POWER CONTROL, DISTRIBUTION & MAINTENANCE

A Project and Thesis 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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October 2019

Certification

This is to certify that this project and thesis entitled "**POWER CONTROL, DISTRIBUTION & MAINTENANCE**" 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 31 October 2019.

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BOARD OF EXAMINERS

First of all, we would like to express our gratitude to omnipotent and almighty Allah, whose invisible guidance helped us to complete this report. Although, time was very limited for getting the sufficient knowledge about all the elements related our dissertation, but the sort experience that we gathered as an, in Daffodil International University asset for all the time to come in our life. We would like to take the opportunity to express our deep sense of gratitude of our supervisor **Md. Ashraful Haque** (Assistant Professor) for his invaluable suggestions and guidance during the study period that has greatly inspired in preparing this dissertation successfully.

We are deeply grateful to all concerned persons who provide valuable guidance, suggestions and advices in collecting information, analyzing and preparing the report. We are particularly indebted to them whose efforts and cordial cooperation made the dissertation possible.

Finally, we want to express deep gratitude to our all university friends who have helped us various ways throughout the time required to prepare this dissertation.

Dedicated to

Our Parents

……..

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AFBL: Akij Food & Beverage Limited

ACB: Air Circuit Breaker

C

CT: Current Transformer

D

DIU: Daffodil International University

E

EMF: Electro Motive Force

H

HRC: High-Rupturing Capacity

HT: High Tension

K

KVA: Kilo Volt Ampere

KVAR: Kilo Volt Ampere Reactance

L

LT: Low Tension

M

MCB: Miniature Circuit Breaker

MCCB: Molded Case Circuit Breaker

MVA: Mega Volt Ampere

O

OCB: Oil Circuit Breaker

P

PFT: Power Factor Improvement

PT: Potential Transformer

V

VCB: Vacuum Circuit Breaker

ACKNOWLEDGEMENT

First of all, we give thanks to Allah or God. Then we would like to take this opportunity to express our appreciation and gratitude to our project and thesis supervisor **Md. Ashraful Haque, Assistant Professor** of **Department of EEE** for being dedicated in supporting, motivating and guiding us through this project. This project can't be done without his useful advice and helps. Also thank you very much for giving us opportunity to choose this project.

We also want to convey our thankfulness to **Dr. Engr. Name, Professor and Chairperson** of the **Department of EEE** for his help, support and constant encouragement.

Apart from that, we would like to thank our entire friends for sharing knowledge; information and helping us in making this project a success. Also, thanks for lending us some tools and equipment.

To our beloved family, we want to give them our deepest love and gratitude for being very supportive and also for their inspiration and encouragement during our studies in this University.

ABSTRACT

The venture is planned for structuring a thickness based unique traffic signal framework where the planning of sign will change naturally on detecting the traffic thickness at any intersection. Traffic blockage is a serious issue in many urban communities over the world and along these lines the time has come to move increasingly manual mode or fixed clock mode to a mechanized framework with basic leadership capacities. Present day traffic flagging framework is fixed time based which may render wasteful on the off chance that one path is operational than the others. To improve this issue, we have made a structure for a clever traffic control framework. Once in a while higher traffic thickness at one side of the intersection requests longer green time when contrasted with standard apportioned time we, subsequently propose here a component where the time span of green light and red light is relegated based on the thickness of the traffic present around then. This is accomplished by utilizing PIR (proximity Infrared sensors). When the thickness is determined, the gleaming time of green light is relegated by the assistance of the microcontroller (Adriano). The sensors which are available on sides of the street will distinguish the nearness of the vehicles and sends the data to the microcontroller where it will choose to what extent a flank will be open or when to change over the sign lights. In resulting segments, we have explained the strategy of this structure.

These days individuals are driving exceptionally quick, mishaps are happening regularly, we lost our significant life by committing little error while driving (school zone, slopes zone, and thruways). So as to maintain a strategic distance from such sort of mishaps and to caution the drivers and to control their vehicle speed in such sort of spots the roadway division have set the billboards. Drivers drive enthusiastically without minding the traffic. Insinuation of driver about speed and clumsy zone is fundamental. It tends to be finished by utilizing programmed innovation with the assistance of inserted framework and sensors.

With this, the power will be wasted up to some extent. This paper gives the best solution for electrical power wastage. Also, the manual operation of the lighting system is completely eliminated.

CHAPTER 1

Akij Food & Beverage Ltd.

1.1 Introduction

Akij Food & Beverage Ltd. (AFBL), a recognized name in the food processing and marketing sector in Bangladesh, formally started its journey in 2006 with only 3 products. But over a period of 10 years, the company has expanded its production area in the food and beverage sector by adding a good amount of products that greatly attract consumers and get a good commercial will. This was possible thanks to the visionary concept of its founder, the late Sk. Akijuddin and his owner, Mr. Sk. Shamimuddin.

1.2 The Factory

The AFBL factory was founded in Krishanpura, Dhamrai, and Dhaka. It is located about 50 km from the capital. The factory built area has over 100,000 square meters.

The machinery thus configured was imported by world-renowned brands such as Krones, Tetra Pak, Alfalaval, Sip, and Husky to obtain high quality products. Most of the raw materials needed for quality

products are imported from abroad. Due to the facts, the quality of the products thus produced is strictly controlled.

The process of maintaining the quality of the finished products recalls the saying of the founder of the Akij Group, or "Quality without compromise even in adverse situations".

1.3 History

The historical backdrop of the Akij gathering goes back to a later piece of the forties. In its earliest stages, the Group started unassumingly with the jute exchange, known as the nation's brilliant fiber, procuring the biggest number of outside monetary forms.

The steady endeavors of the Akij Group with the dynamic administration and backing of our numerous clients have driven our Group to enhance its business exercises. In the subsequent stage, the Group began delivering distinctive cigarettes prevalently known as bides. This segment has given a significant lift to the Group's income gathering, just as making a generous commitment to the administration of the legislature. After some time, the Group has embraced new activities and at present there are 15 units of ventures under its umbrella, for example, cigarettes, high quality cigarettes, printing and bundling, materials, boards, pharmaceuticals, calfskin handling and land exercises in business, providing food for more than 32,000 individuals in different classes.

The Group intends to build up more ventures. The tasks are as of now in progress. Remote speculators have indicated extraordinary enthusiasm for going along with us for joint endeavors. The issue is under

our cautious thought and we would like to develop soon. This will likewise support the country's financial development and make openings for work for some experts.

The Akij bunch additionally partakes in socio-social exercises. The gathering dealt with a significant halfway house for nothing in the area city. The gathering likewise gained a cutting edge maternal and kid medical clinic which was recently possessed by Save the Children (UK). The medical clinic is kept running as an unrewarding worry by the Ad-Din Welfare Trust.

1.4 The Funding

The AFBL is a US $ 90 million venture and is subsidized by its parent organization called Akij Group. The yearly deals yield is around US $ 181 million and the fare rate speaks to 2% of its all-out venture.

1.5 The Manpower

In excess of 3000 representatives work at the manufacturing plant. Representatives are administered by R&D and CC staff of 15 and 90 separately.

The manufacturing plant was worked with the most present day working structures of European inception for handling and bundling, including the aseptic filling line, which is the main model in the whole subcontinent.

CHAPTER 2

BBT (Bus bar Trunking)

2.1 Introduction

Transport bar Trunking System is definitely not another innovation in 1930 it was first presented in USA. Contrasting and the traditional wire or link BBT is much better. In some advanced development, individuals presently incline toward BBT other than link.

BBT or Bus Bar Trunking framework is a substitution to conventional link and board appropriation. MCB, MCCB in BBT is module part as transport is reached out to purchaser region.

Transport bar Trunking frameworks (BBT) comprise of protected copper or aluminum transport bars encased in a Trunking. Utilize an authority epoxy sap covering to protect every conductor, the covering is applied to the transport bars utilizing an in-house created and industry driving procedure. Current transport bar Trunking is secluded in plan and is provided in pre-manufactured lengths and accessible in a scope of conductor setups. The item extend regularly incorporates elbows, T-connectors, feeder units, board spines and different other standard or custom parts that make it easy to arrange for practically any application.

Fig 2.1: BBT (Bus bar Trunking)

2.2 Advantages of Bus bar Trunking system over conventional Cable distribution systems

Bus bar Trunking System is the is an arrangement of conveying electric power utilizing copper or aluminum Bus bar with reasonable fenced in areas and great measure of insurance to keep the links from getting harmed because of outside bodies.

Bus bar are currently getting to be basic basically as a result of the accommodation and security factor. While utilizing customary links, the expense of cabling and Trunking and the time taken for establishment is a lot higher than bus bars too.

Introducing bus bars over traditional cabling has a scope of focal points some of which are referenced beneath:

2.2.1 Design:

Bus bar have a minimized plan through which compacted level conductors can go through the walled in area. Because of the reduced structures, bus bars require lesser space than customary cabling frameworks and this is a significant favorable position when a large number of amperes of power should be transmitted.

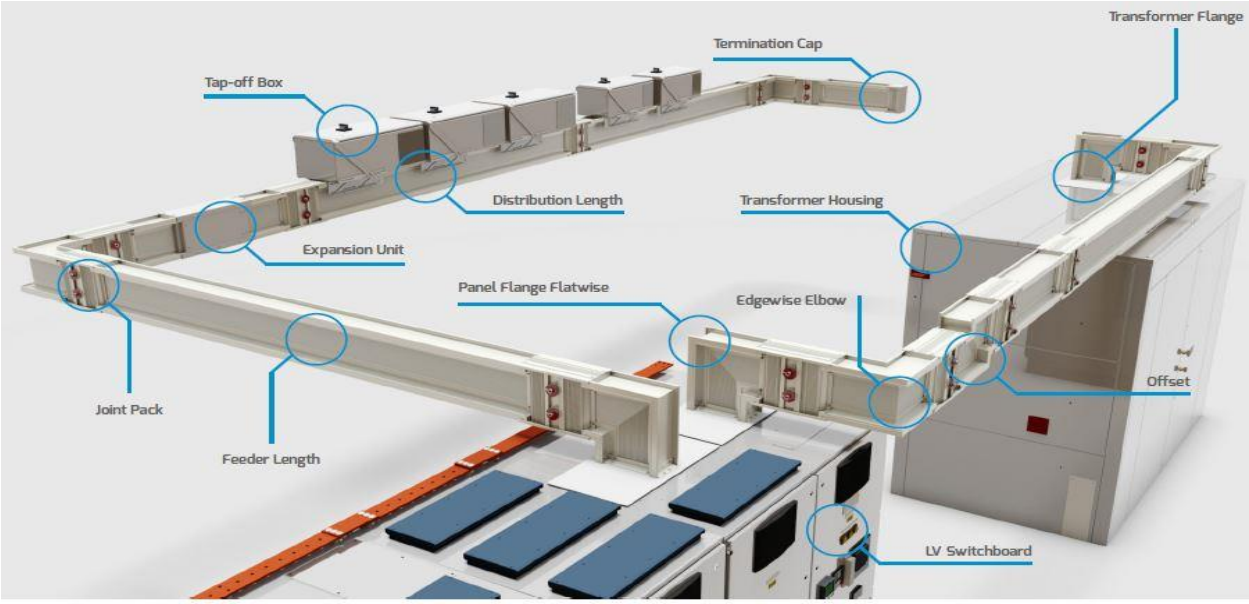

Fig 2.1: Design of BBT for A Setup

2.3 Features:

Easy to configuration control conveyance and clear system structure, simple designing and establishment plausibility

- Law start vitality and high short out worth.
- Fast and basic establishment with least instruments.
- Tap-off associations can be made to Distribution Bus bar lengths; Tap-offs can be included, evacuated and repositioned as essential.
- During establishment, there is no waste or scrap. So it's condition amicable.
- Easily be evacuated and re-utilized where required.

2.3.1 Heat Absorption

Since the structure is conservative and has a metal packaging with well-characterized surface, bus bars can assimilate warmth produced while transmissions and dispersion of power in the dividers of the fenced in area. The arrangement of cooling is vastly improved than customary cabling framework.

2.3.2 Flexibility

Bus bar are progressively adaptable in nature contrasted with links as in it very well may be utilized in any sort of structure with any setup. They are effectively modifiable and subsequently the expansion of an additional room or building can be effectively done. Bus bar can likewise be migrated without a lot of capital consumption.

2.3.3 Cost Savings

Bus bar can be mounted effectively than a link and causes a lesser expense of establishment than customary links. They can likewise be mounted at a lesser time than customary links.

2.3.4 Better Resistance

Bus bar have unbending plan components and thus has preferable obstruction over links, particularly if there should arise an occurrence of short-circuits. Bus bar have a base separation between the conductors

which thusly decreases the enlistment of obstruction. Bus bar likewise have a flimsy and punctured tire which aides in ideal conveyance of thickness of current and thusly diminishes obstruction. Because of lower levels of thickness, voltage misfortune is a lot of lower than links for a similar length.

2.3.5 Reduced Loss of Energy

Bus bar have lower opposition than links. Thus the loss of vitality because of transmission and circulation is lower in Bus bar. Bus bar additionally have a restricted development of receptive capacity to work contrasted with link frameworks.

2.3.6 Lower Electromagnetic Field

Because of the minimized plan and the steel shell, a nearly lower electromagnetic field is made around a Bus bar when contrasted with a link. Henceforth, high heaps of 4000 ampere to 5000 ampere can without much of a stretch be made close to the information links which is free from electromagnetic impedance.

2.3.7 No Dependency on Length

If there should be an occurrence of conventional links interfacing a stage with high amperage, the length of the links differs both on area and association. However, in the event of Busbar, the distinction of length is disposed of since they have the parameters of dynamic and inductive protection from guarantee that the heap on each stage is equivalent.

2.3.8 Ease of Distribution

Bus bar help in simple, productive and safe dissemination of line with the intersection encloses places where they are required. Additionally, the area information intersection boxes can be changed at whatever point and any place later on. The intersection boxes can be effectively expanded later on too with bus bars.

2.3.9 Standard Cells

Completely affirmed standard cells are an essential piece of Bus bar which is intended to dispense with human blunder. Instances of such standard cell incorporate intersection boxes and plugs. These are confirmed pieces of Bus bar which meet a wide range of security guidelines.

2.3.10 Safe and Secured

Bus bars are fitted with a steel casing and cannot be damaged by rodents as compared to cables.

2.4 Bus bar Trunking vs. Cables

	Bus bar Trunking	Cables
i.	**Features:**	
	Finishing is very good, hence adds to aesthetics of building	Improper laying of the cables may spoils the aesthetics of building
	Multiple floor building power feeding can be done with single Bus Trunking system	Multiple floors building power feeding has to be done with multiple cable sets. This makes the complete system cumbersome.
	Power tap off can be done from the single system installed..In case the load changes we have to just replace the Tap off boxes of higher rating.	Not possible. Additional cables to be laid till the particular floor.
ii.	**Voltage Drop:**	
	The voltage drop of bus Trunking is less as compared to cables.	The voltage drop is more in cables.
iii.	**Structure:**	
	Example for i3200A(Cu) dimensions: 151(w)x340(h) and light in weight	Cables and its structure 700mm wide i.e., cable tray etc. is very heavy and occupies more

		space.
	Total run is made up of multiple element which are joint together. Thus making the complete system maintenance friendly.	As single length of multiple cables are installed, making it maintenance no friendly.
	Easy retrofitting of the element is possible in case the location and consumer load	Easy retrofitting of the element is not possible in case the location and consumer load
	Totally enclosed, cannot be tampered. Fit and forget system	Insulation can wear off with time. Can get damaged by rodents. Has to maintain on regular basis.
iv.	**Degree of Protection:**	
	IP-54 for plug in type, IP55, 65 for feeder	No protection as such
	Special protection is to be taken for installation in OUTDOOR area.	Special protection is to be taken for installation in OUTDOOR area.
v.	**Enclosure:**	
	It consists of bus bars in a protective enclosure, including straight lengths, fittings, devices and accessories.	Cables are simply insulated with multiple layers of PVC.
	High Short circuit strength & high fire protection	Low Short circuit strength & low fire protection
	Termination:	
	Direct termination through bus bars	The method for cable termination is very cumbersome.
	Termination is simple and easy.	Additional supports are required to hold the cables inside the panel.
	Have a highly compact structure and can be bent up to 90 degree.	Cables are generally installed in bundles & with such a cross section that they cannot be bent tightly.
vi.	**Time &cost consumption:**	

	When sizing bus bars the designer only needs to make calculations on a single riser which reduces design time and costs.	It is necessary to protect each cable individually with a fuse and when laying the cables in bundles it is necessary to anchor them properly so that they can withstand the electro dynamic forces generated in the event of a short ckt. So, the designers have to spend more time on calculations.
vii.	**Use of additional items:**	
	No additional supports are required.	Heavy labor is required to lay the cables
	No extra holes/cutouts are required.	Holes to be made in the gland plate for fixing cable glands
	No cable tray is required, supported on ceiling /wall.	Cable tray or the digging of the trench is required to lay the cables
	No special tools are required.	Special tool are required for crimping the cable lugs
	Design verified switchgear assembly, limits from manufacturer's catalogue	Limits depend on the laying method and cable accumulation. The derating factor must be determined / calculated
viii.	**Halogen Free:**	
	Principally free from halogen.	PVC cables are not free from halogen. Halogen-free cables are very expensive.
ix.	**Damage by rodents:**	
	Bus bar systems cannot be damaged by various rodents, which prevents the steel casing.	Cables can be damaged by various rodents

Table 2.1: Difference between Bus bar Trunking vs. Cables

CHAPTER 3

Motor & Drive

3.1 Three Phase Induction Motor Starting Methods

The more commonly used methods of motor starting are:

- VFD Drive
- Direct On Line
- Star Delta
- Auto-Transformer
- Soft Starter

3.1.1 Direct-on-line starting

This kind of starting mode is the most basic and simplest in the motor starting. The method is characterized by less investment, simple equipment and small quantity. Although the starting time is short, the torque is smaller at starting and the current is large, which is suitable for starting small capacity motors.

3.1.2 Star-delta starting

In the typical activity, 3 stage enlistment engines whose stator winding is stipulated to interface in delta association can be begun in star while beginning, to decrease the voltage of each period of the engine and afterward diminish the beginning current. Subsequent to completing the beginning, at that point, it is associated with the delta.

Star-delta beginning is generally utilized as a result of its points of interest including straightforward beginning hardware, minimal effort, increasingly dependable activity, and simple support.

3.1.3 Auto-transformer starting

Autotransformer reduced-voltage starting refers that the reduced voltage of grid power is attached to the motor stator windings until the speed approaches to a steady value and then the motor is connected to the power grid.

At starting, the switch is pulled to the "start" position, and the autotransformer is linked to the grid followed by connection to the stator windings of motor to achieve reduced-voltage starting. When the rotation speed approaches to the rated value, the switch will be pulled to "running" position, and the motor directly access to the grid under full pressure operation through cutting off autotransformer.

3.1.4 Soft starter

Soft starter is a new type control device whose main advantages include soft starting, light load and energy saving, and quickness. One of the most important features is that the electronic circuit is conducted in the silicon controlled rectifier of motor under the tandem connection of power supply. Using the soft starter to connect the power supply with the motor and different methods to control the conduction angle in silicon controlled rectifier can make the input voltage of motor increase gradually from zero and transfer all the voltage to motor from the beginning to the end, which is called soft starting. When starting in this way, the torque of motor will gradually increase with enhancive speed. In fact, the soft starter is a voltage regulator that only changes the voltage without altering the frequency at starting.

3.2 Problems Encountered During Motor Starting:

The most basic feature of an Induction motor is its self-starting mechanism. Due to the rotating magnetic field, an emf is induced in the rotor, because of which current starts flowing in the rotor. As per the Lenz law, the rotor will start rotating in a direction so as to oppose the flow of electric current and this gives a torque to the motor. Thus the motor gets self-started.

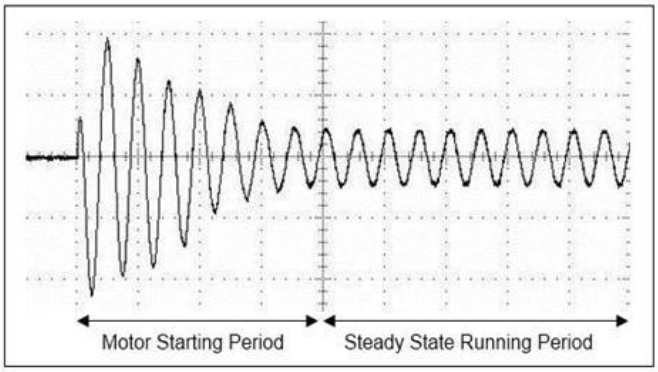

Fig 3.1: Motor Starting Period

3.3 What is a variable frequency drive?

A variable frequency drive (VFD) is a type of motor controller that drives an electric motor by varying the frequency and voltage of its power supply. The VFD also has the capacity to control ramp-up and ramp-down of the motor during start or stop, respectively.

Fig 3.2: VFD (Variable Frequency Drive)

Even though the drive controls the frequency and voltage of power supplied to the motor, we often refer to this as speed control, since the result is an adjustment of motor speed. There are many reasons why we may want to adjust this motor speed.

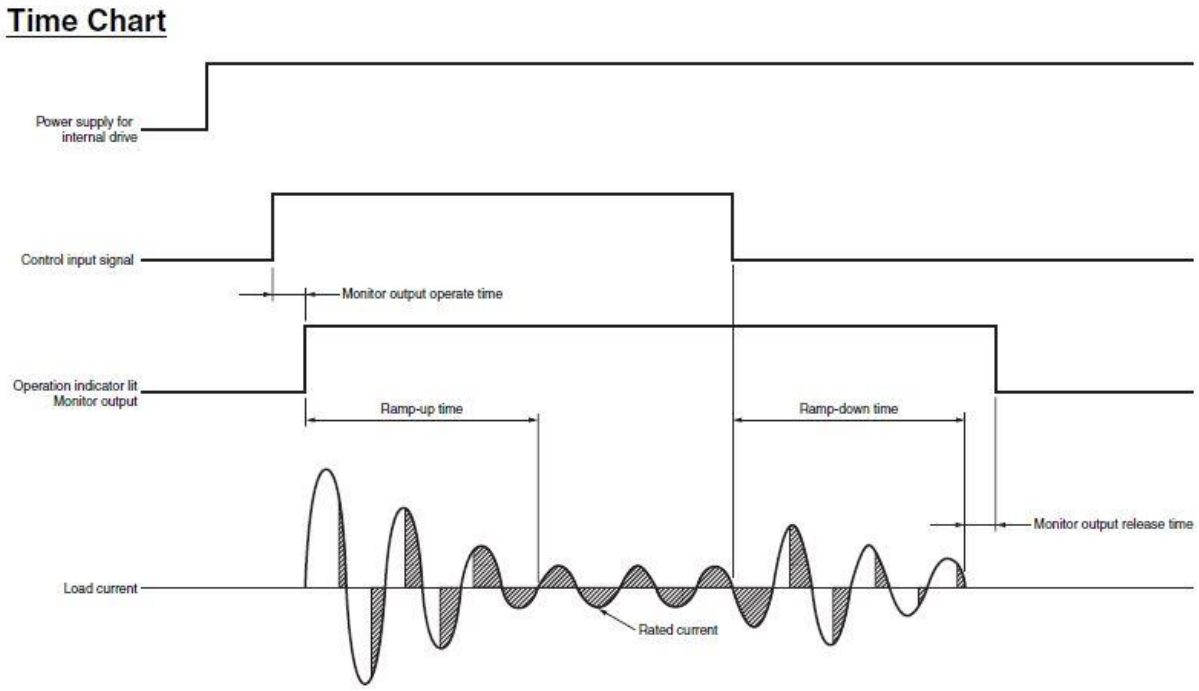

Fig 3.3: Time Chart

For example, to

- Save energy and improve system efficiency
- Convert power in hybridization applications
- Match the speed of the drive to the process requirements
- Match the torque or power of a drive to the process requirements Improve the working environment Lower noise levels, for example from fans and pumps
- Reduce mechanical stress on machines to extend their lifetime
- Shave peak consumption to avoid peak-demand prices and reduce the motor size required

In addition, today's drives integrate networking and diagnostic capabilities to better control performance and increase productivity. So, energy savings, intelligent motor control and reduction of peak-current drawn are three great reasons to choose a VFD as the controller in every motor-driven system.

The most common uses of a VFD are for control of fans, pumps and compressors, and these applications account for 75% of all drives operating globally.

Soft starters and across-the-line contactors are other, less sophisticated types of motor controllers. A soft starter is a solid-state device and provides a gentle ramp-up to full speed during startup of an electric motor.

3.4 What's special about drives from Dan Foss?

The difference between drives from Dan Foss and other suppliers is that Dan Foss is global market leader in VFDs, specializing in drives only. You receive a high-quality drive which you have customized to your exact requirements. And every single drive is thoroughly tested before leaving the factory. Our experts are focused on every possible detail of drive optimization, and are always abreast of the newest technological developments. Often, we invent the newest developments. Dan Foss Drives has a broad offering of VLT® and VACON® drives, and you get much more than the drive itself. You also have access to our application know-how and a range of maintenance services to keep your systems running optimally throughout the drive lifecycle.

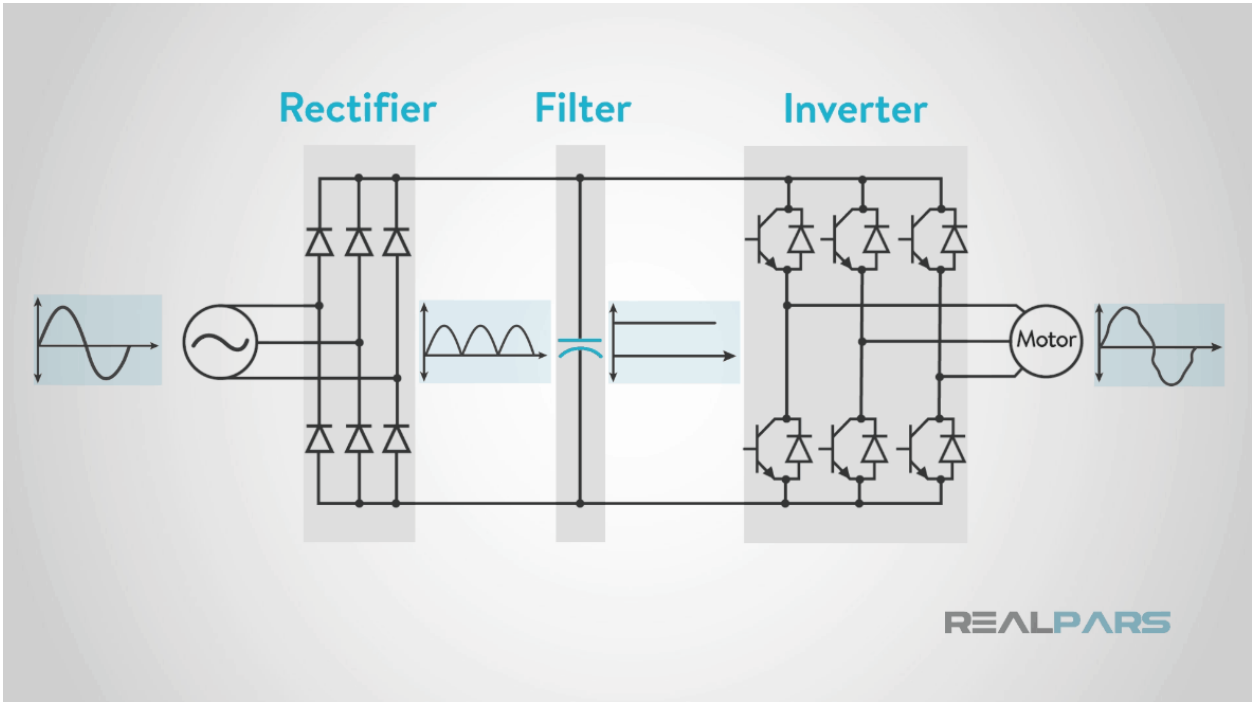

Fig 3.4: Inverter CKT Diagram

We offer you the best possible components and full flexibility so you can fine tune system performance to suit your application exactly. An important aspect of this flexibility is the ability to use your drives with all typical motor technologies, since VLT® and VACON® drives are designed for full compatibility. This enables significant savings in spare part inventories and in retrofit situations.

3.5 What's the difference between a VFD, an AC drive, and a variable speed drive?

None All these names refer to the same kind of devices, also known AC variable speed drives, AC variable frequency drives, VFD inverters or variable voltage variable frequency drives.

3.6 What is the main advantage of using a VFD?

3.6.1 VFD Advantages:

- A VFD may be used for control of process temperature, pressure, or flow without the use of a separate controller. Suitable sensors and electronics are used to interface the driven equipment with the VFD.
- Lower maintenance costs, as lower operating speeds result in longer life for bearings and motors.
- The motor does not require a starter.
- The ability of a VFD to limit torque to a user-selected level protects driven equipment that cannot tolerate excessive torque.
- Users can utilize multi-motor applications, such as pumps or fans, with one control unit.
- High-speed applications for the wood finishing industry.

3.6.2 VFD Disadvantages:

- High cost
- Generating harmonic pollution power grid
- The output of the PWM wave, will cause additional heating of the motor and cable,
- The generation of the common mode voltage may reduce the life of the motor shaft.

CHAPTER 4

Sensor

4.1 Proximity Sensor

Proximity sensors detect the presence of objects without physical contact. Since 1983 Fargo Controls' proximity sensors have been of the highest quality, durability & repeatability to meet today's tough industrial requirements. We provide a wide range of proximity sensors to meet all types of applications.

Typical applications include the detection, position, inspection and counting on automated machines and manufacturing systems. They are also used in the following machinery: packaging, production, printing, plastic molding, metal working, food processing, etc.

Classification of proximity sensors
The most common types of proximity sensors are briefly described below

1. Sensing Property
    a. Induction Type
    b. Capacitive Type
2. Power Supply
    a. AC Type
        i. Relay Type
    b. DC Type
        i. Relay Type
        ii. Transistor Type

3. Output Response

    a. Relay Type

        i. Normally Open (NO)
        ii. Normally Close (NC)

    b. Transistor Type

        i. NPN Type

            i.i NPN Normally Open (NO)
            i.ii NPN Normally Close (NC)

        ii. PNP Type

            ii.i PNP Normally Open (NO)
            ii.ii PNP Normally Close (NC)

4.2 Inductive Sensors:

Detection of metallic objects. Inductive sensors are used to detect metallic object Inductive proximity sensors operate under the electrical principle of inductance, where a fluctuating current induces an electromotive force (emf) in a target object.

The inductive sensor using the oscillator circuit to generate a high-frequency electromagnetic field. When a metallic object comes to contact with the field, an eddy current will produce at the object surface. The eddy currents on the object absorb some of the radiated energy from the sensor, resulting in a loss of energy and change of strength of the oscillator.

The sensor detection section monitors the change in the strength of the magnetic field and triggers a solid state output level if there is a decrease in the strength of magnetic field.

If the metallic object released from the field, the oscillator turns to the initial stage.

4.2.1 Advantages:

- Accurate compared to other technologies.
- Have high switching rate
- Can work in harsh environment condition

4.2.1 Disadvantages:

- Detect only metallic target
- Operating range may be limited

4.3 Capacitive Sensors:

Detection of metallic and non-metallic objects (Liquids, plastics, woods). Capacitive sensors use a similar principle of inductive sensors. Only main difference is that capacitive sensors produce electrostatic field instead of an electromagnetic field.

Sensing surface is formed by two metal electrodes, oscillator produces electrostatic field between the two plates. When a metallic or non-metallic material enters the electrostatic field it changes the capacitance of the oscillator.

As a result, the oscillator circuit begins oscillating and changes the output state of the sensor when it reaches certain amplitude. As the target moves away from the field the oscillator comes to the original state.

4.3.1 Advantages:

- It can detect both metallic and non-metallic objects.
- High speed
- Good stability
- Good in terms of power usage
- Low cost

4.3.2 Disadvantages:

- Affected by temperature and humidity.
- Not accurate compared to inductive sensors
- Difficulties in designing

4.4 Photoelectric Sensors: Use light sensitive elements to detect objects

4.5 Magnetic Sensors: Detects the presence of permanent magnets

CHAPTER 5

Power Distribution System

5.1 Primary and secondary power distribution systems (layouts explained)

5.1.1 What is the main purpose of a substation?

The purpose of a substation is to 'step down' high voltage electricity from the transmission system to lower voltage electricity so it can be easily supplied to homes and businesses through our distribution lines.

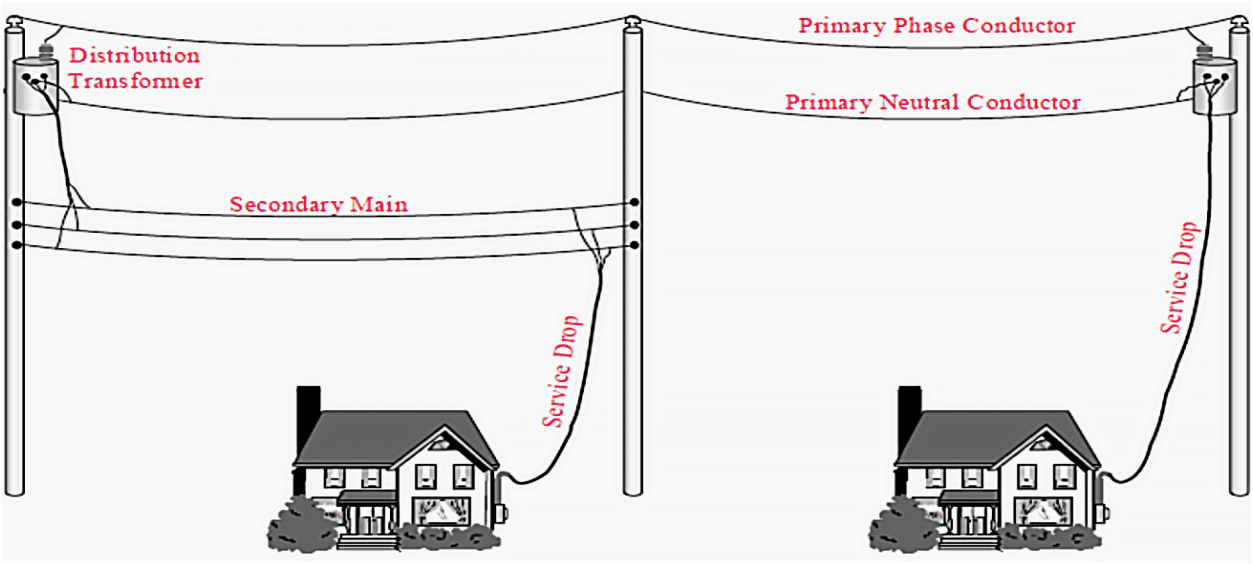

Fig 5.1: Distribution Line

5.1.2 What happens at a substation?

The electricity is transmitted at very high voltages and low currents to reduce the heat, eddy currents, and other transmission losses. The substations are where the voltages are increased to high values by using step up transformers, and after the transmission, they are again stepped down for distribution.

5.2 **Primary distribution systems**

Primary distribution systems consist of feeders that deliver power from distribution substations to distribution transformers. A feeder usually begins with a feeder breaker at the distribution substation. Many feeders leave substation in a concrete ducts and are routed to a nearby pole.

At this point, underground cable transitions to an overhead three-phase main trunk. The main trunk is routed around the feeder service territory and may be connected to other feeders through normally-open tie points. Underground main trunks are possible-even common in urban areas, but cost much more than overhead construction.

The simplest primary distribution system consists of independent feeders with each customer connected to a single feeder. Since there are no feeder interconnections, a fault will interrupt all downstream customers until it is repaired.

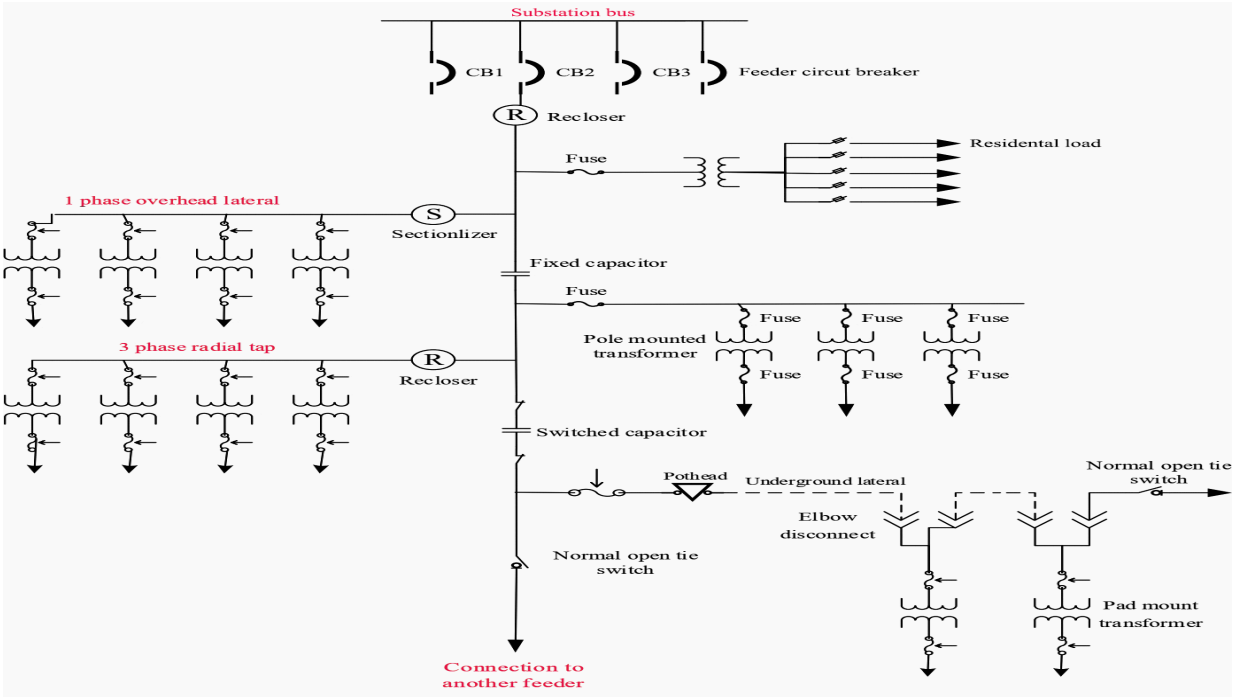

Fig 5.2: Primary distribution systems

5.2.1 Primary selective service

connects each customer to a preferred feeder and an alternate feeder. If the preferred feeder becomes de-energized, a transfer switch disconnects the preferred feeder and connects the alternate feeder.

5.2.2 Secondary selective service

Achieves similar results by using switches on secondary voltages rather than primary voltages. With secondary selective service, each distribution transformer must be able to supply the entire load for maximum reliability benefits.

5.3 Secondary distribution systems

A low-voltage network or secondary network is a part of electric power distribution which carries electric energy from distribution transformers to electricity meters of end customers.

Secondary networks are operated at a low voltage level, which is typically equal to the mains voltage of electric appliances. Most modern secondary networks are operated at AC rated voltage of 100–120 or 230–240 volts, at the frequency of 50 or 60 hertz.

Operating voltage, required number of phases (three-phase or single-phase) and required reliability dictate topology and configuration of the network.

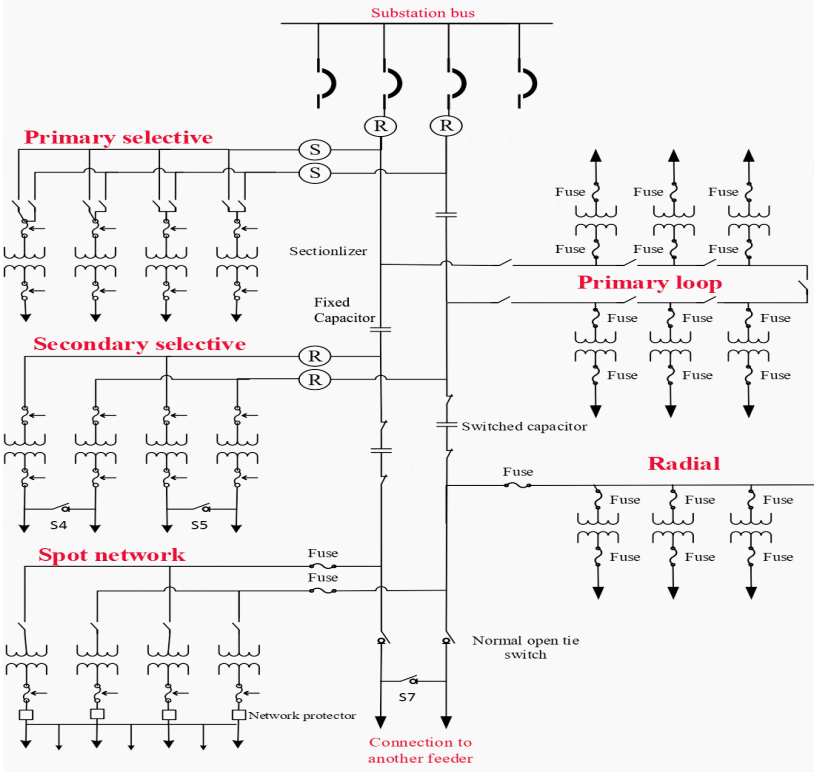

Fig 5.3: Secondary distribution systems

Electric power distribution systems are designed to serve their customers with reliable and high-quality power. The most common distribution system consists of simple radial circuits (feeders) that can be overhead, underground, or a combination.

Distribution transformers or secondary transformers, placed along feeders, convert the voltage from the medium to a low voltage level, suitable for direct consumption by end customers (mains voltage).

CHAPTER 6

Transformer

6.1 What is the use of power transformer?

The Power transformer is a one kind of transformer, which is used to transfer electrical energy in any part of the electrical or electronic circuit between the generator and the distribution primary circuits. These transformers are used in distribution systems to interface step up and step down voltages.

6.2 What are main Transformer parts

Transformer parts, in this article I talked about transformer parts. As indicated by development transformer comprises of following parts.

- Core
- Winding
- Main Oil Tank and Conservator Tank
- Breather
- Buchholz Relay
- Bushings
- Tap Changer

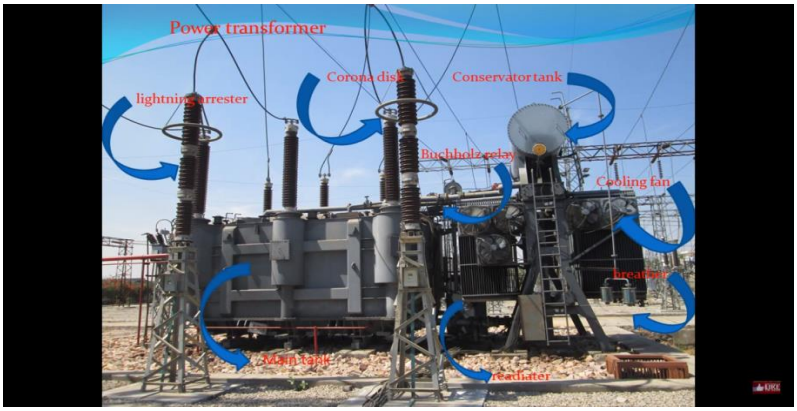

Fig 6.1: Transformer Parts

6.2.1 Core

Core provides less reluctance to the magnetic flux and it also holds the windings. It is made from Cold Rolled Steel or Hot Rolled Steel. These Steel types contain different amount of silicone. The core is formed by joining thin laminations. These laminations have varnish coating. Due to lamination eddy current losses are reduced. The lamination is U-shaped, L-shaped, E-shaped and I-shaped.

6.2.2 Steel tank

It is the fundamental piece of the transformer. It is steel made box. The transformer center is put inside this tank. Windings and other accommodating gadgets are put inside this tank. It is loaded up with protecting oil (mineral oil). It has generally barrel shaped or cubical shape contingent upon transformer development. It is covered inside and remotely with shading for wellbeing perspective. Shading covering additionally gives security if there should be an occurrence of twisting association with tank unintentionally.

6.2.3 Breather

Breather is a gadget which utilized for Breathing of transformer. Its mean air go in or out from the transformer with the assistance of breather. Presently the Question is the reason we need breather in transformer? Since when hot oil extends, air goes out from transformer and when oil contracts in the wake of cooling, air enters in transformer. Breather one side is associated with conservator tank. A mirror cylinder is set inside breather. This mirror cylinder loaded up with calcium chloride or silica gel. At the point when air enters in transformer, this air contains dampness. Silica gels ingest dampness and just enable dry air to enter in transformer. Along these lines breather with the assistance of silica get stop dampness contain air to go into transformer and keep away from oxidation in transformer primary tank. With the time silica gel shading changes from blue to pink in the wake of engrossing determining amount of dampness from air. We can reuse this silica gel subsequent to warming it.

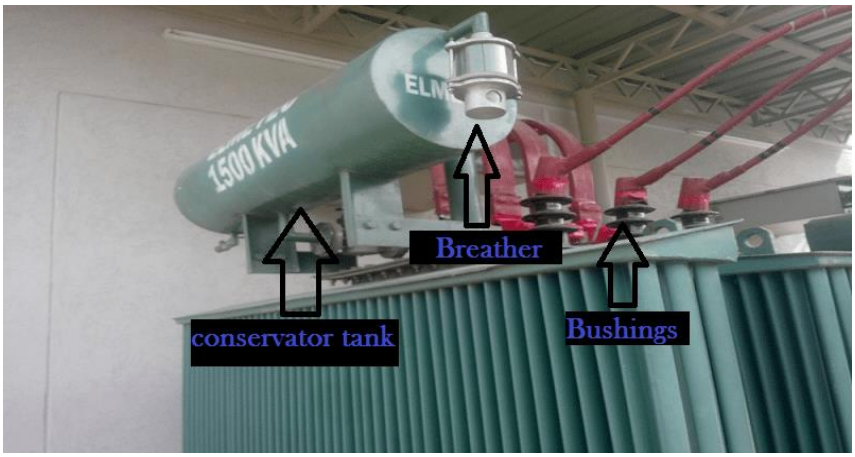

Fig 6.2: Transformers Conservator tank, Breather, Bushings

6.2.4 Conservation tank

It is a little tank utilized in high power transformers. It is associated over the principle transformer tank. It has a round and hollow shape. The principle tank and the preservationist tank are associated with one another through a pipe. The Buchholz transfer is utilized between the capacity tank and the principle tank in transformers that have a limit of more than one MVA.

The traditionalist tank has the accompanying capacities in the transformer:

- It gives a spot to the extension of the hot transformer oil. It likewise supplies oil in the transformer after the oil has chilled off.
- It is additionally used to lessen oxidation by diminishing the territory of oil around the air.
- Rusty oil stays in the preservationist tank. The mirror cylinder is likewise associated with the moderate tank to peruse the oil level in the transformers. A pre-checked meter is additionally present in the mirror tube. It is important to have a virus oil level up to the measure mark.

6.2.5 Bushing

The bushings are utilized to expel the twisting terminals from the tank and are likewise utilized for protection. For instance, porcelain bushings, oil fillings, and condensers. The circular segment speakers are likewise associated with the bushings to give lightning security. In the past 34 KV transformer, totally fixed capacitor brambles are utilized. Smooth bushings are utilized in transformers beneath 25 KV.

6.2.6 Buchholz relay

This hand-off is associated with a pipe between the fundamental tank and the traditionalist tank. It is truly gas fueled. It is a significant piece of the transformer. I will distribute a different article on this. For what reason is it hard to clarify the Buchholz hand-off that works in this article. In rundown, the Buchholz transfer gives security to low oil and high temperature.

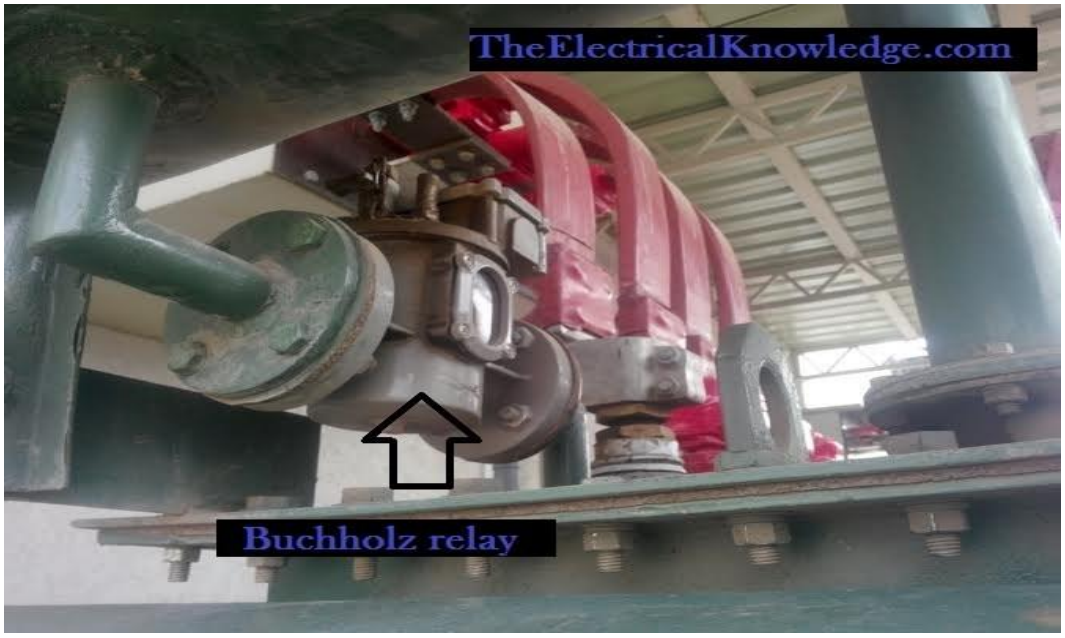

Fig 6.3: Buchholz Relay

6.2.7 Radiator

In transformers more than 50 KVA, the radiators are utilized with the fundamental transformer tank for cooling purposes. It resembles a pipe or pipes. Increment the outside of the transformer. The radiator makes cooling in the transformer increasingly powerful. This cooling strategy is called ONAN (common oil, characteristic air).

6.2.8 Cooling fans

In the 26MVA and higher transformers, the cooling fans are additionally utilized in the radiator. The oil temperature check gives an on or off sign for the cooling fans. At the point when the temperature arrives at more than 75º the oil temperature check turns on the cooling fans. This cooling strategy is called ONAF (normal oil and constrained from the air).

6.2.9 Oil pumps

At 26 MVA over the transformers, oil siphons are additionally utilized together with fans and cooling radiators. Oil siphons are utilized to turn the oil in the transformer. This cooling strategy is called OFAF (constrained oil and constrained air).

CHAPTER 7

SWITCHGEAR AND POWER FACTOR IMPROVEMENT

7.1 Introduction

A great demand for electrical energy is a notable feature of modern civilization. Most of this energy is needed for lighting, heating, domestic appliances, industrial electrical machinery and electric traction. The importance of electric supply in everyday life has reached such a stage that it is desirable to protect the power system from harm during fault conditions and to ensure maximum continuity of supply. For this purpose, means must be provided to switch on or off generators, transmission lines, distributors and other equipment under both normal and abnormal conditions. This is achieved by an apparatus called switchgear. Switchgear consists of switching and protecting devices such as switches, fuses, circuit breakers, relays etc. During normal operation, switchgear permits to switch on or off generators, transmission lines, distributors and other electrical equipment. However, the switchgear detects the fault and disconnects the unhealthy section from the system. In this way, switchgear protects the system from the damage and ensures continuity of supply. In this chapter, we shall present the elementary introduction to switchgear .The switchgear is classified into two types according to their voltage:

i. High Tension Switchgear (HT)

ii. Low Tension Switchgear (LT)

Figure 7.1: HT Switchgear

Figure 7.2: LT Switchgear

7.2 Switchgear Equipment

Switchgear covers a wide range of equipment concerned with switching and interrupting currents under both normal and abnormal conditions. It includes switches, fuses, circuit breakers, relays and other equipment.

7.3 Switchgear Types

Switchgear along with control panels are installed in generating stations, transformer stations, distribution systems, and almost all types of industries. Nowadays. Now according to their types, switchgears can be

- Outdoor type- above 66KV
- Indoor type-below 66KV

It can operate under both are:

- Normal condition
- Abnormal condition

The switchgear is classified into two types according to their voltage:

i. High Tension Switchgear (HT)
ii. Low Tension Switchgear (LT)

7.4 High Tension Switchgear

TPPL high tension switchgear comprises of SF6 Circuit Breaker, Vacuum Circuit Breaker, Minimum Oil Circuit Breaker, Load Break Switch, Vacuum Contactor, disconnect etc. to meet individual requirement which comply with IEC/ BS and other relevant international standard. TPPL high tension switchgears are suitable for inexpensive electrical substation with transformer feeder, measuring, sectionalizing, auto change over and motor protection. HT switchgear is shown in below figure 7.3

Fig 7.3: HT Switchgear

7.5 Low Tension Switchgear

TPP Low tension switchgear, DB & MCC panels are specially designed to control and distribute power for diverse installations such as power station, industries, mills & factories, irrigation, tea gardens, housing complex and other different loads. Switchgear panels are designed and manufactured for indoor and outdoor of fixed type or fully draw out type with frame structure of modular construction for easy extension & coupling depending on the condition of installation. The Low Tension Switchgear comprises of Air Circuit Breaker, Molded Case Circuit Breaker, Fuse, Switch, unit, Disconnect etc., to meet individual requirement which comply with IEC/ BS and relevant international standard. LT switchgear is shown in below fig 7.4

Fig 7.4: LT Switchgear

7.6 Circuit Breaker

Protective electrical switch that turns itself off (trips) to interrupt flow of electricity, if the current exceeds a preset limit. When the current returns to normal, the circuit breaker is either manually or automatically reset for reuse. The circuit breakers are classified by the following parameters:

- Low voltage: Less than 1KV
- High voltage: Higher than 1KV

7.6.1 Vacuum Circuit Breaker

The vacuum circuit breaker is classified as a medium voltage circuit breaker, with a current up to 6300 A and is generally applied to voltage level of about 40KV. As it is known that, vacuum is a great perhaps the best insulator, it uses the same principle. The breaker is confined in a vacuum container, or bottle. One of the contacts is fixed and one is movable. When the circuit breaker detects a fault, the movable contact pulls away from the fixed contact, interrupting the current. It usually moves away 6-10 mm of length. Now since the contacts are in a vacuum, arcing between the contacts is suppressed, ensuring that the circuit remains open. Automated vacuum circuit breakers will reset automatically once the fault is cleared. But there are also manual circuit breakers where an operator has to manually reset the reclose, in this case, maximum safety measures has to be taken.

The prefer ability of vacuum circuit breakers are high because, there are certain advantages of such a device. They are:

- Compact, reliable, longer life
- No fire
- No gas produce
- Can handle all fault current, VCB shown in Fig 7.5

Fig 7.5: Vacuum Circuit Breaker (VCB)

7.6.2 Air Circuit Breaker (ACB)

It is an air switch and is designed to open a circuit under load. In order to quench the arcthat occurs on opening such a switch, special arcing horns are provided. Arcing horns are pieces of metals between which arc is formed during opening operation. As the switch opens, these horns are spread farther and farther apart. Air-break switches are generally used outdoor for circuits of medium capacity such as lines supplying an industrial load from a main transmission line or feeder. Air Circuit Breaker (ACB) is shown below in Fig 7.6

Fig 7.6: Air Circuit Breaker (ACB)

7.6.4 Miniature Circuit Breaker (MCB)

Now a day, more commonly, miniature circuit breaker or MCB is used instead of fuse. There are some certain advantages of MCB over fuse and there are some definite advantages to it also It automatically switches off the electrical circuit during abnormal conditions, both overload and faulty condition.

- It is much more sensitive than fuse
- Quick restoration of MCB is possible, restoration can be simply done by turning a switch
- Handling of MCB is electrically safer than fuse

There are two operating principles of MCB. For overload current, thermal effect works. The bimetal strip is heated during the overload current, and it deflects by bending away. This releases the mechanical latch which is attached to the operating mechanism that opens the MCB. Secondly for short circuit current, electromechanical current works. As a result of short circuit, if there is sudden rise in current, a mechanical displacement of plunger occurs, tripping the coil. The only disadvantage of MCB over fuse is, it is more expensive than fuse. Miniature Circuit Breaker (MCB) is show below in Fig 7.7

Fig 7.7: Miniature Circuit Breaker (MCB)

7.6.5 Molded Case Circuit Breaker (MCCB)

The MCCB is circuit breaker is a plastic that interrupts an electrical current if the current exceeds the trip rating of a breaker. The plastic encloses the mechanism in the breaker box, and also separates conductors from each other and from metal grounds. It is most commonly used in switchboards, starters and control panels. It has an operating range of current 25-1600 A and a fault level of (16-50KA). In the case for TPPL, it is used in the switching panels. Molded Case Circuit Breaker (MCCB) is shown in Fig 7.8

Fig 7.8: Molded Case Circuit Breaker (MCCB)

7.7 High-Rupturing Capacity (H.R.C.) Cartridge Fuse

The primary objection of low and uncertain breaking capacity of semi-enclosed rewire able fuses is overcome in H.R.C. cartridge fuse. High-Rupturing Capacity (H.R.C.) Cartridge Fuse is shown in Fig-7.9

Fig 7.9: High-Rupturing Capacity (H.R.C.) Cartridge Fuse

7.8 Power Factor

As a commercial customer, it is important to understand how power factor is calculated, since you may be charged a reactive power fee if your facility's power factor is below 95%. The power factor triangle below illustrates how real power, reactive power and apparent power relate to each other to get the power factor angle. One way to get the power factor is by getting the cosine of the power factor angle.

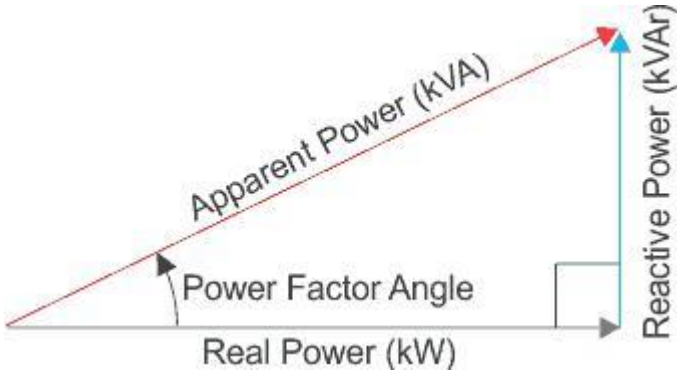

Fig 7.10: Power Factor Angle

7.9 Power Factor Improvement

Mathematically it is cosine of the phase difference between source voltage and current. It refers to the fraction of total power (apparent power) which is utilized to do the useful work called active power Real power is given by P = VI cosφ. To transfer a given amount of power at certain voltage, the electrical current is inversely proportional to cosφ. Hence higher the pf lower will be the current flowing. A small current flow requires less cross sectional area of conductor and thus it saves conductor and money. TPPL Power Factor Improvement Plant has been designed to meet the needs of all forms of power factor correction by Capacitor banks from small unit to a large plant. PFI Plant are preferably designed to eliminate the penalties for consumption of reactive power, reduction of voltage drop, increase in transformer capacity with some losses (load), reduction line losses. The PFI Plant supplied in Cubicles of sheet metal clad, dust & vermin proof, free standing and floor mounting (wall mounting in special cases.) Automatic PFI plant comprises of Capacitor Banks Power Factor Improvement Relay / Regulator, Contactors, HRC Fuses, Manual

Automatic change over switch, reactors for large plant comply with IEC/B5 and other relevant international standard. The automatic PFI Plant are available in steps of 5KVAR to 120KVAR are capacitor banks and up to a maximum output of 10,000 KVAR.

7.9.1 Capacitor Combination

The major aspect of a PFI panel is capacitor to provide necessary power when needed to maintain the power factor near to unity power factor, 5 KVAR, 10 KVAR, 20 KVAR and 25 KVAR rating capacitors are combining in different stages to make the desire power combination in a PFI panel. Stages depend of required rating of PFI panel. Before the first stage one fixed capacitor is connected to bus bar to reduce the eddy current loss coming out from transformer. The rating of this fixed capacitor is also depends on the eddy current loss.

For30 KVR capacitor ratings are- (written on capacitor body)

- 415 volt
- 600 Hz
- 42 A

For 25 KVR capacitor ratings are- (written on capacitor body)

- 415 volt
- 50 Hz
- 35 A

7.9.2 Contactor

A contactor is an electrically controlled switch used for switching a power circuit. In a PFI panel contactors are used for switching between required capacitor to support the improvement of power factor. Contactor connects the Bus bar with capacitor in the PFI panel. The fixed capacitor in the PFI panel is directly connected with Bus bar without the contactor.

7.9.3 Fuse

Fuse is another important aspect in PFI panel to protect the component from access flow of current. Fuses are connected between Bus bar and contactor. For every single line one fuse is needed. For the fixed capacitor which is connected to Bus bar without contactor, there are also three

Fuses for every single line of three phase connection

7.9.4 Bus bar

Bus bar is made of copper and the size of Bus bar varies depend on cost estimation and setup area of a PFI panel. Current flowing through $1mm^2$ is 1.6A.

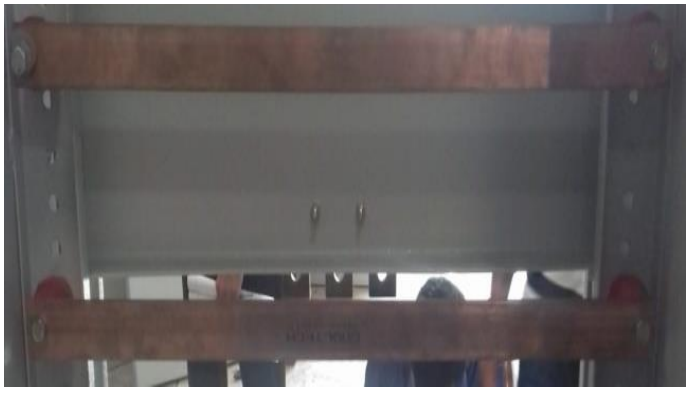

Fig 7.11: Bus bar.

CONCLUSION & FUTURE WORK

8.1 Conclusion

This internship was extremely helpful to me. I have gained practical knowledge, skills and met so many people. AFBL has allowed me to venture into the world of manufacturing and assembling power products which is effectively, a major contribution to the power system industry of our country. During this three months of industrial attachment, I have learnt the techniques, steps, methods, precautions, rules and regulations to construct such complex products namely transformers, switchgears and PFI. I have had the opportunity to see the various machineries and tools used to constructs these products. I have seen how the complex work core assembly of transformer is done carefully done by hand, the winding rolling are done by roller and how it is controlled and done, and how the core and windings are put into place. I have seen the construction of transformer body and putting the core and windings into the body and finally finishing the process completely. As simple as loading the oil and connecting the bushings seemed amazing to me. From a simple tool such as a gas cutter to the complex machinery of transformer testing unit, I have learnt how to use these tools and became familiar with the various uses of different tools. These tool sets were very unfamiliar to me and seeing them in use was a great experience. I have also learnt about the safety measurements in an industry and the safety materials that are used for the protection of the workers to avoid any undesired accidents.

I have achieved the immediate experience of manufacturing procedures of transformers, switchgear and PFI units. These experiences cannot be learnt in text books or the in class. Although I have found that, these technical aspects are in contrast with the studies done inside of the classroom, so I have seen how the theories learned in the class is directly used in the manufacturing of the goods. The calculations, measurements are exactly similar to the ones done in the class. It was a good experience to learn the theories and to see them put into use. The manufacturing of transformers, switchgear and PFI are one experience that will help me guide my way to the career as an Electrical Engineer. I think our four years' course will be fruitless if we do not learn the manufacturing of electrical devices.

8.2 Future Work

In the modern world, no country can achieve their long term economic goals without having a sustainable power sector. Though the generation capacity of our power sector is limited but an efficient distribution system can mitigate the problem a great extent. A customer focused distribution system can relieve the miseries of the common people. For poverty alleviation and socio-economic development electricity is very much essential for a nation. Without providing continuous electricity it is impossible to develop a country. The power sectors of Bangladesh are not satisfactory. It has numerous problems like supply capacity, frequent power cuts and unacceptable quality of supply. For removing those problems proper PFI, LT, HT panel, transformer and insulation property should be accurate. Both government and company should take some steps to increase the power sector and sustainable equipment for power side. They also look to the cost of production; cause due to maintain the own power plant they need to pay some extra cost. If our power development board can produce enough power to serve the industries, then the production cost can come down than the present situation. However, our government encourages the proprietor for various sustainable, efficient and low cost power production systems.

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