CHAPTER 1

INTRODUCTION

The student industrial work experience scheme (SIWES) is the accepted skilled training program forming part of the approved minimum academic standard in the various degree program of all Nigerian universities. It is geared towards closing the existing gap between theory and practices of science, agriculture, medicine, engineering and technology, management and other professional educational programmes in Nigeria tertiary institutions. It is aimed at exposing students to machines and equipment's, professional works, methods and ways of safeguard of work areas, workers, industries and organizations. The minimum duration stipulated for SIWES should be twenty-four (24) weeks except for engineering and technology program where the minimum duration is forty (40) weeks , the scheme is a tripartite programme involving the students, the universities and the industries (employers of labour) it is founded by the federal government of Nigeria and jointly co-ordinated by the industrial training fund (ITF) and Nigerian university commission (NUC).

1.1 OBJECTIVES OF STUDENTS INDUSTRIAL WORK EXPERIENCE SCHEME (SIWES).

In accordance with the SIWES programme, it is made specifically that the objectives of the students industrial work experience includes;

1.To provide avenue for the student in Nigerian universities to acquire industrial training skills and experience in their course of study.

2.To prepare students for the work situation they are likely to encounter after graduation.

3.To expose students to work methods and techniques in handling equipment that may not be available in the university.

4.To make transition from the university to the world of work and this enhances student contact for better job placement.

5.To provide student with an opportunity to apply the theoretical in real work situation, thereby bridging the gap between university work and actual work experience.

6.To enlist and strengthen employers involvement in the entry process of preparing university graduates for employment in industries.

The following mandates are on the part of the students to play;

1.To be regular and punctual at respective places of attachment.

2.To comply with the employers rules and regulations.

3.To keep proper records of training activities and other assignment in the log book.

4.To submit to ITF through their employers form SPE-1.

5.To submit to ITF through their institution the evaluation report FORM-8 duly completed by the student, employer and the institution.

1.2 ROLE OF THE EMPLOYERS

1.To accept the student and assign them to relevance on-the job training.

2.To attach experience to the students for effective training and supervision.

3.To control and discipline students as permanent staff.

4.To pay student monthly as at when due.

5.To provide medical cares for the students within the limits of the employers and conditions of service during attachment.

6.To permit representation of ITF and that of the institute based supervisors to visit the students on attachment for assessment.

7.To grade students as provided in the assessment form and the ITF form-8 at the end of the programme and submit the same to the institution.

1.3 WARRI REFINING AND PETROCHEMICAL COMPANY LIMITED(WRPC).

Warri Refining and Petrochemical Company Limited is one of the subsidiary of the Nigerain National Petroleum Corporation(NNPC) incorporated in November 1988 as a result of the merger of the Warri Refinary and Ekpan Petrochemical Plant in the wake of NNPC's commercialization exercise.The refinery was commissioned in 1978 with an initial nameplate capacity of 100,000 BPSD and this was later debottlenecked in 1987 to 125,000 BPSD,and the petrochemical plants,commissiond in march,1988 are made up of a 35,000MT/year of polypropylene and 18,000MT/year of carbon production facilities.

The refinery is designed to process Escravos Light Crude(chevron) and UQCC Crude(shell) into finished petroleum products while the petrochemical plants converts the otherwise low utility refining by-products namely propylene and decanted oil to produce value-added polypropylene and carbon black products.

WPRC is self reliant on power supply and generates its utilities for process requirement.WRPC also maintain a tank farm for storage of finished products and crude oil for internal processing and export to KRPC(kaduna refining and petrochemical company).WRPC power supply also extends to other neighbouring NNPC subsidiaries namely,PPMC and NGC.

1.4 WARRI REFINING AND PETROCHEMICAL COMPANY FACILITIES.

WRPC's production processes can be classified into two broad categories namely the primary and secondary processes.The primary processes use distillation principles to separate crude into intermediate and some finished products while the secondary processes use catalyst to convert the intermediates to higher quality finished and value added petrochemical products

The marketable products from WRPC's facilities are:

i.Liquefied petroleum gas(Cooking Gas)

ii.Premium Motor Spirit(Petrol)

iii.Kerosene(Domestic/Aviation)

iv.Automotive Gas Oil(Diesel Oil)

v.Fuel Oil

vi.Polypropylene pellets(Nipolene)

vii.Carbon Black Pellets

At maximum design capacity refinery is configured to produce the petroleum product at the following rates.

WRPC Design Product Slate

Product at Maximum Design Capacity

DESIGN PARTICULARS	METRIC TON/DAY	LITRES
FUEL GAS	273.65	482,716.22
LPG	204.39	362,591.22
PMS	5,498.31	7,285,261.82
KERO	1,778.82	2,170,033.78
AGO	5,119.93	5,959,601.35
F.OIL	3,496.62	3,671,452.70FC

Table 1.0

The primary processes are carried out at the Atmospheric Distillation Unit,the Vacuum Distillation Unit and the gas plant.The secondary processes units are the Naphtha Hydrotreating Unit,The catalytic Reforming Unit,Kerosene Hydro treating Unit,the Fluid Catalytic Unit,the HF alkylation Unit,Polypropylene and Carbon Black Plants.The functions of the various units are described as follows:

1.5 CRUDE DISTILLATION UNIT(CDU).

Crude is pumped to the unit directly from the storage tank.In order to reduce the cost of operating the unit,the in-coming crude is **desalted** and passed through series of **heat exchangers** where it absorbs heat from the hot streams before entering the crude heater.The crude is heated to the desire temperature in the heater before entering the atmospheric distillation column.Some of the crude entering the flash zone of the distillation column flashes into vapour,which rises up the column while the remaining liquid residue drops downwards.The lightest product,which is generally naphtha,passes overhead and is condensed and sent to the stabilizers and splitter for further separation.The products that are heavier than the net overheads are obtained by withdrawing portions of the internal reflux streams as side cuts.Three side cuts or products are withdrawn from the crude column and sent to storage.These are Household Keresene(HHK),Diesel Oil(Light Atmospheric Gas Oil i.e LAGO).path of the household kerosene is sent to kerosene hydrotreating unit while all the HAGO is sent to FCC(Fluid Catalytic Cracking) for further processing to vacuum distillation unit for further separation.

1.6 VACUUM DISTILLATION UNIT(VDU).

In order to increase the recovery of gas oil,atmospheric residue from crude distillation unit is further processed in a vacuum distillation unit.The product of VDU are vacuum gas oil,slop wax,and vacuum residue.The vacuum gas oil are sent to FCC unit for further processing.The distillation of atmospheric residue is conducted under vacuum pressure or reduce pressure in order to avoid thermal decomposition or cracking at high temperature.

The basic principles upon which vacuum unit operate is that the boiling point of any material drops as the pressure is lowered.At atmospheric pressure,reduced crude containing gas oil with boiling points ranging from 340 degress Celsius to 560 degress Celsius would be subjected to cracking temperature long before meaningful quantities could be flashed off.By distilling under vacuum or reduced pressure,the desired quantities of gas oil can be flashed off and recovered before cracking temperatures.

1.7 GAS PLANTS.

The overhead from the stabilizers in CDU is the feedback to the gas plants,It is predominantly a mixture of butane and propane otherwise reffered to as mixed LPG.The basic operation in this unit is similar in principle to that of the CDU as it is separation of mixtures by distilllaton process.The mixed LPG is charged into the de-ethanizer for the for the removal of ethane and lighter ends.Thw bottom is then fed into the de-polarizer where propane and butane are separated.Butane is sent to HF Alkylation plant as feedback or storage while propane is sent to fuels plant and carbon black fuel gas systems.

1.8 NAPHTHA HYDROTREATING UNIT

Heavy Naphtha from CDU constitutes the feedback to NHU.The main purpose of Naphtha Hydrotreating unit is to clean up or eliminate catalyst poisons such as organic Sulphur,nitrogen and oxygen compounds to that it is suitable as charged to catalytic reforming unit.

Heavy Naphtha mixed with hydrogen is heated in a furnace and charged into a fixed bed reactor containing cabalt-molybdenum catalyt.The posion containing compouds undergo reaction in the presence of hydrogen releasing their poisonous components as gases.

1.9 CATALYTIC REFORMING UNIT.

The CRU and NHU are both designed to process 2035.9Metrics Tons per stream day or 16,600 BPSD of heavy Naphtha.The main function of the catalytic reforming unit is to upgrade low octane number straight-run heavy Naphtha to higher-octane motor fuel blending component by catalytically promoting specific groups of chemical reaction.In these reaction,naphthenes and paraffins are converted into aromatic compounds.Hydrogen,the by-product from the aromatic producing reactions is used in supporting operations in NHU as well as CRU.

Treated heavy naphtha mixed with hydrogen is heated in the furnace and charged through four catalytic fixed bed reactors arranged in series.The hot reactor effluent is stabilized by separating it into Reformate LPG and Fuel gas.The reformate is pumped to the premium motor spirit blending pool while the LPG is transferred to the gas plant for further processing.Reformate is a high quality premium motor spirit blending stock.

1.10 KEROSENE HYDROTREATING UNIT(KHU).

Straight run kerosene or household kerosene obtained from CDU is the feedstock to this unit.This unit converts straight run kerosene to aviation turbine kerosene(Jet Fuel) by improving its combustion characteristics.Fixed bed catalytic reactors are employed in the presence of hydrogen for removal of impurities and smoke point improvement.This general operating principles are similar to those of NHU and CRU.The installed capacity of this unit is 8,500bpsd.

1.11 FLUID CATALYTIC UNIT(FCC).

The unit is designed to process 26,000 bpsd as oil feedstock into high valued product like premium motor spirit and LPG.This is very important unit,and can truly be described as the “heart of refining operation”.Heavy Atmospheric and,Vacuum Gas oils are mixed together and then heated by a train of heat exchangers and also in a heater(furnace) before the oil is injected into a flowing stream of injected into a flowing stream of catalyst particles in a long pipe reactor usually referred to as **Riser**.

In the riser,the oil meets hot regenerated catalyst from the regenerator.The hot catalyst vaporizes the feed,raises it to reaction temperature of about 521 degree Celsius and supplies the necessary heat for cracking reaction to proceed.The flow of the mixture of cracked feed and catalyst continues into the horizontal “crossover” section and into two parallel “rough cut” cyclones for an abrupt separation of the hydrocarbon vapor and catalyst.This is to ensure that re- cracking of the premium motor spirit component to lighter components is avoided.

The total hydrocarbon vapour and tream flows upwards through the disengage towards four singles staged cyclones.These cyclones separate all but a small quantity of the entrained catalyst from the vapors and return to the stripper and back into the **Regenerator** where the coke deposit is burnt off with the aid of air.The vapors then pass out of the cyclones,into the disengaged overhead vapor line and into the **Main Fractionating Column** where separation into column overhead vapors,Heavy Naphtha,Light cycle oil and Decant oil is effected.The column overhead vapors and part of the Heavy Naphtha stream are further treated in the Vapor Recovery Unit to produce Fuel gas,propane and Butane and premium motor spirit.

The premium motor spirit product is a high octane value and as such for blending in the premium motor spirit pool.The decant oil is used as feedstock for carbon Black plant but can also be blended into fuel oil.The propylene-propane is likewise used as feedstock to polypropylene plant(PP plant) or for LPG blending.The olefinic butane also serves as part of the feedstock to the HF Alkylation unit and with butane as domestic cooking gas.

1.12 WRPC MANAGEMENT STRUCTURE.

The refinery is staffed with highly professional and skilled personnel with considerable experience in refining operations. Although employment in NNPC is conducted at operations headquarters (NNPC TOWERS, central business district, Abuja), the peculiar needs of each of the subsidiary companies are usually taken into consideration in the development of personnel.Below is the refinery organogram, depicting the administrative structure of the company. The managing director is the chief executive officers of the company, he is supported by two executive directors, one in charge of operations while the other services i.e. in charge of the day to day activities of the company’s key functions. The operations division is made up of production, maintenance, engineering and technical services, production programing and quality control, power plant and utility, and the health, safety and environment departments while the services division is served by the Financial and Accounts, Administration, human resources, public Affairs and security Departments.

In addition, there is a managing director’s Division made up of Materials Management, planning and Budget management and the company secretariat and legal advisory services department.

All department are supported by sections and units head. The total staff strength is about 2000.

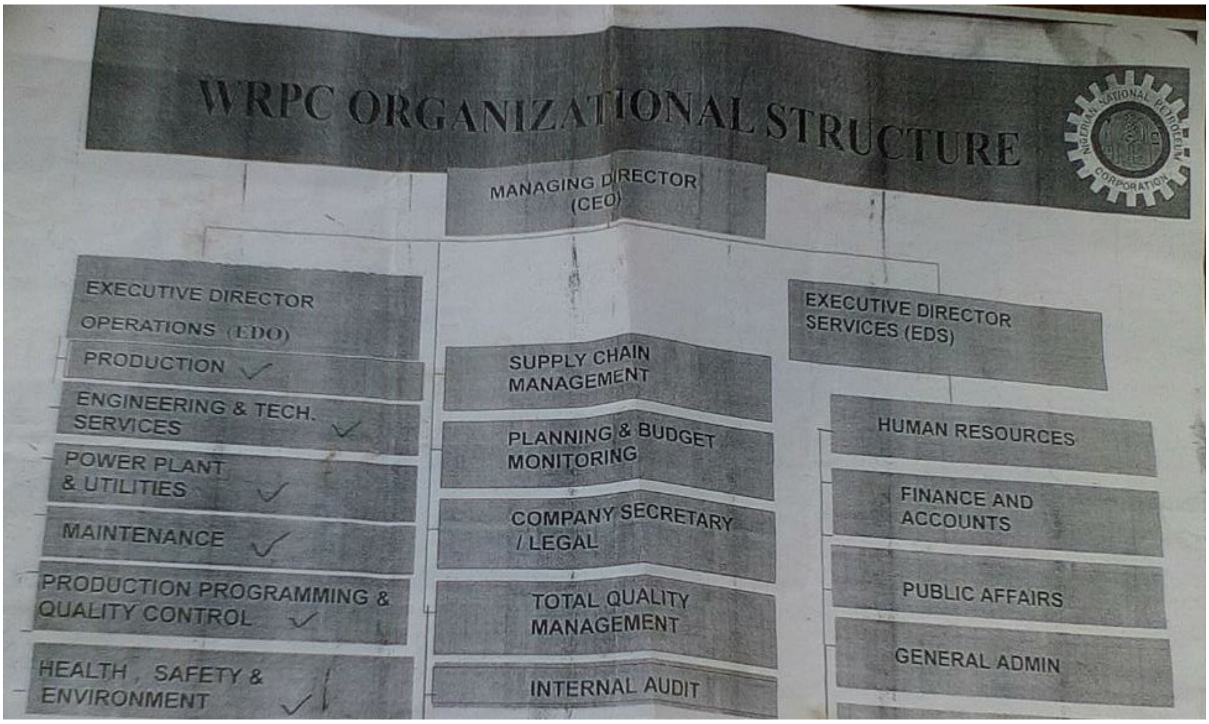


Figure 1.12 Organization chart of Warri Refining and Petrochemical company.

1.13 FUNCTIONS OF THE MAJOR POSITIONS IN WRPC

1.Managing director: The managing director's role is to design,develop and implement strategic plans for the company in a cost-effective and time-efficient manner.

2.Executive director of operation: The executive direction of operation is responsible for the day-to-day operation of the company,which includes managing committees and staff as well as developing business plan in collaboration with the board.

3.Executive director of services: : The executive direction of services is responsible for the day-to-day services of the company

4.Manager of maintenance: The maintenance manager oversees the facilities maintenance function and associate of the department.

5.Manager of production: The production manager is responsible for the technical management,supervision and control of industrial production processes.The production manager also ensure that manufacturing processes run reliably and efficiently.

6.Manager of Engineering and Technical services: The ETSD manager supervises all technical staff that are responsible for district-wide data network and computer and network operation.Assigns and coordinates work assignment and resolution of critical technical and procedural problems.

7.Manager of Health, Safety and Environment: The HSE manager is responsible for developing and implementing organizational safety programs.He also evaluate the workplace environment and develops safety management policies that identify and define the safety responsibility of all employees.

8.Manager of Programming and Quality control: The PQC manager is to ensure that the products meet quality and efficient standard set by the company and he also ensure that manufacturing production lines run smoothly and generate a consistently suitable output for their employers

9.Manager of Public Affairs: The manager of the public affairs is responsible for the development and implementation of the company's communication strategy and objectives.He also develops communication plans and implements a broad range of public relation activities.

10.Manager of Administration: The manager of administration oversees the support operation of an organization.He ensure that there is effective information flow and that resources are employed efficiently throughout the company.

11.Manager of Human resources: The human resources manager has two basic functions:overseeing department functions and managing employees.

12.Manager of Security: The manager of security and his team role is to ensure the perimeter of the company is secured from any external and internal visible threat that may arise.They also ensure that the lifes of the workers and the company's property are secured.

1.14 MAINTENANCE

Maintenance can be seen as certain activities or actions carried out on working machines, equipment's, facilities in order to maintain, keep them functioning or restore to serviceable conditions.

1.15 TYPES OF MAINTENANCE STRATEGY:

1.**Preventive maintenance**: preventive maintenance is practiced in order to delay or prevent breakdown.

2.**Corrective maintenance**: this strategy is employed when no maintenance activities is carried out until breakdown occur or is about to occur. Corrective maintenance is usually done to restore a faulty system.

1.16 SUMMARY OF INTERN'S ROLE/RESPONSIBILITY AND WORK DONE

In the maintenance department in WRPC where I was scheduled to,I was involved in carrying out corrective and preventive maintenance on different equipments such as Pumps(centrifugal pump in particular),Steam and Gas Turbines,Air Coolers,Centrifugal Compressor,Valves(Pneumatics and Manually operated).

Some of the work I did on pumps were,rectification of stiffness of the shafts of the electric motor and centrifugal pump,fixing of coupling spacers,mechanical seals,packings,shaft sleeves,impellers and bearings on the pump's shaft,carrying shaft alignment on pumps.Thereafter I moved to Air coolers unit where I participated in the fixing and removal of blades on the coupling hub,changing of the bearings on the shaft,fixing and removal of loosed and worn-out belts on the wheel of the Air cooler. Thereafter I moved to Compressor and Blower unit where I was involved in the replacement of lube oil filters in compressor's lube oil tanks,fixing of belts in blowers,installation and greasing of stack damper pins. Thereafter I moved to Pneumatic workshop where I personally did a series of calibration of pressure gauges using the dead weight tester and from time to time I also went around the plant area inspecting the control valves(safety valve,relief valve) and the manually operated valve. Thereafter I moved to Machine tools unit where I took part in performing some operations like Boring,Turning,Thread cutting on the lathe machine. Thereafter I moved to Power Plant and Utility unit where I participated in the alignment and fixing of governors on steam turbines,fixing on mechanical seals on centrifugal pumps,extraction and changing of bearings of centrifugal pumps,construction on shelter on different rotating equipments.

Finally I moved to Planning unit in Area 3 where I was involved in the registering,recording and dispatching of work request in the different unit under AREA 3,I also participated in taking vibration readings(three times a week) on the Gas turbines,stock taking from the warehouse of the maintenance department.

CHAPTER 2.

DETAILED INTERN'S ROLE AND DAILY ACTIVITIES

In this chapter, a detailed explanation of the work done, knowledge gained or skill obtained on a weekly basis throughout the training.
Most of the practices done during this training are briefly described weekly.

In the ***first week*** was the final submission of documents to the company and final processing of my admission and clearance as an industrial training students,followed by dispatching and receiving of documents from the various section of the company.

At the beginning of the ***Second week*** I was scheduled to the AREA 1 OFFSITE UNIT where I was involved in the installation of mechanical packing of a fire pump,removal of the coupling spacer of the fire pump (so that repairs can be carried out on the electric motor),installation of a multi stage centrifugal pump to its driver.

In the ***third week*** I participated in the overhauling of a single stage centrifugal pump,carrying out shaft alignment of a fire pump using the dial indicator method and decoupling of 203 centrifugal pump from the plant.

In the ***fourth week*** decoupling and assembly of a 15-P-02 centrifugal pump installing a coupling spacer, alignment of the 15-P-02 centrifugal pump with the electric motor was successfully carried out.

In the ***fifth week*** I was scheduled to AREA 1,PUMP AND TURBINES UNIT where I was involved in the checking and rectifying of faults on 16-K-02 of a **Turbine Actuator,** I aslo participated in the installation of a new single stage centrifugal pump in the plant,thereafter I coupled the coupling spacer of the new pump.

The ***sixth week*** saw my development in performing shaft alignment with **SKF alignment tools**,fixing of coupling spacers.I was also exposed to process on how to change and replace **inboard** and **outboard** bearings of pumps.

In the ***seventh week*** was all about **rectification of stiffness** on 10-P-10B,15-P-06A,15-P-07B Centrifugal pumps thereafter I aslo developed my skills on how to perform shaft alignment and coupling of spacers.In the same week I was introduced to a component of a pump called the **shaft sleeves(**which ptotects the expose part of the shaft from corrosion),how to fix it on the shaft.

In the ***eight week*** I was scheduled to AREA 1 AIR COOLER UNIT.This week had two holidays nevertheless I was involved in overhauling of 16-A-06 Air cooler,fastening of missing nuts in 10-AM-01E Air cooler motor,and also replacing of the missing belt of 10-AM-08A Air cooler.

The ***ninth week*** was all about replacing missing belts on different Air coolers and installing bearings on the shaft of an Air coolers,participating as well in the fixing of blades to the coupling hub of Air coolers.

In the ***tenth week*** I was involved in coupling of the wheel and fixing of V-belts and blades on differents Air coolers.I also participated in the decoupling of a soda overhead crane electric motor for repairs.

In the ***eleventh week*** I was scheduled to AREA 1 COMPRESSOR UNIT where I participated in replacement of Lube oil filter in the lube oil tank of a compressor package,decoupling and coupling of the gear box of the stack damper of a heater.

The ***twelfth week*** was all about replacement of lube oil filter in a compressor turbine unit and an installation of lube oil clarifier of the compressor unit.

In the ***thirteenth week*** provision of a new pin for stack damper wheel,greasing and exercising of the stack damper of an heater and plenty of shaft alignment was done.

In the ***fourteenth week*** I was scheduled to PNEUMATICS WORKSHOP UNIT where I was opportune to learn how pneumatics valves works and steps to observe when calibrating pressure gauges.I also participated in the decoupling,assembly,testing and calibration of a pressure differential gauge.

In the ***fifteenth week*** dismantling of the outer casing and outer components of a dead weight tester,changing the hydraulic oil in the oil tank of the dead weight tester,coupling of the dismantled part of the test weight tester and testing the dead weight tester was done.

In the ***sixteenth week*** I moved according to my schedule to MACHINE TOOLS UNIT where I participated in boring of an inboard and outboard bearing housing on the lathe machine,I did aslso turning operation,thread cutting and tapering of HV stem.Lastly in this week I learnt how to cut thread on hexagonal bolts.

In the ***seventeenth week*** drilling on the circumference of and impeller,cutting of internal internal thread using tap and wrench,stock loading and stock taking were done.

Drilling of holes on the surface of an impeller,drilling of holes on a gar coupling hub,machining of Teflon gasket was done in the ***eighteenth week*** on a lathe machine.

Throughout the ***nineteenth week*** I was involved in the decoupling of a kick starter of an hillux car,changing the Bendix of the decoupled kick starter,fixing of engine sitter of the foundation of the engine,fixing of a 13ton capacity folklift.

In the ***twentieth week*** I was made to undergo a Health Safety and Environment program that lasted for three days,nevertheless in that same week I also coupled a spacer of a centrifugal pump.

The ***twenty-first week*** was one which I remember clearly that we worked on a steam turbine for a week. I decoupled the outer casing of the turbine,removed also the labyrinth seals and spacers from the turbine shafts,I did participated in the extraction of the bearings from the two ends of the shaft(both the journal bearing and the ball bearing.).

In the ***twenty-second week*** I participated in the fixing of a mechanical seal on a centrifugal pump,extraction and fixing of the bearings of the above centrifugal pumps,shaft alignment of a centrifugal pump driven by a steam turbine(109-PT-01C),fixing of coupling spacers on 101 -P-15A and 101-P-15B centrifugal pump.

In the ***twenty-third week*** I was involved in following activities;fixing of the mechanical governor of 109-PT-01C steam turbine,replacing the casing,shaft sleeves and shaft of 101-P-12 centrifugal pump,construction on shelter on a lub hydroxyl pump,shaft alignment of 101-P -18A and B centrifugal pump.

At the beginning of the ***twenty-fourth week*** I was schedule to PLANNING UNIT AT AREA 3 where I joined in the registering,recording and dispatching of work request in the different unit under AREA 3,I also participated in taking vibration readings on different rotating equipments,stock taking from the warehouse of the maintenance department.

CHAPTER 3

PUMPS

A pump is a mechanical device used to increase the pressure,flow rate of the fluid it handles.Pumps are used to transfer fluids from low pressure zones to high presure zones by means of a mechanical action.Generally pumps are used to raise the pressure and velocity(flow rates) of fluids

Pumps operate by some mechanism(typically reciprocating or rotary),and consume energy to perform mechanical work by moving the fluid.Pumps operate via many energy sources,in Warri refining and petrochemical company(WRPC) pumps are mostly driving by electric motors.

3.1 TYPES OF PUMPS

Pumps may be classified on the basis of the application they serve,the liquids they handle,and thier orientation in space.

However all such classifications are limited in scope and tend to substantially overlaps each other.A more basic system of classification is the principle by which energy is added to the fluid and based on this principle;all pumps are divided into two major category;the positive displacement pumps(reciprocating pumps) and the dynamic pump(centrifugal pumps).

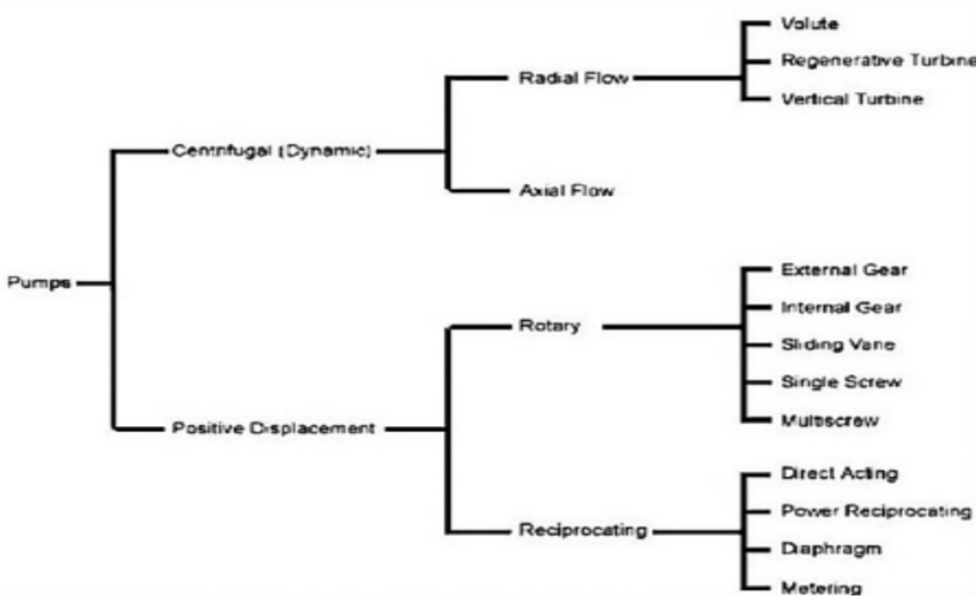


Figure 3.1 classification of pumps.

In Warri refining and petrochemical company(WRPC) the most commonly used pumps are the centrifugal pumps.

3.2 CENTRIFUGAL PUMPS

Centrifugal pumps is a rotodynamic pump that uses a rotating impeller to increases the pressure and flow rate of a fluid.its working principle is simple.

At the heart of the system lies the impeller.it has a series of curved vanes fitted into shroud plates.The impeller is always immersed in water,when the impeller is made to rotate,it makes the fluid surrounding it also to rotate and this imparts centrifugal forces to the water(assuming the fluid to be water) particles,and the water particles tends to move radially outwards in all directions.In fig.3.2a this process is illustrated.

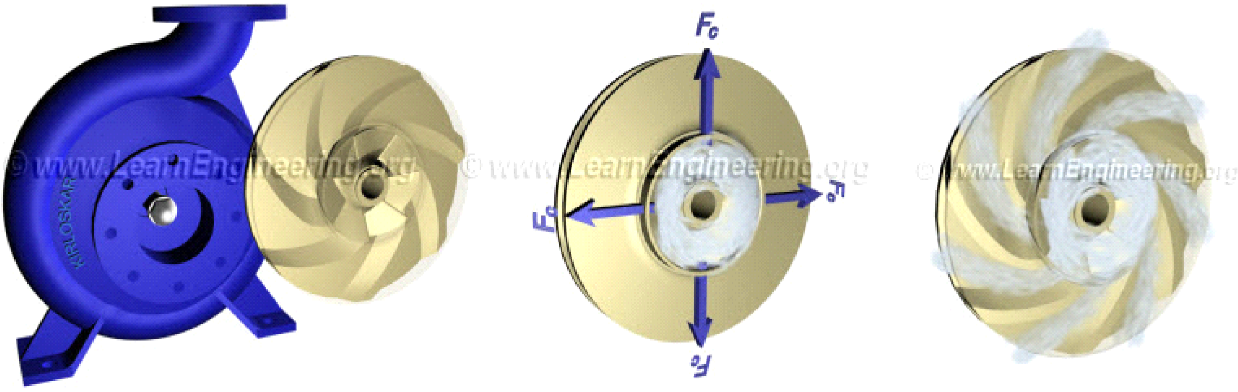


fig.3.2a The rotating impeller imparts a centrifugal force to the water particles and the water moves radially out.

Since the rotational mechanical energy is transferred to the fluid,at the discharged side of the impeller,both the pressure and the kinetic energy of the water rises.At the suction side,water is getting displaced,so a negative pressure will be induced in the eye of the impeller.such low pressure helps to suck fresh water into stream into the system again,and this process continues.

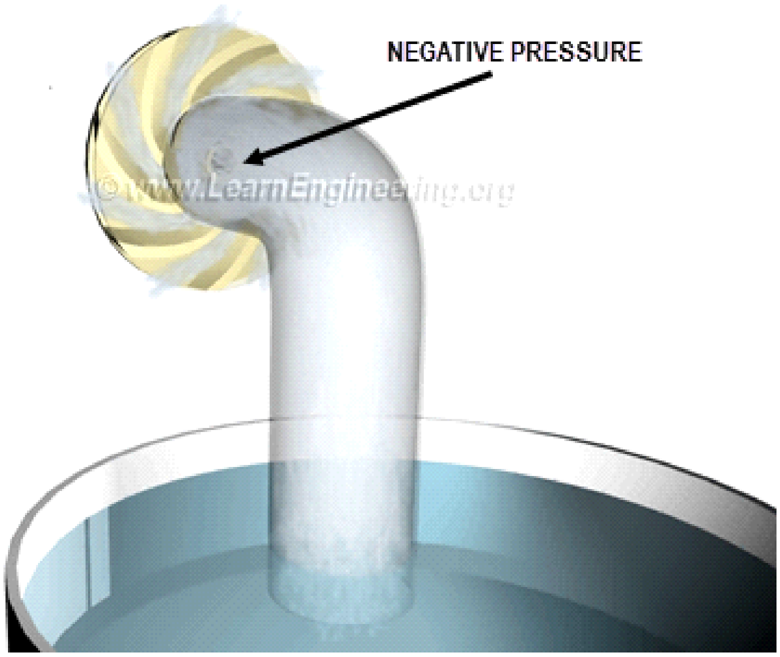


Fig.3.2b negative pressure created by displacement of water from eye of the impeller helps to suck fresh steam of water from a reservoir.

From foregoing discussion it is clear that,the negative pressure at the eye of the impeller helps to maintain the flow in the system.if no water is present initially,the negative pressure developed by the rotating air at the impeller eye will be negligibly small to suck fresh stream of water.As a result the impeller will rotate without sucking and discharging any water content.so the pump should be initially filled with water before starting it.this process is known as **priming**.

The impeller is fitted inside a casing.As a result the water that moves out will be collected inside it(casing),and will move in the same direction of rotation of the impeller to the discharge nozzle.this is shown in the fig3.11c

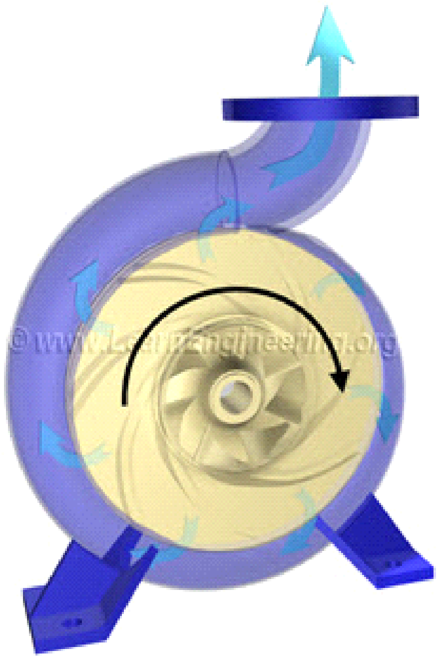


Figure.3.2c. Water which leaves the impeller gets collected inside the casing,flow direction is also marked

Most of the centrifugal pumps in Warri refining and petrochemical company(WRPC) are run by electric motors.Below are some of the diagrams centrifugal type pumps in Warri refining and petrochemical company(WRPC)

Fig.3.2d diagrams of some common pumps in WRPC.

3.3.GENERAL COMPONENTS OF A CENTRIFUGAL PUMPS

A centrifugal pumps has two main components

a.A rotating component comprised of an impeller and a shaft.

b.A stationary component comprised of a casing,seal chamber,and bearings,etc.

The general components, both stationary and rotary,are depicted in fig.3.3a.The main components are discussed in brief below.Figure 3.3b shows these part on a photograph of a pump in warri refining petrochemical company ltd(WRPC).

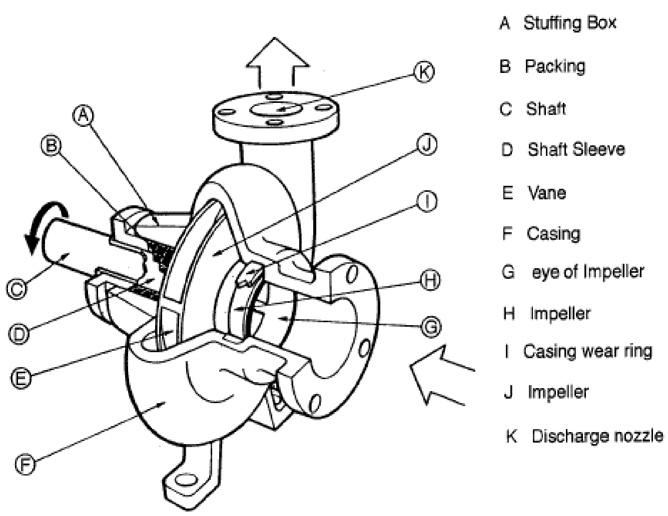


Figure.3.3a.The general components of a centrifugal pumps.

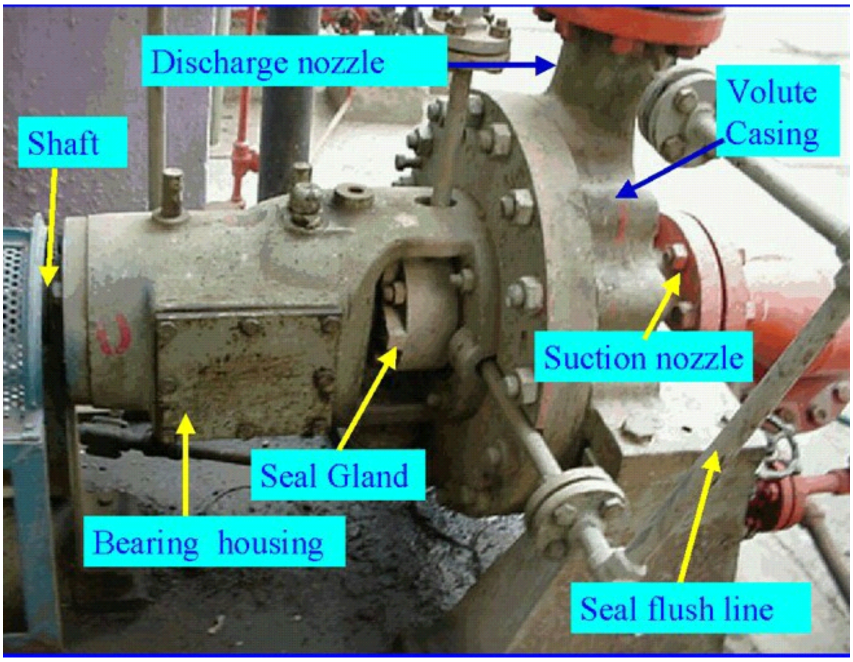


Figure.3.3b.Photograph of a centrifugal pump in WRPC

3.4 STATIONARY COMPONENTS

3.4.1.CASING

The casing contains the liquid and acts as a **pressure containment vessel** that directs the flow of the liquid in and out of the centrifugal pump.The casing are generally in two types;**volute and circular(Diffuser)**,however in WRPC the volute type of casing is prevalent.

The volute is a curved funnel that increases in area as it approaches the discharge port.The volute of a centrifugal pump is the casing that receives the fluid being pumped by the impeller,slowing down the fluid's rate of flow.Therefore,according to **BERNOULLI'S PRINCIPLE**,the **volute converts kinetic energy to pressure by reducing the speed of the fluid while increasing pressure energy of the fluid.**

Figure.3.4a shows the volute of a centrifugal pumps.

3.4.2.SEAL CHAMBER AND STUFFING BOX

Seal chamber and stuffing box both refers to a chamber,either integral with or separate from the pump case housing that forms the region between the shaft and casing where sealing media are installed.when the sealing is achieved by a mechanical seal,the chamber is commonly referred as a **Seal Chamber.**When the sealing is achieved by means of a packing,the chamber is reffered to as a **Stuffing Box.**Both the seal chamber and the stuffing box have the primary function of protecting the pump against leakage at the point where the shaft passes out through the pump pressure casing.The seal chamber is made up of the following parts

1.Gland: The gland is a very important part of the seal chamber or the stuffing box.It gives the packing or the mechanical seal the desired fit on the shaft sleeve.It can be easily adjusted in axial direction.The gland comprises of the seal flush,vent,etc.

2.Throat Bushing: The bottom or inside end of the chamber is provided with a stationary device called the throat bushing that forms a restrictive close clearance around the sleeve(shaft) between the seal and the impeller.

3.Throttle Bushing: It refers to the device that forms a restrictive close clearance around the sleeve(shaft) at the outboard end of the mechanical seal gland.

The mechanical seal is a device that forms a barrier between the rotary and stationary parts in the pump and to prevent leakage of the fluid.

4.Mechanical Seal: Mechanical seal has been design to block leakage at three points.

i.Between the rotating and stationary face of the seal.

ii.Between the stationary element and the seal camber housing of the pump.

iii.Between the rotary element and the sleeve of the pump.

The mechanical seal has component which includes; sleeves, rotating face, stationary face, sleeves gasket, seal cage, seal packing and carbon rings.

Figure 3.4b showing the components of a mechanical seal.

3.4.3.BEARING HOUSING:

The bearing housing encloses the bearings mounted on the shaft.The bearings is one of the pump accessories that aids the pure rotation of the shaft without friction, a bearing is a machine element that constrains relative motion between the rotating part to the desired motion. The design of a bearing may provide linear movement of the moving part or for free rotation around a fixed axis. They are mainly two types of bearings mostly used in a centrifugal pump they are; thrust and ball bearing.Thrust bearings restrict axial movement of the shaft while the ball restricts radial movement of the shaft.

Figure 3.4c showing the external and internal surfaces of a ball bearing.

3.5.ROTATING COMPONENTS:

3.5.1.IMPELLER:

An impeller is a rotating components of a centrifugal pump,usually made of steel,iron,bronze and brass,which transfers energy from the motor that drives the pump to the fluid being pumped by accelerating the fluid outwards from the center of rotation.The velocity achieved by the impeller transfer into pressure when the outward movement of the fluid is confined by the pump casing(in the volute).Impellers are usually short cylinders with an open inlet(called the **eye**) to accept incoming fluid,vanes to push the fluid radially,and a splined,key,or threaded bore to accept a drive shaft.Impellers are often classified in many ways these are,

Based on major direction of the flow in reference to the axis of rotation

1.Radial flow impeller

2.Axial flow impeller

3..mixed flow impeller

Based on suction type

1.Single suction

2.Double suction

Based on mechanical construction

1.closed impeller

2.open impeller

3.semi-open or vortex type impeller

In WRPC the impeller we were introduced to was the one based on construction i.e closed impellers and open impellers.The figure below shows the different types of impellers based on mechanical construction

closed impeller semi-open impeller open impeller.

Figure 3.5.1 .kind of impellers used in centrifugal pumps.

3.5.2.PUMP SHAFT:

The purpose of a centrifugal pump shaft is to transmit the torques when starting and during operation while supporting the impeller and other rotating parts.it must do this job with a deflection less than the minimum clearance between the rotating and stationary components.

3.5.3.SHAFT SLEEVE:

Pump shaft are usually protected from erosion,corrosion,and at the seal chamber,leakage joints,internal bearings by **sleeves**.The shaft sleeve acts as a shield for the shaft assembly in pumps.A shaft sleeve is a hollow metal cube,cylindrical in shape,which is mounted over a shaft and shaft assembly to protect it in a corrosive environment.

The basic function of a shaft sleeve is to protect the shaft from packing wear at the stuffing box,and also protect the running surface of the shaft seal or the surfaces in contact from damage or abrasive wear.The hardness of the material used to construct the shaft must be sufficient;otherwise it may cause a shaft sleeve to fail.

The thermal expansion of must be considered when designing a shaft sleeve.In ideal conditions,the shaft coefficient of thermal expansion should be equal to that of the shaft sleeve.

Figure 3.5.3 showing differents types of shaft sleeves.

3.6.PUMP AND MOTOR SHAFT ALIGNMENT:

Shaft alignment,often called coupling alignment is a process to make two or more rotating shafts co-linear,or in the same straight line,both vertically and horizontally.

When a driver like the electric motor is coupled to the pump,it is essential that the shafts of the motor and the pump must be aligned,any misalignment between the two shafts increases the stress on the shafts and will also certainly result in excessive wear and premature breakdown of the equipment,bearings and mechanical seals can also be damaged.

The implication of a pump exhibiting rotary unbalance includes;

1.Excessive running noise.

2.Vibration and excessive loads on the bearings causing premature failure of the bearing.

3.Rapid wear on the couplings and eventually premature failure.

4.Premature packing of seal failure.

5.Wears and rubbing between close tolerances rotary and stationary element in the pump leads to their failure.

6.Premature driver bearing failure.

3.7 TYPES OF MISALIGNMENT:

There are two types of misalignment:parallel and angular misalignment.With parallel misalignment,the center lines of both shafts are parallel but they are offset.With angular misalignment,the shafts are at an angle to each other.

The parallel misalignment can be further divided into horizontal and vertical misalignment.Horizontal misalignment is misalignment of the shafts in the horizontal plane and vertical misalignment is misalignment of the shaft in the vertical plane.

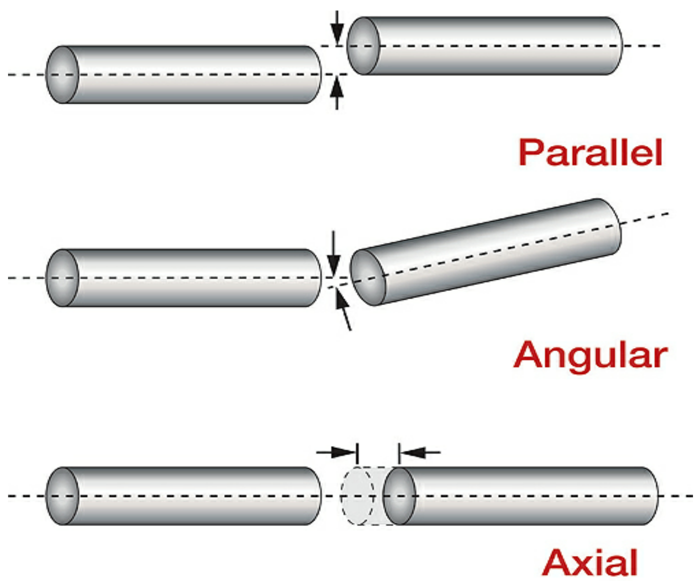


Figure 3.7. A diagram showing the three major types of misalignment

3.8.ALIGNMENT TECHNIQUES: There are different types of shaft alignment, which includes;

1.Reverse dial indicator alignment.

2.Rim and face alignment.

3.Straight edge alignment.

4.Laser alignment.

Only the laser and reverse dial indicator alignment are used in WRPC.

3.8.1.REVERSED DIAL INDICATOR ALIGNMENT: This method uses two dial indicators one on the pump and the other on the motor shaft. Sometimes the two indicators are mounted in the couplings, as the shaft is been rotated the indicator deflects showing the adjustment required.When the indicators are at the 9'o clock and 3' o clock position,it reads the horizontal misalignment and when the indicators are at the 12'o clock and 6' o clock position it reads the vertical misalignment.

Figure 3.8.1 A diagram depicting the position of the dial indicators on the shafts.

The figure above shows the dial indicators mounted on the shafts of the pumps and motors

3.8.2..LASER ALIGNMENT: A laser alignment system uses a transmitter(one that emits a laser) and receiver.The transmitter of the laser is installed on the pump shaft,During operation the laser emit a low intensity beam,the beam is detected by a device call the **receiver** a **detector** which is mounted on the motor shaft.As the shaft are rotated during the alignment,the beam will hit the circular face of the receiver at different point,the location of beam on the receiver is related to the misalignment between the two shafts.The receiver is connected to a display computer,the computer uses the information receives from the receiver to calculate how much misalignment exist and how to correct the misalignment. Shims are inserted to correct the gap indicated by the alignment tester. If the two coupled shaft are perfectly aligned then they are said to be co-linear which means that a single straight line will define the Centre of both shaft. The laser method is the most accurate method or techniques used in detecting and correcting misalignment of shafts.The laser alignment techniques is the most common alignment method used in WRPC for shaft alignment due to its ease of reading offset values.

Figure 3.8.2 laser alignment technique

3.9. PUMP MAINTENANCE PROCEDURES

Below are some of the steps taken to ensure proper maintenance that leads to proper functioning of centrifugal pumps in WRPC.

1.Regular checking and cleaning of **strainers** to avoid the pump from being choked by foreign particles.

2.Regular checking of the oil level in the oil cup so as maintain a high level of oil for lubrication of some parts of the pump.

3.Cleaning of the **Check valve** of the discharge line to prevent back pressure of the fluid on the pump.

4.Ensure that the pump is **primed** before starting the pump so as to protects some delicate components of the pump and to prevent **cavitation** from taking place in the pump casing.

5.Ensure concentricity(alignment) of the shafts of both the electric motor and the pump.

3.10. PUMP LUBRICATION

1.Certain parts of centrifugal pumps need continual lubrication to avoid damage through overheating and wear. The wear rings are lubricated during normal operation by the fluid that is being pumped. If the pump runs dry, serious problems will occur, such as the wear rings can seize up

2.Pump stuffing boxes must be continually lubricated. Normally the fluid from the pump lubricates them. The fluid is allowed to leak slightly through the packing rings. If corrosive or hazardous liquids are being pumped, then the packing must be lubricated externally. This is done through the lantern ring, which is supplied, with oil from outside the pump

3.Grease cups instead of oil lubricate some stuffing boxes. The pump shaft must rotate freely, with as little friction as possible

3.11. METHOD OF PUMP LUBRICATION

Slinger Rings are often used to lubricate the bearings. They lift the oil from the reservoir and throw it into the bearings as they turn; they rotate with the shaft.

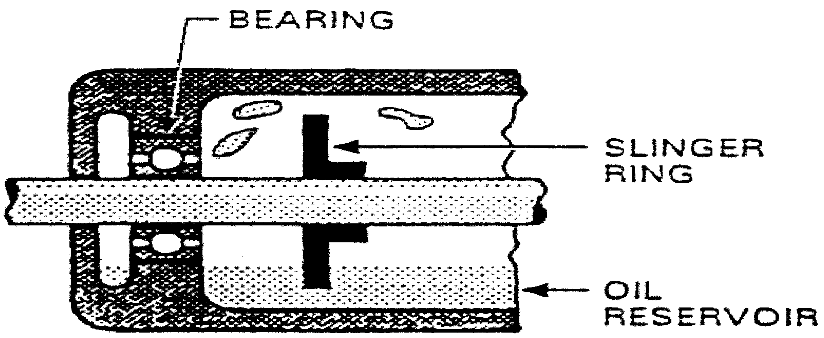


Figure 3.11a.A diagram showing the slinger rings used for lubrication of the bearing

Oil can be supplied to sleeve, or plain bearings, using an **oil ring**. The oil ring works in a similar way to a slinger ring. It picks up the oil from the reservoir, as it rotates on the shaft it carries the oil to the bearing.

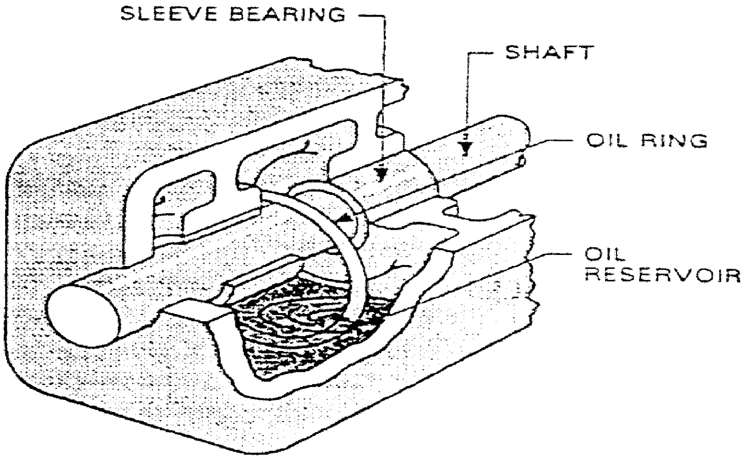


Figure 3.11b A diagram showing the oil rings used for lubrication of the bearing

3.12.PUMP COOLING

Centrifugal pumps do heavy work, and those pumping hot fluids get very hot. Normally these pumps have water jackets. Inside the water jacket, cold water is circulated to cool the lubricating oil, the packing and any other parts that may get hot. If heat is not removed it will cause damage. Water jackets are channels inside the casing, around the bearing housing and stuffing boxes. The water or coolant is pumped to a heat exchanger, where it is cooled and then recycled back to the water jackets.

When the bearing lubricating oil needs to be cooled, it can be covered with a water jacket. If the heat is too much the lubricating oil is pumped through a shell and tube cooler and then back to the bearing

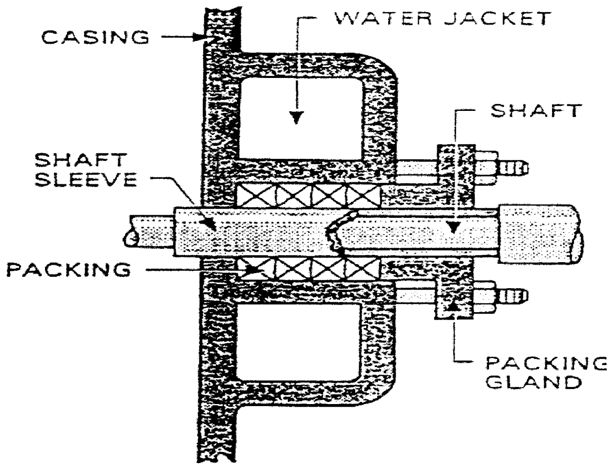


Figure 3.12.A diagram showing the water jacket used for pump cooling.

3.13. CAVITATION IN CENTRIFUGAL PUMP

The formation of vapour bubbles within a liquid at low-pressure regions that occur in places where the liquid has been accelerated to high velocities, as in the operation of centrifugal pumps, water turbines, and marine propellers.

Cavitation is undesirable because it produces extensive erosion of the rotating impeller, additional noise from the resultant knocking and vibrations, and a significant reduction of efficiency because it distorts the flow pattern.

The cavities form when the pressure of the liquid has been reduced to its vapour pressure; they expand as the pressure is further reduced along with the flow and suddenly collapse when they reach regions of higher pressure. The sudden growth and collapse of these vapour cavities cause the extreme pressures that pit the metal surfaces exposed to the cavitating liquid.

3.14.COMMON CENTRIFUGAL PUMPS PROBLEMS IN WRPC

There are many common problems that occur in centrifugal pump operation. Others are found during routine or planned maintenance or through bad assembly work afterwards.

Five Common ones are:

1.Alignment and vibration

2.Abrasion

3.Corrosion

4.Fractures and cracks

5.Misalignment

3.14.1.ALIGNMENT AND VIBRATION

A centrifugal pump and prime mover are joined together by couplings. When they are joined together they must be aligned correctly. If the pump is handling hot fluids, then the pump should be heated to near operating temperature before checking alignment. Improper alignment of the pump and prime mover can:

1.Put a strain on the shaft, causing the shaft and the coupling to wear or break

2.Cause the bearings and seals to wear out quickly

3.Damage the wear rings and permit the impeller to rub against other parts

4.Cause imbalance that will create vibration

5.Excessive vibration indicates mechanical problems. If unusual noise or vibration occurs, the pump must be shut down as soon as possible.

3.14.2.ABRASION

Abrasion occurs when a fluid contains an abrasive substance such as sand or fine gravel.This is why the internal parts of pumps are made with abrasive resistant materials depending on the fluid being pumped within the pipe.

3.14.3.CORROSION

Various substances can cause corrosion.These substances become corrosive when they are mixed with gases or other materials, or because of a change in temperature.An example of a corrosive substance is salt water mixed with air.Corrrosion causes wear and deterioration of some of the delicate components.

3.14.4.FRACTURES AND CRACKS

Fracture and cracks in pumps can be caused as a result of the following

1.Too much stress on the pump parts.

2.The fluid being to hot or cold can cause stress(temperature stress) on the pump parts.

3.Overheating of parts, such as bearings, put additional heat on the shaft.

4.Vibration can also cause cracks in pump parts, and metal fatigue can make the part break down completely.

3.14.5.MISALIGNMENT

One of the most common faults on centrifugal pumps is misalignment of the driver and driven shafts. Misalignment will cause the pump to operate with noise and vibration. In serious misalignment, the effect of damage to the pump parts can happen very quickly.

For example, overheating bearings cause damage to the pump. Stuffing boxes should always be checked for concentricity with the shaft centre line.

If the concentricity is out of tolerance, the packing rings will wear quickly. This means the pump will have no effective sealing device.

This causes other problems such as fluid leaking from the pump or air getting into the pump. If a mechanical seal is used as the sealing device, the seal faces will be damaged if the stuffing box is not concentric.

3.15.REMOVAL OF PUMP FOR INSPECTION AND MAINTENANCE

The following are some steps involved in removing a fitted pump for maintenance;

1.Isolate pump electrical circuit breaker on main switch board and attach a warning notice. (Do Not Operate-Men at Work).

2.Switch off and lock pumps supply at its local supply panel. Attach a warning notice to pump local supply panel.

3.Close suction and discharge valves.

4.Open pump suction and discharge pipe drain valves to bilge and when product ceases to flow; crack open the pipes / pump flange joints carefully to ensure that pump has drained off and is safe for opening.

5.Use a center-punch to match/mark coupling and casing, then removes the coupling bolts

6.Disconnect, fix i/d tag and remove motor supply cables; taping over bare ends with insulating tape.

8. Disconnect all external fittings from pump casing e.g. cooling pipe, pressure gauge, oil reservoirs and air cock.

9.Remove bolting from top cover and remove cover. Scrape off old gasket and check mating surfaces, and renew gasket on assembly. (Light smear of grease on gasket / faces).

10.The pump shaft with impeller can be lifted out of casing.

11.Dismantle the impeller, and remove the wear ring.

12.Remove the gland packing for inspection

3.16. COMPRESSORS

A compressor is a mechanical device like a pump that is used to increase the velocity and kinetic energy of a fluid and then converts the kinetic of the fluid to pressure energy.The compressors differs from a pump in that compressors are usually used for increasing the pressure,velocity and kinetic energy of gases specifically(according to the assumption on the molecular theory of matter that liquids are nearly incompressible.).while pumps are usually used for increasing the pressure,velocity and kinetic of liquids specifically.There are two main types of compressors these are the dynamic compressors and positive displacement compressors.The most common type of positive displacement compressor is the reciprocating compressor and the most common type of dynamic compressors is the centrifugal compressors.

The centrifugal compressors I worked on at WRPC are normally purchased as a **compressor package**,that is there are made up of a compressor and several other components.A typical compressor package at WRPC(AREA 1,COMPESSOR UNIT.) is made up of a compressor,a driver or a power source, gear box and couplings which are used to connects these components together,and also a seal oil system and a lube oil system which can easily be identified by the means of smaller pippings surrounding the compressor package,sometimes a gas cooling system is also part of the overall package.

The compressor is the most easy and identifiable part of the compressor package because of is large casing.The casing is where the internal part of the compressor are housed and is also where the gas is compressed.Inside the casing are two special gas passages that forms the stationary parts of the compressor,these are the inlet guide and the diffuser or discharged volute.The rotating part of the compressors is called the rotor assembly.The rotor assembly consist of a shaft with one or more impellers mounted on the shaft,as the rotor assembly rotate each impeller delivers energy to the gas coming from the suction line.The rotor assembly shaft is supported by bearings which prevents the axial and radial movement of the shaft.

3.17. CENTRIFUGAL COMPRESSORS:

Centrifugal compressor works on Bernoulli's principle,according to which,the total mechanical energy of a flowing fluid,comprising the energy associated with fluid pressure,the gravitational potential energy of elevation,and the kinetic energy o the fluid motion,remains constant.So,if the potential energy is kept constant,then decrease in kinetic energy will result in a corresponding increase if pressure and vice versa.

In a centrifugal compressor additional kinetic energy is imparted to the fluid with the help of a rotating component called the impeller.Here fluid(gas) enters the primary suction eye of the impeller,which consist of radial vanes cast in it.As the impeller starts rotating,the blades on the impeller pushes the gas outwards.In this travel,the velocity of the impeller is imparted to the gas and hence,its kinetic energy increases.Next the gas from the pheriphery of the impeller is guided through a passage called diffuser,where the velocity ,hence kinetic energy is decreased.This result in increase of pressure energy of the fluid.So basically it works on the principle of conversation of kinetic energy into pressure energy.

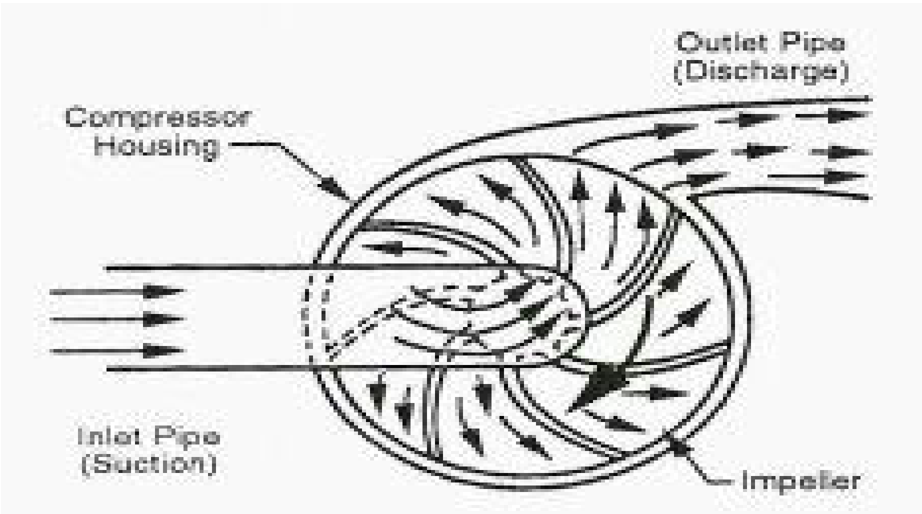


Figure 3.17.showing the operation of a centrifugal compressor

3.18.MAJOR COMPONENTS OF A COMPRESSOR

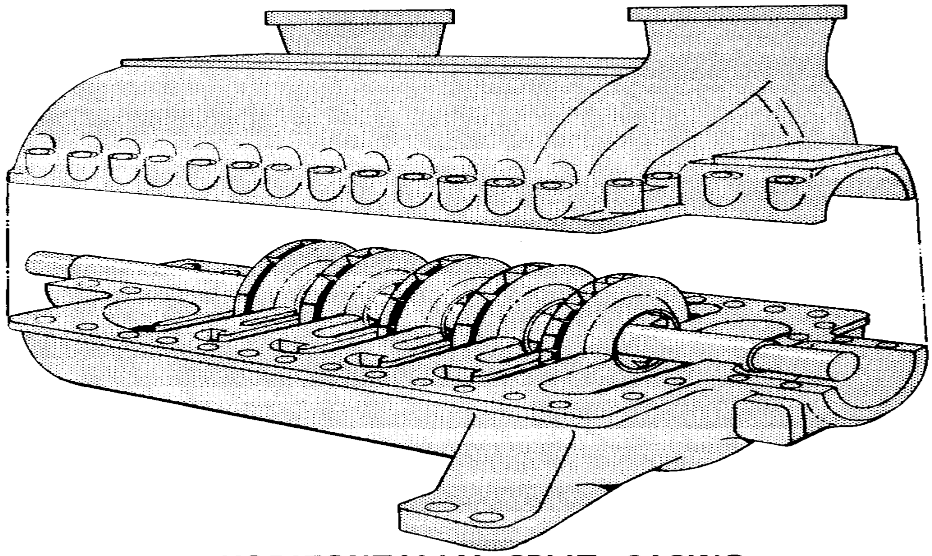
3.18.1.CASING

The casing or housing is the pressure containing components of the compressor.The case houses the stationary internal components and the compressor rotor.Bearings are attached to the case to provide both radial and axial support of the rotor.The case also contains nozzles with inlet and discharge flange connections to introduce flow into and extract flow from the compressor.The flange connection must be properly sized to limit the gas velocity as necessary.The case is manufactured in one of the two basic types,these are the horizontally split case and the vertically split case

1.HORINZONTALLY (AXIALLY) SPLIT CASE.

A horinzontally split case is split parallel to the axis of the rotor.The upper half of the case is bolted and doweled to the lower half.Access to the internal components for inspection and maintenance is facilitated with this case design.The horizontally split design is inherently pressure-limited to prevent gas leakage at the case joint.

The main advantage of horizontally split case is that it can be opened up, so that the internal parts can be seen, without disturbing it too much.



HORIZONTALLY SPLIT CASING

Figure.3.18a showing the horizontally split casing

2.VERTICALLY (RADIALLY) SPLIT CASE.

This case is split perpendicular to the axis of the rotor.The vertically split case configuration is capable of handling higher pressures than the horizontally split type.The rotor and stationary internals are assembled as a cylindrical inner bundle that is inserted axially through one end of the case.Inspection and maintenance of a radially split centrifugal compressors require that the inner bundle be removed for dissambly.Removal of the inner bundle requires that sufficient space be provided in the layout of the compressor installation. The main advantage is that the internal parts can be removed for repair, while the volute is left in place.

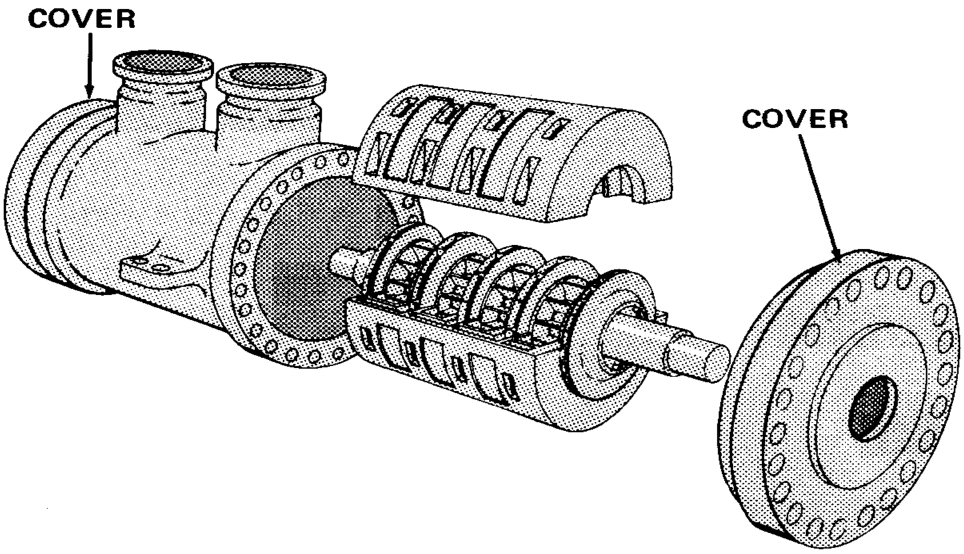


Figure.3.18b showing the vertically split casing

3.18.2.ROTOR ASSEMBLY:

The compressor rotor assembly is fundamentally an assembly of impellers mounted on steel shaft.Some additional rotor components includes impeller spacers,seal sleeves,a thrust disc,couplings.

The impellers imparts velocity to the gas with blades that are attached to the rotating disc.The rotating vanes accelerates the fluids as it moves from the impeller input known as the **inducer or eye** to the impeller output known as the **exducer**.

Figure 3.18.2 showing the rotor assembly of a compressor.

Impellers are design in many configurations including the open type without a covered plate or the closed-type that incorporates a cover plates attached to the blades.There are three different types of impeller these are **open**,**semi open** or **partially open** and **closed** or **enclosed impeller**.

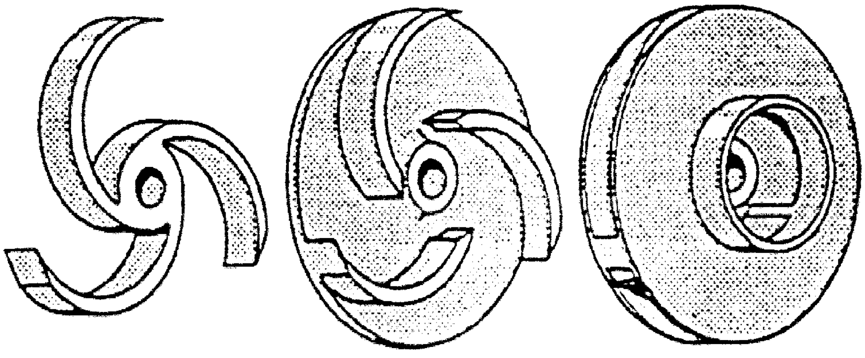


Figure.3.18a showing the differents types of impeller.

The **open type** has just enough shroud to keep the vanes rigid, so they do not move. They are used for pumping very thick, dirty fluids.The **enclosed type** is the most efficient because there is less slip.They are used for thin clean fluids, which contain very few solid particles.This type of impeller can control flow better, and so, they move more fluid.

Enclosed type impellers are also grouped into two other groups. They are either **single or double suction**. Single suction impellers have only one suction eye. Therefore, the fluid enters from one side of the impeller only.

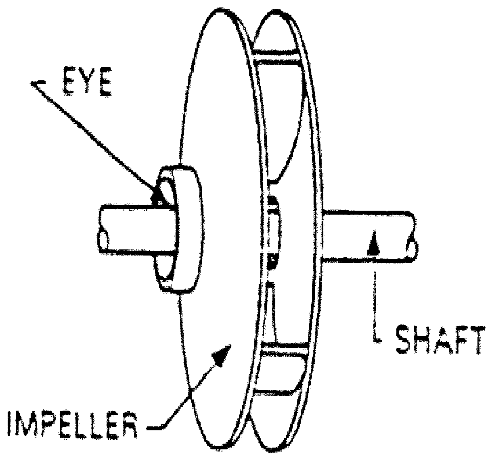


Figure.3.18b showing the diagram of a single suction impeller.

The **double suction** type has fluid entering the pump from both sides of the impeller. That means it has two suction eyes. This type has the advantage over single suction because the thrust is balanced.

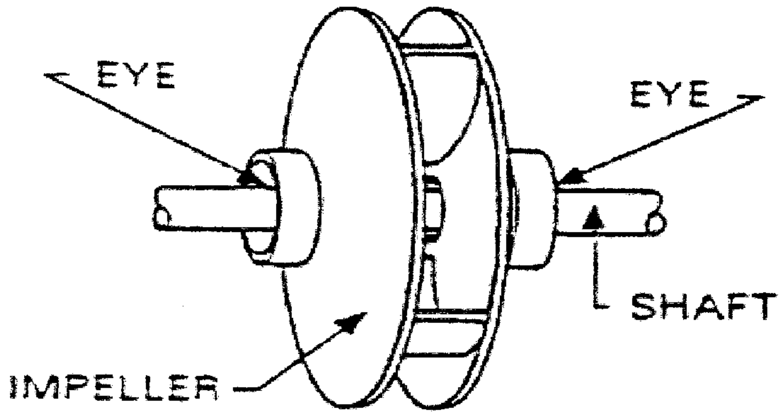


Figure.3.18c showing the diagram of a double suction impeller

For most applications,high-strength alloy steel is selected for impeller material.stainless steel is often the material of choice for use in corrosive environments.Because the impeller rotates at high speeds,centrifugal stresses are an important design consideration,and high-strength steels are required for the impeller material.

NB:Closed impellers are mainly used for multi-stage compressors.

3.18.3.DIFFUSERS: The diffuser can be vaned,vaneless,or its combination.The gas exits impeller vanes at very high velocity and enter the diffuser.The diffuser is a components of centrifugal compressors which has the function to convert the high kinetic energy of the gas into pressure energy of the gas,between diffusers blades passages.

3.19. LUBE OIL SYSTEM IN A COMPRESSOR PACKAGE

The lube system supplies oil to the compressor and driver bearings and to the gears and couplings.The lube oil is drawn from a reservoir by pumps and is fed under pressure through coolers or heat exchangers and lube oil filters to the bearings,the oil drains back to the reservoir.the reservoir is design to permit circulation of its fluid volume between eight to twelve times per hour.

When in operation,the compressor lubricant oil is normally circulated by main pump.An auxiliary pump stands as a standby.These two pumps generally have different type of drive or power source.The warm oil from the reservoir then flows into a cooler or an heat exchanger for the purpose of extracting heat from it,thereafter the oil then flows into the lube oil filters.The lube oil filters removes contaminants(like dust,sand) from the oil before it reaches the lubrication points and a pressure differential gauge monitors the degree of fouling(flow restriction)of the filters,the oil then flows to the clarifier that furthers purifies the oil by centrifugal effect from debris and dust particles that couldn't be filtered.The filtered oil is then regulated by individual orifices to each bearing and couplings

Figure.3.19 showing lube oil system and lube oil filters respectively.

3.20..ROUTINE MAINTENANCE FOR CENTRIFUGAL COMPRESSORS

The following are typical minimum maintenance requirements for centrifugal compressors

1.Monitor all gauges and indicators for normal operation

2.Check lubricant level

3.Check for lubricant leaks

4.Check for unusual noise or vibration

5.Drain water from lubricant reservoir

6.Check safety valve operation

7.Service air filter as needed

8.Check operation of all controls

9.Check operation of lubricant return system

10.Go over unit and check all bolts for tightness

11.Change air filter

3.21. BLOWERS.

Industrial blowers are machines whose primary function is to transport a large volume of air without necessity being laid having a high increase of the pressure of the air.There are two major compressors.This blowers is made up of impellers mounted on a shaft that is connected to a types of blowers;centrifugal and positive displacement blowers.

3.22. CENTRIFUGAL BLOWERS

The centrifugal blowers works in similar manner to the centrifugal pumps and driver(electric motor) supported by bearings at each end of the shaft.

As the impeller of the blowers rotates it creates a suction pressure at the suction side and air enters to the center of a spinning impeller,and is divided between the impeller's vanes.As the impeller turns,it creates a centrifugal force that accelerates(to increase the velocity) the air outwards.This high velocity air is then diffused and slowed down in the surrounding housing(just like a volute in the case of a pump) to create pressure that's converted to pressure energy.

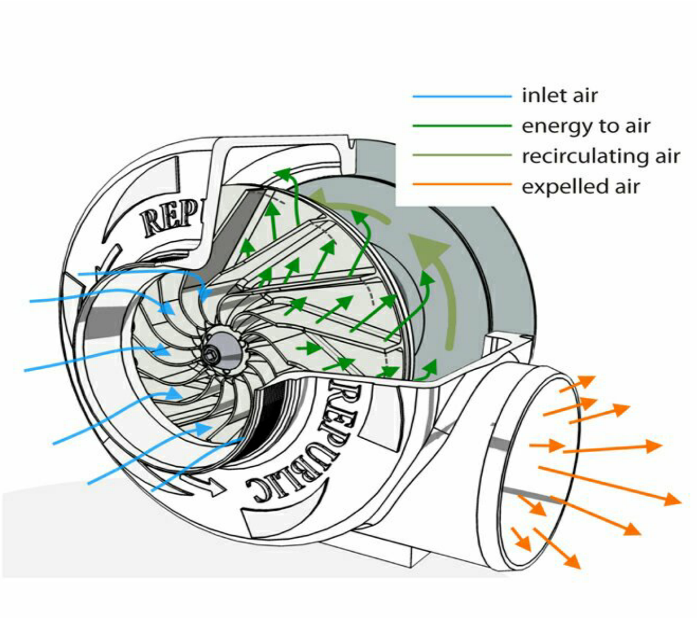


Figure.3.22 showing the diagram of a centrifugal blower.

In WRPC centrifugal blowers are commonly use compared to the positive displacement blower.

3.23. APPLICATION OF BLOWERS IN WRPC

1.Conveying combustion air for burners and industrial water heater

2.Conveying combustion air for heaters

3.Transporting steam produce from power plant unit to all industrial process requirement.

4.Cooling electrical and mechanical equipment or parts from over heating.

5.Pressurizing cabinet and rooms.

6.General ventilation of rooms or factories

7.Blow-off systems to remove moisture from parts prior to painting and coating.

Below are some of the steps required for maintaining centrifugal blowers in WRPC to prevent it from long period of repairs and downtimes

i.The belt drive must be visually inspected after 24hours of operation.Afterwards it should be checked every three months.The belt should also be protected against dripping oil and other chemicals.Permanent exposure to this fluid causes early wear of belts.

ii.Apart from the regular visual inspection(at least once a year) the impeller must be cleaned whenever it is dirty.The cleaning interval depends on the fluid conveyed.

iii.When cleaning the bearing housing,completely remove old grease,possibly clean the bearing and fill with new grease.

3.24.AIR COOLERS.

Industrial air coolers WRPC plays vital role in cooling transported liquid products before there are stored in storage tanks. Usually the products produce from some areas(unit) in the company are at a very high temperature at such if stored without cooling it may cause explosion in the storage tanks.

Air coolers are devices that extracts heat from a flowing hot substances and then cools(reduces the temperature) it by the helps of rotating blades.

3.25. COMPONENTS OF AN AIR COOLER.

The major components of an air cooler are

1Air cooler unit

2.Electric Motor

3.V-belts

4.Aluminium Fins

5.blades

6.Wheel.

The electric motor provides the torque needed to drive the air cooler unit.A v-belts is use to transfer the torque generated by the electric motor by connecting the v-belts from the shaft of the electric motor to the wheel of the air cooler unit.The wheel of the air cooler is mounted on the air cooler shaft.So as the wheel rotates it also causes the shaft of the air cooler to rotates thereby making the blades which are coupled to the shaft of the air cooler to rotates.Aluminium fins being a high conductive material than the pipe usually made of carbon materials fins are wounded round the pipes that carries the hot fluid so as to extract the heat from the liquid through convection thereafter.The blades of the air cooler then blows the extracted heat away from the surrounding of the air cooler.

Figure 3.25 showing the diagram of an industrial air cooler

3.26. MAINTENANCE PROCEDURES FOR AIR COOLERS.

Below are some of the steps required for maintaining Air coolers in WRPC to prevent it from long period of repairs and downtimes.

i.Changing of belts when there are worn out for this may cause low torque transmission,also slacked belt should be replaced with newer ones for maximum transmission of power.

ii.Lubricating the bearing housing with grease or any suitable lubricant to reduce friction between the rotating shaft and the internal surface of the bearing.

iii.Draining of hot lubricant or grease from the bearing housing.

iv.Check for vibration

v. Check lubricant level.

3.27. VALVES

Valves are mechanical devices that regulates the flow of fluids by opening,closing,or partially obstructing various passageways.

Valves are quite diverse and may be classified into a number of types.Valves can be categorized into the following basic types.

3.28 GATE VALVE

A gate valve, also known as a sluice valve, is a valve that opens by lifting a round or rectangular gate/wedge out of the path of the fluid. The distinct feature of a gate valve is the sealing surfaces between the gate and seats are planar, so gate valves are often used when a straight-line flow of fluid and minimum restriction is desired. Gate valves are characterized as having either a rising stem. Rising stems provide a visual indication of valve position because the stem is attached to the gate such that the gate and stem rise and lower together as the valve is operated.

Bonnets provide leak-proof closure for the valve body. Gate valves may have a screw-in, union, or bolted bonnet. Screw-in bonnet is the simplest, offering a durable, pressure-tight seal.

Figure 3.28 showing a outer components gate valve.

3.29 BALL VALVE.

A ball valve is a form of quarter-turn valve which uses a hollow, perforated and pivoting ball (called a "floating ball") to control flow through it. It is open when the ball's hole is in line with the flow and closed when it is pivoted 90-degrees by the valve handle. The handle lies flat in alignment with the flow when open, and is perpendicular to it when closed, making for easy visual confirmation of the valve's status.Below is figure showing a ball valve

Figure 3.29. A Ball valve

3.30 BUTTERFLY VALVE

A butterfly valve is a valve which can be used for isolating or regulating flow. The closing mechanism takes the form of a disk. Operation is similar to that of a ball valve, which allows for quick shut off. Butterfly valves are generally favored because they are lower in cost to other valve designs as well as being lighter in weight, meaning less support is required. The disc is positioned in the center of the pipe, passing through the disc is a rod connected to an actuator on the outside of the valve. Rotating the actuator turns the disc either parallel or perpendicular to the flow. Unlike a ball valve, the disc is always present within the flow therefore a pressure drop is always induced in the flow, regardless of valve position.

3.31 CHECK VALVE

This type of valve only allows flows of liquid in one direction, it is employed to prevent the back flow of product passing through it, it makes use of a sleeve that is automatically controlled by the flow, to open the valve, if the product tends to flow back the sleeve closes the inlet of the valve

Figure 3.31 showing the check valve.

3.32 CONTROL VALVES

A control valve is a valve used to control fluid flow by varying the size of the flow passage as directed by a signal from a controller.This enables the direct control of flow rate and the consequential control of process quantities such as pressure , temperature , and liquid level. In automatic control terminology a control valve is termed a "final control element

Figure 3.32 showing diagrams of control valves

The opening or closing of automatic control valves is usually done by electrical , hydraulic or pneumatic actuators. Normally with a modulating valve, which can be set to any position between fully open and fully closed, valve positioners are used to ensure the valve attains the desired degree of opening.

Air-actuated(pneumatic) valves are commonly used because of their simplicity, as they only require a compressed air supply, whereas electrically-operated valves require additional cabling and switch gear, and hydraulically-actuated valves required high pressure supply and return lines for the hydraulic fluid.

The pneumatic control signals in WRPC are traditionally based on a pressure range of 3-15psi (0.2-1.0 bar)

An automatic control valve consists of three main parts in which each part exist in several types and designs:

Valve actuator: which moves the valve's modulating element, such as ball or butterfly.

Valve positioner : Which ensures the valve has reached the desired degree of opening. This overcomes the problems of friction and wear.

Valve body:is the area which the modulating element, a plug, globe, ball or butterfly, is contained.

Taking the example of an air-operated valve in WRPC, there are two control actions possible:

Air or current to open(coloured green): The flow restriction decreases with increased control signal value.

Air or current to close(coloured red): The flow restriction increases with increased control signal value.

3.33 PNEUMATIC VALVES(ACTUATORS).

Valves are either operated manually(with hand wheels or levers) but some valves have to be open,closed or throttled frequently.Manually positioning vlave in this type of situation is not always pratical so instead of hand wheels or levers pneumatic actuator are used to position the valve.Pneumatic actuator are defined as a mechanism that moves or controls a device such as a valve.When actautors are used valve can be positioned from a remote location such as a control room.The pneumatic actuators uses air pressure to position the valve.

Pneumatic actuators consist of the actuator and the valve.In the arrangement shown a flexible diaphragm forms a pressure tight chamber in the upper haft of the actuator and the controller signl is fed in.Air pressure from a soucre passes through a air regulator(that regulates the amount of air that enters the chamber.This pressurized air forces the diaphragm to moves either upward or downwards depending on the positioning of the inlet to the air chamber.Movement of the diaphragm results in a movement of the valve spindle and the valve.The diapragm movement is opposed by a spring and is usually arrangd so that the variation of controller output correspond to full travel of the valve.

The valve body is arranged to fit into the particular pipeline and houses the valve and seat assembly.Valves operation may be direct acting where increasing pressure on the diaphragm closes the valve.A reverse acting valve opens as pressure on the diaphragm increases.The diaphragm movement is opposed by a spring which close or open the valve in the event of air supply failure depending upon the action of the valve.

Figure 3.33 showing the diagram of a pneumatically controlled valve.

3.34 DEAD WEIGHT TESTER

A dead weight tester is an instrument that calibrates pressure by determining the weight of force divided by the area the force is applied. The formula for dead weight testers is pressure equals force divided by area of where force is applied

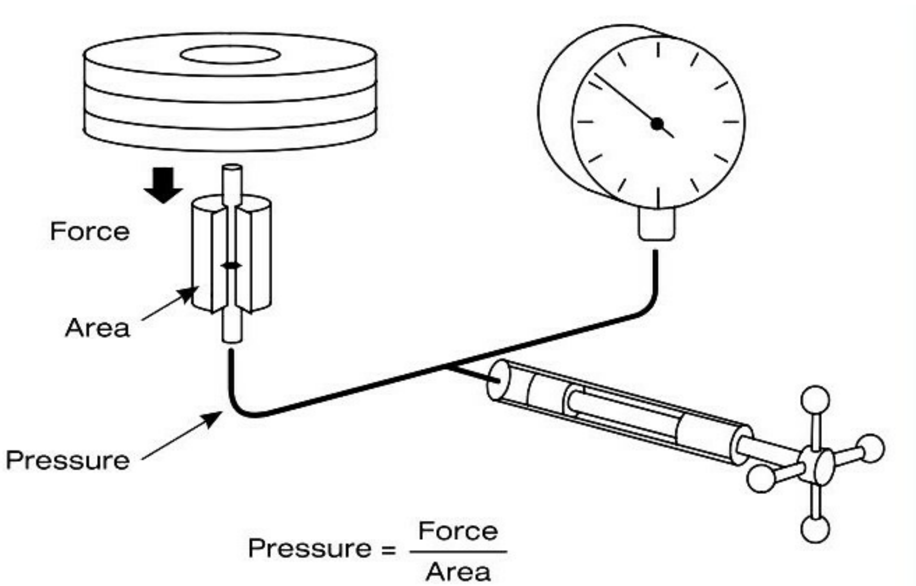


Figure 3.34 schematic diagram of the operation of a dead weight tester.

Dead weights are usually used for pressure gauge calibration as they come with high accuracy, So they can be used as primary standard (as mentioned before).there are many types of them depending on the application and they are operated with oil (hydraulic) or with air (pneumatic).

Dead weight testers are the basic primary standard for accurate measurement of pressure. They are used to measure the pressure exerted by gas or liquid and can also generate a test pressure for the calibration of numerous pressure instruments. In dead weight tester, we put the weight on the weight stand of the dead weight tester, the weight added is called the reference weight which is to be calibrated and further we applied pressure by a moving piston ,when applied pressure and reference weight(Pressure)is equal at this condition reference weight will be zero(Dead). therefore it is called dead weigh tester.

A deadweight tester (DWT) is a calibration standard which uses a piston cylinder on which a load is placed to make an equilibrium with an applied pressure underneath the piston.

The formula to design a DWT is based basically is expressed as follows :

$p = F / A$ [Pa]

where :

p : reference pressure

F : force applied on piston

A : effective area

3.35 WORKING OF A DEAD WEIGHT TESTER

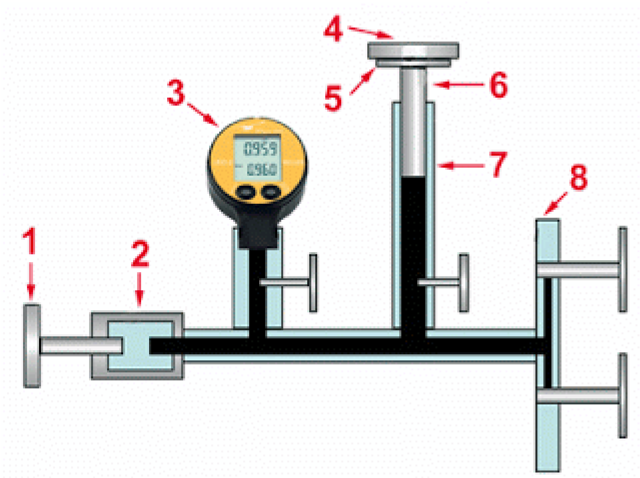


Figure 3.35.A Diagram showing the components of a Dead Weight tester

Figure 3.35a A diagram showing the different components of a dead weight tester.

1 – Hand pump

2 – Testing Pump

3 – Pressure Gauge to be calibrated

4 – Calibration Weight

5 – Weight Support

6 – Piston

7 – Cylinder

8 – Filling Connection

Dead weight testers are a piston-cylinder type measuring device. As primary standards, they are the most accurate instruments for the calibration of electronic or mechanical pressure measuring instruments.

They work in accordance with the basic principle that P= F/A, where the pressure (P) acts on a known area of a sealed piston (A), generating a force (F). The force of this piston is then compared with the force applied by calibrated weights. The use of high quality materials result in small uncertainties of measurement and excellent long term stability.

The testing pump (2) is connected to the instrument to be tested (3). A special hydraulic oil or gas such as compressed air or nitrogen is used as the pressure transfer medium. The measuring piston is then loaded with calibrated weights (4). The pressure is applied via an integrated pump (1) or, if an external pressure supply is available, via control valves in order to generate a pressure until the loaded measuring piston (6) rises and 'floats' on the fluid. This is the point where there is a balance between pressure and the mass load.

The dead weight tester apparatus consists of a chamber which is filled with oil free impurities and a piston – cylinder combination is fitted above the chamber as shown in diagram. The top portion of the piston is attached with a platform to carry weights. A plunger with a handle has been provided to vary the pressure of oil in the chamber. The pressure gauge to be tested is fitted at an appropriate plate.

The dead weight tester is basically a pressure producing and pressure measuring device. It is used to calibrate pressure gauges. The following procedure is adopted for calibrating pressure gauges. Calibration of pressure gauge means introducing an accurately known sample of pressure to the gauge under test and then observing the response of the gauge. In order to create this accurately known pressure, the following steps are followed. The valve of the apparatus is closed.

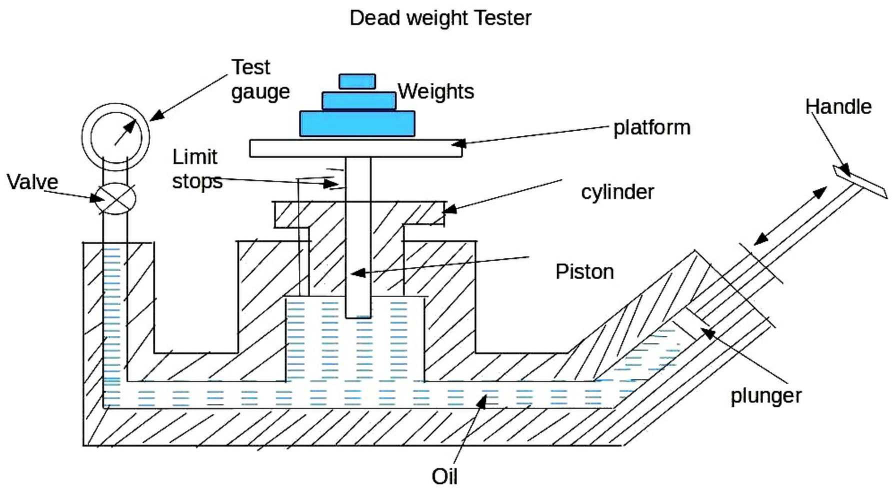


Figure 3.35b A diagram showing the sectional view of a dead weight tester.

A known weight is placed on the platform. Now by operating the plunger, fluid pressure is applied to the other side of the piston until enough force is developed to lift the piston-weight combination. When this happens, the piston weight combination floats freely within the cylinder between limit stops. In this condition of equilibrium, the pressure force of fluid is balanced against the gravitational force of the weights plus the friction drag.

Therefore, $PA = Mg + F$

Hence : $P = Mg + F / A$

where, P = pressure

M = Mass; Kg

g = Acceleratoion due to gravity ; m/s^2

F = Friction drag; N

A = Eqivalent area of piston – cylinder combination; m^2

Thus the pressure P which is caused due to the weights placed on the platform is calculated. After calculating P , the plunger is released. Now the pressure gauge to be calibrated is fitted at an appropriate place on the dead weight tester. The same known weight which was used to calucated P is placed on the platform. Due to the weight, the piston moves downwards and exerts a pressure P on the fluid. Now the valve in the apparatus is opened so that the fluid pressure P is transmitted to the gauge, which makes the gauge indicate a pressure value. This pressure value shown by the gauge should be equal to the known input pressure P. If the gauge indicates some other value other than P the gauge is adjusted so that it reads a value equal to P. Thus the gauge is calibrated.

Figure 3.35c A diagram showing of a Dead weight tester

Applications:

It is used to calibrated all kinds of pressure gauges such as industrial pressure gauges, pressure transmitters etc.

Advantages:

it is simple in construction and easy to use. It can be used to calibrated a wide range of pressure measuring devices. Fluid pressure can be easily varied by adding weights or by changing the piston cylinder combination.

Limitations:the accuracy of the dead weight tester is affected due to the friction between the piston and cylinder, and due to the uncertainty of the value of gravitational constant ‘g’.

3.36 MACHINE TOOLS

A machine tool is a machine for shaping or machining metal or other rigid materials, usually by cutting, boring, grinding, shearing, or other forms of deformation. All machine tools have some means of constraining the work piece and provide a guided movement of the parts of the machine. Thus the relative movement between the work piece and the cutting tool (which is called the toolpath) is controlled or constrained by the machine to at least some extent, rather than being entirely "offhand" or "freehand".

Any machine tool generally has the capability of;

1.Holding and supporting the work piece either by a machine vice, clamps or dividing heads.

2.Holding and supporting the work piece.

Impacting a suitable movement (rotating or some means of constraining the work piece and provide a guided movement of the parts of the machine. Thus the relative movement between the work piece and the cutting tool (which is called the toolpath) is controlled or constrained by the machine to at least some extent, rather than being entirely "offhand" or "freehand".

Any machine tool generally has the capability of;

1.Holding and supporting the work piece either by a machine vice, clamps or dividing heads.

2.Holding and supporting the work piece.

3.Impacting a suitable movement (rotating or reciprocating) to the cutting tool or the work.

4.Feeding the cutting or the work so that the desired cutting action and accuracy will be achieved.

Various techniques can be used to remove unwanted metal during the process of fabricating or shaping parts, namely single edge cutting tools; multiple edge cutting tools, electrical discharge machining and grinding (abrasive cutting).

3.37 TYPES OF MACHINE IN MACHINE TOOLS WORKSHOP AT WRPC

3.38 THE LATHE MACHINE

A lathe is an accurate versatile machine in which many operations can be carried out on, such as shaping and machining of various work pieces.

In manufacturing, it is important to produce work pieces according to specifications. This is where the lathe machine comes in handy. A lathe machine is used for the machining and working of hard materials. Conventionally, the main function of the lathe is to remove material from a work piece through the use of cutting tools. The lathe shapes a material by holding and rotating the material as a cutting tool is advanced into it

The major path of a lathe machines are;

1.**The bed** – the bed is a heavy, rugged casting, made to support the working part of the lathe. One its top section are machine ways that guide and align the major part of the lathe.

2.**The head stock** – the head stock is located at the left hand side of the bed, on the head stock is the head stock spindle, and gear box. It is used to hold, support and rotate the work

3.**The carriage** – it is located on top of the bed, it consist of three major part the cross slide, saddle and apron. It is used to move the cutting tool along the lathe

4.**The tail stock** – it is located at the right end of the lathe. This consisting of the upper and lower tailstock casting, it can be adjusted for taper or parallel turnings by two screws set to the base. The tail stock can be locked in any position along the bed of the lathe by the tail stock clamp.

5.The lathe has three jaw chuck or depended chuck and the four jaw chuck or independent chuck.

There are three general types of lathe machines which are engine lathes, turret lathes, and special purpose lathes. Each of these lathes has specific applications and distinctive characteristics.

During the course of my industrial training in WRPC I came across the engine late, Its main components include the bed, headstock, and tailstock. The engine lathes can be adjusted to variable speeds for the accommodation of a wide scope of work. The good thing about engine lathes is that it can be used in various materials, aside from metal. The lathe performs several operations which includes;

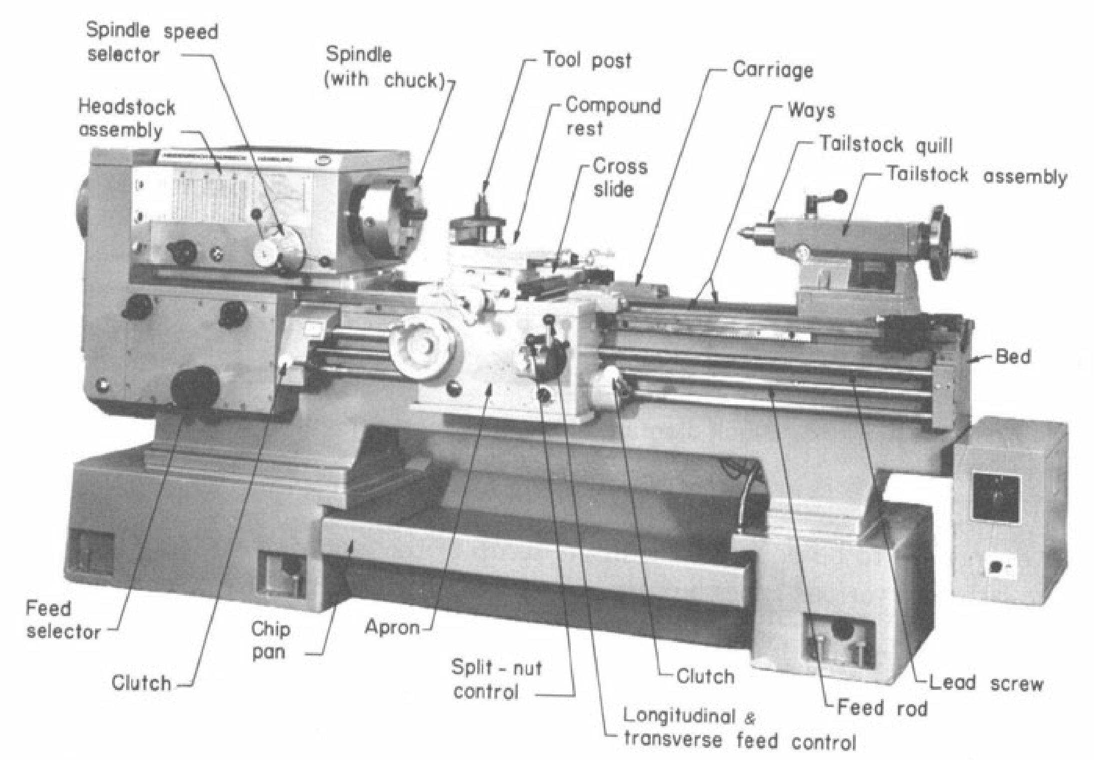


Figure 3.38 A diagram showing the components of a Lathe machine

1.Boring – creation of a hole in a work piece.

2.Drilling – increasing and already existing hole.

3.Threading – creation of with desired pith along a material internal or external length.

4.Tapering – uniform reduction of material along the length.

5.Counter sink and counter boring.

6.Grinding and polishing.

They are several factors that affect the speed of a lathe which include;

1.The type of operation to be performed by the lathe e.g. boring, tapering etc.

2.Nature of the material to be machined e.g. stainless steel, carbon steel, bronze, pvc etc.

3.Type of cutting tool to be used e.g. high speed steel (HSS), carbide etc.

3.39 DRILLING MACHINE

Drilling machine comes in many shapes and sizes, from small hand-held power drills to bench mounted and finally floor-mounted models. They can perform operations other than drilling, such as counter sinking, counter boring, reaming, and tapping large or small holes. d

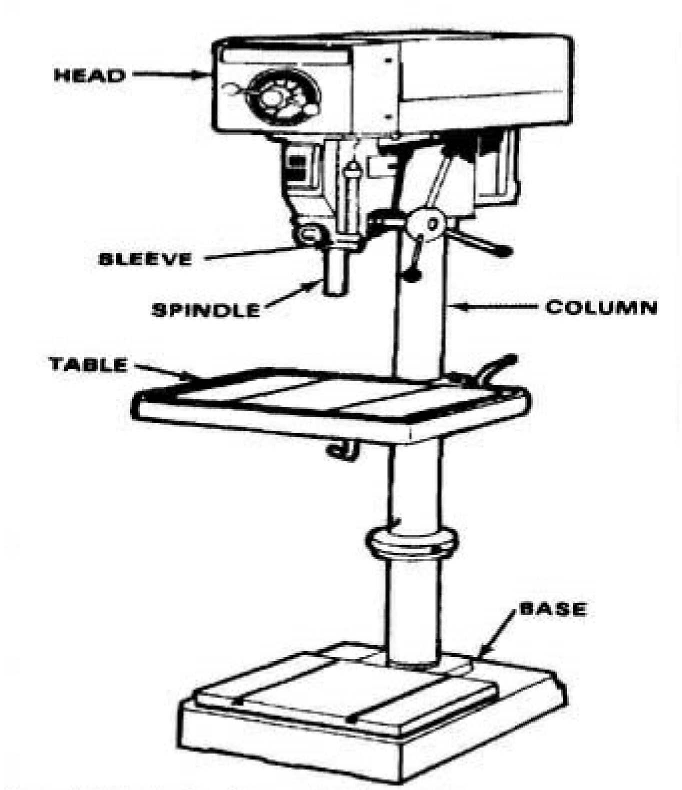


Figure 3.39 Diagram of a Drilling machine.

A drilling machine, called a drill press, is used to cut holes into or through metal, wood, or other materials. The cutting tool is held in the drill press by a chuck or Morse taper machines use a drilling tool that has cutting edges at its point. This and is rotated and fed into the work at variable speeds.

3.39.1.THE RADIAL DRILLING MACHINE.

A radial drilling machine or radial arm press is a geared drill head that is mounted on an arm assembly that can be moved around to the extent of its arm reach. The most important components are the arm, column, and the drill head. The drill head of the radial drilling machine can be moved, adjusted in height, and rotated. Aside from its compact design, the radial drill press is capable of positioning its drill head to the work piece through this radial arm mechanism.

The tasks that a radial drilling machine can do include boring holes, countersinking, and grinding off small particles in masonry works.

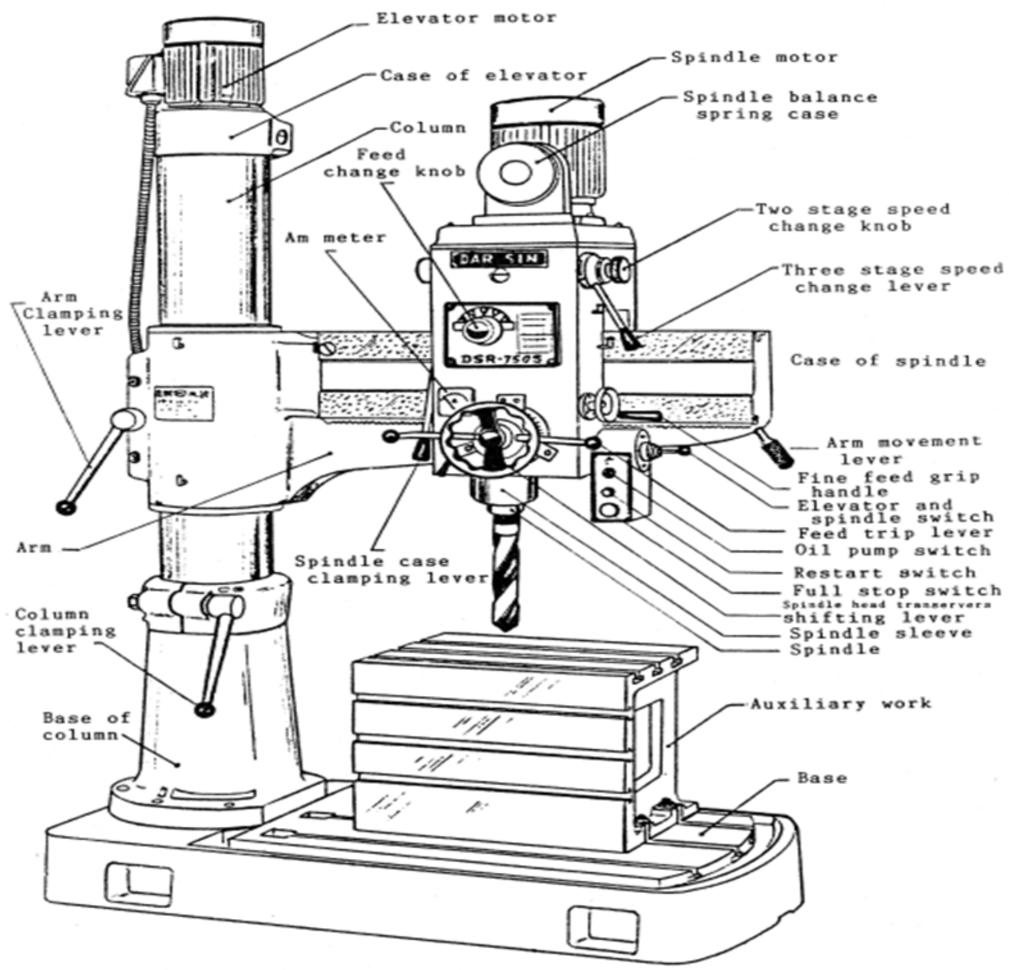


Figure 3.39.1 Diagram of a radial drilling machine

Here are some of the major parts of the radial arm drilling machine:

- Column - is the part of the radial arm drill press which holds the radial arm which can be moved around according to its length.
- Arm Raise - adjusts the vertical height of the radial arm along the column.
- Arm Clamp - secures the column and the arm in place.
- Table - is the area where the work pieces are fed and worked on.
- Base - is the radial arm drill press part that supports the column and the table.

- Spindle - is the rotated part of the drill press which holds the drill chuck used in holding the cutting tool.
- Drill Head - is the part of the drill press that penetrates through the material or work piece and drill through the specific hole size.
- Radial Arm - holds and supports the drill head assembly and can be moved around on the extent of its length.

3.40 MAINTENANCE PROCEDURES FOR MACHINE TOOLS

Lubrication is important because of the heat and friction generated by the moving parts. the manufacturer's manual should be followed for proper lubrication methods.

i. Clean each machine after use, clean T-slots, grooves, and dirt from belts and pulleys.

ii.Remove chips to avoid damage to moving parts.

iii.Wipe all spindles and sleeves free of grit to avoid damaging the precision fit.

iv.Put a light coat of oil on all unpainted surfaces to prevent rust.

v.Operate all machines with care to avoid overworking the electric motor.

vi.Operations under adverse conditions require special care. If machines are operated under extremely dusty conditions.

viiOperate at the slowest speeds to avoid rapid abrasive wear on the moving parts and lubricate the machines more often.

viii.Under extreme cold conditions, start the machines at a slow speed and allow the parts and lubricants to warm up before increasing the speeds.

Metal becomes very brittle in extreme cold. so do not strike the machines with hard tools. Extreme heat may cause the motor to overheat. so use intermittent. or on and off, operations to keep the motor running cool.

3.41 TURBINES

A turbine is a rotary mechanical device that extracts energy from a fluid flow and converts it into useful work. A turbine is a turbo-machine with at least one moving part called a rotor assembly, which is a shaft or drum with blades attached. Moving fluid acts on the blades so that they move and impart rotational energy to the rotor. In WRPC I worked frequently on the steam turbine and once on a Gas turbine.

3.42 STEAM TURBINES

The steam turbines is essentially a flow machine in which heat energy in the steam is transferred into kinetic energy and its kinetic energy is utilized to rotate the rotor while the steam flows through the turbine.During the flow of steam through the nozzle,the heat energy is converted into kinetic energy,The steam with high velocity enters the turbine blades and suffers a change in direction of motion which gives rise to change of momentum and therefore to a force.This constitute the driving force of the turbine.This force acting on the blades in the circumferencial direction sets up the rotation of the wheel or rotor.As the wheel rotates each one of the blades fixed on the rim of the jet of steam which causes the wheel to rotate continuously.

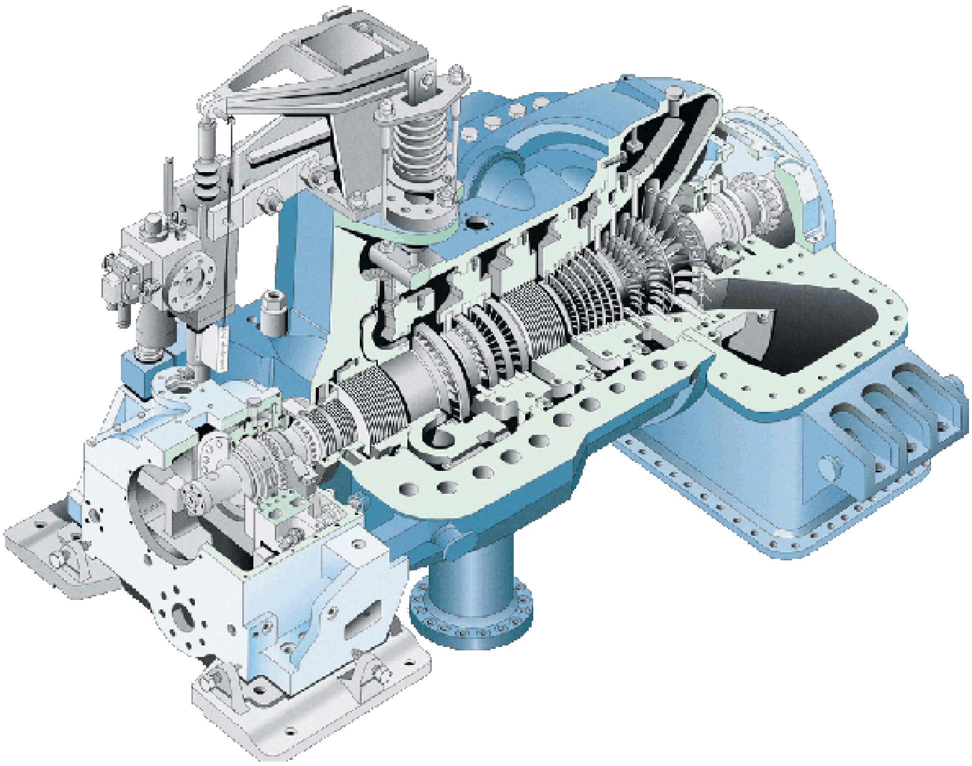


Figure 3.42 showing the internal parts of steam turbine.

The main parts of a steam turbines are:

i.Rotor.

ii.Blades(fixed and moving)

iii.Bearings(thrust and journal)

iv.Turbines casing

v.Valves (main stop valves,control valves etc).

3.43 ROTOR ASSEMBLY

The turbine rotor assembly consist of the turbine shaft and the attached moving blades.The rotor assembly absorbs energy from working fluid(steam,gas,water) and converts that energy into mechanical energy.

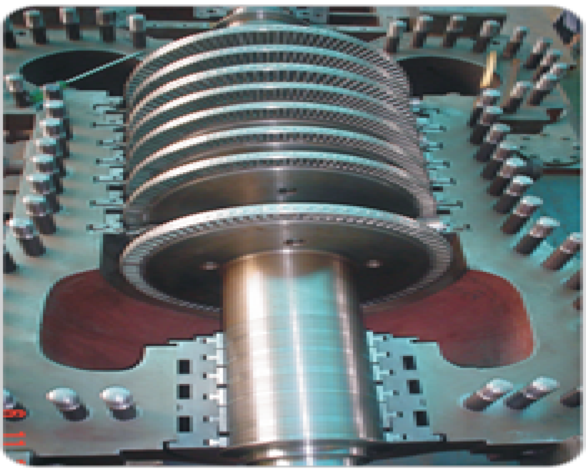


Figure 3.43. A diagram showing the rotor assembly of a steam turbine.

3.44 TURBINE BLADES: The energy conversion takes place through the turbine blades.A turbine consist of alternate rows of blades.this blades convert the thermal energy of the working fluid into kinetic energy and then from kinetic energy to mechanical energy as rotation of the shaft.

There are two types of blades,fixed and moving blades.The moving blades is of two types,one is impulse blades and the other reaction blades.

Figure 3.44 A diagram showing the blades of a turbine

3.45 FIXED BLADES

A fixed blade assembly is very important for turbine blading.it is also known as diaphragm blades.The shape of the blade is the key to the energy conversion process.Since the fixed blades have a conversing nozzle shape,it is also called nozzle.When steam is passed over the fixed blades,they increase the velocity of the steam as an operation of a nozzle.These blades converts the thermal energy of the steam into kinetic energy by causing the steam to spend up and gain velocity.

3.46 MOVING BLADES

Moving blades can be shaped in either of two ways:reaction shaped or impulse shaped.The shape of the blades determine how the energy is actually converted.Either type of moving blades or combination can be attached to the shaft of the rotor on the disc called wheel.Along the outer rim of the blades is a metal band,called shrouding which ties the blades together.The moving blades converts the kinetic energy of the steam into the mechanical energy as a rotor rotation.

3.47 BEARINGS IN STEAM TURBINES:

Two types of bearings are used to support and locate the rotors of steam turbines:

Journal bearings are used to support the weight of the turbine rotors. A journal bearing consists of two half-cylinders that enclose the shaft and are internally lined with Babbitt, a metal alloy usually consisting of tin, copper and antimony.

Figure 3.47 A diagram of a journal bearing

Thrust bearings is a particular type of rotary bearing.Like other bearings they permit rotation between parts,but they are designed to support predominately **axial** load.

Figure 3.47 A diagram of thrust bearing

High-pressure oil is injected into the bearings to provide lubrication. The oil is carefully filtered in the lube oil system to remove solid particles. Specially designed centrifuges like **clarifier** remove any water from the oil.

3.48 TURBINE CASING

Steam turbines consist essentially of a casing to which stationary blades are fixed on the inside and a rotor carrying moving blades on the periphery. The rotor is fitted inside the casing with the rows of moving blades penetrating between the rows of fixed blades.

Thus steam flowing through the turbine passes alternately through fixed and moving blades with the fixed blades directing the steam at the right angle for entry into the moving blades. Both casings and rotors must be constructed to minimize damaging thermal stresses and the moving blades must be fitted to the rotor securely to withstand the high centrifugal forces. Where the shaft of the rotor passes through the ends of the casing, a seal is required to prevent steam leakage. Also within the casing, seals are required to prevent steam from leaking around the blades rather than passing through them.

Figure 3.48 A diagram showing the casing of a steam turbines

3.49 VALVES IN STEAM TURBINES

Steam from the boiler is routed to the turbine through a steam line that contains the main stop valve and the control valve.

3.49.1. MAIN STOP VALVES

It is such a valve through which steam passes to the turbine blades.By controlling this valve steam flow can be controlled.Each main stop valve consit of a valve disk,a valve stem and a hydraulic actuator.The hydraulic actuator contains a piston and compression spring.Since the valve disk and stem are connected to the piston,movement of the piston causes movement of the valve disc.During normal turbine operation,hydraulic oil is directed into or out of the hydraulic actuator.Directing oil into the actuator opens the valve and compress the spring.As long as the amount of oil in the actuator allows is held conatant,the valve will remain in the same position.Bleeding oil from the actuator allows the spring to push on the piston,closing the valve.Tripping the turbine causes hydraulic oil to be bled quickly from beneath the piston,allowing the spring to quickly shut the valve

3.49.2 CONTROL VALVES

When the main stop valve are fully opened,the flow of steam into the high pressure turbine is usually regulated by four or more control valves.The control valves regulate the turbine speed or its power output.Steam from the main stop valve flows to the control valve through a steam line below the control valves.Each control valve feeds only one section of the nozzle block.

The control valve are operated by hydraulic actuactors.The control valves regulate steam flow into the turbine by opening and closing in sequence.As each valve is opened,more steam is admitted to the trurbine.During normal operation,the control valve are automatically positioned to compensate for changes in load.For example,if load increases,the control valve are opened more which increases the flow of steam into the turbine.If load decreases,the control valve are closed more which decreases the flow of steam into the turbine.At full condition,all the control valve are completely opened.

3.50 TURBINE GOVERNING SYSTEM

3.51 MECHANICAL GOVERNOR: The purpose of a mechanical governor is to maintain the speed of the turbine at desired value.The main parts of mechanical governor are

i.Flyweights

ii.Bracket

iii.Spring

Figure 3.51 A diagram showing governor of a steam turbine

When the turbine shafts rotates,the governor flyweights respond to the centrifugal forces created by the rotations.As the turbine speed increases,the centrifugal to move outwards,overcoming the tension of the spring.

The force of the spring tends to pull the flyweights towards the center of the governor.When turbine speed decreases,the centrifugal force also decreases,allowing the spring to pull the flyweights inwards.

When the speed of the turbine increases,the flyweights move outward,which causes the pilot valve stem to move upward.The movement of the stem and disc unblocks the port of the control line and allows oil to flow from the actuator,through the pilot valve,to the drain.The resulting decrease in the pressure beneath the piston allows the actuator spring to expand,forcing the piston towards.This action decreases the opening of the control valve and Less steam is admitted to the turbine and the turbine speed decreases.

When turbine speed decreases the flyweights moves inward and the connecting rod moves downwards.As the rod moves downwards,the pilot valve also moves downwards.Then the pilot valve blocks the drain line and opens the lube oil supply line,as a result oil from the supply line flows through the pilot valve and then into the control oil line to the actuator.Now the pressure of the lube oil cause the psiton to move upwards.Thus the opening of the control valve increase and mare steam is admitted to the turbine.Hence the turbine speed increases gradually until it reaches a desire speed.

3.52 SHAFT SEALS IN STEAM TURBINES

Large steam and gas turbines applications commonly employ **labyrinth seals** for reducing the leakage of steam

3.52.1 LABYRINTH SEALS

A labyrinth seal is a type of mechanical seal that provides a tortuous path to help prevent leakage. An example of such a seal is sometimes found within an axle 's bearing to help prevent the leakage of the oil lubricating the bearing.

A labyrinth seal may be composed of many grooves that press tightly inside another axle, or inside a hole, so that the fluid has to pass through a long and difficult path to escape. Sometimes screw threads exist on the outer and inner portion. These interlock, to produce the long characteristic path which slows leakage. For labyrinth seals on a rotating shaft, a very small clearance must exist between the tips of the labyrinth threads and the running surface.The "teeth" of the labyrinth seal may be on the rotating shaft.

Labyrinth seals on rotating shafts provide non-contact sealing action by controlling the passage of fluid through a variety of chambers by centrifugal motion, as well as by the formation of controlled fluid vortices. At higher speeds, centrifugal motion forces the fluid towards the outside and therefore away from any passages. Similarly, if the labyrinth chambers are correctly designed, any fluid that has escaped the main chamber becomes entrapped in a labyrinth chamber, where it is forced into a vortex-like motion. This acts to prevent its escape, and also acts to repel any other fluid. Because these labyrinth seals are non -contact, they do not wear out.

Many gas turbine engines, having high rotational speeds, use labyrinth seals due to their lack of friction and long life.

Figure 3.52.1 Diagram of Labyrinth seals.

3.53 MAINTENANCE PROCEDURES FOR STEAM TURBINES

Problems with turbines are now rare and maintenance requirements are relatively small.A few is listed below

1.Monitor all gauges and indicators for normal operation
2.Check lubricant level
3.Check for lubricant leaks
4.Check for unusual noise or vibration
5.It is however essential that the turbine be turned with dry steam.If water gets into the steam and is blasted onto the blades(moisture carry over) rapid impingement and erosion of the blades can occur,possibly leading to imbalance and catastrophic failure.Also water entering the blades will likely result in the destruction of the thrust bearing for the turbine shaft.To prevent this,along with control and baffles in the boiler to ensure high quality steam,condensate drains are installed in the steam pipping leading to the turbine.

3.54 GAS TURBINE

A gas turbine, also called a combustion turbine, is a rotary engine that extracts energy from a flow of combustion gas. It has an upstream compressor coupled to a downstream turbine, and a combustion chamber in-between. Gas turbine may also refer to just the turbine component. Energy is added to the gas stream in the combustor, where fuel is mixed with air and ignited. In the high pressure environment of the combustor, combustion of the fuel increases the temperature. The products of the combustion are forced into the turbine section. There, the high velocity and volume of the gas flow is directed through a nozzle over the turbine's blades, spinning the turbine which powers the compressor and, for some turbines, drives their mechanical output. The energy given up to the turbine comes from the reduction in the temperature of the exhaust gas.

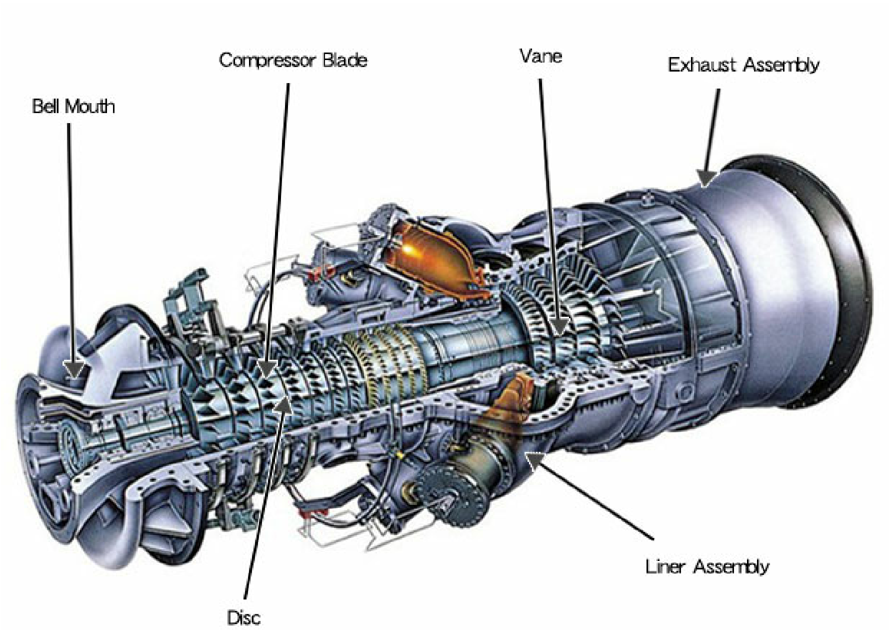


Figure 3.54 A diagram showing the internal components of a Gas turbine.

3.55 COMPARISON BETWEEN A STEAM TURBINE AND A GAS TURBINE.

GAS TURBINES	STEAM TURBINES
1.Flue gas acts as working fluid	Steam acts as working fluid
2. Main components are compressor and combustor.	Main components are boiler and accessories.
3. It requires the use of fuel	Its doesn’t require the use of fuel.
4. Its efficiency is less.	Its efficiency is more
5. It requires less space for installation.	It requires more space for installation
6. The mass of gas turbine per KW	The mass of gas turbine per KW developed

developed is less.	is more.
7. It does not depend upon water supply.	It depends upon water supply.

Table 3.55 Showing the differences between gas turbine and steam turbines

3.56 SOME OF THE PROBLEMS I ENCOUNTER DURING MY INDUSTRIAL TRAINING ATTACHMENT AND HOW IT WAS SOLVED

1.THE IMPELLER OF 203-P-210 CENTRIFUGAL PUMPS: After receiving a newly bought impeller from the planning department,we tried fixing in into the shaft but it happens that the internal diameter of the impeller was smaller than the diameter of the shaft.So we had to machined the internal diameter of the impeller to the required diameter where it can fit in to the shaft with some allowable clearance.

2.THE BEARINGS OF 101-P-18A: When trying to change the bearings of 101-P-18A centrifugal pump with a new one we encountered a difficulty because the bearing designation has cleaned off from the bearing surfaces making hard for us to know the particular bearing(in size and thickness) to use for the shaft.So we had to turn our attention to the SKF CATALOGUE MANUAL for bearings which shows us how we can get the bearing designation from measuring the external and internal diameter bearings and the thickness,after we took the measurement of those three parameters we traced it on the SKF CATALOGUE MANUAL and then got the bearing designation.

3.SHAFT ALIGNMENT OF 15-P-06A CENTRIFUGAL PUMPS: While trying to carry out shaft alignment on 15-P-06A centrifugal pump we observed that the values in the display unit sensor was tolerable(accepted) but it was intolerable for the vertical misalignment.So we tried to correct the vertical misalignment by adjusting the pump,but the more we tried the more the vertical and hoizontal misalignment values increases.Finally we resolved to adding shims on the foot of the electric motor which gave us an acceptable misalignment values.

4.THE SHAFT SLEEVES OF 101-P-18B:A new shaft sleeve was to be fixed on the shaft of the 101-P-18B centrifugal pump,but it happened that the diameter of the shaft sleeve was a bit smaller than the shaft diameter,seeing that the shaft sleeve was costlier than the shaft we had to produce another shaft that can suits the diameter of the shaft sleeve.

CHAPTER 4

CONCLUSION,LIMITATION AND RECOMMENDATION

CONCLUSION

Student industrial work experience scheme (SIWES) is a crucial and practically educative programme for all engineering students, which orientate them practically and broaden their knowledge in their respective engineering department also expose them how to handle challenges ahead. Having a six month industrial training has enlightened me on how relevant the Mechanical Engineering skills are in the daily transverse in an engineering field particularly as regards to crude refining activities and petrochemicals. My period of industrial training was a period of intense learning both theoretically and practically. Thanks to the team of supervisors, managers and the operators who made sure that the training was successful. Ability to feel a sense of responsibility in all spheres of engineering has made me ready for the challenges that will face a mechanical engineering graduate. Without any doubt the importance of the industrial training programme cannot be overemphasized since its basic aims has been achieved which include the following;

1.Exposing students to machines and equipments.

2.Bridging the existing between theory and practice of engineering.

3. Professional work methods/approach and way of safe guarding the personnel and work areas.

Also, it was made known that confidence is very crucial in the daily proceedings of an Engineer and it is paramount when it comes to undertaking target. It was brought to my understanding that no matter the pressure mounted by time or serviceability, one should not compromise safety for either speed, monetary gain or favour as the case may be. With these and other values I gained during these weeks, I can say with great confidence that the purpose of SIWES has been accomplished. Also safety measure to heed to in a process industry was also acquired. My initiatives and intelligence was also tested by my industrial-based supervisors whereby asking me several questions and carrying out some work activities in the plant under due supervision and safety.

4.1 LIMITATION IN THE USE OF THE EQUIPMENTS AND PROCEDURES FOR CARRYING OUT JOB IN WRPC

The limitation I observed at WRPC about the use of their equipments and the procedure for carrying out jobs were;

1.Some of the equipments are operated on **breakdown maintenance mode** that's the operators waits until the equipments fails and repairs it.Such a policy is not suitable for a refinery because it will significantly affect the operation and production of products in the refinery.It can also cause a total failure of the machine beyond repair as maintenance is only carried out when the materilas fails.and if the equipments fails beyond repairs it leaves the company with no choice but to incur a new machine and that may cost the company as well.

2.The age of the equipments in WRPC affects the efficiency of the equipments and the process of productions in general

3.Work request that are stated for emergency purpose was not really carried out on emergency basis and this reduces or slows down the production rate of products in WRPC.

4.Work permit was only collected by staff and not support staff

4.2 RECOMMENDATIONS

1.Preventive,periodic and predictive maintenance should be carried out on all the working equipments.Preventive maintenance entails cleaning,inspecting,oiling,re-tighthening of the parts of the machines.

2.Newly designed equipments should be purchased to ensure that optimum production takes place.

3.Work request instruction should be obeyed at all times,for this will reduce the downtimes of the company's operation.