	0
3	Obobo	80	54	15	5	0	0	0	0	0
4	Opepe	91	43	12	5	2	2	0	0	0
5	Apa	27	18	9	9	9	0	0	0	0
6	Danta	29	21	7	7	0	0	0	0	0
7	Ekhimi	91	79	43	13	8	7	0	0	0

Table 6: Effect of water content on sample insulation resistance at 2.5kV

S/N	SAMPLE NAME	Start	Day1	Day2	Day3	Day4	Day5	Day6	Day7	Day8	Day9
1	Obeche	0	0	1000	2000	1200	1000	3000	4000	4000	4000
2	Black Afara	0	0	1000	1600	1200	1000	2000	4000	4000	4000
3	Obobo	0	0	0	80	1200	1400	2000	4000	4000	4000
4	Opepe	0	0	6	4000	1200	1400	1400	4000	4000	4000
5	Apa	0	540	1000	4000	1600	1200	1000	4000	4000	4000
6	Danta	0	0	250	4000	1400	1500	1000	4000	4000	4000
7	Ekhimi	0	0	0	0	400	2000	2000	4000	4000	4000

Table 7(a): Effect of water/oil mixture on sample weight

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S/N	Sample name	Day 1 (Oil Only - 100%)	Day Oil & 25ml of water	Day 3 Oil & 50ml of water	Day 4 50:50 Oil & water mixture
1	Ocche	37	39	39	42
2	Black Afara	31	32	32	32
3	Obobo	50	55	55	60
4	Opepe	60	60	60	60
5	Apa	80	85	85	90
6	Danta	100	100	105	105
7	Ekhimi	60	60	60	60

Table 7(b): Effect of Contaminants on the insulation resistance(MΩ) of samples

S/N	Sample name	Day 1 (Oil Only - 100%)	Day Oil & 25ml of water	Day 3 Oil & 50ml of water	Day 4 50:50 Oil & water mixture
1	Ocche	4000	1200	1200	1100
2	Black Afara	4000	1000	1000	800
3	Obobo	2000	1500	1500	800
4	Opepe	2000	1400	500	500
5	Apa	4000	1400	1400	1000
6	Danta1700	1000	800	400	7
Ekhimi	1000	600	500	260	

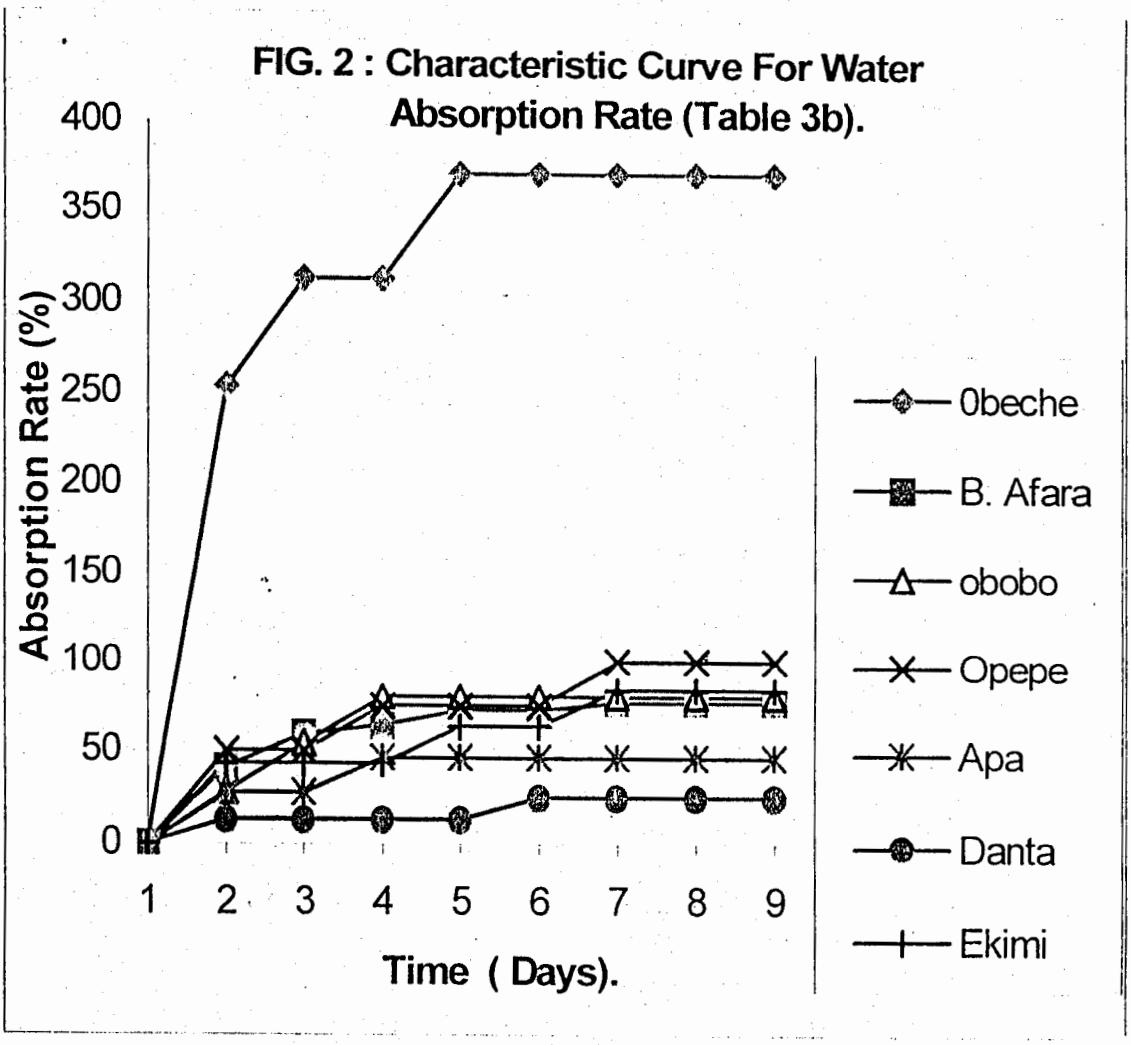


FIG. 2 : Characteristic Curve For Water Absorption Rate (Table 3b).

FIG. 2b : EFFECT OF OIL CONTENT ON INSULATION RESISTANCE (Table 4)

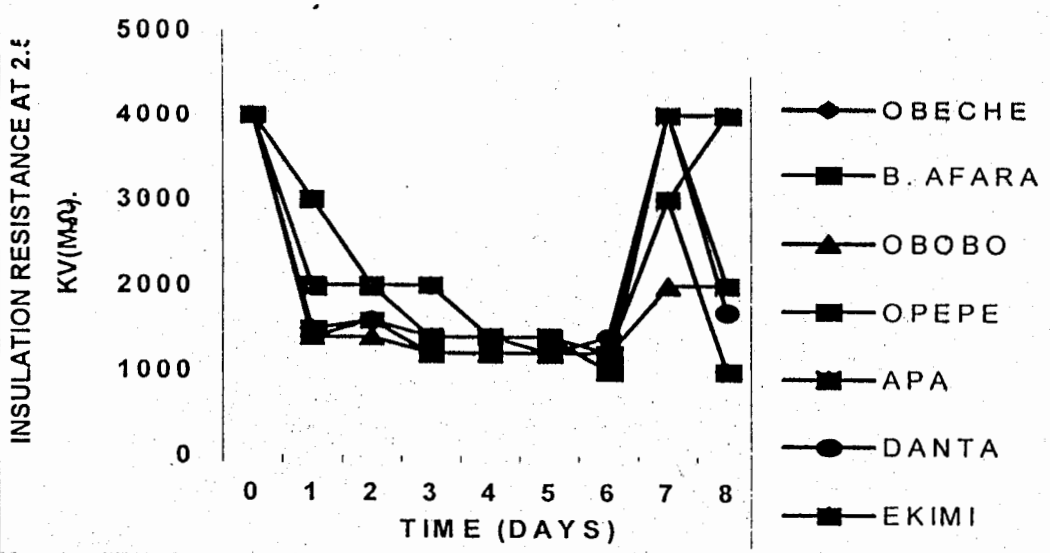


FIG. 3 : EFFECT OF WATER CONTENT ON INSULATION RESISTANCE(TABLE4)

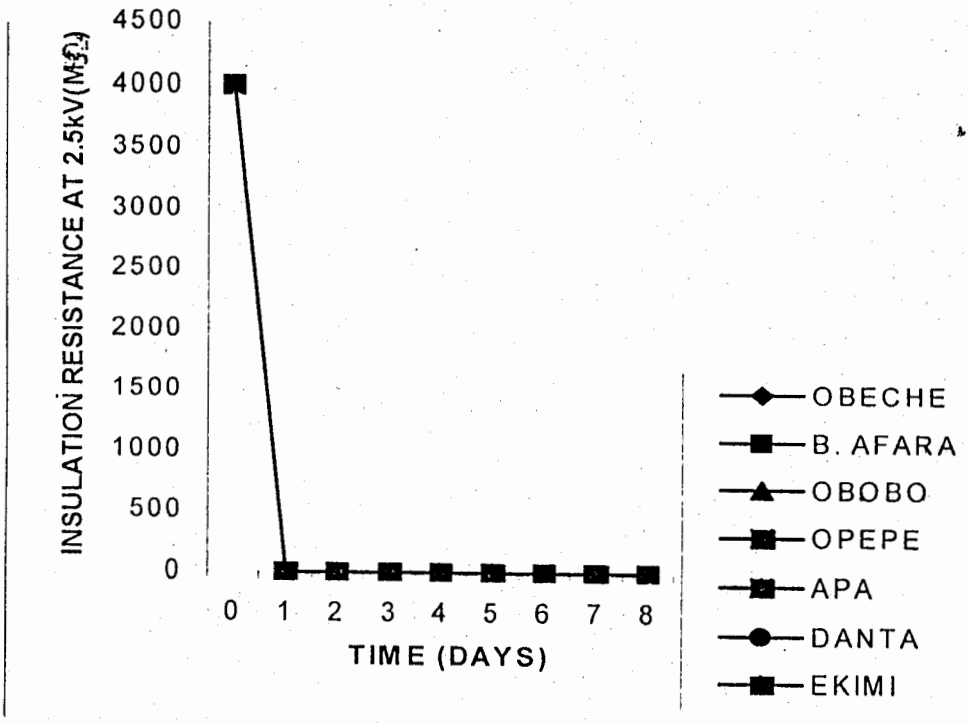


FIG. 4 : INSULATION RESISTANCE VARIATION WITH LOSS IN WATER CONTENT(Table 6)

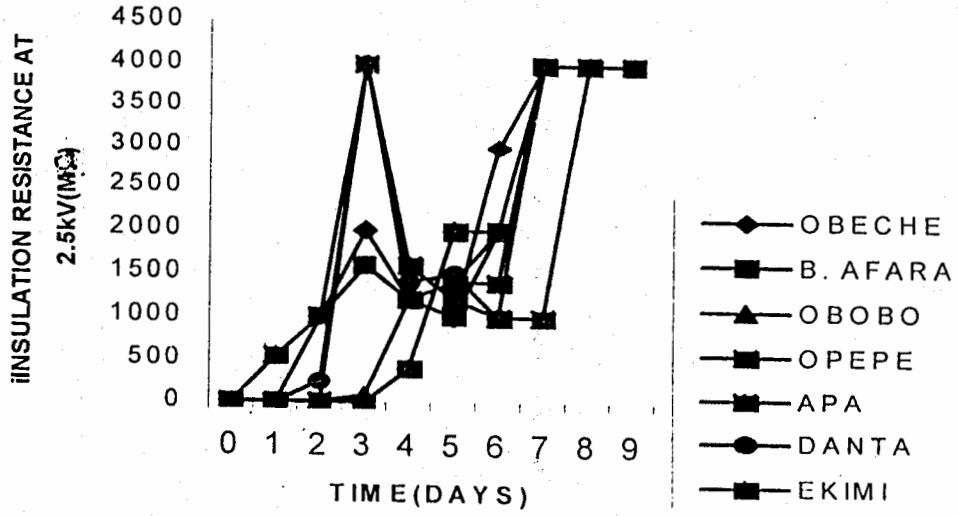
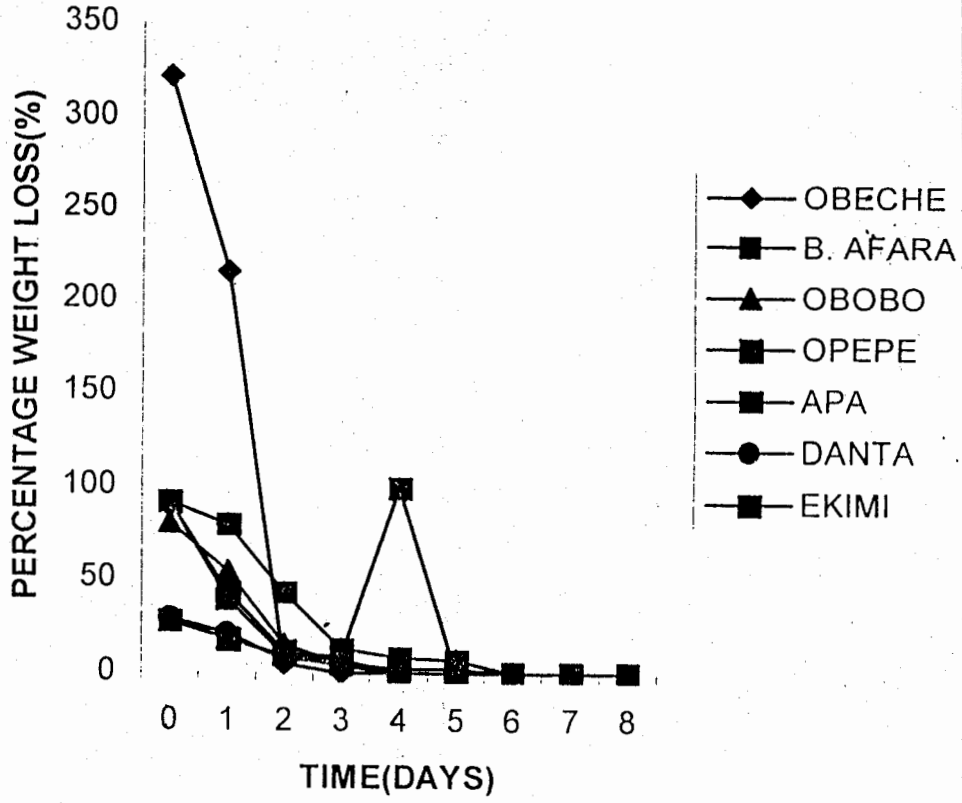


FIG. 5 : EFFECT OF HEAT TREAMENT ON SAMPLES FOMERLY IMMERSED IN WATER



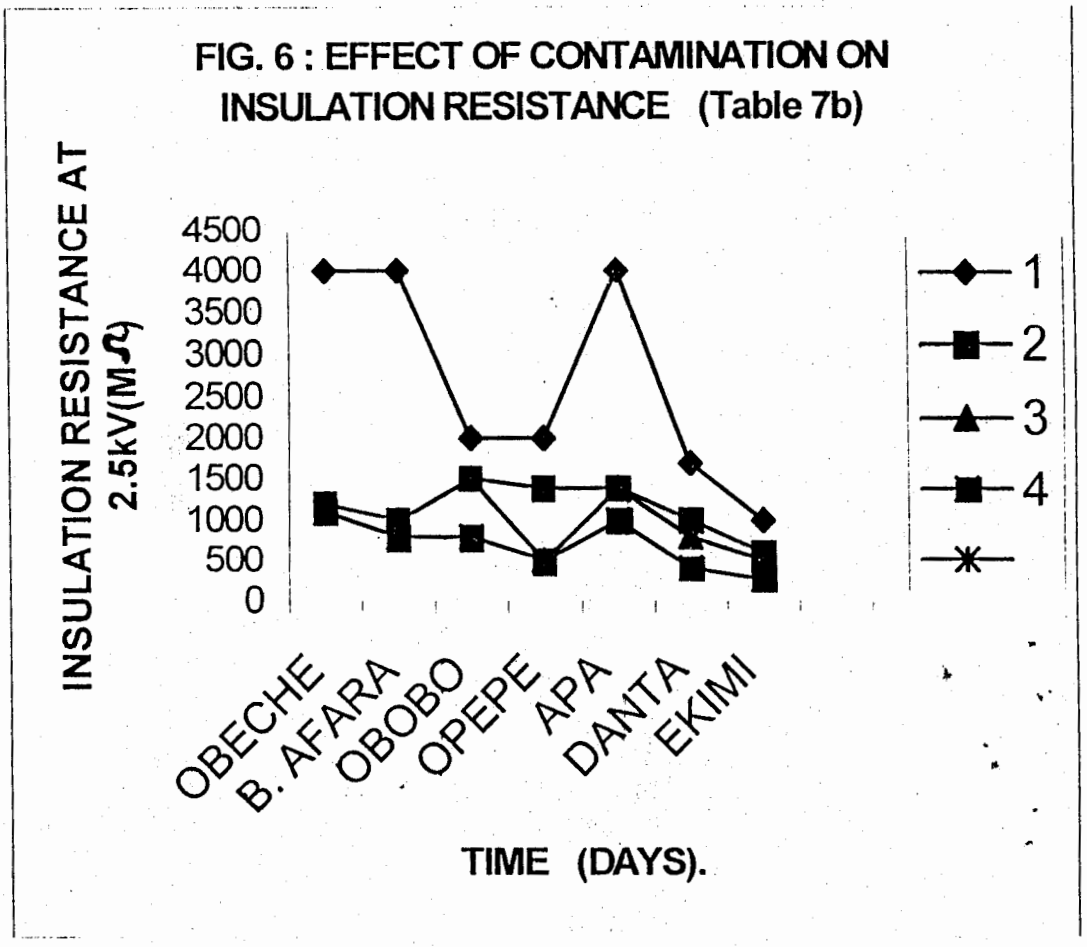


FIG. 6 : EFFECT OF CONTAMINATION ON INSULATION RESISTANCE (Table 7b)