AN INTERNAL PROJECT ON

Lubricating Oils Blending, Filling and Packing at Indian Oil Corporation Ltd Lube Blending Plant, Budge Budge

&

THE POTENITAL USE OF BIOLUBRICANTS IN THE INDUSTRY

Submitted by

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ACKNOWLEDGEMENT

It's a great pleasure to express my gratitude to Professor Shirshendu De, Head of the Dept. Chemical Engineering, IIT Kharagpur for recommending me for internal project at IOCL, major National Oil Company of the country & Ms. Maria Bhattacharya, General Manager (L&D) ER, IOCL for referring me to Lube Blending Plant, Budge Budge to execute this project. This project has given me an excellent overview of lubricants manufacturing process and marketing.

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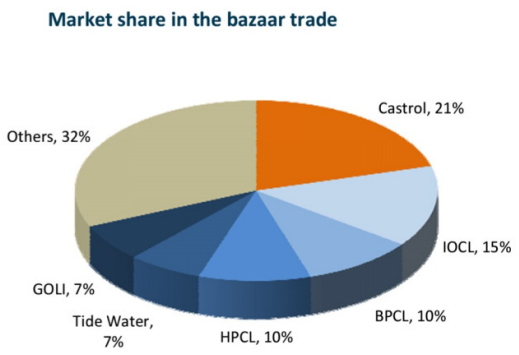
INDIAN OIL CORPORATION LIMITED

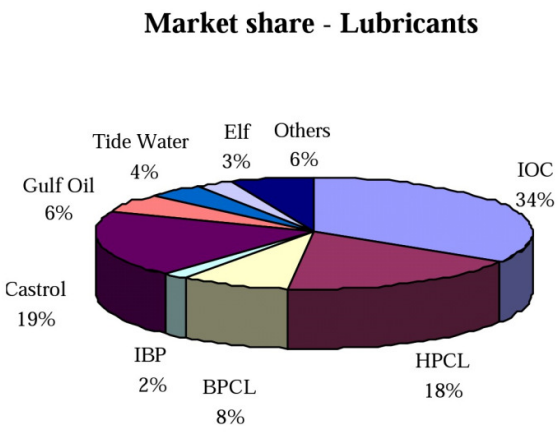
INTRODUCTION

Indian Oil Corporation Limited was established in 1959. It mushroomed itself into The INDIAN OIL CORPORATION in 1964, collaborating with the Indian Refineries Ltd. It covers various operations under its wings like Pipelines, Refineries Marketing, Petrochemicals, etc. which has helped it to establish its roots stringently to its empowerment and growth in this frontier. With over 1000 commercial grades and over 1,500 formulations developed by our in-house R&D Centre, SERVO serves as a one-stop shop for complete lubrication solutions in the automotive, industrial and marine segments.

The lube market was liberalized in 1993. Before the lube market was liberalized, public sector companies dominated the market. SERVO had about 80% of the market shares producing only monograde. CASTROL was the only MNC marketing company with 5% shares. There were no promotional activities and the selling was confined to petrol pumps. Post liberalization, there were 22 players in the market. EXXON MOBIL, SHELL, CHEVRON, CALTEX, TOTAL, ELF, BP, VALVOLINE/MITSUBISHI, BALMER LAWRIE, INDIAN OIL BPC, HPC, RAJ/APAR/SAVITA (LOCALS) were the major players. LOBS and additives were allowed for free import. That time Castrol repositioned itself in the market by becoming a volume player and entering into the institutional segment. IOC brought some changes in its system by introducing multigrades at that critical moment. Its market share came down to 30% due to increase in its prices but it re-engineered the business by re-engineering the supply chain, distribution, retailing and pricing. It retained the core strategy of being low cost player and doing volumes. Finally it retained its market leadership with 43% share.

Currently, SERVO has the 2nd largest share in retail lubes and is undisputed no.1 in institutional market.





LUBE BLENDING PLANT, BUDGE BUDGE

HISTORY

The Budge Budge Lube Blending Plant started in September 1989 and belonged to Caltex. Then it was taken over by IBP Corporation Limited. IBP Corporation limited was found in the name of Indo Burma Petroleum Corporation Limited in 1909 and in 1983 the company's changed to IBP Corporation Limited. On 2nd June 2007, IBP merged with IOC and this plant became a part of IOCL's lube blending plant.

LBP Budge Budge has a blending capacity of 35000MT/PA in single shift and produces mainly industrial and automotive grades of lubricants. The plant has an ISO 9001-2015, 14001:2015 and ISO/TS 16949: 2009 certification.

PLANT LOCATION

The Lube Blending Plant, known as LBP Budge Budge, is located at Budge Budge which is an important port and industrial location for oil and jute located on the eastern bank of river HOOGLY, 22 kms off Kolkata. This plant lies under the administrative jurisdiction of 24 PGS(S). It gets refined oil from Haldia refinery, 60 nautical miles away.

PLANT AREA

The design engineering and construction management for the plant has been carried out by m/s. Balmer Lawrie & Co Ltd, based on the process package prepared by m/s. Engineers India Limited. The plant spreads over 2940 Sq.m of area. There is a NDP area where the base oil storage tanks, fire water tanks, fire water pump house and base oil pump house are located.

The total plant area is divided in different sections that are shown in the chart below:

Area name	Area m^2
Plant area	953
Plant office area	233.88
Ware house area	234
Store area	24
Barrel filling area	464
Quality control room	263
Welfare block	143
Small can filling section	310
Administrative building	315

LUBRICANT

Lubricant or lube is a substance introduced to reduce friction between moving surfaces by applying additional medium/film between the surfaces.

Lubricants are of two types:

1. Mineral base
2. synthetic base

MINERAL BASE LUBRICANT

This is a complex mixture of paraffinic, olefinic, aromatic and napthenic hydrocarbons of molecular structure C14 to C40 and above along with asphaltenes, resins, wax, Nitrogen, Phosphorus and Sulphur molecule.

Paraffinic base oils are preferentially used to formulate most of the world's automotive and industrial lubricants including engine oils, transmission oil, gear oil due to their high oxidation stability, high viscosity index and low volatility.

Napthenic base oils have lower pour point, low viscosity index and better solvency characteristics compared to paraffinic base oil. They are most preferably used to formulate refrigeration oil, shock absorber oil etc.

SYNTHETIC BASE LUBRICANT

Synthetic base oils are superior quality base stock over mineral base stock in lubricant technology. These are highly stable, durable, biodegradable and costlier base stock. Most widely used synthetic base stocks are as follows:

1. Organic esters
2. Phosphate esters
3. Poly alkylene glycols
4. Alkyl benzenes
5. synthetic hydrocarbons
6. poly hydrocarbons etc.

FUNCTIONS OF LUBRICANT

1. Lubricants form a thin layer between moving parts thus keeping them apart. This helps to reduce friction, surface fatigue, heat generation, operating noise and vibrations.

2. Liquid and gaseous lubricants can transfer heat. Liquid lubricants are more effective as they have high specific heat capacity. Circulation of lubricants helps temperature regulation.
3. Lubricants reduce surface-to-surface friction. The lubricant-to-surface friction is much less than that and it contains additives known as friction modifiers which help in reducing friction.
4. The circulation of lubricants helps to carry away the internally generated debris and external contaminants that get introduced into the system.
5. It prevents wear and tear by keeping the moving parts apart.
6. Lubricants are formulated with additives that form chemical bonds with surfaces or exclude moisture to prevent corrosion and rust
7. It occupies the clearance between moving parts through capillary force thus sealing the clearance. This effect is used to seal piston and shafts.
8. It is also used to transmit power by acting as a hydraulic fluid.

BASE OIL

MINERAL BASE OIL- GROUP I, II, III:

This is a complex mixture of paraffinic, olefinic, aromatic and naphthenic hydrocarbons of molecular structure C14 to C40 and above along with asphaltenes, resins, wax, Nitrogen, Phosphorus and Sulphur molecule

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SYNTHETIC BASE OIL

Synthetic base oils are superior quality base stock over mineral base stock in lubricant technology. These are highly stable, durable, biodegradable and costlier base stock. Most widely used synthetic base stocks are organic esters, phosphate esters, poly alkaline glycols, alkyl benzenes, synthetic hydrocarbons& poly hydrocarbons etc. GROUP IV, V falls under this category.

ADDITIVES

Additives are used to boost performance of lubricants and impart performance characteristics. It is vital for prolonged use of motor oil in modern internal combustion engines, gear boxes, automatic transmissions and bearings. Some of the additives used and their functions are given below:

Function	Type	Remarks
For Controlling chemical breakdown	Detergents	* Used to clean and neutralize oil impurities which would normally cause deposits (oil sludge) on vital engine parts. * Typical detergents are magnesium sulfonates.
For contaminant control	Dispersants	* Keep contaminants (e.g. soot) suspended in the oil to prevent them from coagulating.
For lubricity	Anti wear & Extreme Pressure	* Agents bond to metal surfaces, keeping them from touching even at high pressure. * Cause a film to surround metal parts, helping to keep them separated. * Zinc dialkyldithiophosphate or zinc dithiophosphates are typically used. * Wear metals from friction are unintentional oil additives, but most large metal particles and impurities are removed in situ using either magnets or oil filters. * Tribology is the science that studies how materials wear.
For Controlling chemical breakdown	Antioxidants	* Retard the degradation of the stock oil by oxidation. * Typical additives are organic amines and phenols.
For Controlling chemical breakdown	Antioxidants & Anti wear	* Create a film on metal surfaces to prevent the metal from causing the oil to be oxidized.
For viscosity	Viscosity Index Improvers	* Makes oil's viscosity higher at elevated temperatures, improving its viscosity index (VI). * This combats the tendency of the oil to become thin at high temperature. * The advantage of using less viscous oil with a VI improver is that it will have improved low temperature fluidity as well as being viscous enough to lubricate at operating temperature. * Most multi-grade oils have viscosity modifiers. * Some synthetic oils are engineered to meet multi-grade specifications without them.
For viscosity	Pour point depressants	* Improve the oil's ability to flow at lower temperatures.
For contaminant control	Antifoams	* Inhibit the production of air bubbles and foam in the oil which can cause a loss of lubrication, pitting, and corrosion where entrained air and combustion gases contact metal surfaces.
For Controlling chemical breakdown	Rust Inhibitors	* Retard the oxidation of metal inside an engine.
For water separation	Demulsifiers	* For Demulsification
For Controlling chemical breakdown	Corrosion Inhibitors	* Retard the oxidation of metal inside an engine.

#Metal deactivators are used as it creates a film on metal surfaces to prevent the metal from causing the oil to be oxidized.

Friction modifiers or friction reducers are used for improving lubricity as it reduces friction between moving parts it alters the lubricity of the base oil. Whale oil was used historically but now molybdenum disulphide is used.

Dyes are sometimes added while blending in amount of about 1L while making selected grades. They are used for checking leakages. Some dyes are fluorescent and can be seen only under UV light.

MAJOR FACILITIES AND INFRASTRUCTURE

STORAGE TANK

BASE OIL STORAGE TANK

The plant has 8 base oil storage tanks with a total capacity of 7043 Kls. The details about the tank and the product are given below:

TANK NO	CAPACITY(kL)	PRODUCT STORED
T001/TK03	530.236	BS150
T002/TK04	526.074	SN150
T003/BS(H)	403.505	SN850
T004/BS(L)	402.098	SN850
T005/BS(150)	1543.029	SN500
T006/TK207	1755	H500
T007/TK208	97.706	SLOP(BASE- OIL MIXTURE)
T019/TK206	1786.273	H150

ADDITIVE STORAGE TANKS

There are 5 storage tanks of total capacity 372kL for storing additives which are used in large quantities and the additives stored in barrels. The details about the tanks and the product stored are given below:

TANK NO.	CAPACITY(kL)
TK09/T009	87.1
T015/1201	57.8
T016/1202	57.7
T018/1204	84.8
T017/1203	84.5

PRODUCT STORAGE TANK

There are 5 product storage tanks or PST of total capacity 420kL for storing finished products. The details about the tanks and the product stored are given below:

TANK NO.	CAPACITY(kL)	PRODUCT STORED
TK08	87.2	SERVO SYSTEM 68
TK11	106	SERVO PREMIUM CF4 15W-40
TK12	52	SERVO PUMPSET OIL 40
TK13	101	SERVO SUP. MULT. GRD 20W40
TK14	74	SERVO SUPER 4T

WATER STORAGE TANK

There are 2 water storage of total capacity 8632kL for storing water which is to be converted into steam for blending operation and for firefighting purpose. The details about the water tanks and their capacity are given below:

TANK NO.	CAPACITY(kL)
203	3597.59
204	5034.36

BLENDING KETTLE

There are 8 blending kettles of total capacity 257kLs. The details of the tank and their capacities are given below:

TANK NO.	TOTAL CAPACITY(kL)	SAFE BLENDING CAPACITY(kL)
BK01	50	48
BK02	50	48
BK03	50	48
BK04	25	24
BK05	25	24
BK06	50	48
BK07	5.5	5.3
BK08	2	1.89

ELECTRICAL EQUIPMENT

The plant receives 11kV power supply from CESC LTD. There is a transformer of 1000kVA which steps down the 11kV supply to 440V for plant use. The details of the transformer are given below:

- Make: Crompton
- Rating: 1000kVA
- Frequency:50 Hz
- Type: Oil

- Primary : 6000V
- Secondary:433V
- Voltage ratio: 6kV/433V
- Weight of oil:770 kg
- Weight of core:1530kg

BREAKER

- Make: Biecco Lawree LTD.
- Type: Oil circuit breaker
- Rate current :800A

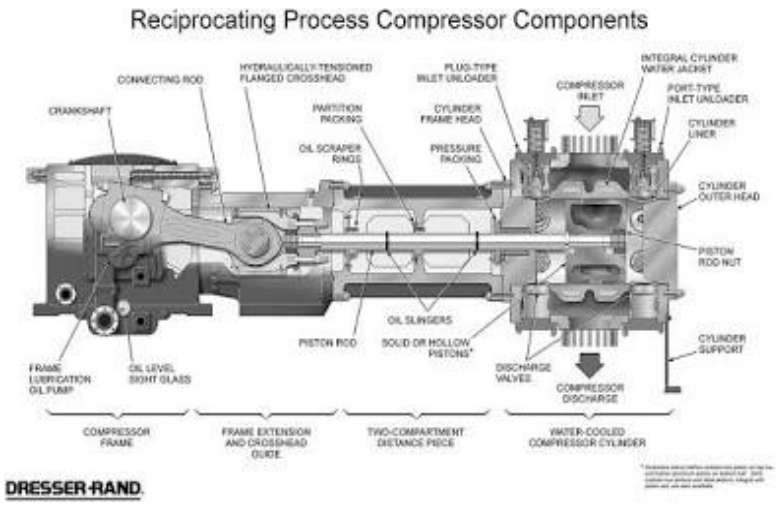
There are 2 DG sets of 320kVA and 1 lighting DG set of 65kVA for emergency purpose. The engine is of Cummins make and alternator is of KEC make. The 65kVA DG set is of Kirloskar make.

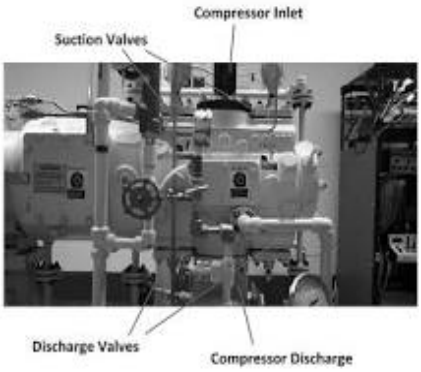
AIR COMPRESSOR

Air compressor is a device that converts power using an electric motor, diesel or petrol engine into pressurized (compressed) air. It is needed in the blending process for agitation of the base oil additive mixture. In this plant there are 2 type of air compressor. They are:

1. Model- B3100M: It is a single acting, single stage & non lubricated (as the piston is made of Teflon & the steel is made of metal so coeff. of friction is less) reciprocating air compressor. The capacity is 100 cuft/min & working pressure is 7kg/cm^2. Air is sucked inside, compressed & discharged.
2. Model – BTDLM: it is a double acting, double stage & lubricated (both the piston & the cylinder is made up of metal so lubrication is used to prevent wear & tear) reciprocating air compressor. Capacity is 350cuft/min & working pressure is 7kg/cm^2. Air is sucked inside the low pressure cylinder, compressed by the reciprocating piston & id discharged into the muffler. The compressed air is extremely hot. So, it is cooled in a pipe having water jacket around it. This compressed air is again sucked in the high pressure cylinder, again compressed by the piston & discharged to muffler from where it is sent for purification after cooling it to normal temperature.

After the compression the compressed air is sent for purification where moisture &oil (from lubrication) which can harm the blending process is removed. First, the compressed air is sent to a moisture & oil separator then the saturated air is received in a air receiver. At last the air is sent to a drier packed with a drier. There are 2 driers. One works while the other gets regenerated. In regeneration the moisture is removed from the alumina by passing hot dry air for 4 hours & then letting it to cool for 2hours.

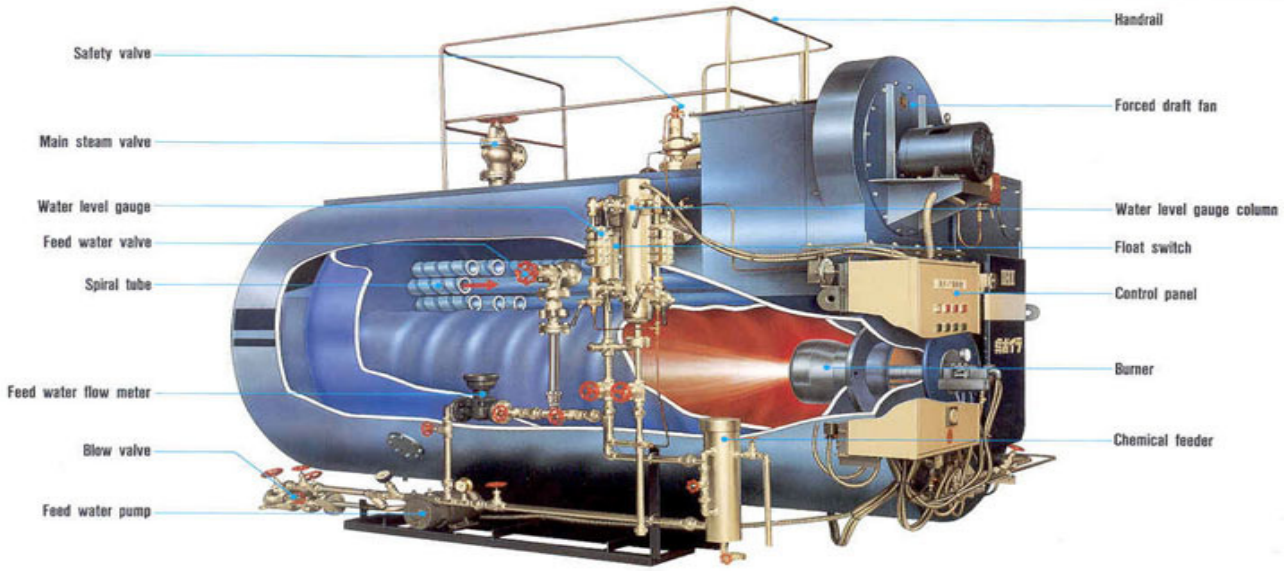




BOILER

Steam is required to maintain the temperature of 50-60°C during blending of lube. So the plant has a 5MT capacity of fire tube boiler to make steam. It is a 3 pass reverse flue smoke tube boiler of RevoTherm make. LDO is used as fuel.

A boiler or a steam generator is a device used to create steam by applying heat energy to water. The steam generated is required to heat the base oil additive mixture while blending process. The boiler used in this plant is an Oil-Fire smoke tube packaged boiler. It is a 3 pass boiler i.e. the flue gas circulates the boiler 3 times with the help of pipes before it gets out of it, so that maximum heating can take place. Forced circulation takes place with the help of a fan. Water used is first softened & then heated. It has 2 operation mode: high fire (more heating for more production of steam) & low fire. Water level should always remain about 70%. The safety devices used are water level indicator controlling the feed pump, fusible plug, safety valve & water gauge.



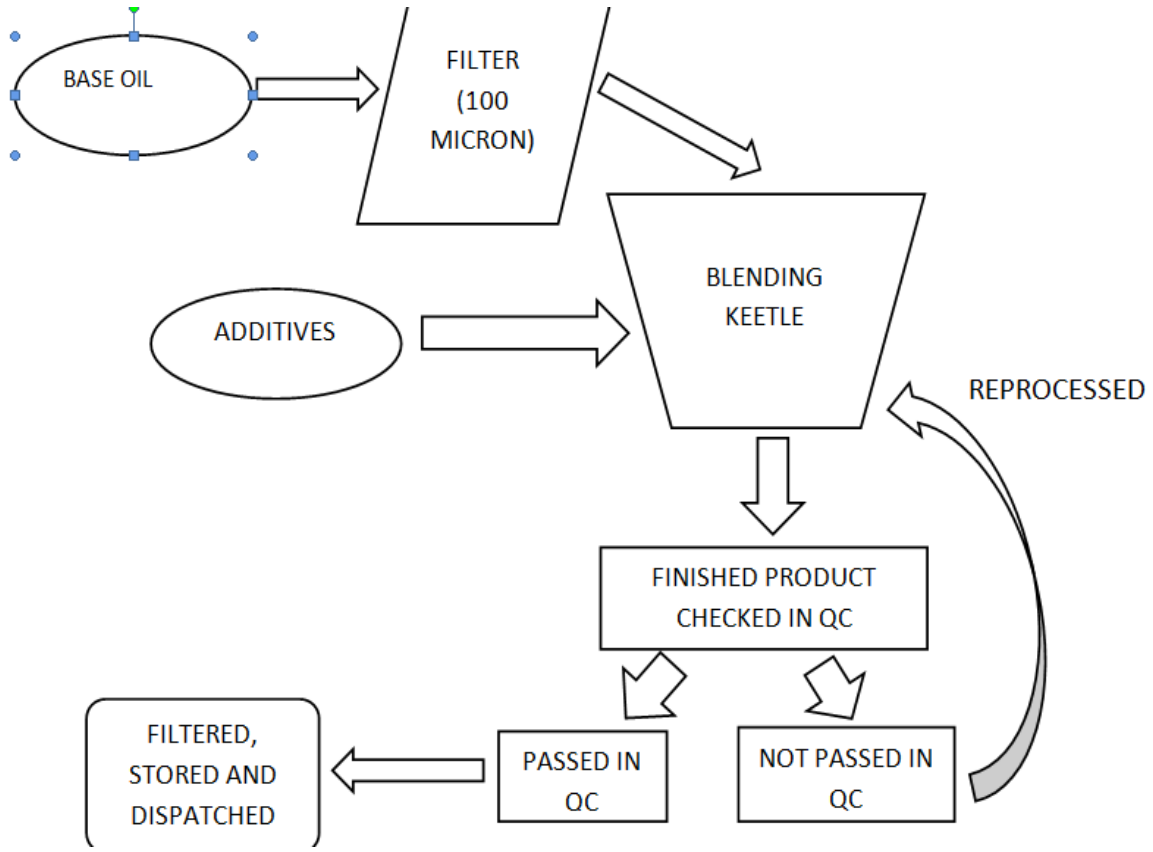
LUBE BLENDING

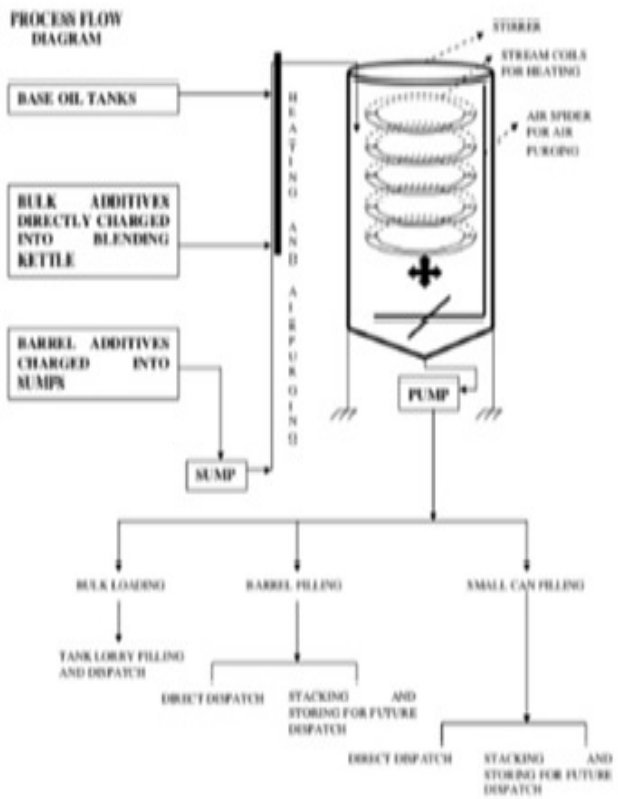
Blending refers to the process of **mixing**. It is a **physical batch** process.

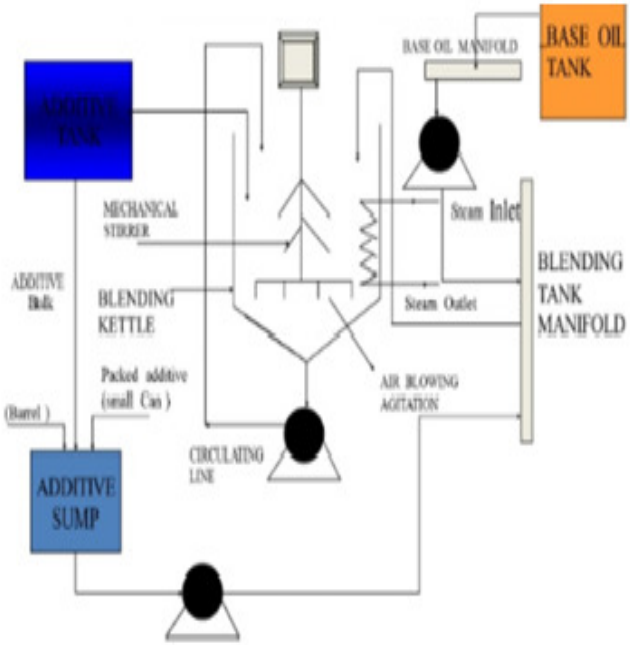
In lube blending **base oil is mixed with additives**(in required amount as per the lube to be processed) according to the formulation made in a blending kettle for 2-3 hours by passing compressed dry air through the mixture agitating it in the process and in presence of continuous heat with the help of superheated steam. The base oil and the additives from the tank is filtered before they are filled in the blending kettle by a 100 micron filter. The additives from the barrel are poured in a place called 'sump' below the blending kettle and then it is pumped to the blending kettle from there. After blending, a sample of the lubricant made is checked by the Quality Control Lab on certain parameters. If the lubricant gets passed for all the test then the lubricant is sent for storage else the lubricant is again blended with rectification.

The lubricant is either direct stored in the storage tank else it is stored and packed in barrels, drums and other containers for direct dispatch after being filtered in a 40 micron filter. The lubricants which are frequently made are stored in the product storage tank.

A flowchart of the process is given below:




PROCESS FLOW DIAGRAM
BASE OIL TANKS
BULK ADDITIVES DIRECTLY CHARGED INTO BLENDING KETTLE
BARREL ADDITIVES CHARGED INTO SUMPS
SUMP
HEATING AND AIRPURGING
STIRRER
STREAM COILS FOR HEATING
AIR SPIDER FOR AIR PURGING
PUMP
BULK LOADING
BARREL FILLING
SMALL CAN FILLING
TANK LORRY FILLING AND DISPATCH
DIRECT DISPATCH
STACKING AND STORING FOR FUTURE DISPATCH
DIRECT DISPATCH
STACKING AND STORING FOR FUTURE DISPATCH


ADDITIVE TANK
BASE OIL MANIFOLD
BASE OIL TANK
MECHANICAL STIRRER
Steam Inlet
ADDITIVE Bulk
BLENDING KETTLE
Steam Outlet
BLENDING TANK MANIFOLD
Packed additive (small Can)
AIR BLOWING AGITATION
(Barrel)
CIRCULATING LINE
ADDITIVE SUMP

QUALITY CONTROL

EQUIPMENTS USED IN THE QUALITY TESTING LAB:

SNO	EQUIPMENT NAME	MODEL	MAKE
1	ASTM COLOR COMPARATOR	AF-650	LOVIBOND,USA
2	ATOMIC ABSORPTION SPECTROPHOTOMETER	AA 220	VARIAN,AUS
3	AUTO COLD CRANKING SIMULATOR, CCS	CCS2100F	CANNON USA
4	BROOKFIELD VISCOMETER	DV II+ PRO	BROOKFIELD, USA
5	CLOUD & POUR POINT APPARATUS		STANHOPE SETA,UK
6	DENSITY METER	DMA 48	ATTON PAAR,AUSTRIA
7	ED XRF LAB-X 3500	LZ 3125 A	OXFORD INSTRUMENTS, BUCKS, JSE
8	EMULSION TESTING EQUIPMENT (54°C)	-	CHEMICAL & INSTRUMENT,INDIA
9	EMULSION TESTING EQUIPMENT (82°C)	-	INHOUSE MODIFIED
10	EVAPORATION LOSS APPARATUS NOACK	NCK-1	ISL FRANCE
11	FOAM BATH for Sq I,II & III	140020-2	STANHOPE SETA,UK
12	FOAM BATH for Sq IV	K 43049	KOEHLER,USA
13	FTIR SPECTROMETER	PARAGON 1000	PERKIN ELMER,USA
14	HIGH TEMP HIGH SHEAR TESTER	HTHS 1F	CANNON USA
15	KINEMATIC VISCOSITY BATH@100°C	CSD 20	LAUDA, GERMANY
16	KINEMATIC VISCOSITY BATH @40°C	CSD 20	LAUDA, GERMANY
17	PARTICLE COUNTER	CM 20.9011	UCC INTRNTNAL,UK
18	PHOTO-COLORIMETER	800-3	KLETT-SUMMERSON,USA
19	SEMI AUTO COC F P APPRTS	-	STANHOPE SETA,UK
20	SHEAR STABILITY TESTER (WITH BOSCH NOZZLE)	TR-294	DUCOM BANGALORE

PROCEDURE OF THE APPARATUS:

NAME OF THE APPARATUS	PROCEDURE	PICTURES OF EQUIPMENT /APPARATUS USED
Appearance	It is a visual examination of the product. This helps to check whether the product is clear, bright & free from suspended particles, sediments. We get to know the purity of the product w.r.t. incomplete blending, additives insolubility &product stability.	
KINEMATIC VISCOSITY BATH @40^{0}C	It is defined as the resistance to flow under gravity. The time is measured in seconds for a fixed volume of a liquid to flow under gravity through the capillary of a calibrated viscometer under a reproducible driving head and at a closely controlled temperature 40$^{0.}$C The kinematic viscosity is then measured as v=c*t (where, c is calibration constant of capillary in centistokes/sec & t is time taken to flow measured in sec).	
KINEMATIC VISCOSITY BATH @100^{0}C	It is defined as the resistance to flow under gravity. The time is measured in seconds for a fixed volume of a liquid to flow under gravity through the capillary of a calibrated viscometer under a reproducible driving head and at a closely controlled temperature 100^{0}C The kinematic viscosity is then measured as v=c*t (where, c is calibration constant of capillary in centistokes/sec & t is time taken to flow measured in sec).	

Viscosity index (ASTM D 2270)	The viscosities of lubricating oils change rapidly with temperature. The rate of change of viscosity varies with the type of oil. The rate of change of kinematic viscosity with temperature is indicated by the viscosity index. It is found with the help of the viscosity at 2 different temperatures (mainly 40 &100˚C) from the V.I. chart.	
AUTO DENSITY METER @29.5^{0}C	It is a fundamental physical property. It is measures by auto density meter or hydrometer. Density obtained can be converted to any required temperature by conversion table. It is the only parameter for conversion of product from volume to weight by sales dept.	
EMULSION/DEMULSION TEST APPARATUS @54/82°C ASTM D1401 (WATER SEPARABILITY CHARACTERISTICS)	It determines the ability of the petroleum products to separate from water. It is a required test for turbine and hydraulic grades which are mixed with water/steam on service. So water separability is a prime requirement of lubricant as emulsion causes failure. This test method covers measurement of the ability of petroleum oils or synthetic fluids to separate from water. Water separation ability of petroleum is determined by this temperature. Testing temperature and time is: At 54˚C for oil having viscosity upto 90cst, time is 30 min. At 82˚C for oil having viscosity > 90 cst, time is 60 min.	

FOAMING CHARECSTERICTS ASTM D-892	Foaming is a surface phenomenon of lubricants. It occurs due to undesirable presence of surfactants in oil. It takes place at the upper surface of lubricant. It is undesirable as it causes inadequate lubrication, cavitations and overflow of lubrication leading to mechanical failure. This test helps to determine empirically the foaming tendency and stability of an oil. The sample is maintained at 24^0C,is blown with air at constant rate for 5min then allowed to settle for 10min. The volume of foam is measured at the end of both periods. The test is repeated on a second sample at 93.5^0C and then, after collapsing the foam at 24^0C	
Pour point (ASTM D 97)	It is defined as the lowest temperature at which the product's flow is observed. It indicates the pumping ability of the product and stability of its use in low temperature zone. It is measured by pour point and cloud point apparatus. It provides the lowest temperature at which it flows which is 3˚C.	
Flash point (ASTM D 92) COC- Cleveland open cup. For low auto ignition temp of 40 to 360˚C.	It is defined as the lowest temperature at which the vapour of the liquid oil ignites on application of flame COC(D 92), PMCC (D 93). It is a mandatory parameter required to be declared during shipping/ transportation of the product as per safety regulation. It indicates the flammability of a product.	

ASTM Colour (ASTM D1500)	The instrument used is Colour comparator. It compares the colour of the product with water and gives the result in no. The no. obtained is matched with the required value. It tells about the degree of refining, possible contamination & colour stability.	
Elemental analysis (ASTM D 6443)	It is used to determine the amount of calcium, chlorine, copper, magnesium, phosphorus, sulphur& zinc in the oil by Wavelength Dispersive X-ray Fluorescence Spectrometry.	
Apparent viscosity (ASTM D 5293)	This is to find the viscosity of an oil at very low temperatures. It is done by cold cranking simulator.	

BASE OIL SLOP- This is a mixture of 2 or more base oils. This is stored in a separate tank. It has a density average of the base oils present in the mixture.

PIGGING-This is a system used for cleaning pipelines to avoid contamination & reduce effluents. It consists of a rubber pig which is propelled along the length of the pipe using neutral oil, air or a flushing agent. As it moves along the line the leftover residue in it is pushed out & collected at receivers end.

DESCRIPTION OF EQUIPMENTS

DENSITYMETER:

Density is the mass per unit volume of fluid at required temperature .for petroleum products it is reported as gm/cc or kg/cubic metre.

- The equipment is allowed to be stable at set temperature.
- The oscillator tube was cleaned and air dried.
- When display shows0.0012-0.0014 the bubble free sample is pushed into the oscillator tube.
- The final reading is recorded when red light stops flickering on the right side.

TEST FOR POUR POINT:

- The test sample is taken upto the specific mark ina pour point jar.

- Depending upon the pour point the test jar is gradually transferred from 0 degree bath to -51 degree bath.
- Observation of flow should be started before 9 degree Celsius and in every 3 degree of interval.
- The pour point should be reported by adding 3 degree with the temperature at which the flow of the sample ceases.

FOAMING TEST:

Foaming takes place at the upper surface of lubricant in system. Storage especially in high speed gearing, high volume pumping and splash lubrication. Foaming is undesirable due to inadequate lubrication; cavitation's and overflows loss of lubricant which leads to mechanical failure.

- 190 ml of the sample is taken in a specified 1000 ml foaming cylinder fitted with diffuser stone.
- The cylinder is immersed in constant temperature bath and the sample is allowed to attain the desired temperature which is 84 degree Celsius.
- Through the flow meter air is passed for 5 minutes into the sample at a rate of 94 +-5 ml/min.
- The volume of foam in ml after 5 mins of air blow is recoded and after 10 mins t the end of a blow.
- The foam volume in ml is reported as tendency and stability.

CLEVELAND OPEN CUP APPARATUS: DETERMINATION OF FLASH AND FIRE POINT:

- The cup is filled at any convenient temperature so that top of meniscus is exactly at filling line. The test flame is lit and is adjusted to a diameter of 3.2mm to 4.8mm.Heat is initially applied. When sample temperature is apparently 56 degree below the anticipated flash point the heat is decreased so that the temperature rise for the last 28 degree Celsius is 5 to 6 degree per minute. For last 28 degree, the test flame is passed across the centre of cup at right angles to diameter which passes through the thermometer. When a flash appears at any point on the oil surface the temperature on the thermometer is recorded as the flash point.
- To determine fire point the heating is continued so that sample temperature increases at the rate of 6 degree per minute and the application of test flame is continued at 2 degree intervals until oil ignites and continues to burn for at least 5 seconds.

COLD CRANKING SIMULATOR:

Many engine oils are non Newtonian at low temperature ,apparent viscosity varies with shear rate .It measures apparent viscosity of engine oils at -5 degree Celsius to -30 degree Celsius at shear stress 50000 pa to 100000 pa .An electric motor drives a rotor that is closely filled inside a stator.oil fills the space between rotor and stator. Test temperature is measured near stator inner wall and maintained by regulated flow of refrigerated coolant through the stator .The speed of rotor is calibrated as a function of viscosity. Test oil viscosity is determined from calibration and measured rotor speed.

KINEMATIC VISCOSITY BATH:

• Identification of class of lubricant with respect to viscosity.• Defined as the resistance to flow under gravity

. • Measured as : v = c * t (where , c- calibration constant of capillary, centistokes/sec and t- measured time in sec) to flow a fixed volume of liquid through Capillary under gravity.

Significance:

• It's a critical property which determines the suitability of application of lubricant to the user.

• Depending upon the load, film thickness and hence the viscosity the class of lubricants is chosen.

Demulsification Test (D 1401) :

• Determines the ability of the petroleum products to separate from water.

• Products whose KV at the rate 40° C is 90 CST or below test temp is 54° C. KV above 90 CST at the rate 40° C test temp is 82° C.

Significance:

• Required test for turbine and hydraulic grades which is mixed with water/ steam/condensate on service. So water separability is prime requirement of lubricant, as emulsified oil causes lubrication failure.

TEST FOR PACKAGING MATERIAL

- **Visual examination**: This test covers the requirement for observing all the packaging materials.
- **Dimension & weight**: The dimension & weight are measured.
- **Drop impact test**
- **Wall thickness test**: Applicable to all HDPE containers up to 5L.
- **Print/ paint adhesion test**: This test allows assessment of the degree of adhesion of paint MS barrels or drums.
- **Brimful capacity/ over flow volume test**: This test helps to quantify the volume of the liquid to measure the capacity of all HDPE containers taken for test.
- **Cap fitment**: This test helps to determine the check for cap fitment in all HDPE containers.
- **Closure leakage test** (IS 7394-1984): This test helps to determine the ability of a closure (on a container) to prevent leakage due to transportation vibration to all HDPE containers upto 5L.
- **Bursting strength of carton** (IS 1060, 1987 part I): This test measures the strength & the toughness of corrugated sheets. It is measured by the pressure developed behind a circular rubber diaphragm when it is forced through the paper so as to burst it.
- **Cobb value test** (IS 1060, 1987 part I): It is carried onto measure the water absorption of carton paper/board. It reflects the sizing & similar properties of paper. It is expressed in g/m^2.
- **Moisture content**: It is an important factor affecting physical strength/flexibility & sheet forming characteristics. It also affects weight, dimensional stability, rigidity, tearing strength, tensile strength, folding endurance & elasticity.
- **Ink adhesion test** (IS 10840, 1994): It allows rapid assessment of degree of adhesion of a printing ink for packaging materials.
- **Determination of paint/epoxy coating thickness** for MS barrels & drums.

STORAGE AND DISPATCH

The lubricant is filtered through a 40 micron filter then stored in storage tank if it is frequently made else it is stored in containers of different capacity and dispatched. Some lubricants are also filtered through NAS (National Aerospace Standard) filter for very fine particle filtering. It converts number of particles present in a specified size range into different NAS class.

PACKAGING

Packaging can be classified into 3 categories as follows:

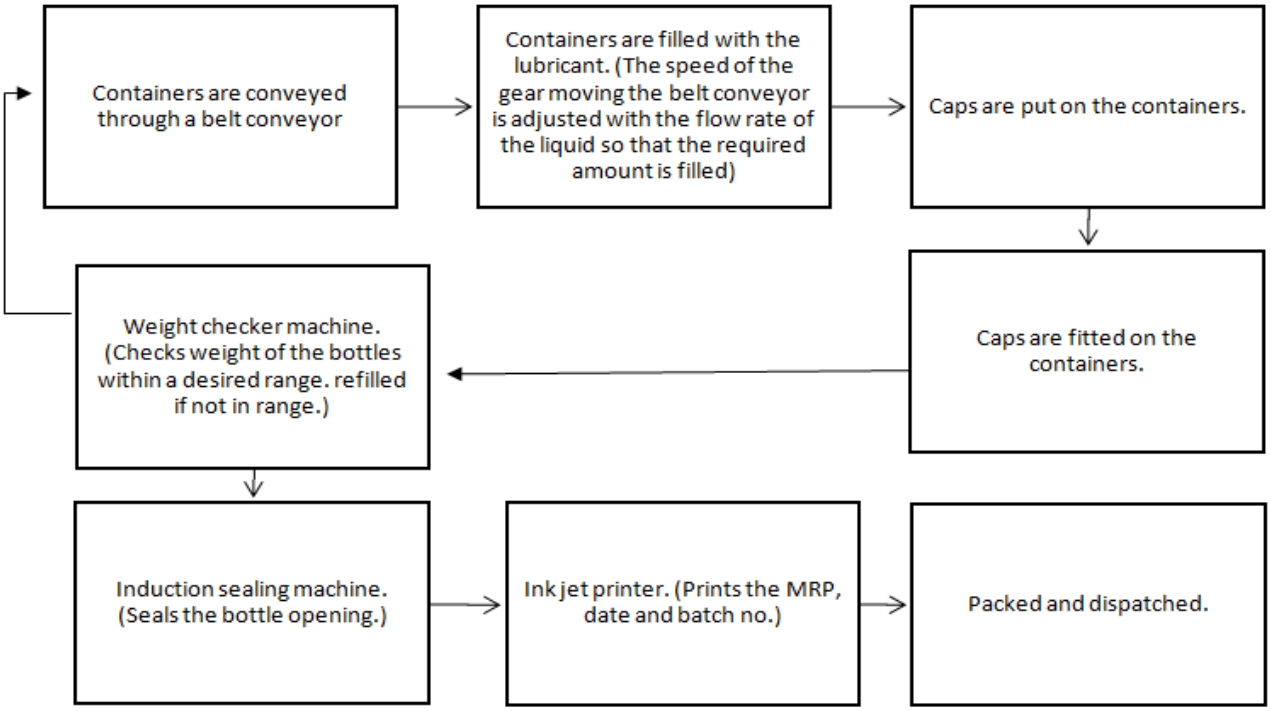
I. **Small**- It consist of buckets of 7.5,20,15&20L capacity, drums of 50L capacity and containers packed in cartons of capacity ranging from 900mL to 6L.
II. **Barrels**- They have a capacity of 210L.
III. **Bulk**- Bulk trucks of capacity 11&18kLs are filled.

FILLING MACHINES

The details of the small cans and barrel filling machines are given below:

MACHINE NAME	CAPACITY	DESCRIPTION
MP1	12 kl / shift	• 900 ml & 1L containers are filled. • Filling speed is 45 containers per min
MP5	15-22 kl/shift	• Fills containers of capacity 2, 2.1, 3, 3.5, 4&5 L. • Filling capacity varies depending upon can capacity
Linear filling machine	32 kl/shift	• Fills containers ranging from 900mL to 6 L.
PL2	14 kl/shift	• Fills buckets of 7.5,10,15&20 L
PL3	10 kl/shift	• Fills 15,20&50 L buckets
DL2, DL3	40 kl/shift	• Fills bucket • Filing capacity varies from 35-50 barrels per hour depending upon filling pressure and viscosity. • Generally a pressure of 6kg/cm² is maintained in the delivery line and a pressure of 4kg/cm² is maintained in the filling point.

Flowchart for filling operation:



Bulk supplies are dispatched by tank trucks.

DISPATCH

Dispatch is done through barrels, smalls or bulks. Finished products are dispatched to SCFP (small can filling plants) in Allahabad, Malda and Jamshedpur in 11kL and 18kL trucks. It is also send to direct customers like Railways. Barrels are dispatched in trucks of capacity 9 MT (45 barrels) or 15 MT (75 barrels). Smalls are also dispatched in them. Some products are also exported to Nepal.

MAJOR CUSTOMERS IN AND ABROAD

A. STEEL INDUSTRIES

* Tata Iron and Steel Co. (TISCO)
* Indian Iron and steel Co (IISCO)
* Rourkela Steel Plant (R.S.P).
* Bhilai Steel Plant (V.S.P)
* Bokaro Steel Plant (BSP)
* Bhusan Steels.
* Steel Authority of India (SAIL)

B. THERMAL POWER PLANTS

* National Thermal Power Corporation (NTPC.)
* Bandel Thermal Power Plant (BTPP.)
* State Electricity Board (SEB)
* Calcutta Electric supply Corporation (CESC)
* Bakreswar Thermal Power station (BTPS.
* Durgapur Thermal Power Station (DTPS)
* Kolaghat Thermal Power Station (KTPS)
* Haldia Petrochemical Co-Generation Unit (H.P.C.C.G.U)
* Damodar Valley Corporation (DVC)

C. CEMENT INDUSTRIES

* Birla Cement
* Ambuja Cement

D. MARINE INDUSTRIES

* Shipping Corporation of India (SCI)
* Dredging Corporation of India (DCI)
* Garden Reach Ship Builders and Engineers Ltd. (GRSEL)

E. REFINERIES AND PETROCHEMICALS

* Haldia Refinery
* Haldia Petrochemicals Limited

F. TRANSPORT SECTORS

* Calcutta State Transport Co. (CSTC
* North Bengal State Transport Co. (NBSTC)
* South Bengal State Transport Co. (SBST)
* West Bengal Surface Transport Co. (WBSTC)
* Calcutta Tram Co. (CTC)

G. RAILWAYS: Indian Railways

H. COALFIELDS

* Eastern Coal Field (ECL)
* Central Coalfield (CCL)
* Mahanadi coal fields (MCL)
* Bengal Emta
* G.S Atwal Mining

I. AUTOMOBILE INDUSTRIES

* Maruti Udyog Limited (MUL)
* Hyundai Motors.
* Tata Motor
* Bajaj Auto
* Lancer
* Mitsubishi
* Hindustan Motor

J. OTHER CUSTOMERS

* Jute industries
* Textile industries
* Paper mills
* Sugar industries
* Knitting mills
* Rubber Industries
* Shoe Industries
* Calcutta Corporation
* Paint Industries .

K. DEFENCE SECTORS

* Indian Army
* Indian Navy.
* Indian Air Force
* Kolkata Police

L. CUSTOMERS ABROAD: Nepal, Bangladesh & Bhutan.

MISCELLANEOUS FACILITIES

- Underground water tank of 40KLs to store water for use in boilers.
- LDO storage tower unit of 20 KLs. (LDO is light diesel oil. It is a fuel used for powering the boiler.)
- 1 Cooling tower unit of 60cum/hr
- 2 Forklifts of 3T capacity each to lift cartons, barrels etc.
- 1 Electronic weigh bridge of 40 T
- For firefighting purpose, there is a hydrant line with water monitors and double headed hoses, 5 kg CO_2 extinguisher kept at various locations, 75 kg DCPs kept near base oil tank and foam kept in jerry tank.
- There are OWS (Oil Water Separator) present in the plant. This separates the oil from the waste water (from e.g. oil spills). The separated water is sent for filtration and purification. The oil can't be reused.

SAFETY

FIRE ENGINE PUMP HOUSE

There are 2 pumps and 1 jockey pump to maintain a water pressure of 7 kg/cm².

- Pump 1 and 2 are manually driven, wherein pump 2 is kept for standby purpose. Pump 2 starts when the pressure drops below 5kg/cm². Further if the pressure drops below 4kg/cm², pump 1 starts. The details of the pump is given below:

Engine Details:

- Inst.: 2010
- Capacity:223HP
- RPM:1800
- Lube used: Premium CF4 16W40
- Cooling type: Radiator water cooled

Pump Details:

- Make: Greave
- Install:2010
- RPM:1800
- Cooling type: Water cooled
- Input: 223HP
- Flow: 410m³/hr

The jockey pump operates in auto mode to maintain a pressure of 7kg/cm². When the pressure gets stabled at 7 kg/cm^2 the pump stops automatically. The pump details are given below:

Engine Details:

- Make: Crompton Greave
- Inst. :2010
- RPM: 2900
- Capacity: 15kW(20HP)

Pump Details:

- Make: SAM
- RPM: 2900
- Cooling type: Water cooled
- Flow: 20 kL/hr

FOR SMALL FIRE:

There is also a sprinkler system which has small nozzle that sprinkles water. It has a bulb which when gets too much heated up explodes and the sprinkler starts sprinkling water.

There are two types of fire extinguisher that are used in case of small fire. These are:

- Dry Chemical Powder type
- Carbon Dioxide type (mainly used in electrical type fire)

Mock fire drills are done every month to see the situation in case of fire and stay aware about the same. There are mainly three teams assigned for the job v.i.z.

- Combating team
- Rescue team
- Auxiliary team

LAB SCALE BLENDING AND TESTING

SERVO PREMIUM CF-4 15W40

DESCRIPTION:

Servo Premium CF-4 15W-40 is a premium quality, API certified, commercial multipurpose diesel engine oil. The oil is designed for the most severe performance requirements of modern, highly rated turbo charged diesel engines in the over the road transport fleet applications and also off highway operations. It assures outstanding protection against high temperature engine deposits, oil degradation, and oil thickening and corrosion resistance. The oil is having excellent shear stability to maintain viscosity under severe, high temperature operations.

PERFORMANCE BENEFITS

- Reduced engine scuffing and bore polishing
- High engine cleanliness
- . Maximum protection from wear and deposits.
- Suitable for mixed fleet operation.
- Improved control of oil consumption
- Easier cold starting.
- Excellent all weather performance due to improved cold weather properties
- Catalytic Converter compatible

APPLICATIONS: Servo Premium CF-4 15W-40 is recommended for new generation commercial diesel vehicles of both American and European design such as Caterpillar and Cummins operating on Heavy duty on-highway and off-highway equipments.

HEALTH AND SAFETY:

These oils are unlikely to present any significant health or safety hazard when properly used in the recommended application and good standards of industrial and personal hygiene are maintained.

BLENDING OF SERVO PREMIUM CF4 15W40

MATERIAL	Volume %	Req Qty ml	Req Qty gm	Density@29.5°C kg/l
Base oil-1	51.505	206.02	173.02	0.8401
Base oil-2	28.348	113.39	96.27	0.8496
Additive-1	13.410	53.64	51.24	0.9845
Additive-2	0.430	1.72	1.91	1.1115
Additive-3	6.200	24.80	16.31	0.8629
Additive-4	0.107	.43	0.27	0.8885
Total blend size	100.00	300.00	257.37	

PROCEDURE: Moisture was firstly removed from the base oil at a higher temperature and then it was brought back to 60-70^{0}C. After that additives were added as applicable. After base oil optimization VII was added, and the blending temperature was maintained at 65+/-5^{0}C with 2hrs through agitation/stirring.

TEST RESULTS:

S No	Test	Method	Spec	Result
1	Appearance	Visual	Clear	Clear
2	Color	D1500	8.0 max	3.5
3	Density @ 29.5°C kg/l	D 4052	Report	0.8575
4	Flash point, COC °C	D92	200 min	242
5	Pour Point, °C	D97	-24 max	-27
6	K.Visc@100°C, cSt	D445	14.0-15.0	14.76
7	K.Visc@40°C cSt	D445	Report	106.34
8	Viscosity Index	D2270	135 min	144
9	CCS @ -20°C, mPa-s	D5293	7000 max	6129
10	TBN, mgKOH/gm	D2896	9.5-11.5	10.50
11	Sul. Ash, % wt.	D874	1.24-1.48	1.36
12	Calcium, % wt.	D7751/EDXRF	0.325-0.390	0.329
13	Zinc, % wt.	D7751/EDXRF	0.088-0.108	0.097

2. SERVO PRIME 57

DESCRIPTION

Servo Prime oils premium quality lubricants especially formulated to give outstanding performance and long life in modern steam, gas and hydraulic turbines. Servo Prime oils are manufactured from selectively refined distilled base stocks and contain carefully chosen antioxidant, rust inhibitor and defoamant additives. Servo Prime LP oils are special purpose low pour turbine oils. These oils have been tested for radiation stability and found suitable for use in turbines exposed to radiation encountered in nuclear power plants.

PERFORMANCE BENEFITS

- Provide excellent long term protection against rust and corrosion
- Readily separate from water

- Ensure long service life since they possess outstanding oxidation stability
- Reduced tendency to foam
- Able to release entrained air at a rapid rate

APPLICATIONS: Servo prime oils are recommended for use in the lubrication system of steam, gas and hydraulic turbines operating under all service conditions. In addition, Servoprime oils give outstanding performance in hydraulic systems, circulating lubrication systems, enclosed bearings and other industrial machines in which long trouble free service of lubricant is required. Servoprime LP oils are meant for low temperature applications such as Roto flow expanders and Turbo compressors used in refrigeration applications

HEALTH AND SAFETY:

These oils are unlikely to present any significant health or safety hazard when properly used in the recommended application and good standards of industrial and personal hygiene are maintained.

LAB BLENDING AND TESTING:

SKU	Volume%	Req Qty ml	Req Qty gm	Density@29.5°C kg/l
Base oil1	32.03	96.09	80.73	0.8401
Base oil2	67.60	202.80	172.30	0.8496
Additive1	0.35	1.05	1.06	1.0076
Additive2	0.01	0.03	0.03	0.8876
Additive3	0.01	0.03	0.03	1.0046
	100.00	300.00	254.14	

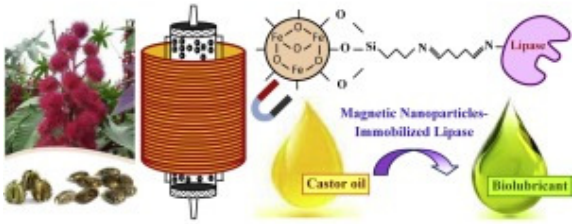
PROCEDURE : Moisture was firstly removed from the base oil at a higher temperature and and then it was brought back to 60-70^{0}C. After that additives are added as applicable. The blending temperature was maintained at 65+/-5^{0}C with 2hrs through agitation/stirring.

S No	Test	Method	Spec	Result
1	Appearance	Visual	Clear	Clear
2	Color	D1500	2.5 max	< 0.5
3	Flash Point COC °C	D92	210 mn	240
4	Pour Point °C	D97	-6 max	-12
5	KV @40°C, cSt	D445	55.6-59.4	57.48
6	Viscosity Index	D2270	95 min	118
7	Demulsion @54°C(40-37-3), mnts	D1401	20 max	10
8	Foam, stab. Seq I,II,III	D892	Nil	Nil
9	TAN mgKOH/gm	D974	0.05-0.11	0.078
10	Zinc, ppm	XRF	20 max	<20
11	Calcium, ppm	XRF	20 max	< 20

Biolubricants:

Raw materials, chemical modifications and environmental benefits

The depletion of the world's crude oil reserve, increasing crude oil prices, and issues related to conservation have brought about renewed interest in the use of bio-based materials. Emphasis on the development of renewable, biodegradable, and environmentally friendly industrial fluids, such as lubricants, has resulted in the widespread use of natural oils and fats for non-edible purposes. In this study, we have reviewed the available literature and recently published data related to bio-based raw materials and the chemical modifications of raw materials. Additionally, we have analyzed the impacts and benefits of the use of bio-based raw materials as functional fluids or biolubricants. The term biolubricants applies to all lubricants, which are both rapidly biodegradable and non-toxic to humans and other living organisms, especially in aquatic environments. Biodegradability provides an indication of the persistence of the substance in the environment and is the yardstick for assessing the ecofriendliness of substances. Scientists are discovering economical and safe ways to improve the properties of biolubricants, such as increasing their poor oxidative stability and decreasing high pour points. ''Green'' biolubricants must be used for all applications where there is an environmental risk.



The role, functions, and requirements of a lubricant

A lubricant is a material used to facilitate the relative motion of solid bodies by minimizing friction and wear between interacting surfaces. In addition to the primary purposes of reducing friction and wear, lubricating oils are also required to carry out a range other functions, including the removal of heat, corrosion prevention, and the transfer of power. Additionally, lubricants must provide a liquid seal at moving contacts and remove of wear particles. In order to perform these roles, lubricating oils must have specific physical and chemical characteristics. Perhaps the fundamental requirement of lubricants is that the oil should remain a liquid over a broad range of temperatures. In practice, the usable liquid range is

limited by the pour point (PP) at low temperatures and the flash point at high temperatures. The PP should be low to ensure that the lubricant is pump-able when the equipment is started from extremely low temperatures . The flash point should be high to allow the safe operation and minimum volatilization at the maximum operating temperature. For the most demanding applications, such as aviation jet engine lubricants, an effective liquid range over 3008C may be required. The efficiency of the lubricant in reducing friction and wear is greatly influenced by its viscosity. The relationship between speed, viscosity, load, oil film thickness, and friction is illustrated by the Stribeck diagram. Furthermore, biodegradability is the most important aspect with regard to the environmental fate of a substance. Primary degradation is the first step in the breakdown of a substance and involves the disappearance of the original molecule. However, the determination of the ultimate degradability or the mineralization of substances to CO2, H2O, and the formation of biomass is important. Ultimate biodegradability guarantees the safe reintegration of the organic material in the natural carbon cycle and is important for its environmental classification.

Biolubricants and the environment

Strong environmental concerns and growing regulations over contamination and pollution in the environment have increased the need for renewable and biodegradable lubricants. Accelerating research and development in this area has also been driven by public demand, industrial concern, and government agencies. Better ways to protect the ecosystem or reduce, or reduce the negative impact of spills or leakage of lubricants must be outlined . Many terms are used for the classification of lubricants and include products that are environmentally friendly, environmentally acceptable, biodegradable, non-toxic, etc. Approximately 1% of the total mineral oil consumption is used to formulate lubricants. Figure 3 reveals the volume of the worldwide lubricant market, showing that about one third of all lubricants are consumed in Europe, America, and Asia. Between 13% (EC countries) and 32% (USA) of all used lubricants return to the environment with altered physical properties and appearances . These lubricants included those used in frictional loss lubrication and total 40 000 tons annually in Germany. Lubricants that remain in the environment also include those used in circulation systems, which are not collected and disposed. In addition, leaked lubricants and those remaining in filters or containers have to be taken into account. Altogether, the environment in Germany is exposed to about 150 000 tons annually. This value is based on the on the static mentioned above and represent the lubricant volume that returns to the environment [17]. A calculation based on the actual lubricants consumption in Germany and the disposal rates for different types of lubricants results in about 250 000 tons annually. Once the volume representing lost lubricants and undefined lubricants is accounted for the total volume of lubricants in Germany returning to the environment may be on the order at least 300 000 t/a . The production, application, and disposal of lubricants have to meet the requirements for the best possible protection of the environment and of living beings in particular. Most often, health hazards to humans are derived from indirect routes through the environment. For all cases of direct contact between lubricants and human beings, compatibility has to be verified. All measures have to be taken to keep the impairment of the environment at the lowest possible level. In evaluating acceptable detrimental effects upon the environment, the benefit of lubricants, such as their performance or economic properties, must be considered and weighed against the risks associated with these lubricants

Conclusions

A tremendous demand for plant oils in the lubricant industry is expected over the next few years because plant oils are natural, renewable, non-toxic, non-polluting, and cheaper than synthetic oils. They will become an important class of base stocks for lubricant formulations due to their positive qualities. Due to growing environmental concerns, plant oils are finding their way into lubricants for industrial and transportation purposes. Plant oils, in comparison to mineral oils have different properties due to their unique chemical structures. Plant oils have better lubrication ability, viscosity indices, and superior anticorrosion properties, which are due to the higher affinity of plant oils to metal surfaces. In addition, flash points greater than 3008C classify plant oils as non-flammable liquids. To improvement characteristics such as sensitivity to hydrolysis and oxidative attacks, poor low temperature behavior, and low viscosity index coefficients, plant oils may be chemically modified. Plant oils may be used in almost all automotive and industrial applications. It will become more difficult to find a balance between the economic possibilities of biolubricants and their ecological requirements. Products with toxicological and ecological issues must be excluded from further use in lubricants, if they pose a significant health risk. However, it must be taken into account that the technological level of lubricants will decrease if unnecessary restrictions are put into place. In conclusion, plant bio-based oils are an important part of new strategies, policies, and subsidies, which aid in the reduction of the dependence on mineral oil and other nonrenewable sources.

The primary goal of this report is to identify action initiatives that make up the action agenda for the experience in working in an industry. In review this training has been an excellent and rewarding experience. I have been able to meet and network with so many people that I am sure will be able to help me with opportunities in the future.

From this training, I learnt about time management & how to motivate myself through being in the industrial laboratory for so many hours. I came up with various proposals and ideas that the company is still looking into using.

At last I can tell in a word that I have learnt a lot and got a view of industrial work process. Before the training I did not have much idea about it. My goal to learn something in the free time of winter is fulfilled and I got a lot of knowledge on the application part of academics and beyond academics too.

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