AUTOMATIC LUBRICATION SYSTEM FOR WIRE ROPE IN LEVEL LUFFING CRANE

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Abstract: This Project is the aim is to provide automatic lubrication system of wire rope in level luffing cranes. In addendum this system when properly installed con function as wire line guide in effectively sprayed using hydraulic oil to the core of the wire rope. In Chennai port trust there are various kinds of cranes are used to load and unload the ship. Cranes the kind of material handling systems, which can be used to handle bulk and discrete goods. A system will be purposeful only if it earns are more than it has earns are more than its operating and maintenance. Hence we increase the net cost saved by reducing the cost spent for operating and maintenance and thereby also increasing the utility of equipment.

I. INTRODUCTION TO CHENNAI PORT TRUST

“Chennai port trust” is one of the twelve major parts dotting the country’s coastline. COAGAN and DAY founded a trading settlement in the fishing village of Chennai Pattinam in 1630. The English East India choose this place as the center of their commercial activities in the South. Thus, was laid by the foundation of the modern city of Chennai, the capital city of Tamil Nadu. Chennai port trust is the one of the best and oldest ports in India, in order to facilitate easier operations like loading and unloading; the Chennai port trust is divided into three district zones. At present the Chennai port trust is handling 10 million tons of coal and 6-7 million tons of iron ore. The Chennai port trust has the deepest draft in India. The Chennai port handles cargo for both import and export and also extends facilities for all types of vessels both Indian and Foreign vessels. In addition to several modern facilities a floating dry dock is also recently added to Chennai harbor. The Chennai port’s deep oil berths can receive super tankers, one with a pumping rate of 7,500 tons per hour and the others with a pumping rate of 4,500 tons per hour. Chennai port is one of the first computerized port in India.

Fig. 1 Photographic view of Chennai port trust
II. INTRODUCTION TO CRANES

- Cranes Classification
- Components of Cranes
- Specification of Cranes

The word cranes are developed from the bird crane, from which the scientist discovered the material handling equipment. Material handling equipment is those which are developed to overcome the difficulties which was present at earlier days. By this material handling equipment we easily do the loading and unloading in sections where human power is used to load and unload the products. These material handling equipment are broadly classified as follows

- Hoisting equipment
- Robotics

These hoisting equipments are again divided into various types as cranes, stackers and derricks. The next in robotics, the equipments used to handle the loads are PLC operate robots by which they easily use the heavy load. Thus the cranes are that one type of material handling equipment which allows handling too heavy loads by the workers who are employed in these section. These cranes have the advantage of providing large service area and freedom for construction on the floor.

2.1 TYPES OF CRANES:
- Overhead Cranes
- Traveling Cranes
- Gantry Cranes
- Derrick Cranes
- Pillar Cranes

![Fig. 2 Schematic diagram of Crane](image-url)
OVERHEAD CRANES:

These cranes have the advantage of providing large service area and freedom for construction on the floor. In this the driver seated in his cabin control movements.

TRAVELLING CRANES:

The base of cranes travels on the railroad type rails set to a very wide gauge. At each corner of the base on one or more wheels are provided. When more than one wheel is used, they are mounted in a boogie that will equalize the load on all wheels at any corner.

GANTRY CRANES:

These are basically bridge cranes. Gantry legs support a grinder at both the ends. These legs may be fixed or provided with wheels to travel on rails with ease. This is mainly applicable for outdoor movements.
**Fig. 5 Gantry Cranes**

**DERRICK CRANES**
This record breaking super weight handling crane is installed at Hitachi harbour. The passage between the quay end and derrick crane enables a trailer to come directly on derrick crane.

**Fig. 6 Derrick Cranes:**

**PILLAR CRANES:**
A pillar crane may be stationary type or mobile type. It is used for light duty and medium loads. A gib or inclined beam is fixed to lift up or lower down the load with the help of rope and pulley arrangement. All the movements to the crane are provided by gearing and electric motor drives.

**Fig. 7 Pillar Cranes:**
2.3 COMPONENTS OF CRANES:
1. CRANE HEAD
2. MACHINERY HOUSE
3. OPERATORS CABIN
4. BOGIE
5. BOOMS AND JIBS
6. WIRE ROPES
7. SHEAVE OR ROPE PULLEY
8. HOOKS
9. ELECTRIC MOTOR
10. SPECIFICATION

CRANE HEAD:
Crane head consist of machinery house and operators cabin.

MACHINERY HOUSE:
The machinery house is generously dimensioned to accommodate and afford access to all machinery. The house is of steel construction covered on the outside with aluminum steels and provided with window. There is a ventilation system with adequate capacity. The doors have windows and electric overhead hoist of 2.5tones for maintenance purpose is running on a beam. The parts can be lowered to quay level through the floor opening at the rear side of the platform.

OPERATORS CABIN:
The operator’s cabin is designed for maximum visibility and is equipped with controls and masters switch. The cab and is fitted with the help of windscreen wipers ventilation. The cabin is a solid
sandwich wall steel structure. Outside blank, sand blaster and paint coater. An upholstered seat of adjustable height slewing type will be provided. The cabin is accessible from the machinery house.

**BOGIE:**

Bogie is the best part of the crane, which is mounted on the wheels, and is connected to the portal frame by means of bolt and nut arrangement. Bogie consists of electric motor, worm and worm wheel arrangement.

**BOOMS AND JIBS:**

Crawler cranes are always fitted with lattice booms, while rubber tired cranes may have booms that are either lattice or hydraulically telescoping. The most common boom attachment consists of a base section plus insert of varying lengths and a tip section. Any boom lengths can be assembled using manufacture specified combination of inserts. When only the base and tip section are used the assembly of lifting the maximum capacity. The base boom for smaller cranes, it runs from 70 to 100 feet. Maximum boom length vary with crane model the longest booms currently in use are now in excess of 350 feet with cross section up to 8 sq.feet or more.

**WIRE ROPES:**

Steel wires are mainly used in hoisting equipments and lifting tackles. Compared to chain pulleys, their main advantages are as follows. They are:

- Less vulnerability to damage from shocks.
- Silent operation.
- More reliability in service.

**ROPE PULLEY OR SHEAVE:**

Rope pulley or sheave should preferably be made of cast steel or rolled steel of welded construction. There are two types of materials are generally used:

1. CAST STEEL GRADE2 IS: 1030.
2. MILD STEEL IS: 2062.

**HOOKS:**

It is extremely important to inspect all hooks frequently, checking their body for cracks, corrosions, and twisting, the saddle for wear the throat for possible opening up beyond new hook dimensions. We want to make sure that all hoisting hooks, except grab and sorting, types are equipped with safety catches. Every hoisting hook should be equipped with swivel and headache ball.

**WIRE ROPES**

![Fig. 9 Wire Ropes](image)
2.4 INTRODUCTION TO WIRE ROPES:
- Wire rope is metal in its strongest form. It consists of a metal of group of strands laid helically around a core.
- The strands of a wire rope, cable consists of a number of individual wires laid about a central wire.
- The term wire rope and cable are used interchangeably. There is some tendency to use the term wire rope of sizes ¼ inches and larger capable for the smaller sizes. But this is not uniform practice and either name is correct.
- It is a machine composed of a number of precise, moving parts all designed to bear a very definite relation to one another.
- In fact wire rope contains more moving parts than many complicated mechanisms. A6 strand rope consist of 49 wires per strand, laid around an independent wire rope, contains a total of 343 individual ropes.
- All of these ropes must be able to blend and more which to one another if the rope is to have flexibility necessary for successful operation.

2.5 CONSTRUCTION OF WIRE ROPES

Wire rope is composed of wires, strands and a core. The basic unit is the wire, which is form to strands. Various types of wire ropes have been designed to meet a wide range of uses and operating conditions. These types are designed by the kind of core, the number of strands, the number, sizes and arrangements of the wires in each strand and the way in which the wires and strands are wound, or laid, about each other. Wire rope forms an important part of many machines and structures. It is comprised of continuous strands wound around a central core. There are many kinds of wire rope designed for different applications. Most of them are steel wires made into strands wound with each other. The core can be made of steel, rope or even plastics. Wire ropes (cables) are identified by several parameters including size, grade of steel used, whether or not it is performed, by its lay, the number of strands and the number of wires in each strand. Small wires are better suited to being bent sharply over small sheaves (pulleys). The large outer wires are preferred when the cable will be rubbed or dragged through abrasives. The lay of a wire rope is in the direction that the wire strands and the strands in the cable twists. There are four common lays:
1. Right lay
2. Left lay
3. Regular lay
4. Lang lay
2.6 STRAND WIRE ARRANGEMENT

A left lay twist to the left. A regular lay rope has the wires in the strands twisted in the opposite direction from the strands of the cable. In the lag lay rope, the twist of the strands and the wires in the strands are both twisted the same way. Lang lay ropes are said to have better fatigue resistance due to the flatter exposure of the wires. A preformed cable is made of wires that are shaped so that they lie naturally in their position in the strand, preventing the wires from protruding and potentially causing injury. Preformed wire ropes also have better fatigue resistance around sharp angles. Most of the wire arrangements used in the strands of the wire rope can be classified into general type filter wire, seal and Warrington. The Warrington type differs from the others in that the outside layer of wire in each strand of the wire is composed outside wire alternately large and small. A typical strand and wire designation is 6*18. This denotes a rope made up of six strands with 19 wires in each strand. Different strand sizes and arrangements allow for varying degrees of rope flexibility and resistance to crushing and abrasion.

2.7 CORES

Wire rope cores are made of fiber cotton asbestos polyvinyl plastic or wire. Manila or sisal fiber of fiber is a type of core often used when loads are not to great it supports strands in their relative position and cushions the wire to prevent their nicking each other. There are three types of cores. An independent wire rope (IWRC) is normally a 6*7 wire rope with a 1*7 wire strand core resulting in a 7*7 wire rope. IWRC have a higher tensile and bending breaking strength than a fiber core rope and a high resistance to crushing and deformation. A wire strand core (WSC) rope has a single wire strand as its core instead of a multistrand wire rope core. WSC ropes high strength and are mostly used as static or standing ropes. Wire ropes also have fiber ropes. Fiber core ropes are traditionally made with sisal rope, but may also use plastic materials. The fiber core ropes have less strength than steel core ropes. Fiber core ropes are quite flexible and are used in many overhead crane applications. Wire ropes (cables) are identified by...
several parameters including size, grade of steel used, whether or not it is performed, by its lay, the number of strands and the number of wires in each strand.

2.8 WIRE ROPE MATERIALS
Wire rope, few expectations, is made from cold drawn carbon steel wires. There have been many different strength grades of rope made. Some of them tabulated with their tensile strength.

<table>
<thead>
<tr>
<th>GRADE</th>
<th>TENSILE STRENGTH (psi)</th>
</tr>
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<tbody>
<tr>
<td>Extra improved prow steel</td>
<td>245,000 to 340,000</td>
</tr>
<tr>
<td>Improved prow steel</td>
<td>220,000 to 300,000</td>
</tr>
<tr>
<td>Plow steel</td>
<td>195,000 to 258,000</td>
</tr>
<tr>
<td>Mild plow steel</td>
<td>168,000 to 225,000</td>
</tr>
<tr>
<td>Iron</td>
<td>100,000</td>
</tr>
</tbody>
</table>

Wire ropes are manufactured from steel wires, which are given special heat treatment, such as “patenting”. The ultimate tensile strength is in the range of 175 to 220kg/mm². The wire rope should conform to IS 1835 specification for steel wire for ropes. Steel wires are mainly used in hoisting equipments and lifting tackles. Compared to chain pulleys, their main advantages are as follows. They are:
- Less weight for equal capacity.
- Less vulnerability to damage from shocks.

2.9 FACTORS THAT INFLUENCE WIRE ROPE AND CABLE PERFORMANCE
Cable life cycle and performance are influenced by several factors, including type of operation, care and environment. Cables can be damaged by worn sheaves, improper winding and splicing practices, and improper storage. High stress loading, shock loading, jerking heavy loads or rapid acceleration or deceleration (speed of cable starting and stopping) will accelerate the wear rate. Corrosion can cause shortened rope life due to metal loss, pitting and stress rises from pitting. If a machine is to be shut down for an extended period, the cables should be removed, cleaned, lubricated and properly stored. In service, corrosion and oxidation are caused by fumes, acids, salt brines, sulfur, gases, salt air, and humidity and are accelerated by elevated temperatures. Proper and adequate lubricant application in the field can reduce corrosive attack of the cable. Abrasive wear occurs on the inside and outside of wire ropes. Individual strands inside the rope move and rub against one another during normal operation, creating internal two-body abrasive wear. The outside of the cable accumulates dirt and contaminants from sheaves and drums. This causes three-body abrasive wear, which erodes the outer wires and strands. Abrasives are generally reduces rope diameter and can result in core failure and internal wire breakage. Penetrating wire rope lubricants reduce abrasive wear inside the rope and also wash off the external surfaces to remove contaminants and dirt.

2.10 LUBRICATION SYSTEM INTRODUCTION
Various forms of lubricating systems are used to simplify and render more efficient the task of lubricating machines. These systems are designed to filter, cool, monitor, meter, and replenish the oil automatically. In such facilities much larger oil quantities are used and they are maintained by regularly assigned lubricating personnel. Here reliance is paced on conservatively chosen fluids with the expectations that they will endure many months or even years of service.
TYPES:
1. Centralized lubrication system
2. Gravity lubrication system
3. Oil-mist lubrication system

CENTRALIZED LUBRICATION SYSTEM:
In general a central reservoir provides the supply of oil which is conveyed to each bearing through individual lines of tubing. Or through a single line of tubing that has branches extending to each of the different bearings. Oil is pumped into the lines either manually by single movement of lever or handle, or automatically by mechanical drive from some revolving part. Feed lubrication is adaptable to various classes of machine tools such as lathe, planner, and milling machines and too many other type of machines. It permits the use of lighter grade of oil especially were complete covering of moving part is assured.

GRAVITY LUBRICATION SYSTEM:
Gravity system usually consists of a small number of distributing center or manifolds from which oil is taken by piping as directly as possible to the various surfaces to be lubricate, each bearing point having its own independent pipe and set of connections. The aim is to provide a reliable means of supplying surfaces with proper amount of lubricating oil it includes various means to maintain the steady supply of oil such as
- Drip feed lubricators.
- Wick feed lubricators.
- Wiping type lubricators.

OIL MIST LUBRICATION SYSTEM:
A very effective system for both lubricating and cooling many elements which require a limited quantity of fluid is found in a device which generates a mist of oil, separate out some denser and longer particles, and then distributes the mist through a piping or conduct system the mist is delivered into the bearing, gear, lubricated element cavity through condensing or spray nozzle, which also serve to meter the flow. In applications which do not encounter lower temperature or which permit the usual devices to monitor the accumulation of solid oil, oil mist devices offer advantage in providing cooling, clean lubricant, pressurized cavities which prevent entrance of contaminant. These devices are supplied with fluid reservoirs holding from a few ounces up to several gallons of oils. With proper control of the fluid temperature, these units can atomize and dispense most motor and many gear oils.

LUBRICANT OILS:
Lubricant oil is used for one or more of the following purpose: To prevent wear, to prevent adhesion, to aid in distributing the load to cool the moving elements and to prevent corrosion. The range of materials used as lubricants has been greatly broadened over the years so that in addition to oils and greases, many plastic and solids and even gases are now being applied in this role. The important limitations on many of these materials are their ability to replenish themselves, to dissipate frictional heat, their reaction to high environmental temperature lubricating materials.

ADDITIVES:
1. Limit the chemical changer or deteriotiation of the lubricant.
2. Protect the machine from harmful deposits or from failure of the lubricant to function properly.
3. Improve existing physical properties of the lubricant or impart new characteristic to it. There are two general classes of attitudes those that affect chemical characteristics such as detergency and those that affect physical properties such as pour point. In most of the automatic lubricating system the cresyl phosphate (anti wear improver), chlorine compounds (film strength improver) additives are preferred.

III. EXISTING SYSTEM

Fig. 13 Manual Lubrication

- In the existing system the lubrication for wire ropes in cranes were done manually.
- Manual operation, consumes lot of time to lubricate each and every wire rope.
- By doing it manually nearly 20-30% of lubricant oil is wasted.
- Huge expenses are spent to labor.
- Application of lubricant to the wire ropes manually disturbs the crane operation, hence production rate is decreased.
- Less safety for the workers.
- The crane area is polluted due to the down pouring of the lubricating oil.
- Huge amount of lubricant is wasted due to manual operation.

IV. PROPOSED SYSTEM

- In the proposed system we implemented the automatic lubrication system for wire rope in cranes.
- This automatic system saves nearly 30-35% of lubricant oil.
- Single operator is sufficient for lubrication.
- Labor cost is totally reduced.
- Lubrication can be performed simultaneously when the crane is in operation.
- High range of safety for the workers.
- When implemented effectively the system can function as wire line guide.
- This automatic lubrication system, consumes very less time to lubricate each and every wire rope.
V. AUTOMATIC LUBRICATION SYSTEM

CONSTRUCTION:
The automatic lubricating system equipment consists of two important circuits. They are,

1. Hydraulic circuit.
2. Pneumatic circuit.

HYDRAULIC CIRCUIT:
Hydraulic circuit consists of the following components they are

- Reservoir
- A.C. Motor
- Pump
- Direction Control Valve
- Temperature Indicator
- Pressure Gauge
- Oil Nozzle

a) Reservoir:
Reservoir is used to store the lubricating oil. It contains the oil strainer in its arrangement.
b) **A.C. Motor:**
   
   It is used to drive the compressor for the required amount of pressure to be entered into the air nozzle.

c) **Pump:**
   
   It is used to pump the lubricating oil from the reservoir to the oil nozzle. Gear pump is used for this purpose.

d) **Direction Control Valve:**
   
   Direction Control Valve is used to direct the pumped lubricating oil into the oil nozzle. Two way three position valve is used for this purpose.

e) **Temperature Indicator:**
   
   It is used to indicate the temperature of the oil which is to be entered into the nozzle for the formation of mist.

f) **Pressure gauge:**
   
   It is used to maintain the required pressure which entered into the oil nozzle.

g) **Oil pipe:**
   
   Oil pipe is the arrangement in the hydraulic circuit which is used to carry the pressurized oil for the formation of oil mist. It contains proper accessories.

h) **Oil nozzle:**
   
   It is used to spray the pressurized oil into the wire rope for its lubrication. Oil is sprayed in concerned pressure for the formation of mist. Oil nozzle plays an important role in the hydraulic circuit.

VI. **CONCLUSION**

In the proposed system we implemented the automatic lubrication system for wire ropes in crane. This automatic system saves nearly 30-35% of lubricant oil. Single operator is sufficient for lubrication. Labour cost is totally reduced. Lubrication cost is totally reduced. Lubrication can be performed simultaneously when the crane is in operation. High range of safety for the workers. When implemented effectively the system can function as wire line guide. At one mine site, the replacement rate for four 44-mm ropes was extended from an average 18.5 months to 43 months. At another mine, life cycles of four 43-mm*2073 meter ropes were extended from an average 8 months to 12 months.

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