New method to separate water from power transformer oils

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Abstract: In the context of this paper , Insulating oil is drawn into the new water trap system, connect with oil purifier equipment and passed through an inlet strainer in the vacuum and created by the system's vacuum pump, Before entering into the Processing/Vacuum Chamber, where water and contained in the oil are thoroughly exposed to vacuum by efficient dispersion and removed through a Vacuum Pumping Oil Purifiers use 5 micron cartridges inside the Vacuum Chamber. The transformer used in this work is high voltage transformer type ASIA , capacity is 63 MVA , quantity of oil is 19.5 ton temperature profile of oil is started at 21C° to 70 C° in time 168 h and we calculate quantity of water in hot oil transformer and break down oil , after oil purification we calculate insulation resistance for 132 kv side and compare theis results with Mitsubishi electric corporation standard

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Keywords: dielectric fluids, transformer oil , oil purifier , electrical insulating oil .

Introduction:-

power station and power transmission networks (132 KV,400 KV) are contain power transformers , these equipments called Oil filled transformer and has been used for many years. The principle of operation has not been changed over many decades. The transformer helps in converting low voltage into high voltage or high to low and accordingly the transformer is termed step-up or step-down. The winding to which the voltage is applied is called primary winding, where us the winding to which the load is connected is called secondary winding. The transformer works on the principle of electro-magnetic induction. Such phenomena can take place in a static device, only, if the magnetic flux is continually verified. A transformer consists of a magnetic core made out of insulated silicon steel laminations. Two distinct sets of windings, one called primary and other called secondary winding, are wound on such core. these winding immerse in insulation oil , However, the maintenance of the insulation system largely determines the extent of a transformer's life. Future transformers will no doubt have increased capacity and size and their design may require the use of new materials. Transformers may operate at higher temperatures and in turn demand transformer oils of greater stability [1] [2] .

Power transformers typically use oil and cellulose us insulation. Transformer specialists state that cellulose is weakest link in the transformer insulation due to the fact that it cannot easily be replaced, whereas the oil can be changed or reprocessed [3] . There is also a consensus of opinion that the oil quality is important, as by-products formed during oil ageing, such as moisture and acids, the rate of cellulose degradation.

Water in oil

Water in insulation oil decreases the dielectric with stand strength , accelerates cellulose decomposition and causes the emission of bubbles at high temperatures . Most water in oil is

found In dissolved state . the deterioration of insulating oil is normally associated with oxidation. [4]. Due to the omnipresence of oxygen and water, insulating oil oxidizes even under ideal conditions. The insulating properties of the oil are also affected by contaminants .[5].

acidity of the oil will be the sign that oxidation of the oil has occurred, because of the presence of air (possibly under the effect of electrical fields and temperature). The acidity is measured as the number of milligrams of KOH (potassium hydroxide) required to neutralize one gram of oil. A new oil would have an acid value of less than 0.05 mg. A transformer oil is considered to be unusable if this value rises above 4 mg. from the solid materials in the transformer dissolving in the oil. When the moistures in oil exceeds the saturation value , there will be free water precipitated from the oil in suspension or drops . The reaction between unstable hydrocarbons in the oil and oxygen, moisture or other chemicals in the atmosphere, with the assistance of accelerators such as heat, results in decay products in the oil Mineral oil insulating fluids undergo oxidative degradation in the presence of oxygen to give a number of oxidation products.

The final products of oxidation are acidic materials that can affect the characteristics of the insulating fluid as well as damage the components of the electrical unit. The high temperatures in due course cause the fluid to be oxidize and ultimately produce sludge and soluble acid in sufficient quantity to impair its heat transfer and dielectric efficiency. Sludge formation is the terminal stage of the deterioration process. The acids formed in the process of oxidation attack on the cellulose fibers and metals forming metallic soaps, lacquers, aldehydes, alcohols and ketones which precipitate as heavy tarry acidic sludge on the insulation. Sludge appears faster in heavily loaded and long operating time, hot running and abused transformers causing shrinkage of the insulation through leaching out varnishes and cellulose materials. the reactions of the oxidative process are complex and involve free radical reactions. [6] [7].

Experimental:-

we used main transformer 63 MVA , (132-33-11) KV voltage, figure (1-a) type ASEA, made in Sweden. In Alnaggibia power station in Basrah In this electrical transformer when electrical energy is transform from primary coils to secondary , heat is developed. This temperature must be within limits so that it will not adversely affect the dimensional stability of the materials used in the construction of the transformer. In power transformers, the high electrical stresses and amount of heat developed require both solid and liquid insulation, with the fluid conducting the generated heat away to cooling surfaces, where it gets dissipated. The combination of oil and cellulose products has remained unchanged for reasons of electric strength and cost. (The amount of insulating oil and cellulose vary with different types of transformers based on function and voltage class).

Because of high degree temperatures, humidity atmosphere and operating transformer at a long time . Break down voltage Oil transformer is 23 KV/2.5mm and Oil insulation in this transformer is became bad .in this case Maintenance transformer is very important , Maintenance time is 168 hour . we purifier transformer oil by using filter purifier and equipment to separate water from insulation oil figure (1-b) this machine combine maximum simplicity with high safety standards. A number of sensing devices are built in, continually monitoring the most vital parameters. If any of these parameters such us rate flow oil , oil temperature ,oil level deviate from normal operation, the purifier will shut down and diagnostic light will remain on to inform their operator what corrective action is required.

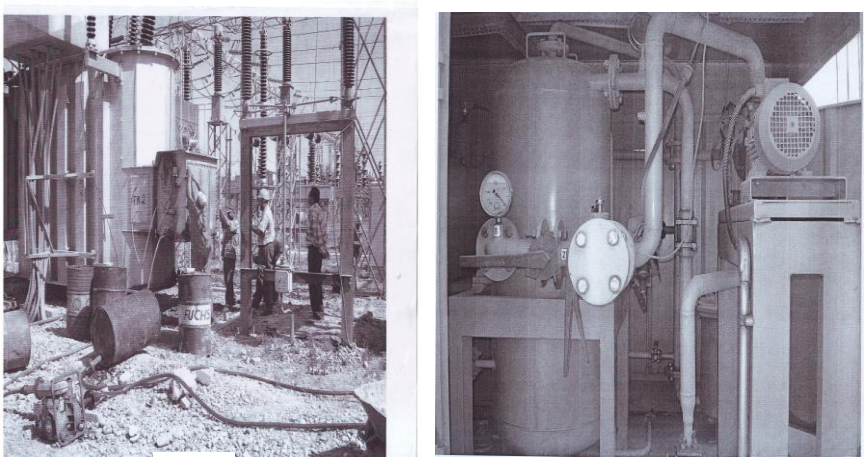


Figure (1) a: Transformer under test . and b: filter purifier and equipment to separate water from insulation oil

New equipment to separate water from insulation oil :-

The new equipment figure (2) is consist of three stages : the first one is called filter element it contains a cartridge filter (5 micron) and the second one is called vacuum chamber in this chamber we can seeing hot oil drop from oil shower in upper chamber to lower in this time the vapour separate from oil ,in third step vapour convert to water by using (chillier) and it condensation .

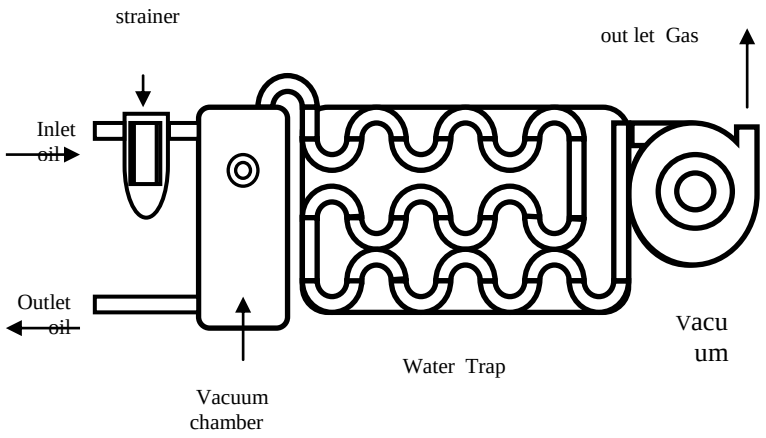


Figure (2):single line diagram for the equipment which separate water from insulation oil

Insulating oil is drawn into the system and is passed through an inlet strainer by the use of the vacuum created system's vacuum pump Before entering into the Processing/Vacuum Chamber, where water and contained in the oil are thoroughly exposed to vacuum by efficient dispersion and removed through a Vacuum Pumping Oil Purifiers using 5 micron cartridges.

Breakdown voltage oil test:-

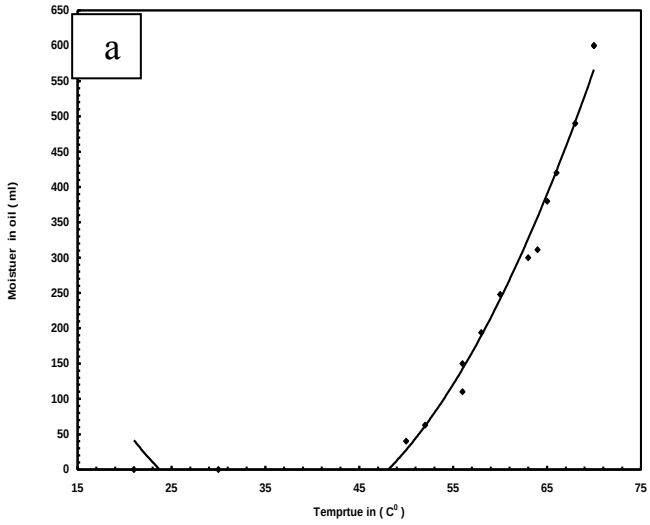
To measure and test dielectric break down Oil transformer We use foster equipment containing two ball electrodes , one positive charge and another is negative charge , distance between them is 2.5 mm . note , when use it keep a flask in clean .maximum voltage 60 KV. Increase voltage with range (2 – 5) KV/sec and see voltmeter reading .Table (1) shows the values breakdown voltage and water with temperature and time . the breakdown voltage increases with increase a quantity of water separated from oil insulation.

Time in hour	Temperature of Oil Transformer (C°)	Break down voltage Oil in KV/2.5mm	Quantity of WATER in ml
0	21	23	0
12	30	23	0
24	50	25	40
36	52	28	75
48	56	30	110
60	56	30	150
72	58	36	230
84	60	37.5	240
96	63	41	300
108	64	45.5	300
120	65	53	380
132	66	60	420
144	68	60	490
156	70	60	600
168	70	60	600

Table (1) values breakdown voltage and water with about temperature and time

At a measuring time we can see change in oil characteristics .the dielectric test one of the electrical tests is very important to measure the oil continuing efficiency.[8] . the test ,carried out with recognized and authorized test equipment , measure the voltage at which the dielectric breaks down . In figure (3-a) . water quantity increase exponentially with increase oil temperatures . this test measures the dielectric strength of oil .

In figure (3-b) in range 30 – 50 C° a low break down oil because of oil oxidation in transformer, acid and sludge are produced , as well as water , temperature degree ranges between 50 – 65 C ° . a severe increase in break down voltage can be detrimental to the insulation system [9] .



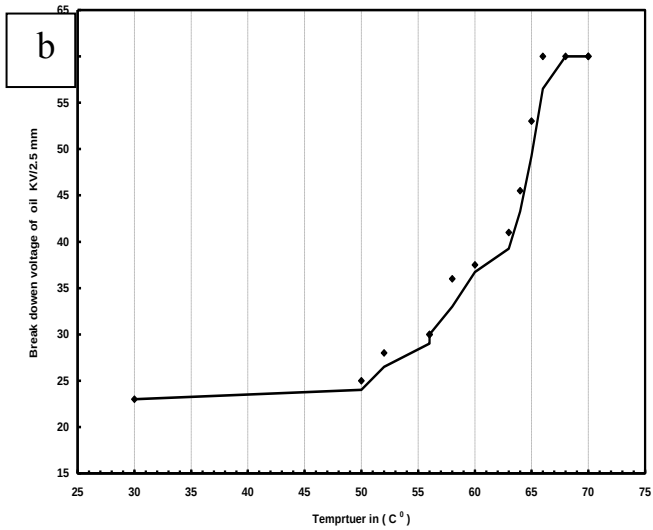


Figure (3) a: changing in water quantity with increase oil temperatures . and b: break down oils and temperature

In this test we measure insulation resistant coils 132 KV side transformer by using MEGGER TEST EQUPMENT , time test is 15sec and continue to the 60sec, Applied voltage (5000 volt), at all tests we record oil temperature degree to calculate insulation resistant at standard temperature (20C˚) .table (2) show data in this test .

TEST NO-	INSULATION RESISTANCE (H- E) IN MΩ		VOLTAGE IN VOLT	OIL TEMPERATURE IN C°	K-FACTOR
	15 sec	60 sec			
1	1400	2590	5000	20	1
2	748	1050	5000	33	1.7
3	350	522	5000	48	3.6
4	297	483	5000	52	4.5
5	227	285	5000	64	7.5

Table (2) winding insulation resistant and oil temperature

insulation resistant is depending on oil dielectric .when oil dielectric increase the insulation resistant coil is increased too .in figure (4) two regions ,upper and lower bold line these represented good and poor insulation resistant respectively, this line is standard applied to MITSUBISHI ELECTRIC CORPORATION . we compare this line and measuring line .

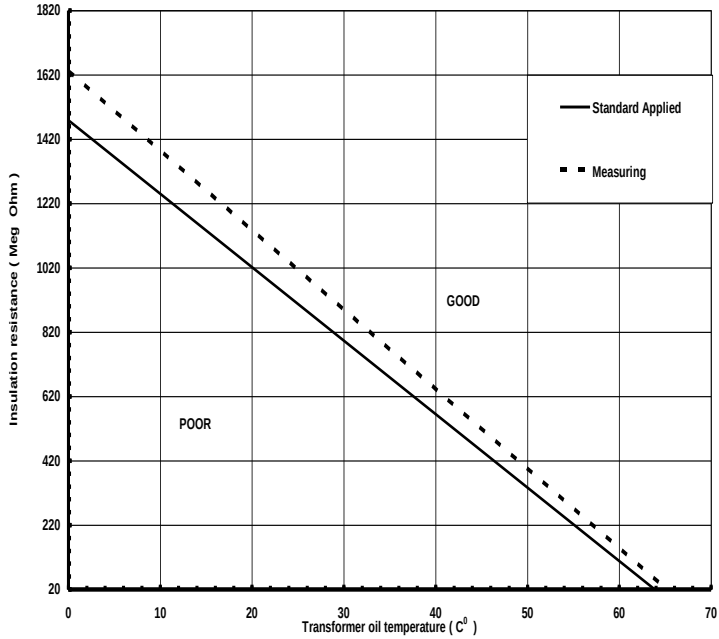


Figure (4) standard and measuring lines insulation resistance

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طريقة جديدة لفصل الماء من الزيت العازل في محولات القدرة

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الخلاصة :- في هذه الدراسة تم التركيز على عملية فصل الماء عن الزيت العازل المستخدم في محولات القدرة الكهربائية وذلك عن طريق تطوير جهاز في المختبر مصمم خصيصا" لهذا الغرض يربط مع جهاز تنقية الزيت وتم دراسة التغير في درجة حرارة الزيت المقاربة للظروف التشغيلية للمحولات مع كمية الماء المستخلصة ومع تغير العازلية الكهربائية للزيت ودراسة تأثير ذلك على العازلية الكهربائية لملفات محولات القدرة عند تسليط ضغوط عالية ومقارنة هذا التاثير مع المواصفات العالمية المعتمدة في محطات القدرة الكهربائية .