A STUDY ON THE POWER DISTRIBUTION, PROTECTION AND POWER FACTOR IMPROVEMENT OF NATIONAL TUBES LIMITED

A Field study submitted in partial fulfillment of the requirements for the Award of Degree of
Bachelor of Science in Electrical and Electronic Engineering

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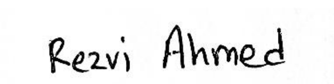
Certification

This is to certify that this project and thesis entitled "**A study on the power distribution, protection and power factor improvement of national tubes limited**" is done by the following students under my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held on January 2020.

Signature of the candidates



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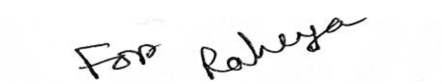

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The field study entitled **"A study on the power distribution, protection and power factor improvement of national tubes limited"** submitted by **Rezvi Ahmed**, ID No: 163-33-3746, and **Dharani Chandra Devsharma**, ID No: 163-33-3681, Session: Fall 2006 has been accepted as satisfactory in partial fulfillment of the requirements for the degree of **Bachelor of Science in Electrical and Electronic Engineering** on January 2020.

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Dedicated to

Our Parents

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At First, We like to thanks Allah for giving us the opportunity and strength to carry on and complete this field study and **Professor Dr. M. Shamsul Alam, Dean, Faculty of Engineering** for being dedicated in supporting, motivating and guiding us through this field study. This field study can't be done without his useful advice and helps. Also thank you very much for giving us opportunity to choose this field study.

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ABSTRACT

This report contains the work done during the internship period which was held in National Tube Limited. under the unit of transformer, power factor improvement & protection device. The report shows an overview of the tasks done during the period of internship in details and explain what is done and learnt during our internship period in the National Tubes Limited. Not only the working principle of transformer, distribution transformer, circuit breaker, magnetic contractor, relay are discussed in the report, but also the rating of the equipment used in national tubes limited are given. Also the power factor improvement technique and calculation used in national tubes limited are included in this report.

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LIST OF ABBREVIATIONS

NTL- National Tubes Limited
DESCO-Dhaka Electric Supply Company Limited
CT-Current Transformer
PT- Potential Transformer
RMU- Ring Main Unit
DOFC- Drop Out Fuse Cut Out
CB- Circuit Breaker
OCB- Oil Circuit Breaker
SF6-Sulphur-hexaflouride
VCB- Vacuum Circuit Breaker
PFI- Power Factor Improvement
KW- Kilo Walt
KVAR- Kilo Volt Ampere Reactive.
KVA- Kilo Volt Ampere.

CHAPTER 1
INTRODUCTION

1.1 Introduction

National Tubes Limited is the only steel pipe production company in Bangladesh. It needs a lot of electricity at national tubes limited. Dhaka Electric Supply Company Limited (DESCO) supplies the electricity directly from the DESCO substation to the NTL substation.

Originally, NTL receives electricity and utilizes power from NTL's own substations. First, it is connected to the transformer from the oil circuit breaker through the power energy meter. Power factor improvement panel has been used to keep the power factor standard.

NTL supplies electricity from its substations to various sectors by utilizing electricity. We have gained practical knowledge about how to operate transformers, circuit breakers, energy meters, magnetic contractors, relays and distribution sub-stations to the field study.

1.2 Objectives

The objectives of this field study and thesis are

i. The main objective is to visit the distribution sub-station and gain real knowledge about it.
ii. We have read about all the equipment used in distribution sub-station but have gained practical knowledge of how to operate and operate all equipment at National Tubes Limited.
iii. National Tubes Limited How to get electricity from Dhaka Electric Supply Company Limited (DESCO) and we have learned about the various sub-stations that supply electricity in different sectors.
iv. We have learned and worked on how all the equipment used at the sub-station (transformer, oil circuit breaker, vaccum circuit breaker, relay, magnetic contactor, MCCB, capacitor bank) and how to operate.

1.3 Scopes

We created this report based on the internship program. Here we review the transformer, alternator, power factor, protection equipment (circuit breaker, magnetic contractor, relay and reactor).We was observed the transformer's working step and transformer tests. We also reviewed the power factor improvement system and alternator working principle. We have reviewed the basic principles and procedures for managing protection equipment. The report contains pertinent information about a sub-station.

1.4 Report Outline

This internship report is organized through the following chapter.

- Chapter 1 : Will be introducing the Thesis
- Chapter 2 : Will be introducing the Literature Reviews
- Chapter 3 : The general knowledge about Transformer And Distribution Transformer
- Chapter 4 : The general knowledge in Protection Device
- Chapter 5 : Will give up general knowledge in Power Factor Improvement
- Chapter 6 : Will be the Conclusion

CHAPTER 2
LITERATURE REVIEWS

2.1 Introduction

Prepare a report creates a unique opportunity for the student to apply there theoretical knowledge onto practice and gain valuable real world business experience. Student can also realize existing business condition a part from having opportunity to solve the problems using various analytical tools. National Tubes Limited was established in 1964.It is a private sector. It is the 1st & largest pipe manufacturing company in Bangladesh. It was nationalized in 1972 & place under Bangladesh steel and engineering corporation (BSEC). In 1989 the enterprise was resolved into a public limited company by off-loading 49 percent shares to the general public. It is the only Government owned steel pipe producer in Bangladesh.

2.2 Commitment of NTL

- Profit through production and sale of products as per demand.
- Increasing the productivity of the production process and quality management method to increase the efficiency of the company.
- To improve the quality of internal services and customer service by maintaining national and international standards.
- Increase the marketing program according to marketing plans at home and abroad.

2.3 Industrial Sub-substation

Basically NTL is needed huge amount of electricity. This electricity supplied by DESCO. When load shedding, NTL receives electricity from their own power generators and keeps the supply running through all types of neutral appliances / sub-stations.

Below is a diagram of the sub-station of DESCO. Through which the NTL receives the electricity.

Fig: 2.1 DESCO Power Consumption

RMU= Rain Main Unit

DOFC= Drop out Fuse Cut out

OCB= Oil Circuit Breaker

2.4 Vision of NTL

- Enrich the domestic industry by reducing the import dependence of pipes by producing international quality pipes and supplying them to the market at affordable prices.
- It vision to continuous improvements for highest customer satisfaction with innovation and motivated workforce.

2.5 Mission of NTL

- Increase profits and provide better service to the customer by achieving the goals of continuous use, efficient development of factories, continuous development, production and marketing of modern technology.
- Conducting continuous research for diversification and market development.
- Meeting the customer satisfaction by producing highest quality import-substitute gas/oil line and water line pipes.

CHAPTER 3
TRANSFORMER AND DISTRIBUTION TRANSFORMER

3.1 Introduction

In the present world, the contribution of transforms in the transmission and distribution of electric power is immense. This device is used to easily transfer energy from one circuit to another without changing the frequency.

During the transfer of electrical energy, the voltage of both coils are decrease or increase, at the same time the current volume is decrease or increase and the power of both coils is approximately equal. The coil of the transformer is located very close so that the magnetic flux generated at one coil can easily be partially or partly related to the other coil.

As a result, its efficiency 95% to 99%) is much higher than other electric machines. The entire process of transferring electric energy is based on the principle of electro-magnetic induction. Scientist Michael Faraday discovered this principle in 1831.

3.2 Transformer

An electric static device that transmits coil from one coil to another without any electrical connection between the coils without changing the frequency, is called a transformer.

A common type of transformer has two coils. Energy can be supplied to any coil, and likewise coil can be added to any coil. The coil in which the energy is supplied between the two coils is called primary winding and the other coil which is connected to the load is called secondary winding. This is why primary and secondary windings are not identified in the transformer. The transformer is characterized by high - voltage winding and low - voltage winding.

High Voltage Winding H1, H2 …… and low - Voltage Winding X1, X2 … is indicated as such. When a transformer is used as a step-up, the low-voltage is identified as the winding primary and is connected to the source. Just as a transformer can be used as a step-down, the high voltage winding is identified as the primary and connected to the source.

Fig 3.1 Distribution transformer

3.3 Types of Transformers

3.3.1 Power Transformer:

Transformers that are only used for transporting high voltage power are called power transformers.

Power transformer rating are given below -

11KV/66KV, 33KV/132KV, 66KV/230KV.

3.3.2 Distribution Transformer

A transformer used to distribute electricity to a customer is called a distribution transformer.

Distribution transformer rating are given below –

11kv/400v or 230V, 33kV/11KV.

33KV/11KV is a distribution transformer because in many cases the factory takes 11KV, 33KV voltage.

3.3.3 Instrument Transformer

The transformer used for measuring work is called Instrument transformer.

Instrument Transformer are two types-

3.3.3. a Current Transformer (CT)

The transformer that helps measure the current through the low range ammeter is called the current transformer. The number of turn has very low for primary side and the number of turn has very high for secondary side. The primary load is connected to the series and an ammeter is connected to the secondary.

Fig 3.2 Current Transformer (CT)

3.3.3.b Potential Transformer (PT)

A transformer that helps measure high voltage through a low-range voltmeter is called a Potential Transformer. Its primary turn of number is very high and low in secondary. Its primary turn of number is very high and low in secondary. The voltage were measured is to be connected in parallel. A low range voltmeter must be connected to the secondary.

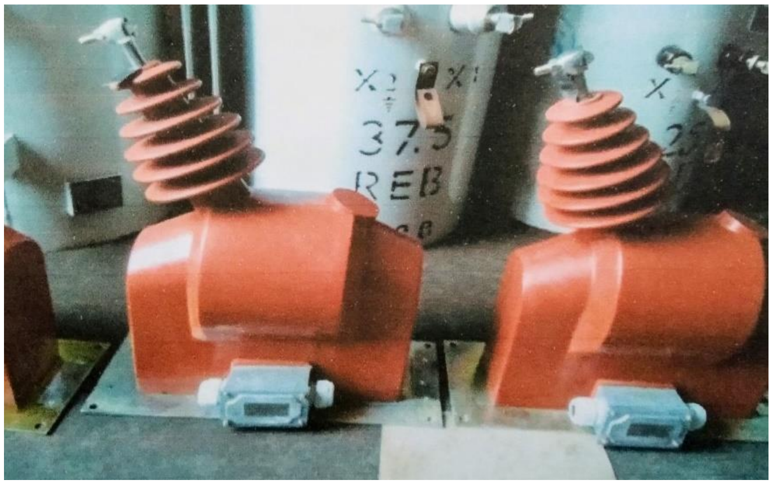

Fig 3.3 Potential Transformer (PT)

3.3.4 Step up Transformer

When a transformer receives a low voltage energy and supplies a high voltage it is called a step up transformer. For example, considering the 33/66 kV transformer, V_p = 33 kV primary voltage and V_s = 66kV secondary voltage. 66kV volt is available in secondary with 33kv supply so it is a step up transformer. In step up transformer, the number of turn 2nd coil is greater than the number of turn 1st coil. E.g $N_s > N_p$ and $a < 1$. a is the transformation ratio and $a = N_p/N_s$.

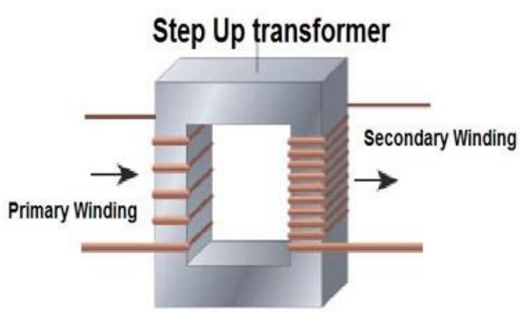

Fig 3.4 Step up Transformer

3.3.5 Step down Transformer

When a transformer receives energy at higher voltage and provides less voltage, it is called a step down transformer. For example, considering a 132/33 kV transformer, it is seen that 33 kV is available with a 132 kV supply, So it is A step down transformer. In step down transformer, the number of turn 1st coil is greater than the number of turn 2nd coil. E.g $N_p > N_s$ and $a > 1$. a is the transformation ratio and $a = N_p/N_s$.

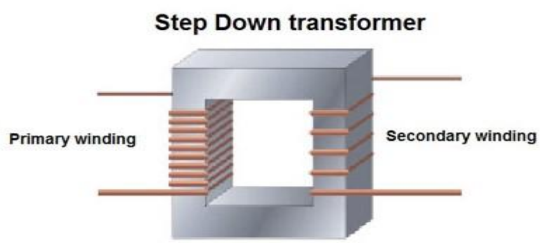

Fig 3.5 Step down Transformer

Table 3.1 Different Transformer Rating

Types of Transformer	Power Rating P(KVA)	Primary Voltage Vp(KV)	Secondary Voltage Vs(KV)
Power Transformer	**25000**	**11**	**66**
	45000	**33**	**132**
	60000	**66**	**230**
Distribution Transformer	**150**	**33**	**11**
	100	**11**	**0.4**
	50	**11**	**0.22**
Step up Transformer	**11000**	**33**	**66**
	5500	**11**	**33**
Step down transformer	**3000**	**132**	**33**
	1000	**33**	**11**

3.4 Working Principle of Transformer

Two circuits or coils under the same magnetic fluxes in the transformer are connected through mutual induction. The two inductive coils are magnetically connected to a uniform laminated core without electrical coupling. Low reluctance and high quality mutual inductance coils. The coils connected to AC source between the coils are called the primary coils and the coils connected to the loads are called the secondary coils.

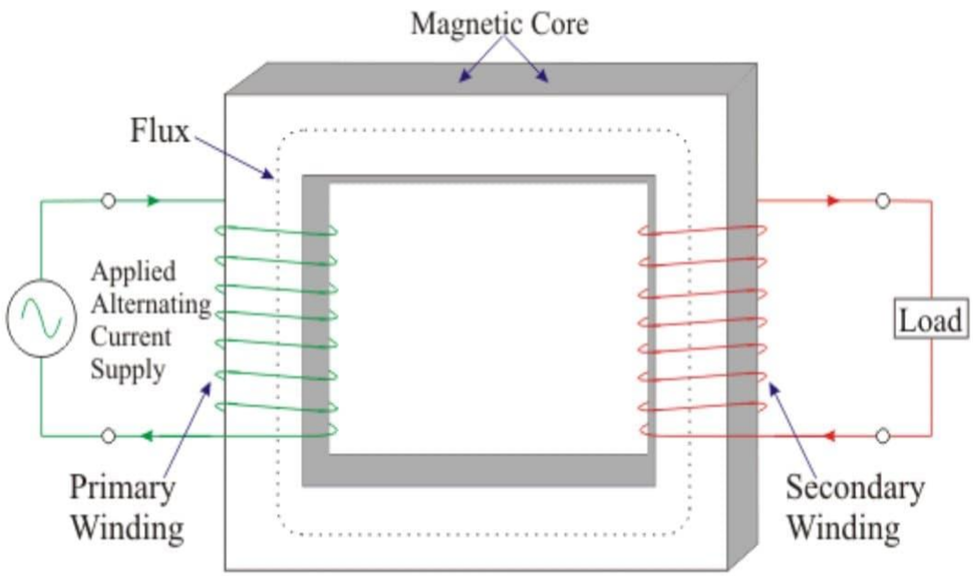

Fig 3.6 Single Phase Transformer

As the alternating voltage is applied to any one of these coils, the variable current creates a variable magnetic line at the core, which cuts the associated coil. As a result, mutual voltage is induced according to the electromagnetic induction principle of the coil. This voltage is the transformer voltage and the process of producing this voltage is called the transformer action. By adding load to the second coil and completing the circuit, the current will flow. In this way, the electrical energy can be transferred from one circuit to another by means of electromagnetic induction.

From the Faraday's law, we know that three things are needed to get EMF.

i. Magnetic field
ii. Conductor
iii. The relative speed between the magnet field and the conductor.

EMF will not be generated if any of these are absent.

3.5 Construction of a Transformer

The following is a structure diagram of a three phase transformer

Fig 3.7 11/33 kv Transformer

3.6 List of different parts of the transformer

1) Tank
2) Primary Winding
3) Secondary Winding
4) Conservator
5) Oil Level Indicator
6) Breather
7) Transformer oil
8) Buchholz relay
9) Bushing
10) Earth terminal

11) Insulation
12) Transformer Core
13) Primary terminal
14) Secondary Terminal
15) Thermometer

3.7 Description of the main parts of the transformer

1. Tank :

The core of the winding and the transformer is immersed in oil in a tank, and the tank is made by welding the steel sheet. The waterproof gasket is mounted on the tank with a lid mounted on it. The core is tightly fastened to the bottom of the transformer tank.

Fig 3.8 Transformer Tank

2. Transformer Winding:

Winding is the coil used for the current flow in the transformer. Transformer winding may contain two or more coils. These coils are usually made by Super Enamel Copper. The coils made of a fixed shape are mounted on a core. The number of turns in the coil and the size of the cable varies. The turn of number and cable size of the coil depends on the desired voltage and current amount. There are two types winding of the primary and secondary winding.

Fig 3.9 Transformer Winding

3. Breather:

As the oil condensation expands, the outside air enters and exits the transformer tank. When air enters the tank, the water vapor is dried through a pump. The part of the transformer through which the air comes in and out and releases the water at its entrance is called a breeder. To reduce the volume of the oil - to increase the air volume during the rise - a conduit is applied to the top of the conservator and a breeder is placed on its head. Bidder contains a type of chemical called silica gel that absorbs air vapor from the air as it passes through the bidder. That's why the breeder is also called the transformer's breathing machine.

4. Conservator:

When the oil of the transformer is heated, the volume increases and cools down. As the volume increases, the oil wants to exit the tank. Therefore, a small drum-shaped tank is attached to the tank by means of a drum, called a conservator. As the volume of the oil increases, the oil is deposited through the pipe to the conservator.

Fig 3.10 Conservator

5. Buchholz relay

Buchholz Relay is one of the high rating transformer's reserve system. The Buchholz relay is fitted between the transformer tank and the conservator connector pipe. The gas in the transformer turns off automatically so that the gas accumulates at the corners. Again, many transformers have vent pipes on top. The mouth of the pipe is closed with glass. Excessive pressure on the gas, the glass burst through the glass.

6. Transformer Oil

The oil used in the transformer is used as insulation and for cooling the winding. The commercial name of this oil is pyranol and silicon.

7. Bushing:

Winding terminals are brought out of the transformer tank via bushing. These bushings are made of very good porcelain. These are fitted with a gasket on the lid of the tank. This bushing connects the service lines and terminals of the transformer winding. Their number, size, and composition method depend on the amount of voltage. High voltage side bushings are larger in size and lower voltage side bushings are thinner and small in shape.

Fig 3.11 Bushing

8. Earth terminal

There are two earth terminals for transformer body earth. The two have to connect well with the Earth. In this way, the security of the body is made by doing body earth.

9. Insulation

The coil is used to apply super enamel insulation on the conveyor used. Moreover, some coils are provided during coil manufacture. In addition, some patches are also used with Ampere Cloth or Leather paper when making coils. In order to insulate the core from the coil, it is best to use insulating paper on the core as well as dampen the core of the large transformer and coil the insulating oil to increase insulating power. The coils on the core are then insulated with a coating of varnish on the coils.

3.8 Rating of a Distribution Transformer:

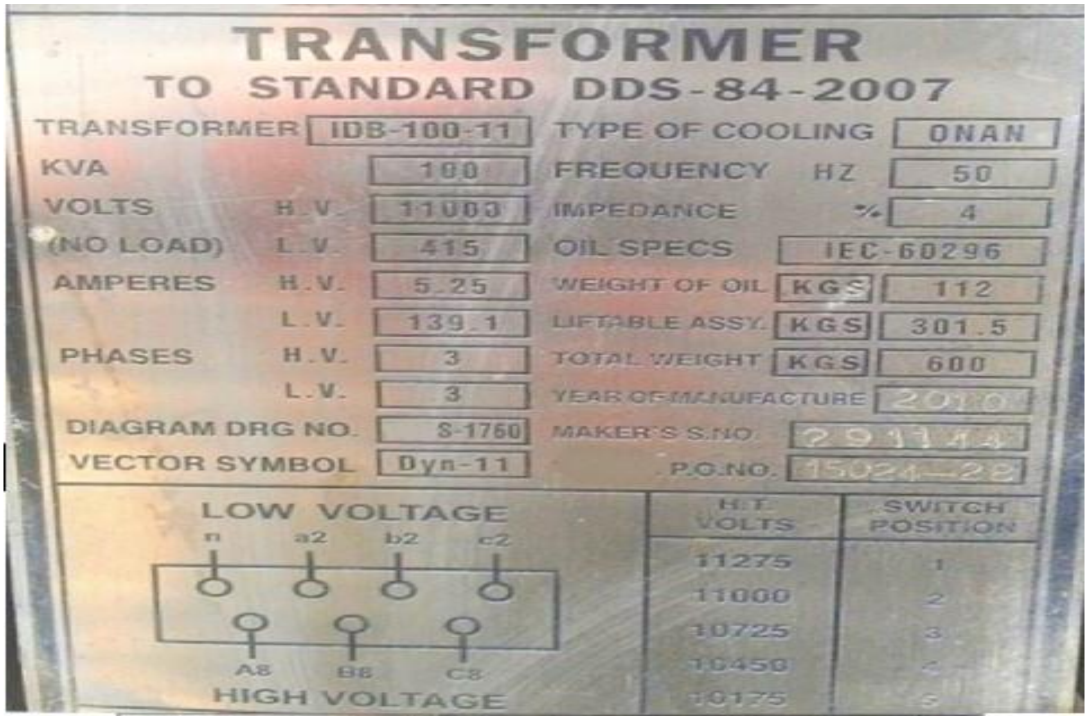

Table 3.2 Rating of a Distribution Transformer

Transformer	**IDB-100-11**	**TYPE OF COOLING**	**ONAN**
KVA	**100**	**FREQUENCY (HZ)**	**50**
VOLTS H.V	**11000**	**IMPEDENCE %**	**4**
VOLTS (NO LOAD) L.V	**415**	**OIL SPECS**	**IEC - 60296**
AMPERES H.V	**5.25**	**WEIGHT OF OIL (KGS)**	**112**
AMPERES L.V	**139.1**	**LIFTABLE ASSY. (KGS)**	**301.5**
PHASES H.V	**3**	**TOTAL WEIGHT (KGS)**	**600**
PHASES L.V	**3**	**YEAR OF MANUFACTURE**	**2010**
DIAGRAM DRG NO.	**$-1760**	**MAKER`S NO**	**29 11 44**
VECTOR SYMBOL	**Dyn-11**	**P.O. NO.**	**15024-28**

3.9 Different Losses of a Transformer

Transformers are a fixed type of device. It does not cause any friction and wind damage. Transformer losses mean no load and full load loss can be detected.

Typically there are two types of losses on the transformer.

i. Core loss or Iron loss
ii. Copper loss

3.9.1 Core loss or Iron loss

Core Loss or Iron Loss is the sum of Eddy Current Loss and Hysteresis Loss. A core loss is specific to a transformer. In the case of a transformer - the full load from the load remains the same in any case. Because the core loss for the transformer is roughly proportional to the square of the mutual flux. This mutual flux is established in the core and its value is not related to the load.

The mutual flux of the transformer depends on the amount of supply voltage imposed on the primary. That is, mutual flux decreases and increases as the applied voltage decreases and increases. The mutual flux does not change if the supply voltage does not change. As a result, the core loss remains the same and does not depend on the increase and decrease of the load.

Otherwise, the load current becomes less and more as the load decreases and increases.

Core loss are two types:

a. Hysteresis Loss
b. Eddy Current Loss

3.9.1.a Hysteresis Loss

Alternating current changes direction per half cycle. As a result, the magnetic flux changes periodically to one of the highest positive means and to the other times the maximum negative. The direction of the pole of the magnet field changes.

As a result of this periodic magnetization and demagnetization, the core's magnets move very quickly in their respective positions and change direction repeatedly, and power is spent as a result of collisions between them. This power deficit is called hysteresis loss.

3.9.1.b Eddy Current Loss

When the current flowing through the coil of an electromagnet changes, the magnetic field around it changes and cuts the core. This creates voltage at the core and a current in the core due to this voltage. This current is called Eddy current. Eddy current loss is caused by the impedance caused by core resistance when the current flows through the core.

3.9.2 Copper loss

Copper loss is the loss of the transformer's primary and secondary winding has the same ohmic resistance. Copper Los belongs to Ladd. As the wave increases, the loss increases. A. Loss is diagnosed by IR. Copper loss is proportional to the square of the current.

Copper loss, $P_c \propto I^2$

Or, $P_c \propto KVA^2$

The amount of copper loss is available from the short circuit text. In case of transformer both are copper loss at winding. So in that case the total copper loss = $I_p^2R_p + I_s^2R_s$

If the load is less or more than the rated KVA of the transformer, the copper loss is reduced and increased very quickly without the ratio.

3.10 Cooling system of a Transformer

A transformer cooling is meant to minimize the heat dissipation process developed on the transformers. The losses in the transformer are converted into heat which increases the temperature of the air and heat. A cooling method should be adopted to control the heat.

3.10.1 Oil Cooling system

In this method, the heat is transferred to the oil around the winding, and it is transferred to the wall of the transformer tank. Eventually, the heat is radiated and transferred to the air. The windings of the transformer are submerged in oil. Due to the winding and core surface, the oil is heated up and overheats the cooling oil. The heating oil transfers to the transformer tank and the hot oil transfers to the surrounding air.

3.10.2 Air cooling system

The air cooling method of a transformer is commonly used in small transformers. This way the transformer is cooled through the surrounding natural air flow. Insufficient cooling in the natural air system. In this method, the fan or blowers are forced to force the air on the origin and winding. Filters must be used on air-conduction tubes to prevent dust accumulation.

3.10.3 Water cooling system

In this method a water is flowing hot into the heat exchanger. Where oil pressure is high and water pressure is low. Using this method, water cannot enter the transformer. This method is used on all types of transformers.

CHAPTER 4
PROTECTION DEVICE

4.1 Introduction of Circuit Breaker

Initially, renowned scientist Tomas Alva Edison describes the circuit breaker in his patent in 1879. Although fuses are used later on in his commercial machines. It was originally used to prevent the filament bulbs and light distribution circuits he discovered from being accidentally short-circuited and overloaded.

Later, in 1920 the patent for a small circuit breaker was patented by Brown, a company called Boveri & Cie, which guides modern circuit breakers.

4.1.1 Circuit breaker

It is a switching device that allows the electrical circuit to be connected and disconnected with the supply. However, one of the major tasks of a circuit breaker is that it automatically disconnects the malfunctioning circuit from being automatically supplied and does not automatically connect the circuit. There are various ways to handle it. Circuit breakers must be mechanically strong to make them. It plays an important role in the operation of various types of very high power electric lines.

4.1.2 Principle of operation

The circuit breaker is a control and maintenance device, which automatically disconnects the circuit from being supplied when a fault (such as short circuit, earth fault, etc.) is attached to the circuit connected to it but does not automatically connect to the circuit breaker, other components connected to it. CT, relay, etc.) Perform co-operation. The functions that a circuit breaker performs on an electrical system.

1. Under normal conditions, it operates manually or remotely as a remote control switch to connect or disconnect a circuit.
2. Automatically detach defective parts from the supply when unusual or defective.
3. Recovers the circuit with a manual and remote control after it is freed.

4.1.3 Working Principle

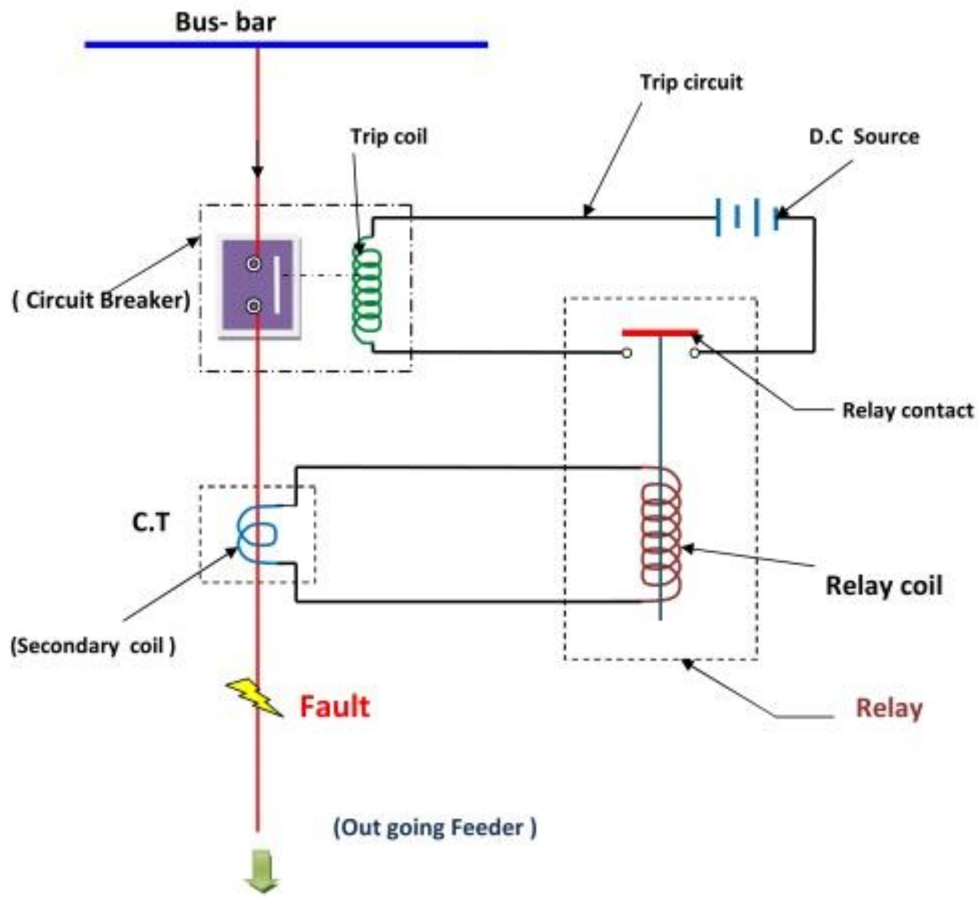

Fig 4.1 C.T relay and circuit breaker connection diagram

Under normal conditions, the relay is not energized by the current flowing through the line. The resulting trip coils are not energizing. As a result, the circuit breaker's moving contact does not separate from the fixed contact. If the system experiences a short circuit or an earthquake error, the amount of current flowing in the line increases unusual.

Then the ratio of CT current increases. It is relay energetic and the trip coil is energized and it pulls off the raw iron. This removes the moving contact with the link mechanism, causing the circuit to break.

It is important to note that the relay function is to detect faults and to signal the circuit breaker to subsequently disconnect the faulty circuit. The relay primary winding is in series with the line to be protected, and the secondary winding relay is connected to the operating coil.

The tripping circuit, circuit breaker trip coil and relay contact and supply source are formed.

4.1.4 Different types of Circuit Breaker

There are several ways of classifying the circuit breaker. However, the most general way of classification in on the basis of medium used for arc extinction. The medium used for arc extinction is usually oil, air, sulfur hexafluoride (SF_6) or vacuum. Accordingly, circuit breakers may be Classified into:

i. Oil circuit breaker switch employ some insulting oil.
ii. Air-blast circuit breaker in which high pressure air-blast is used for extinguishing the arc.
iii. Sulphur-hexaflouride (SF_6) in which Sulfur hexafluoride gas is used for arc extinction.
iv. Vacuum circuit breaker in which vacuum is used for arc extinction.

4.2 Oil circuit breaker

The oil in the oil circuit breaker has two functions. First, the arc works to extinguish, secondly, the insulation works. Testing has shown that most of the oil used in the circuit breaker is insulation, while only 10% of the oil is used for the removal of arc.

4.2.1 Explanation of the oil circuit breaker

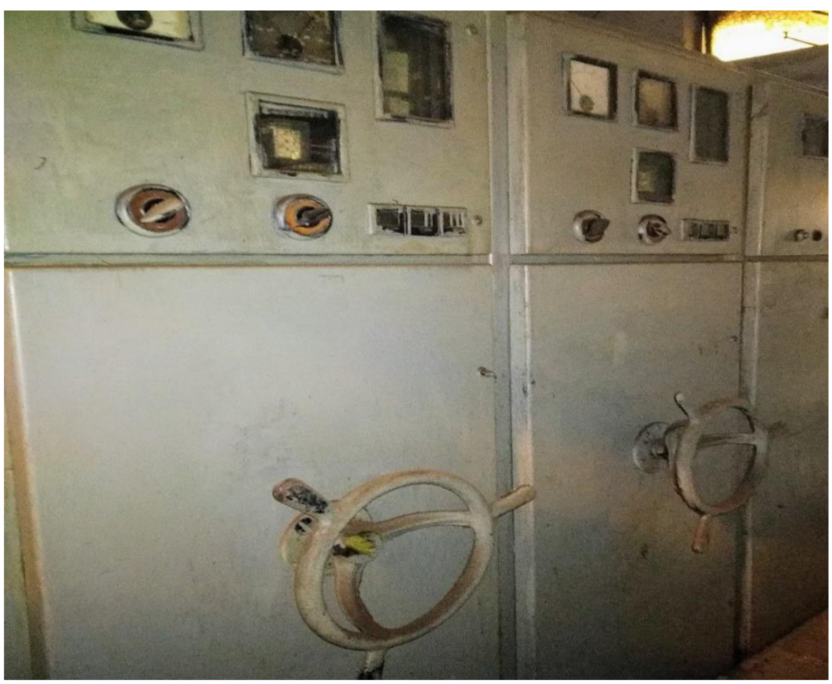

Fig 4.2 Oil circuit breaker

It is made with a weatherproof solid steel tank, and insulating linings are placed around the tank. The tank is filled with transformer oil. The breaker's moving contacts and fixed contacts are well immersed in the tank oil. . Fixed contact is connected to the current running contacts of the circuit. Abnormally high current flow causes the contact current through the trip coil to reverse the circuit's connection.

Again, in the unusual situation, the fierce arc created immediately after the contact is dissipated into the oil. The oil stored in the breaker tank acts as an arc extinguisher and insulator. Since no other action is taken on this breaker, only the arc is extinguished at the normal pressure of the oil, hence it is called plane break oil circuit breaker. A vent pipe is installed on the surface of the tank to drain the gas and bubbles that are generated in the arc heat. It should be noted here that the arctic heat generated during contact is too high (about 5000 ° K) to produce a large amount of explosive gases and there is a danger of serious danger if they are not taken out.

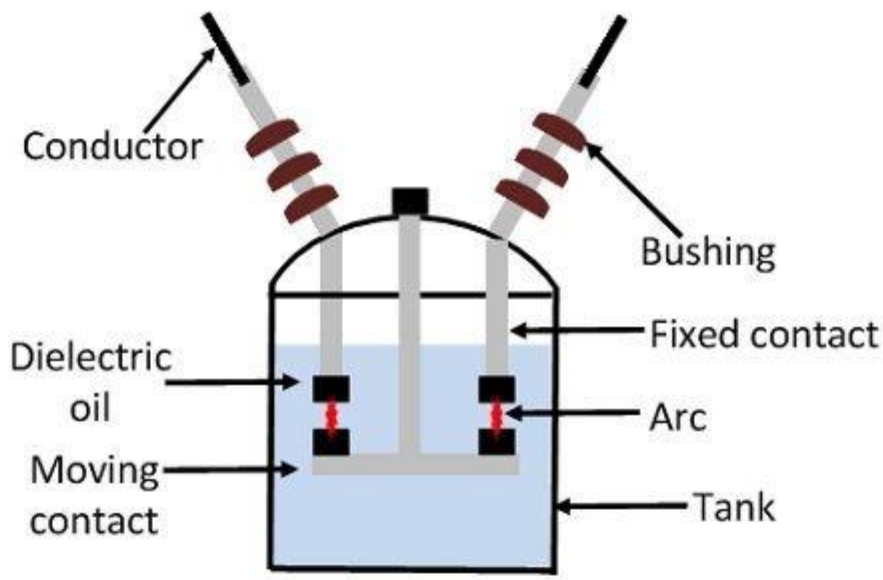

Fig 4.3 Inside diagram of the oil circuit breaker

The arc length increases as the running contacts begin to disintegrate. During this time, the rate of gas production decreases as the temperature drops. The distance between the contacts is obtained when a Critical value is obtained and the current of the arc reaches zero at that state. This involves a relatively long and unwanted period of time for arc extinguishing.

4.2.2 Advantage

i. It's simple and straightforward.
ii. Can be handled manually or automatically.
iii. Current transformers are easy to install in Bushing.
iv. It is possible to take special measures to remove the arc structure is.

4.2.3 Disadvantage

i. It is difficult to remove the arch since it is not possible to move the moving contact away.
ii. It is expensive to take special measures for arc removal.
iii. It takes longer to put an arc.
iv. Recovery voltage does not split evenly between the two contact points during the Earth fault.
v. Because of the high amount of oil, there is more space and more weight.
vi. Its maintenance costs are high.
vii. Only need to be set in the Outdoor.
viii. The quality of the oil used can be wasted, resulting in all the oil being replaced.
ix. Does not work at high speeds.
x. Not used for much voltage (up to 11 K).

Table 4.1 Oil Circuit Breaker specification

Type	DCH-5207H-S
RAT.VOLTAGE	14 KV
RAT. CURRENT	100 A
RAT. INTERR. CAP	450 MVA
RAT. FREQUENCY	60 Hz
RAT. INTERR. TIME	4 C/S
WT. TANK WITH OIL	4 P
TOTAL WT. WITH OIL	730 Kg
RAT. OPERTING VOLTAGE	DC 110 V
RAT. CONTROLE VOLTAGE	DC 110 V
TRIPPING CURRENT	DC 5 A
CLOSE OPERATING CURRENT	DC 60 A
SERIAL NUMBER	62067
DATE	19/7/1997

4.3 Air-blast circuit breaker

Air blast circuit breaker arc extinguishing, opening and closing it all is done by high pressure air. The lower part of the circuit breakers moving contact is piston-shaped, which breaks the breaker chamber into three parts. The lower chamber is used for closing the circuit breaker, the middle chamber for the abnormal state of the breaker, and the upper chamber for arc removal. The lower chamber is the closing inlet, the tube through which the pressure air comes. The opening inlet in the middle and upper chamber is called the opening inlet.

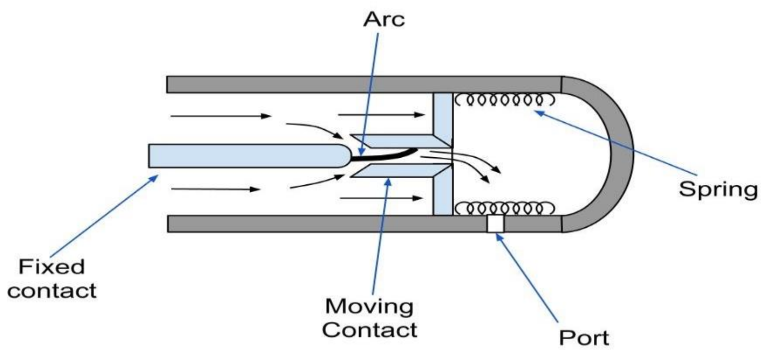

Fig 4.4 Air blast circuit breaker

4.3.1 Working principle

When closing the circuit breaker, high pressure air is inserted through the closing inlet. The air pressure moves above the contact, and the fixed contact above it goes into the middle of the two and closes the circuit breaker. In the abnormal state of the circuit, the air with the opening inlet covers the middle and upper chambers. The air in the middle chamber presses down on the moving contact, causing the moving contact to break away from the static contact. The arc created during the separation blows the air out of the upper chamber entering the upper chamber. To operate the circuit breaker again, high pressure air is to be inserted through the closing inlet of the lower chamber.

4.3.2 Advantage

i. It works very fast.
ii. It has no combustible material and does not have the risk of spreading.
iii. The ability to put the arc higher.
iv. Contacts are rarely wasted.
v. Contact points are easy to change.

vi. In comparison, its weight is less.
vii. It can be made with high power.

4.3.3 Disadvantage

i. It has to provide a fully ventilated air, including electric meter, air compressor and air tight tubes.
ii. The initial cost is higher.
iii. Its structure is relatively complex.
iv. It requires skilled manpower for maintenance.
v. Restricting is very touching for the voltage.
vi. There is a possibility of air leakage on the line.

Table 4.2 Air Circuit Breaker specification

Serial number	**Y606183**
Frame	**LH800 DMIT3P**
IIEC-947.2	**IS:3947**
Utilization Category	**8**
IN	**400 A**
ITH@ 40°C	**800 A**
ICS & ICU	**50 K**
ICW	**50 KA, 1sec**
Power Factor	**0.25**
UI=1000V UE=4.15V	**Frequency 50/60 Hz**
U/V	**40 VCA**

4.4 Sulphur-hexaflouride (SF_6)

A circuit breaker which is SF_6 under pressure gas are used for extinguish there is called SF6 circuit breaker. SF_6 circuit breaker mainly consists of two part .First the interruption chamber and second the Gas system.

The interruption chamber: This units consists of moving and fixed Chamber containing SF_6 gas. This chamber is connected to SF_6 gas reservoir when the conducts of the circuit breaker are opened the valve mechanism permit high pressure SF_6 gas.

Gas chamber: This units consists are two part. There are low pressure and high pressure Chamber. When the gas pressure chamber is low the low pressure alarm warning switches.

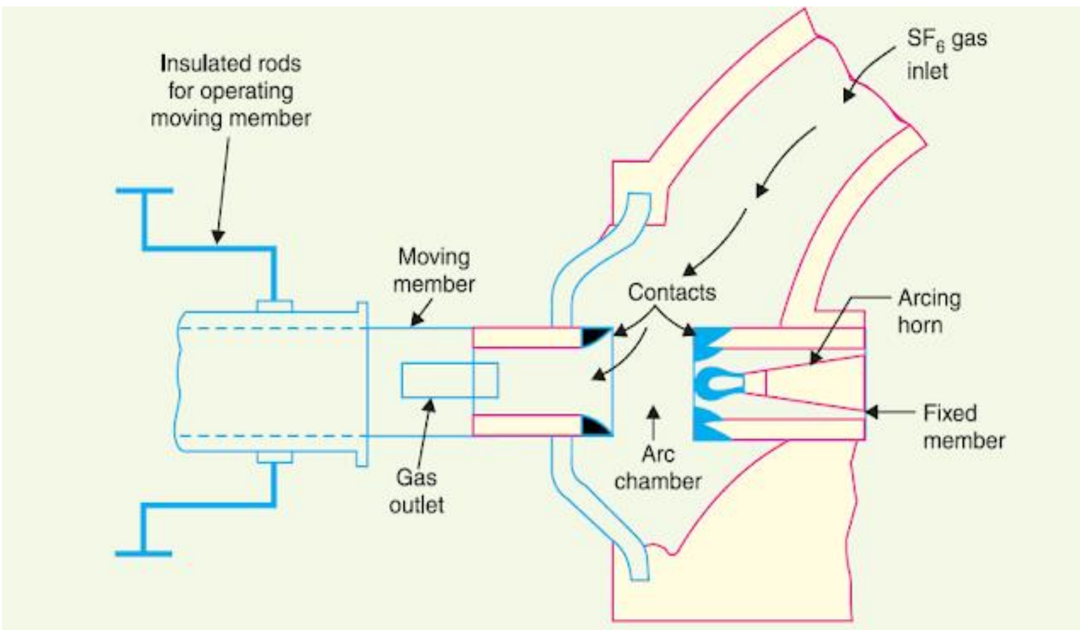

Fig 4.5 Sulphur-hexaflouride (SF_6)

4.4.1 Working principle

Sulphur-hexaflouride (SF_6) is a dielectric and inert gas for arc extinguishing. It is electro negative religious. This gas is free - capable of absorbing electrons. Based on this principle, the SF6 circuit breaker works normally when the breaker is closed, the gas pressure at the contacts of the contact is 2 - 5 kg / square C.M Remain In unusual circumstances, running contact is disconnected from fixed contact. At this time the SF6 % gas from the reservoir is 14 kg / square C.M .The arc comes into the arc chamber. This gas is free - conducts electrons. This increases the dielectric strength of the medium between fixed and moving contact. The resulting arc is extinguished. After the arc is extinguished, the valve is closed again through the spring.

4.4.2 Advantage

SF6 the arcing time of the gas is enhanced as the arcing time is reduced.

i. It is used in the case of SF6, gas-dielectric power 2 to 3 times more current than air.
ii. During operation noise does not and does not leave anything in the outside air.
iii. There is no such difficulty.
iv. SF6 there's no fear of gas fires. Because, this gas is fiery.
v. No carbon is deposited.
vi. The cost of repair is low, light foundation is needed and less auxiliary equipment takes place.
vii. This type of breaker is fully sealed from outside air, so that no accident occurs.

4.4.3 Disadvantage

1. This breaker is expensive because of the high cost of SF6 gas.
2. The reservoir has to store enough gas.
3. After each operation SF6 gas is required to move to the previous position, as additional equipment is required.

4.5 Vacuum circuit breaker

Fig 4.6 Vacuum circuit breaker

Fixed contact, moving contact, and arc shield were placed in a vacuum chamber. The moving contact is connected to the contact mechanism through a stainless steel jet. This will not cause leakage in the vacuum chamber. Glass Vessel or Ceramic Vessel is used as the insulating body on the outside. Arc shields prevent the collapse of internal die-electric power.

4.5.1 Working principle

Vacuum die - Electric power is very high. Vacuum circuit breakers are operated on the basis of this principle. When the breaker operates, the moving contact is disconnected from the fixed contact and the arc is created between the contacts. This arc is produced by the ionization of

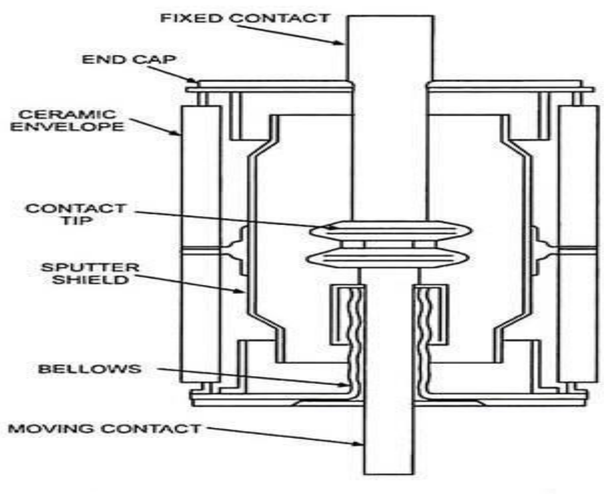

Fig 4.7 Vacuum circuit breaker diagram

Metallic content and metallic ions. In a very short time the arc was released and moved to a fixed contact surface and shield. The vacuum's die - electric energy is very high, so the arc is rapidly extinguished. During this breaker operation, the moving contact moves a short distance (0 to 625 cm) from the fixed contact.

4.5.2 Advantage

i. It is firm, trustworthy and lasting.
ii. There is no fear of fire.
iii. No gas is produced during and after the operation.
iv. It operates on a defective current.
v. Repair costs are low and operation is simple.

vi. Lightning Surge also works well.
vii. The arc is low.
viii. The control mechanism requires less power.
ix. Silent operation.
x. Die - electric and contact resistance remain constant.

4.5.3 Disadvantage

i. Vacuum - It is very expensive to put the arc through it.
ii. Vacuum fails cannot be repaired easily.
iii. 36 KV - On top of that it's not convenient.

Table 4.3 VCB Circuit Breaker specification

Serial number	**VBBA-4742**
Type	**VBBA**
Year of Manufacture	**2006**
Specification	**IS>1881**
Rated Voltage	**7.2 KV**
I/L	**20/60 KV**
Rated Current	**800 Amps**
Frequency	**50 Hz**
Making Capacity	**62.5 Amps**
STC	**25 KA**

4.6 Relay

In the absence of adequate protection, the small error can also lead to a larger error. For example, if the thermal overlaid protection of the motor is provided, the over-loading can be protected, and the motor and another equipment can also be protected from over-voltage, over-current etc. If the motor and another equipment is wasted, the cost and time it takes to repair or replace it will be high. Therefore, using different types of relays, the losses will be less due to the faults of the machinery, and the motor and the cost of crushing will be less cost and time, hence the production will be higher.

4.6.1 Definition

A relay is an automated device that responds to a predetermined electrical condition on the electrical circuit and helps to work on other protective devices connected to the circuit. For example, the circuit breaker protects the circuit by disconnecting it. The change in electrical conditions refers to the change in voltage, current, phase, frequency, temperature, direction of the current, etc. defined in the circuit. Relay is also briefly called Electromagnet. In fact, the relay is positioned between the circuit breaker and the current transformer. The relay is always called 'insider' or 'silent guard' at every fault of the system.

4.6.2 Types of Relay

There are different types of relays. Something important types of relay are given below.

i. Electromagnetic relay.
ii. Static relay.
iii. Primary relay.
iv. Secondary relay.
v. Instantaneous relay.
vi. Operating Time relay

4.6.3 Working principle

Primary winding of a current transformer is connected to the line to which it must be protected. The current consists of secondary winding and relay operating coil of current of the transformer. This section contains the trip circuit. It is very important to arrange the circuit breaker fast by starting the trip circuit through the relay contract close. This is why every circuit breaker has a

Tripping coil called automatic trip circuit for automatic breaker. It seems that the short-circuit fault at point F has occurred. As a result, extra current flows in the line. In this case, with the secondary winding of the City, the relay operating coil will be energized and terminate the relay contract. The trip circuit will be energized as soon as the relay contract is closed and the circuit breaker's contract will open and remove the defective part only after the circuit breaker's trip coil is excited. It is important to note that the circuit breaker will not work unless the relay is working.

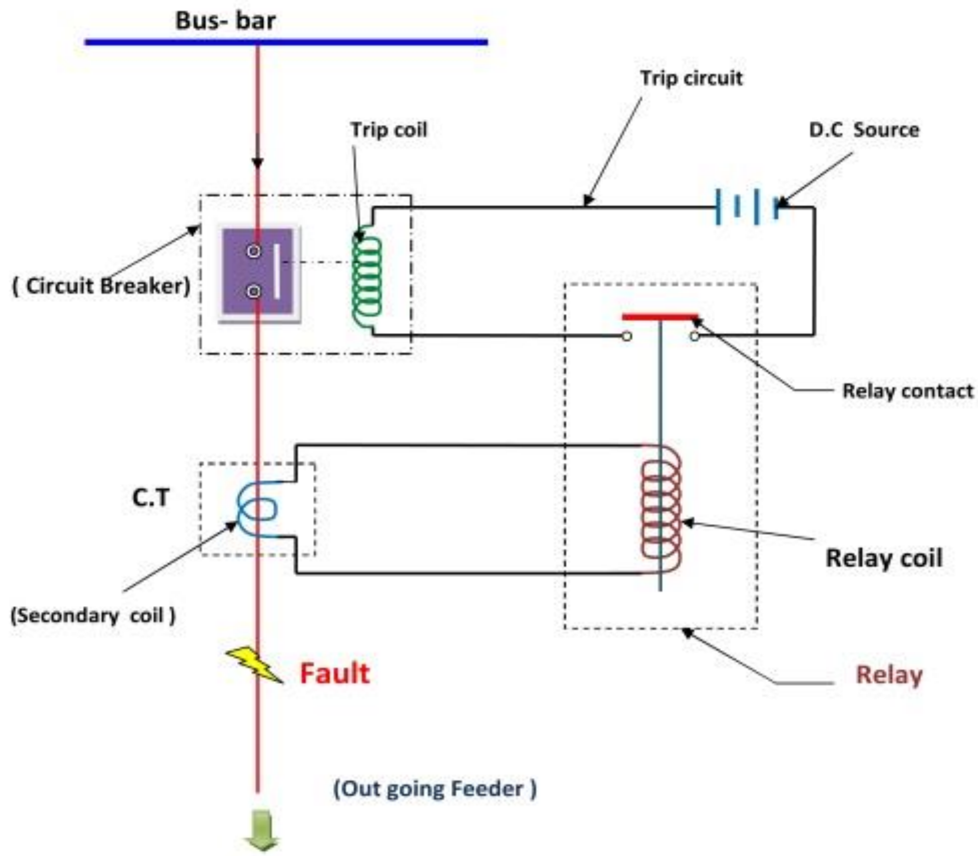

Fig 4.8 Connection diagram of a relay coil

4.6.4 Advantages of using relay

i. If any part of the electrical system is found to be defective, it can be quickly isolated from the supply due to the relay operation.
ii. It is known which part of the electrical system has caused the fault.
iii. What kind of error has occurred is known through the relay operation.

4.7 Introduction of Magnetic-contractor

Magnetic contactors are the name we hear about the most, and the magnetic contactors are very well known to those who are electrical and electronics. The use of magnetic connectors is unacceptable in all the places where the power supply is controlled.

4.7.1 Magnetic-contactor

Magnetic contactors and relay are very similar in function but cannot be used in two but equal voltage. Because, magnetic contactors are used at high power voltage and relay is used at low power voltage. Magnetic contactors are commonly used in large industries. One can say that magnetic contactors are a type of contactor that is used to turn on and off electric loads.

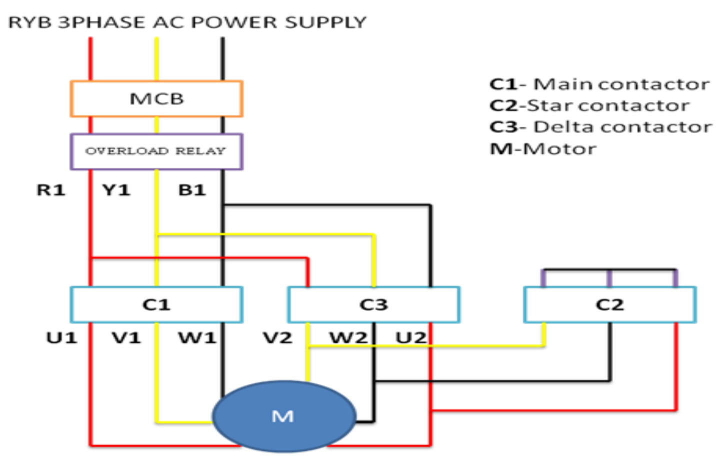

Fig 4.9 Magnetic contactor connection diagram

4.7.2 Structure of Magnetic contactor

The structure of a magnetic contactor is much simpler than that of other electrical devices. Details of these are given below

Contactor coil: A terminal coaxial contactor coil is located between the three terminals of the input, the contact coil has two ends where the electro-magnetic field is created after the power supply .Where both A1 and A2 terminate with these terminals.

Main Terminal: Normally there is a main terminal on the two sides of the magnetic contactor. There is an input terminal on one side and an output terminal on the other. It has three input terminals and three output terminals. The input terminals are three by L1, L2, L3, and the output terminal three is by T1, T2, T3.

Auxiliary Terminal: The auxiliary terminal has two types of contacts. They are Normally Open (NO) and Normally Close (NC).

Normally Close: In a situation where the power flow between the magnetic contactor is closed, which means no supply is supplied, then the magnetic contact is closed to the auxiliary contact. It is usually expressed by NC.

Normally open: In a situation where the power flow is provided between the magnetic contactors, the magnetic contactor's auxiliary contact is open. This condition is called normal opening. It is usually expressed by NO.

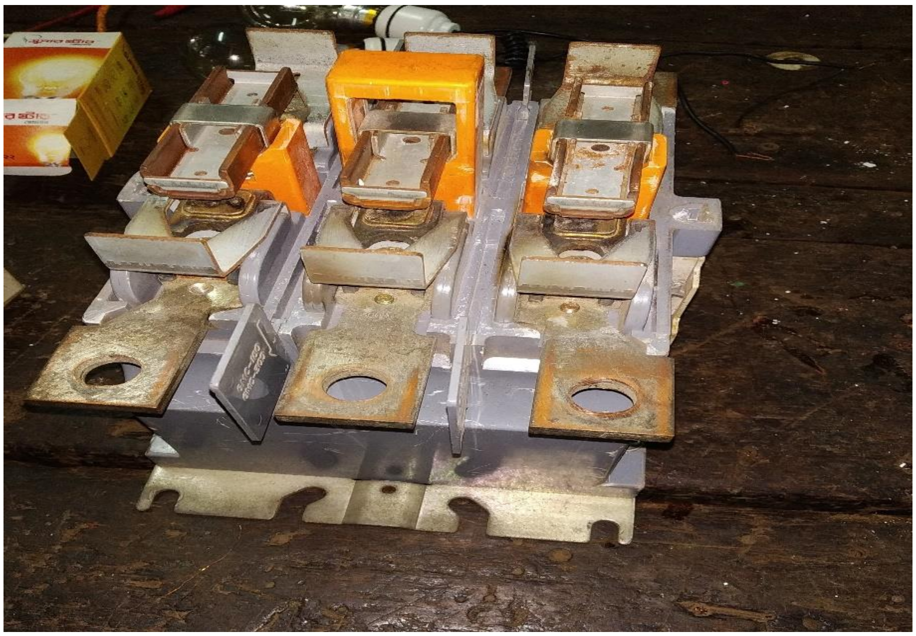

Fig 4.10 Magnetic contactor

4.7.3 Working principle

Usually when the current is supplied to the magnetic contactor, the magnetic field is formed inside it and this magnetic field begins to attract the moving core between the moving core and the fixed core. This attraction of the magnetic field continues to energize the moving core, at one time the short circuit between the moving core and the fixed core becomes current and the current moves to the next step. Although more current flows through the armature coil at the beginning of the supply, the current flow rate decreases a little later. At one stage when the current flow is stopped, the coil de-energizes and the contact is opened. In this way, the magnetic contactor travels from start to finish. Maximum two to three seconds.

4.7.4 Advantages

1. Magnetic contactors are very useful for controlling electric machines.

2. Very easy control of the motor by the magnetic conductor.

4.7.5 Disadvantages

1. Coil may burn due which would cause no magnetic field, hence the contacts won’t close and the contactor wouldn’t operate.

2. Contacts may burn or fray which may also cause the contactor not to work. Contacts may also weld shut which may cause the load to keep running even when there is no control voltage which may cause unsafe machine or machine damage.

CHAPTER 5
POWER FACTOR IMPROVEMENT

5.1 Introduction

Power factor correction is done using capacitor bank in the industry. We can use the capacitor at each load without using the capacitor bank or reduce the use of the load and reduce the power factor that is responsible for the power factor. If there is a coil connection to the loaded then the load is lagging. And if a load has a capacitor connection, then that load is running in Leading. There will be damage to the machine. The efficiency of the work will be reduced. If the load is in the unity, the electricity bill will not come up and the machine will not be damaged.

5.2 Power factor

The Cosine of angle between Voltage and current in an a.c circuit is known as Power factor. In an a.c Circuit There is generally a phase difference between Voltage and Current. The term $\cos\theta$ is called the power factor of the circuit. If the circuit is inductive. The current lags behind the voltage and the Power factor is referred to as lagging. However, in a capacitive circuit. Current leads the voltage and the Power factor is said to be leading.

5.2.1 Power triangle

The analysis of power factor can be made in terms of power drawn by the a.c circuit. The power triangle for lagging current is show in figure below-

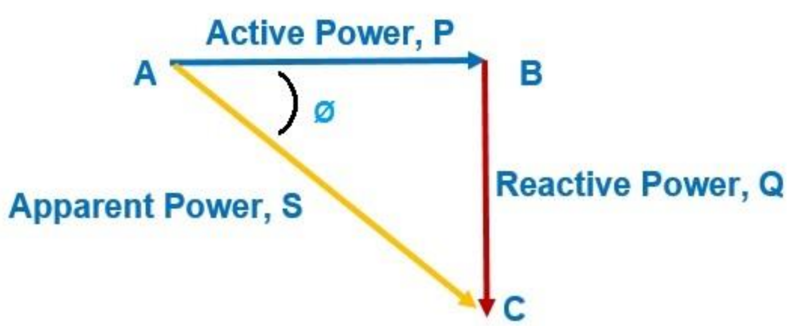

Fig 5.1 Power triangle

Where,

AB=VI cosθ and represent the active power in watts or kW.

BC=VI sinθ and represent the reactive power in VAR or KVAR.

AC=VI and represent the apparent power in VA or KVA.

Power triangles can be noted from the following points:

i. The apparent power in an a.c circuit has to components active and reactive power at right angles to each other.

$AC^2=AB^2+BC^2$

Or, $(\text{Apparent power})^2 = (\text{active power})^2 + (\text{reactive power})^2$

$(KVA)^2 = (KW)^2 + (KVAR)^2$

2. Power factor, cosθ = AB/AC =active power / apparent power = KW/KVA

3. The lagging reactive power is responsible for low power factor it is clear from the power triangle that smaller the active power component the higher is the power of the circuit.

KVAR = KVA sin = (KW/cosθ) sinθ

KVAR = KW tanθ.

4. For leading current, the power triangle becomes reversed.

5. The power factor of a circuit can be defined in one of the following three ways:

a) Power factor = cosθ = cosine of angle between V and I

b) Power factor = R/Z = resistance/impedance

c) Power factor = VI cosθ /VI = active power / apparent power

5.2.2 Disadvantage of low power factor

i. Large KVA rating of the equipment. KVA = kw/ cosθ
ii. Greater conductor size to Carry load current
iii. Large copper loss
iv. Poor voltage Regulation
v. Reduce handing capacity of the system. i.e large installed capacity (KVA) for the same power (KW) requirement.

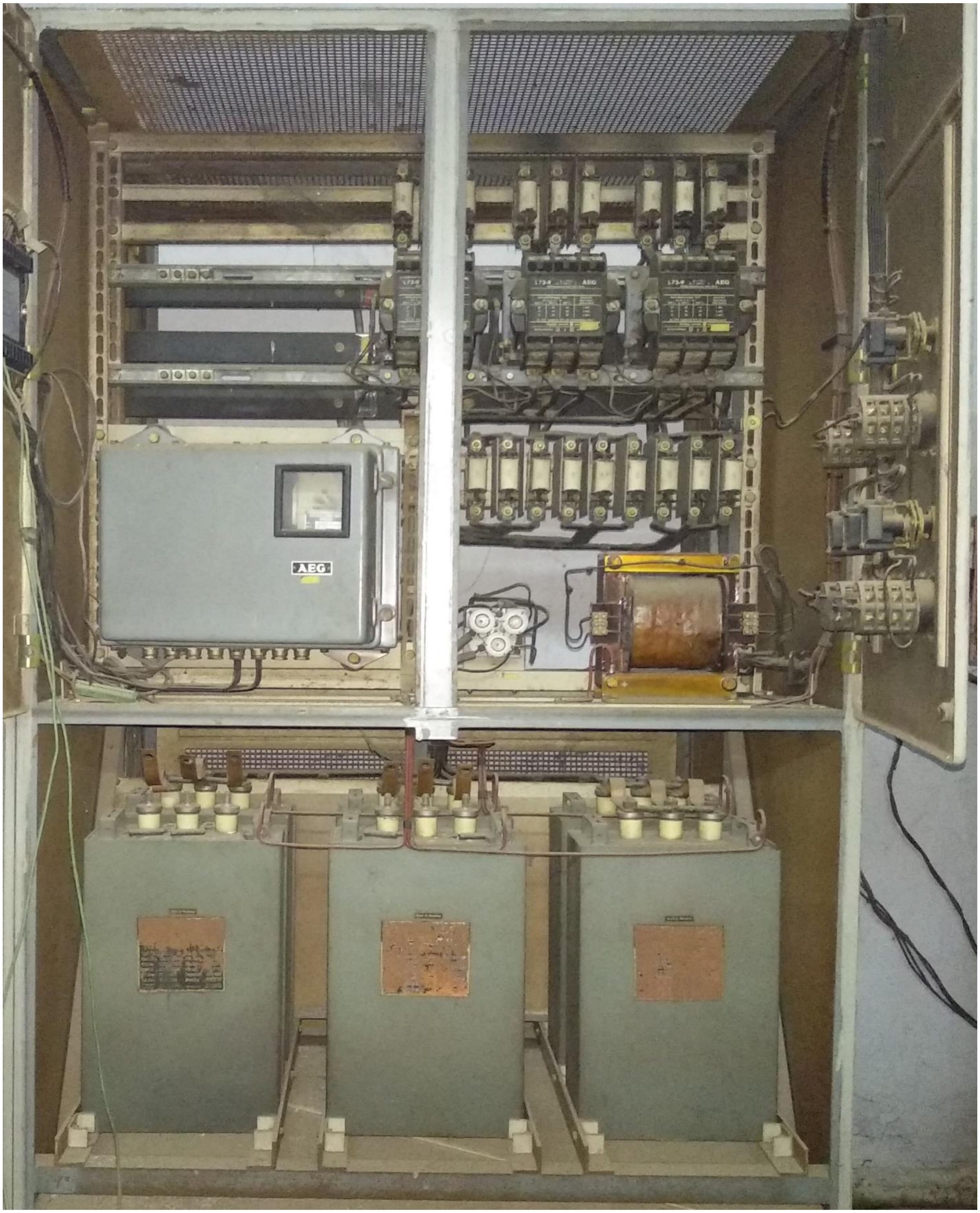

Fig 5.2 Power factor improvement equipment's

5.2.3 Causes of Low power factor

From an economic point of view, the low power factor is undesirable. Normally, the power factor of the whole load on the supply system in lower than 0.8 .The following are the causes of power factor.

1. A.C induction type motors (1 phase or 3 phase) have power factor of 0.2-0.3 on light load. Which rises to 0.8-0.9 on full load.

2. Arc lamps, electric discharge lamps and industrial heating furnaces operate at low lagging power factor.
3. On light load at night the power factor of the power system goes down.

5.3 Power factor improvement

Power factor Correction or Power factor Improvement we can easily understand how to reduce the amount of reactive power in a system and increase the amount of active power. We usually use correction and improve Power Factors using a capacitor bank or a synchronous motor or phase advancers.

5.3.1 Power factor improvement equipment's

i. **Static Capacitor**
ii. **Synchronous condenser**
iii. **Phase advancer**

5.4 Static Capacitor

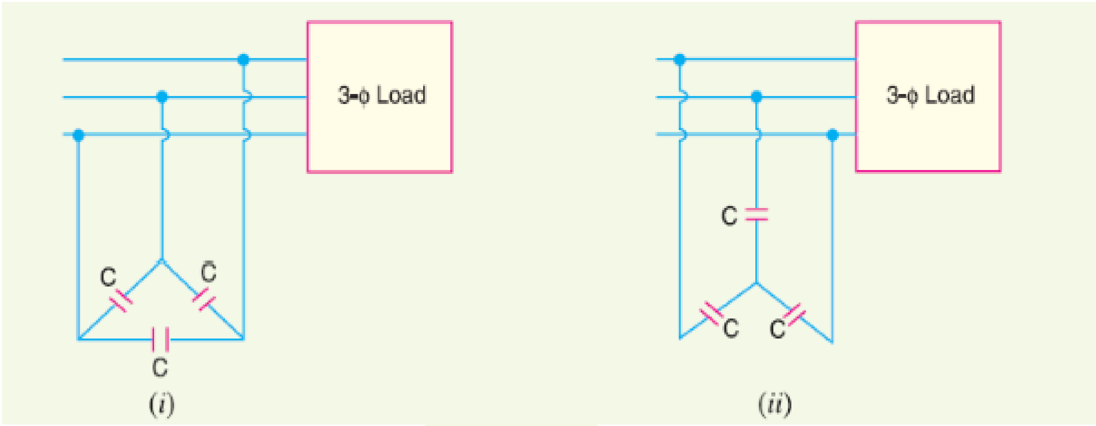

Fig 5.3 Star and Delta Capacitor Bank Connection

The 3 phase lagging power factor is coupled to the delta bank (△- bank) or star bank (Y-bank) capacitor parallel to improve the power factor of the load. In the above figure (a) and (b) the power factor of 3-phase load is developed using delta bank and star bank capacitors respectively. The capacitor reduces the lagging reactive current of the bank's reactive current load. But at the active current of the load the quantity remains the same. So the power factor of the load is developed. Because of the delta combination of line voltage and phase voltage, using a delta bank to develop the power factor, the capacitance per phase is lower.

5.4.1 Advantages of static capacitor

1. They have low losses.
2. They require little maintenance as there is no rotating parts.
3. They are light and can be easily installed and require no foundation.
4. They can handle normal atmospheric conditions.

5.4.2 Disadvantages of static capacitor

1. They have a short service life of 8 to 10 years.
2. If the voltage is higher than the rated value then they are easily damaged.
3. Once the capacitors are damaged, their repairs are done exclusively.

5.5 Synchronous condenser

To develop the power factor with a synchronous motor, a synchronous motor is connected parallel to the 3-phase inductive load. In the figure above is a synchronous motor with a 3-phase load parallel connection diagram is shown.

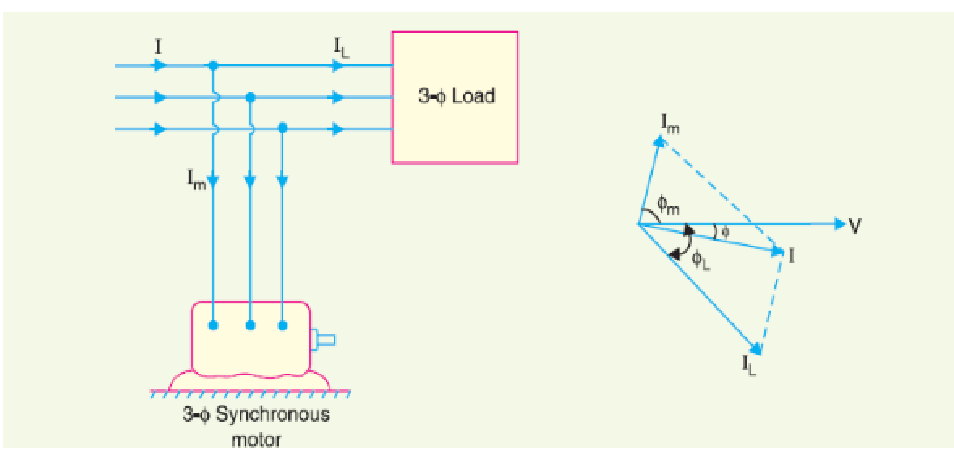

Fig 5.4 Improving power factor with synchronous condenser

Let's say a 3 phase, inductive load cosθ1, in the lagging power factor KW is taking the load. A synchronous motor whose input power is increased to P and the leading power factor cosθm, when the overall power factor is increased to cosθ2.

5.5.1 Advantages

(A) Increase the field excitation and lower the value of p.f

(B) Normal stability of the motor is sufficient to withstand short circuit current.

(C) The fault can be easily removed.

(D) Voltage loss in line is less.

5.5.2 Disadvantages

(A) Motor loss is relatively high.

(B) Maintenance costs are high.

(C) Environment is affected by noise pollution.

(D) The cost of motor generated above 500 KVA is relatively high.

(E) Synchronous motor has no self-starting torque due to extra expensive equipment.

5.6 Phase advancer

Large induction motors are developed through the power factor phase advancer. This is an advanced type of brush shifting three phase A.C commutator motor.

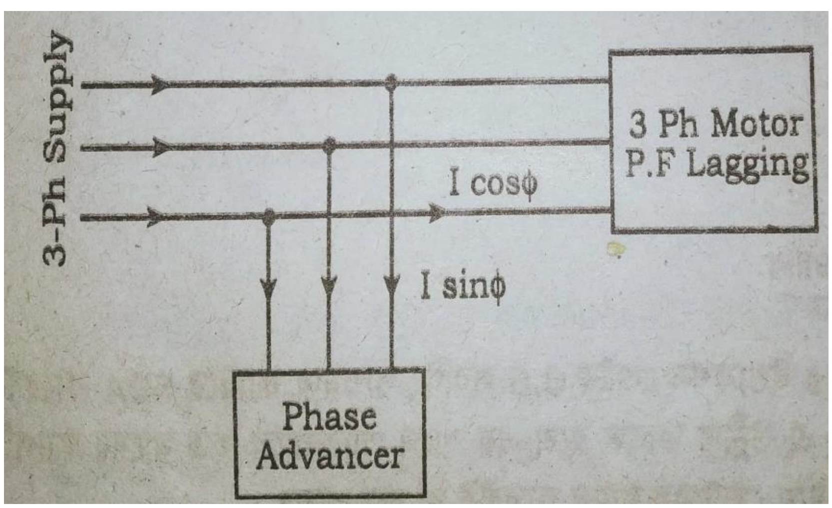

Fig 5.5 phase advancer

At a certain speed, the phase advancer is integrated with the inductor motor's rotor or field circuit. Depending on the position of the brush, the voltage value of the stator is changed such that the majority of the lagging reactive current (leading I Sinθ) of the leading reactive current (leading I Sinθ) line is adopted by the phase advancer.). Consequently, the meter receives only effective current I cosθ from the line and the single power factor is capable of operating from half load to full load.

5.7 PFI for NTL

National Tube Limited uses capacitor bank to improve power factor.

National tubes limited has an estimated total load of 20 KW and power factor (0.7). So below is the standard capacitor we can use.

Load in KW = 20 KW

Kw to KVA = kw/power factor.

=20/0.7

=28.57 KVA

=29 KVA

Then the input transformer will be 50% higher than the KVA. Because it has to be taken from the possibility of increasing the load in the future.

So, KVA =29*50%

=14.5

The total KVA = 29+14.5

=43.5 KVA =43 KVA

Power factor cos1 = load in kw/input transformer

=20 /43

=0.47 lagging.

The lagging value of 0.47 should be brought closer to unity.

We know, P=20 KW = 20000 W.

V= 400 V

Cosθ1 = 0.47

θ1=61.96

I = P/3*V*Cosθ1

=20000/3*400*0.47

=61.42 amp

But the standard value of the power factor is 0.95

$Cos\theta2 = 0.95$

$\theta2 = 18.19$

Now, $KVAR = KW (tan\theta1 - tna\theta2)$

$=20(\tan 61.96 – \tan 18.19)$

$= 30$ KVAR

So, $Ic = KVAR/V$

$= 30000/400$

$=75$ amp

Now, $Ic = V*2*\pi*F*C$

$C= Ic/V*2*\pi*F$

$= 75/400*2*3.1416*50$

$=5.96*10^{-4}*10^{-6}$

$C=596.82$ micro farad

The value of (596.82 micro farad) capacitor must be connected at parallel.

Fig 5.6 Power factor improvement value

CHAPTER 6
CONCLUSION

6.1 Conclusion

The National tubes limited company of Tongi, Gazipur, Bangladesh is responsible for manufacture of steel pipe. The industrial training in National tubes Limited helps us various ways in the field of Electrical Engineering.

Thus they are using equipment power factor improvement plant, Distribution Transformer, Circuit breaker, Vacuum Circuit breaker, Oil circuit breaker, Relay, MCCB, Fuse, Switchgear etc. The study is very useful for us.

We have gathered a clear knowledge about different equipment of substation system. We have experienced a lot of things which we have only heard or read about. It helps us to gather the experience that, this position is really challenging since everyone who desire being successful in their career in the field of Electrical Engineering.

After completing our internship, this report contains the assembling and operation of transformers, Circuit breaker, Relay and PFI plants. These devices are used in electrical power system and industrial plants. The production engineer helping us to known various type of equipment work and we get help from Prof. Dr. M. Shamsul Alam, Dean, Mahmudur Rahman Sr. Lecturer make a report. From this study we have gathered a clear knowledge about substation equipment. It will be helpful in our future life.

6.2 Limitations

1. Two month are not enough time for an internship.
2. There are some limitation with connecting and installing the transformer.
3. The transformer has to be given very carefully. Otherwise it will have to face any problem. The voltage is low and high as a results the load is low and high.
4. If there is a problem with the short circuit or any problem on the line, then if the circuit breaker does not work at that moment, then there will be major problems. So you have to monitoring the time of the circuit breaker. A large amount of magnetic contractors have been used in the NTL. If the magnetic contactor connection is loose for any reason, the magnetic contractor distortion the sound.

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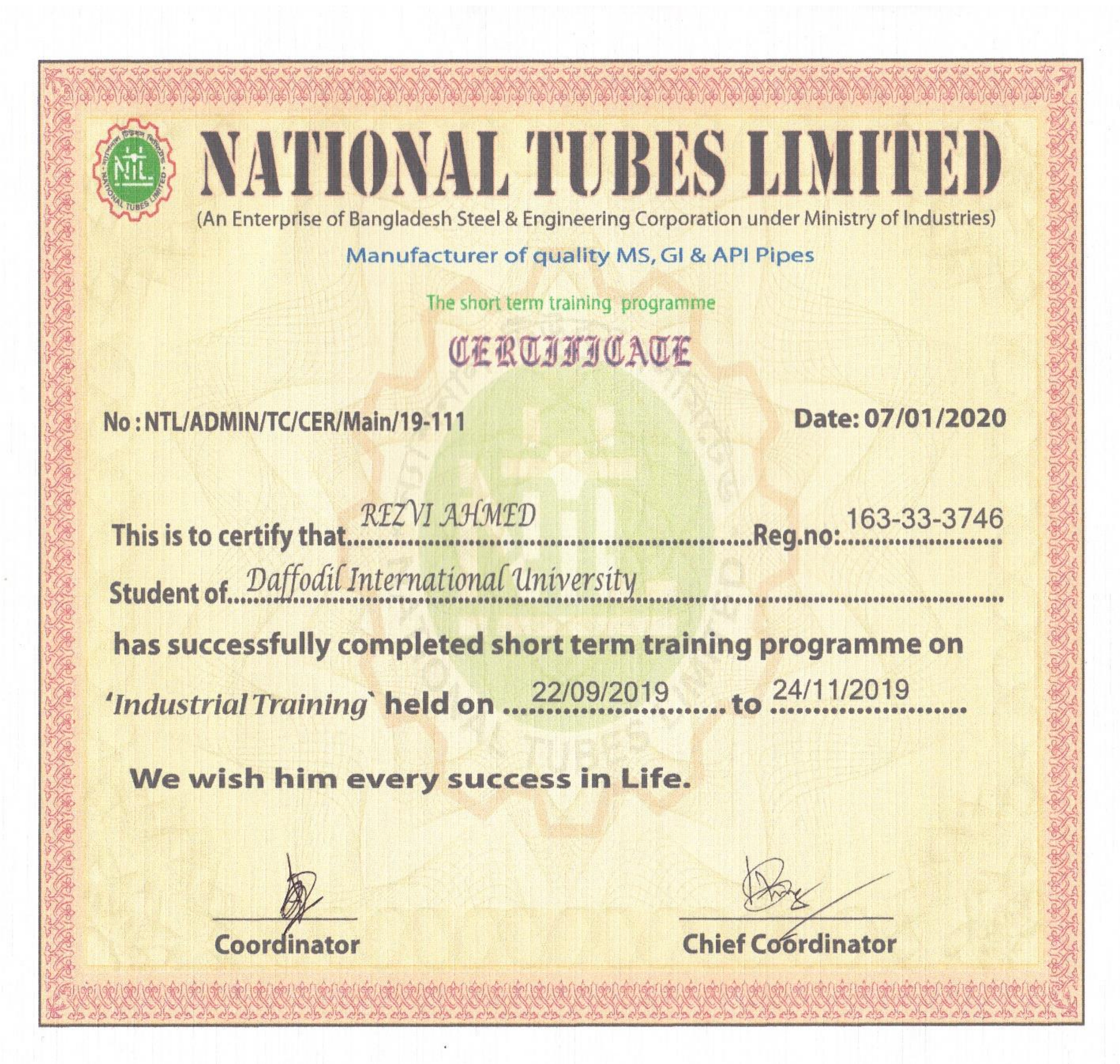
Appendix



NATIONAL TUBES LIMITED

(An Enterprise of Bangladesh Steel & Engineering Corporation under Ministry of Industries)

Manufacturer of quality MS, GI & API Pipes

The short term training programme

CERTIFICATE

No : NTL/ADMIN/TC/CER/Main/19-111

Date: 07/01/2020

This is to certify that REZVI AHMED Reg.no: 163-33-3746

Student of Daffodil International University

has successfully completed short term training programme on

'Industrial Training' held on 22/09/2019 to 24/11/2019

We wish him every success in Life.

Coordinator

Chief Coordinator

NATIONAL TUBES LIMITED

(An Enterprise of Bangladesh Steel & Engineering Corporation under Ministry of Industries)

Manufacturer of quality MS, GI & API Pipes

The short term training programme

CERTIFICATE

No : NTL/ADMIN/TC/CER/Main/19-112 **Date: 07/01/2020**

This is to certify that *DHARANI CHANDRA DEVSHARMA* **Reg.no:** 163-33-3681

Student of *Daffodil International University*

has successfully completed short term training programme on

'Industrial Training` **held on** 22/09/2019 **to** 24/11/2019

We wish him every success in Life.

Coordinator **Chief Coordinator**