

General Design Philosophy and  
introduction to design of  
**OIL FILLED DISTRIBUTION  
TRANSFORMERS**

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## Introduction:

- The distribution transformer forms vital equipment in the power network. It forms the majority of the population in the network. Hence the reliability is all the more important. Unlike other power transformers, distribution transformers will be energized through out the day, which means No load loss plays prominent role. Hence, all day efficiency is to be given due importance.
- Design of distribution transformer is intricate to the extent that it has to accommodate all the necessary fittings (including LV & HV Cable boxes wherever applicable) and accessories with necessary external clearances.
- Since distribution transformers forms the major portion of power net work, energy efficiency distribution transformers are gaining its importance recently. Already Bureau of Energy Efficiency ( as per the directions of Central Government), are formulating guidelines of energy efficiency transformer with different star ratings.

***The Motto of Star ratings is  
" MORE STARS MORE  
SAVINGS".***



# **Types of distribution transformers:**

- Conventional Non-CSP
- Sealed Non-CSP
- Sealed CSP
- Conventional CSP
- Hermetically sealed

# Transformer construction:

- Core
- Windings
- Insulation
- Core coil assembly
- Tank
- Fittings and accessories

# CORE

Types: 1) CRGO

2) AMORPHOUS

CRGO : (Cold rolled grain oriented silicon steel)

Available grades : M3, M4, M5, MOH etc

Thicknesses : 0.23mm; 0.27mm; 0.30mm etc

Annealing Temp.: 800 Deg.C

Saturation Flux density : 1.92 Tesla

AMORPHOUS METAL:

Available ribbons : 5.6"; 6.7" & 8.4"

Thicknesses : 0.023mm

Annealing Temp: 360 Deg.C

Saturation Flux Density : 1.58 Tesla.



# **Advantages of Amorphous Metal Transformers**

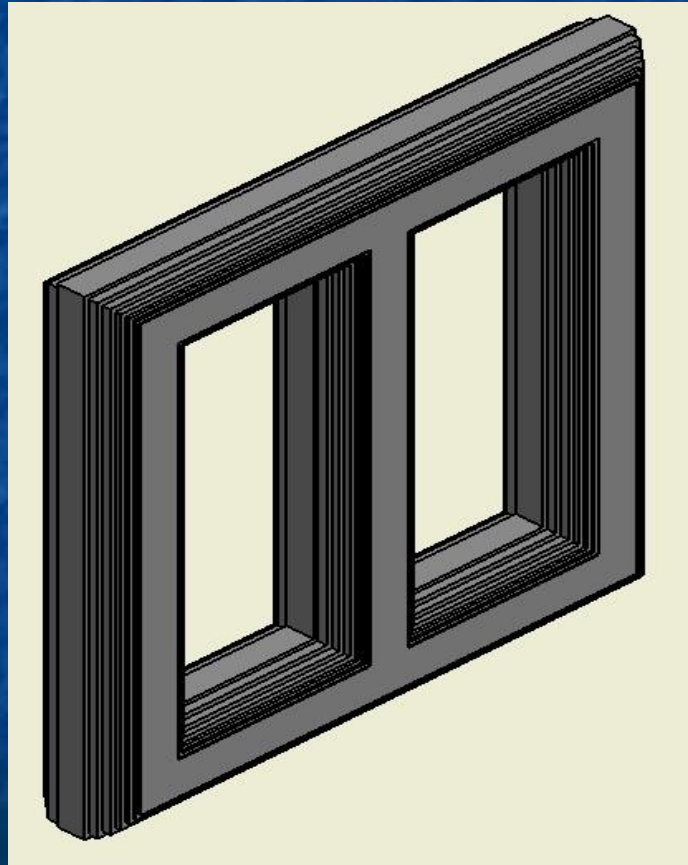
- No-load loss reduced to a rock bottom low of 75% as compared to CRGO transformers
- Less magnetizing current
- Cumulative saving of energy cost
- Total owning cost to customer is much less
- Better “demand side management”
- Less temperature rise of core
- Less noise level due to less magnetostriction
- As the sheet thickness of the material is 10 times lesser to that of conventional grade material, the eddy current losses in the amorphous core are less

## Core Construction:

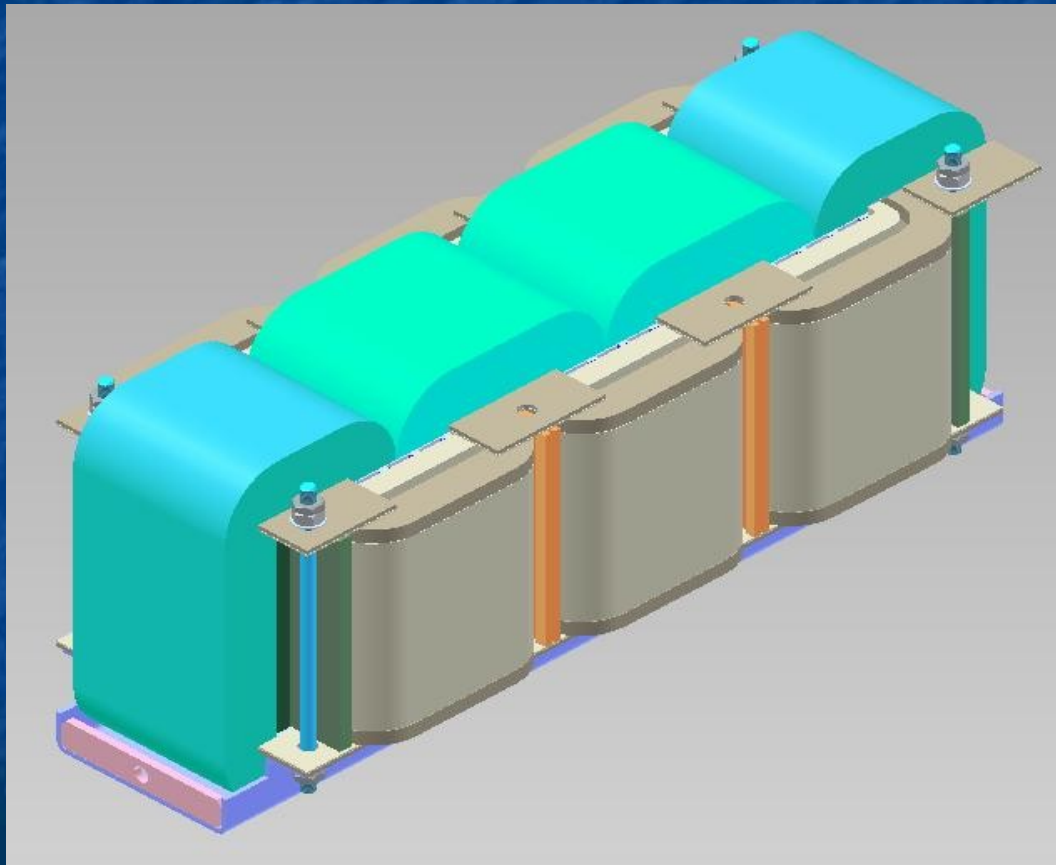
- Stacked Core (CRGO)
  - Three Limbed core type
  
- Wound core (CRGO & AMORPHOUS)
  - Shell type
  - Core type



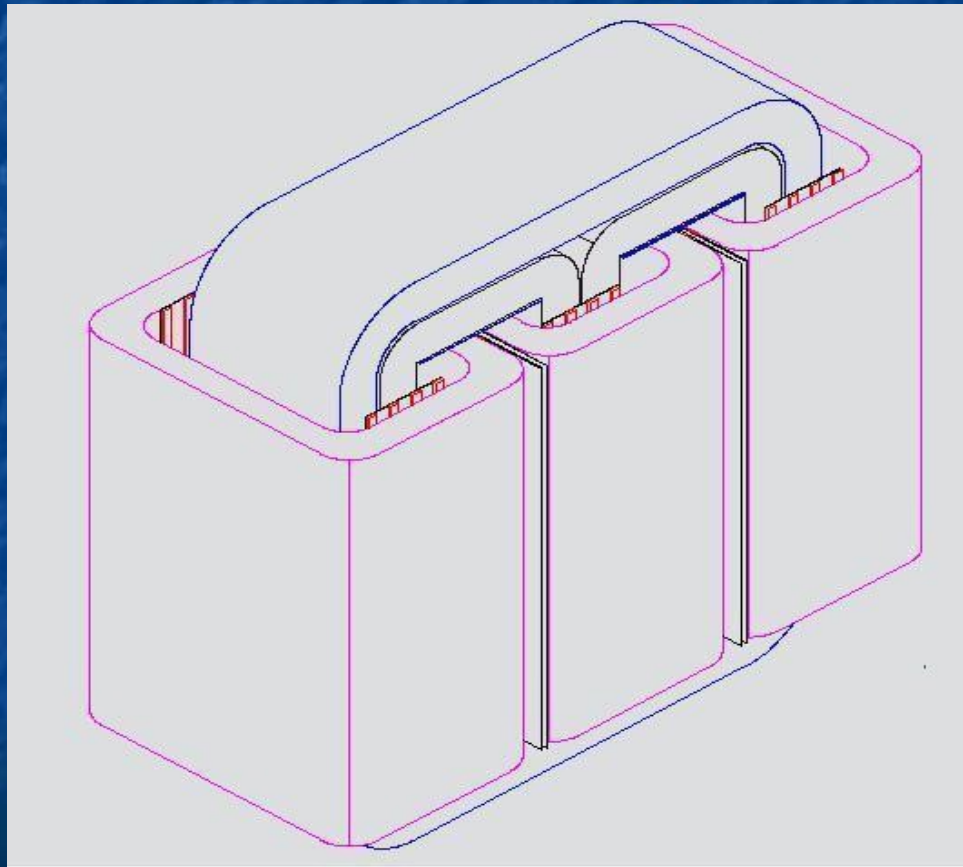
# Three limbed stacked core



# Shell type wound core construction



# Core type wound core





# WINDINGS

## Winding Materials:

- Copper
- Aluminum

## Covering:

- Super Enamel
- Double Paper

Selection of Conductor Size mainly depends upon Current Density.

### **Parameters effecting Current Density :**

- ❖ Load Losses
- ❖ Short Circuit Thermal ability
- ❖ Winding Temperature Gradients corresponding to the guaranteed winding temperature rise
- ❖ Any Customer's stipulation

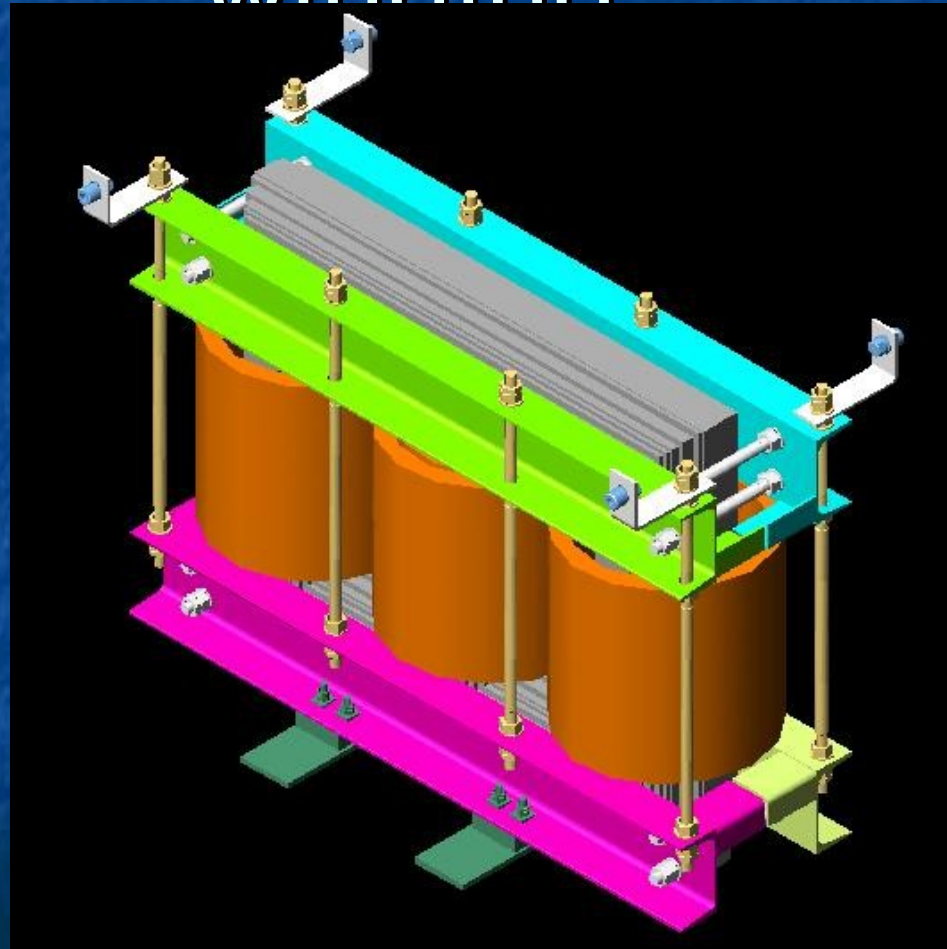
Further, a maximum current density  
3.8 Amp/mm<sup>2</sup> for copper and  
2.2 Amps/mm<sup>2</sup> for aluminum  
can be taken meeting the above mentioned  
considerations

# Types of windings:

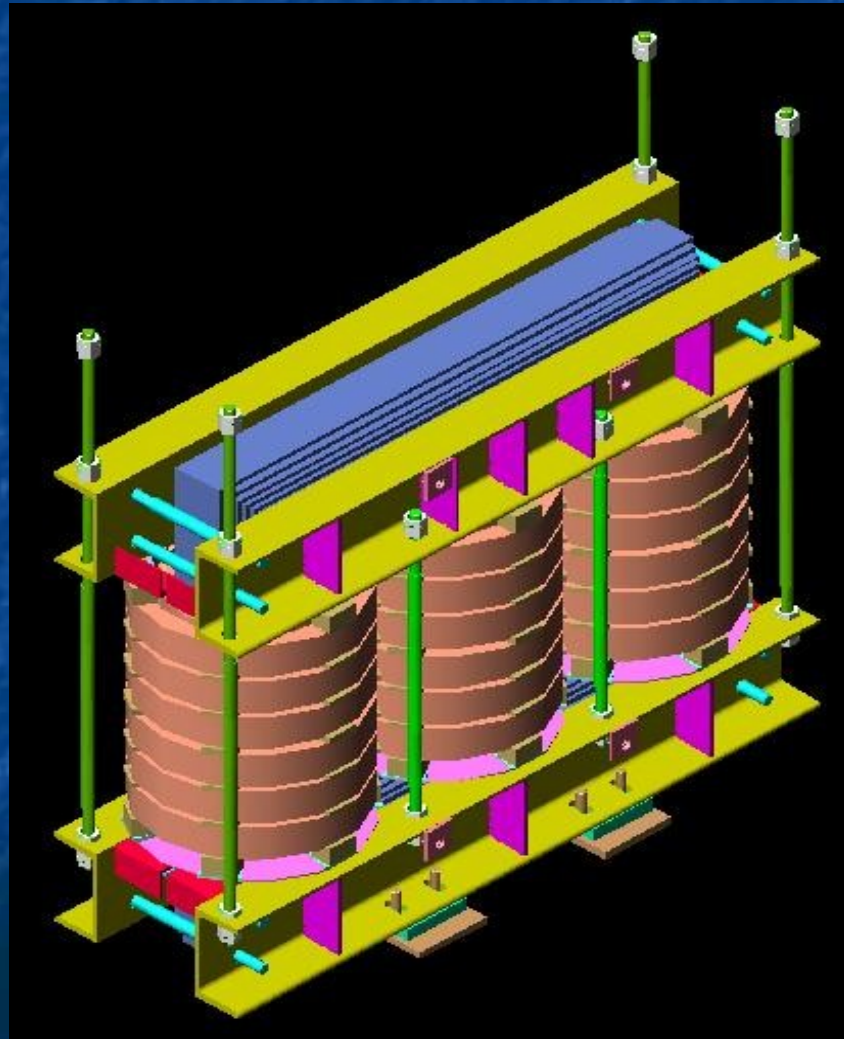
- **LV winding :** LV winding will be predominantly Spiral winding with two layers or foil winding.
- **HV Winding:** HV winding will be generally of multilayer helical for 11kV transformers and cross over coils in case of 22 kV and 33 kV transformers.



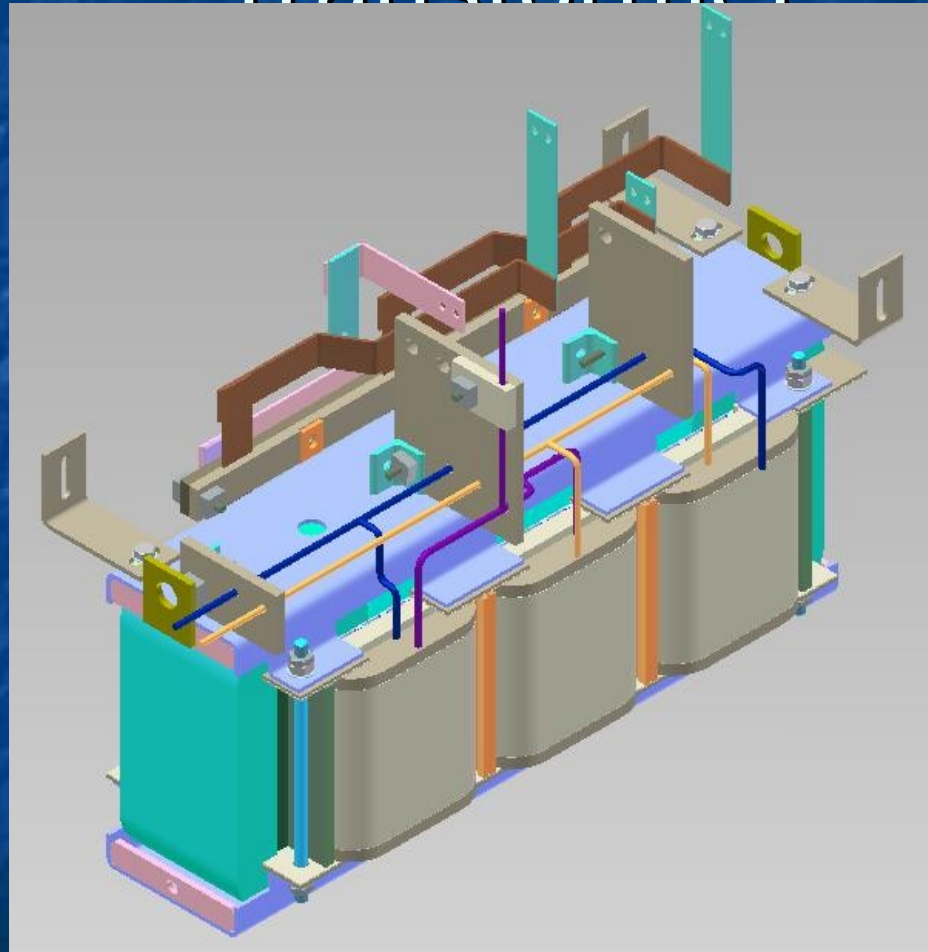
# CCA of stacked core construction & single coil winding



# CCA OF STACKED CORE CONSTRUCTION & CROSS OVER COILS



# Shell Type wound core transformer

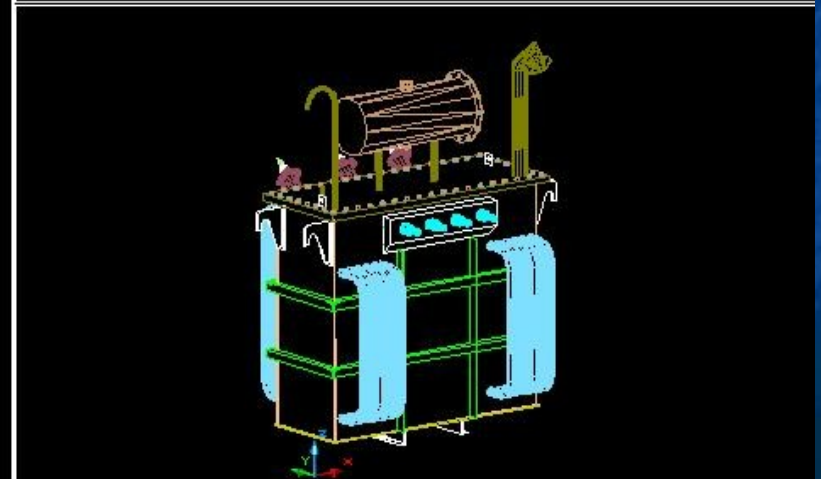
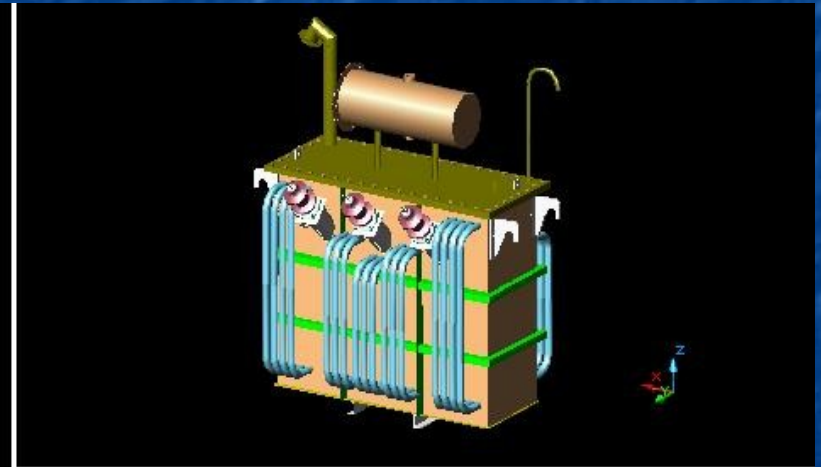
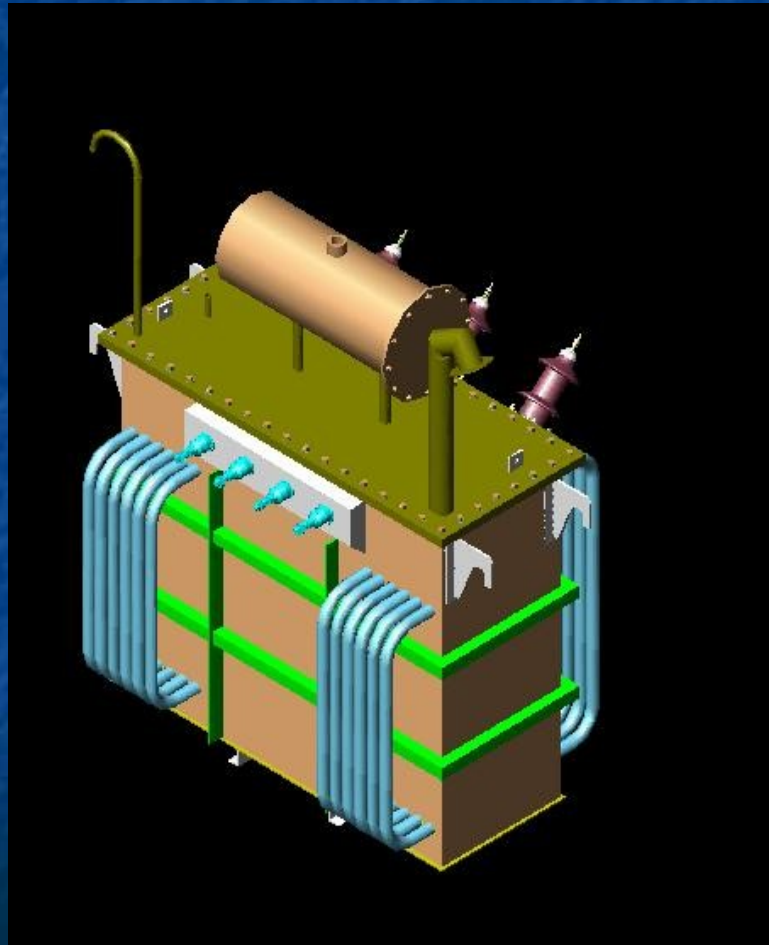




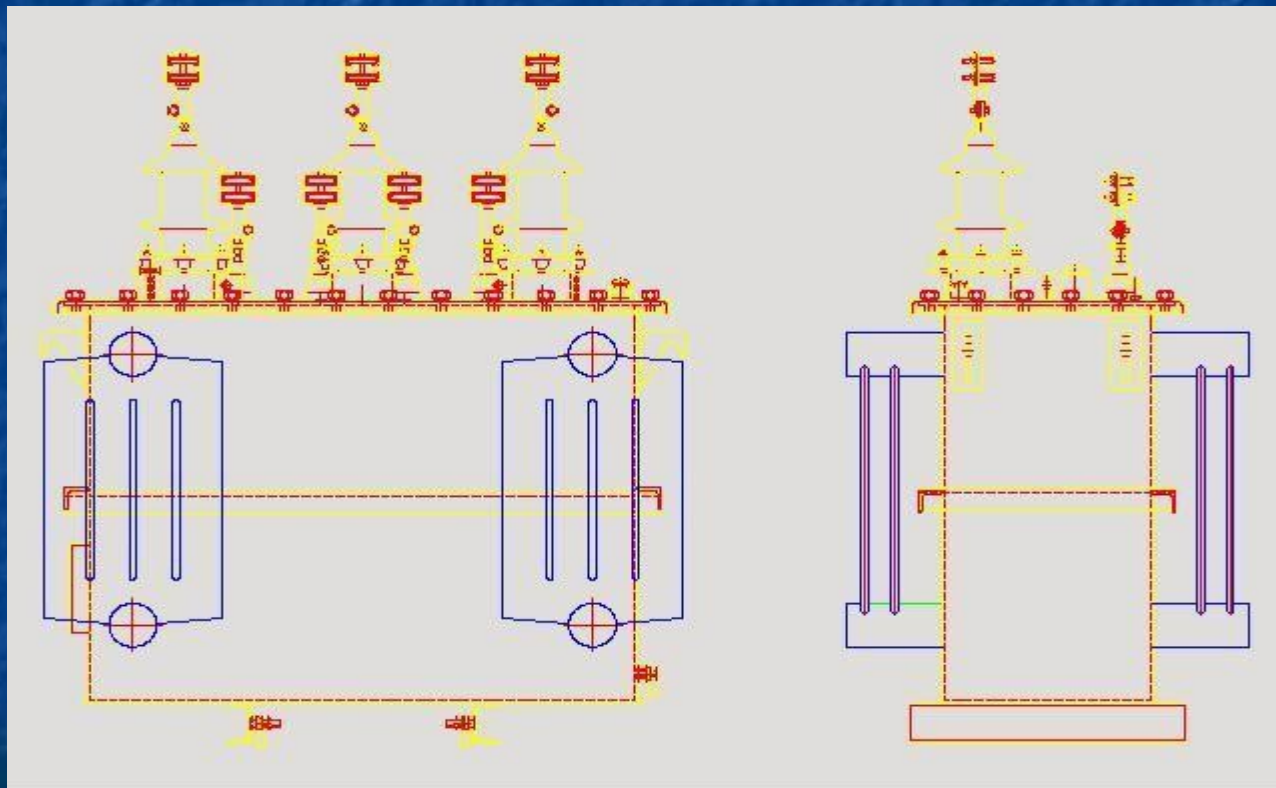
# TANK

- Tank shall be designed maintaining the required internal clearances from the CCA depending on the Voltages.
- Normally for dist.transformers, rectangular tanks will be preferred.
- The tank is manufactured with mild steel; and shall be robust in construction. Proper stiffening shall be provided wherever necessary
- Tank shall be provided with sufficient cooling area by using different types of cooling arrangements like cooling tubes, pressed steel radiators and corrugated fins etc.

# Transformers with Cooling Tubes



# Transformer with radiators





# Corrugated Tank

## Advantages:

- Compact in size.
- Improved heat dissipation.
- Elegant appearance.
- Due to vertical oil channel greater stability is achieved.
- Oil expansion during service can be absorbed by expansion in corrugation.
- No blockage of oil flow into the fins.
- Oil cleaning is easier and less expensive.



# Fittings & Accessories

- Rating & diagram plate
- VE Logo plate
- Off-circuit tap switch
- Earthing terminals
- Tank lifting lugs
- Top cover lifting lugs
- Drain cum sampling valve & filter valve
- Oil level gauge
- Pressure relief device or explosion vent
- Thermometer pocket
- Silicagel breather
- Bottom channels
- Conservator
- Oil filling plug
- Bushings

THANK YOU