Transformers:

Evocation:

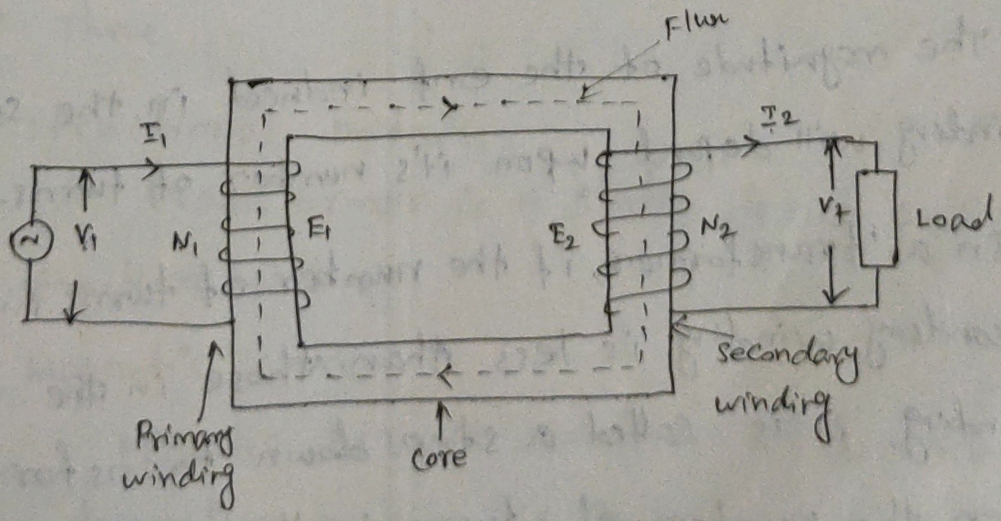
Going to show the video of construction and operation of single phase Transformers.

Introduction:

* The Transformers works on the principle of electromagnetic induction. A transformer is an electrical device, having no moving parts, which by mutual induction transfers electric energy from one circuit to another at the same frequency, usually with changed values of voltage and current.

* It consists of two winding insulated from each other and wound on a common core made up of magnetic material.

* Alternating voltage is connected across one of the windings called the primary winding. In both the windings emf is induced by electromagnetic induction. The second winding is called the secondary winding.



Concept:

Working principle of a Transformer:

* When the primary winding is connected to an ac source an exciting current flows through the winding. As the current is alternating, it will produce an alternating flux in the core which will be linked by both the primary and secondary windings.

* The induced emf in the primary winding (E_1) is almost equal to the applied voltage (V_1) and will oppose the applied voltage. The emf induced in the secondary winding (E_2) can be utilised to deliver power to any load connected across the secondary. Thus power is transferred from the primary to the secondary circuit by electromagnetic induction.

* The flux in the core will alternate at the same frequency as the frequency of the supply voltage. The frequency of induced emf in secondary is the as that of supply voltage.

* The magnitude of the emf induced in the secondary winding will depend upon it's number of turns.

* In a transformer, if the number of turns in the secondary winding is less than those in the primary winding, it is called a step-down transformer, when the number of turns in the secondary winding is higher than the primary winding, it is called step-up transformer.

winding:

There are two winding. one is primary & another is secondary winding. It's made up of copper.

Insulation:

Paper is still used as the basic conductor insulation.

Insulating oil:

It protects the paper from dirt & moisture & removes the heat produced in the core & coil. Also act as a insulating medium.

Expansion tank (or) conservator:

It's mounted above the transformer and connected to main tank by a pipe. It's function is to keep a transformer tank full of oil despite expansion. It permits the gas above the oil in the transformer to pass into expansion tank, so that the transformer tank will be completely filled with oil.

Temperature gauge:

It's to indicate hot Boil temperature.

oil gauge:

It's to indicate the oil level present in the tank If reduces it gives alarm

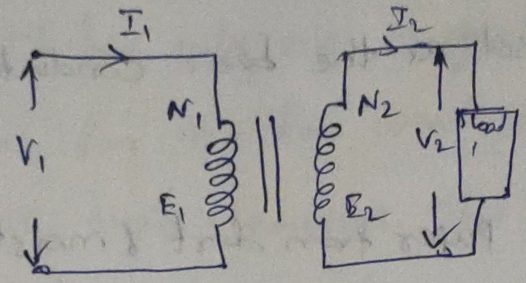
Buchholz Relay:

The first warning that a fault is present may be given by the presence of bubbles in the oil. If conservator tank no place to collect the gas. so that it gives an alarm in case of minor fault and to disconnect the transformer from supply in case of severe faults.

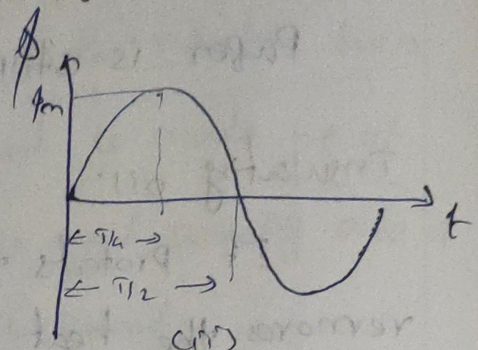
Breather:

It's prevent the entry of the moisture inside the tank. silical gel is used.

EMF Equation of a Transformer:



(i)



(ii)

W.K.T $T = \frac{1}{f}$

$\therefore$ Average rate of change of flux $= \frac{\phi_m}{1/4f}$ wb/sec

If we assume single turn coil, then according to faradays law

Avg. value of emf induced/turn $= 4f * \phi_m$ V

$$\text{Form factor} = \frac{\text{RMS value}}{\text{Avg. value}} = 1.11$$

RMS value = Form factor * Avg. value

$= 1.11 * (4f * \phi_m) \Rightarrow 4.44 f \phi_m$ in V

$\therefore$ RMS value of EMF induced in the primary winding

$E_1 = 4.44 f \phi_m * N_1$

$E_1 = 4.44 f B_m A N_1$ in V

W.K.T for secondary winding

$E_2 = 4.44 f \phi_m * N_2$

$E_2 = 4.44 f B_m A N_2$ in V

i/p = o/p

Transformation Ratio (k)

$$\frac{E_2}{E_1} = \frac{N_2}{N_1} = \frac{I_1}{I_2} = k$$

$E_1 = 4.44 f \phi_m N_1$

$E_2 = 4.44 f \phi_m N_2$

$\frac{E_1}{E_2} = \frac{N_1}{N_2}$ constant

$\frac{E_1}{E_2} = \frac{V_1}{V_2} = \frac{N_1}{N_2}$

$V_1 I_1$ cosθ$_1$ = $V_2 I_2$ cosθ$_2$

p.f = cosθ at both

$V_1 I_1 = V_2 I_2$

$\frac{V_2}{V_1} = \frac{I_1}{I_2}$

Applications:

* Electrical power Engineering for Transmission & Distribution
* Measuring purpose (CT & PT)
* To change the output voltage
* Radio, TV circuits, telephone circuits etc

Problems on Transformers:

1. The No-load ratio required in a 1ϕ 50Hz transformers is 6600/300V. If the maximum value of the flux in the core is to be about 0.09 wb. find the no'of turns in each winding.

Given:

$f = 50Hz$, $V_1 = 6600V$, $V_2 = 300V$, $\phi_m = 0.09 wb$

To find:

N_1 & N_2 = ?

Solution:

$\therefore \quad V_1 = 4.44 f \phi_m N_1$

$$N_1 = \frac{V_1}{4.44 f \phi_m}$$

$$= \frac{6600}{4.44 * 50 * 0.09}$$

$$N_1 = 330$$

$\therefore \quad V_2 = 4.44 f \phi_m N_2$

$$N_2 = \frac{V_2}{4.44 f \phi_m} \Rightarrow \frac{300}{4.44 * 50 * 0.09}$$

$$N_2 = 15$$