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IMPROVING PLANT OVERALL EQUIPMENT EFFECTIVENESS (OEE) AND EQUIPMENT AVAILABILITY FOR EDIBLE OIL INDUSTRY BY USING PREDICTIVE MAINTENANCE

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Abstract

Maintenance is essential to the core business operation. Maintenance is about preserving the function of assets. The main purpose of maintenance in an industrial perspective is to reduce the business risks. The scope to improve Plant availability is one of the greatest opportunities in creating value. The study describes various types of equipment and process failures and causes.

Liberalization and global competitiveness have come as a further challenge to the industry for achieving high productivity, Product quality, Shorter lead and delivery time, overall reliability, Consistency and economy.

The scope of this dissertation work is to examines gap in the system and Improving Plant OEE (Overall Equipment Efficiency) and Equipment Availability by using Predictive Equipment, to provide a background for the study and analysis, we will first discuss the manufacturing process and OEE, determining the cause of Equipment breakdown. Strategy changes in Maintainability.

Key Word: Improving Plant Overall Equipment Efficiency (OEE) and Equipment Availability for Edible oil industry by using Predictive Maintenance

1. INTRODUCTION

The main objective of the research is to improve OEE 20% and the maximization of availability of plant and machinery/equipment for smooth and efficient operation. To overcome Plant Stoppage due to Equipment Breakdown, set up Downtime, studying Root cause analysis, Predictive equipment tools.

- Minimize the breakdown time.
- Improving and ensuring highest equipment availability
- To Improving OEE (Overall Equipment Effectiveness)
- Improve the productivity and ensure the improvement of profit margin

2. IMPLICATION OF OVERALL EQUIPMENT EFFECTIVENESS

2.1 OEE

Overall equipment Effectiveness a measure of Overall Equipment Effectiveness, OEE measurement is an effective way of analyzing the efficiency of a plant. Overall equipment effectiveness (OEE) has been considered the ultimate efficiency guide for production Equipment. Overall Equipment Efficiency is the technique for calculating and identifying the losses of a manufacturing system, Countermeasures such as planned downtime management, root cause analysis, management routines and FMEA Organization are used collectively for the improvement of three major blocks of OEE which includes availability, performance and quality.

2.2 Maintenance Purpose - The main purpose of maintenance in an industry perspective is to reduce the business risks in the general operation and maintenance is synonymous with high level of availability, reliability and assets operability linking directly with production capacity productivity and Maintenance team role/purpose of maintenance is no more limited to immediate reaction to emergencies and over-power problems. Under the maintenance excellence umbrella, the maintenance function becomes an equal partner within the corporation. It runs like any other for-profit business in a fully integrated plant organization

2.3 Maintenance Responsibilities

- To maintenance plants and equipment's at its maximum operating efficiency, reducing downtimes and ensuring operational safety.
- To analysis Equipment breakdown and implement corrective measure and maintenance strategy (Preventive, Predictive, Proactive analysis)
- To help management in tacking decisions on replacement or new investment and actively participate in specification preparation equipment selection its erection and commissioning etc.
- Help in implementation of suitable procedures for procurement storage and consumption of spares tools and consumable etc.
- Standardization of spare and consumable in conformity with plant national and international standard and help in adoption of these standards by all users in the plant.
- Running of captive workshop for repairs and conditioning and also for making some new spares.

3. CONCEPT AND APPROACH OEE METHODOLOGY

The main aim of the dissertation is to analyze lacuna in the system and Improve OEE and Equipment availability by using Predictive equipment and Root cause analysis.

The methodology includes,

- Determining the reason for the less OEE and More equipment down time.
- Monitoring and measurement of data from relevant sources.
- Pareto analysis of total failure hour and breakdown analysis for equipment availability.
- A Predictable technique shall be established by Predictive equipment to avoid breakdown.
- Improving maintenance practices by reviewing Preventive flow chart as figure 4 and implementing predictive flow as figure

The objective of this dissertation work is to improve OEE 20% and the maximization of availability of plant and machinery/equipment for smooth and efficient operation. This leads to the increase in the standard of the process used and productivity. This directly contributes to the equipment availability.

3.1 Preventive maintenance

Periodic maintenance and component replacement improve equipment life and avoid unplanned maintenance. Traditional preventive maintenance was created on the concept of the bathtub curve. That is, new parts went through three stages—an infant mortality stage. A fairly extended run stage and a wear out stage. The PM concept was to replace these parts before they centered the wear out phase. The PM should focus on cleaning, Lubrication and correcting deficiencies found through testing and inspection. When there is need to adjust or replace components

Condition-based maintenance uses the prediction tool long before the failure occurs at predetermined and specified intervals. Advantage Monitoring equipment before replacing spare and Breakdown. By predictive equipment availability of equipment is increased.

3.2 ANALYZING THE OEE AND EQUIPMENT AVAILABILITY BY ROOT CAUSE

The manufacturing process stream studied in a detailed manner by step by step in the OEE Loss. The major sources of Less OEE on Equipment breakdown are listed out and by the brainstorming session the major causes again divided in to sub-sources. Production processes from the log data has been collected and used for OEE. Suitable corrective measure used as shown table 4 to improve OEE. Appropriate corrective measure are highlighted in table 4. Table 1, 2, 3 Value used for FMEA.

Production OEE has measured period of (Jul 18 to Dec 18), with corrective measure considered (Jan 19 to Jun 19). OEE data shown in Table 20&21.

The major causes of Less OEE due to Availability X Performance rate X Quality rate effect.

Availability Time calculation=Total Time –Planned Maintenance Time.

Planned maintenance means Changeover of the product-Cannot avoid but can be improve.

Equipment availability is the metric used for calculating the downtime losses.

$$\text{Availability (A)} = \left(\frac{T}{P} \right)$$

Where,

A-Availability

T - Operating time (P-D)

P – Available time or planned time

D – Downtime

Performance efficiency is used for quantifying the reduced speed losses

$$E = \left(\frac{(T - L)}{T} \right)$$

Where,

E-Performance efficiency

T – Operating Time (P-D)

L – Performance Loss in Time

Note: Performance Loss =Minor Stoppage, Reduced speed

Rate of quality products produced is used to calculate the poor quality

$$R = \frac{(T - Q)}{T}$$

Where,

R – Rate of quality products

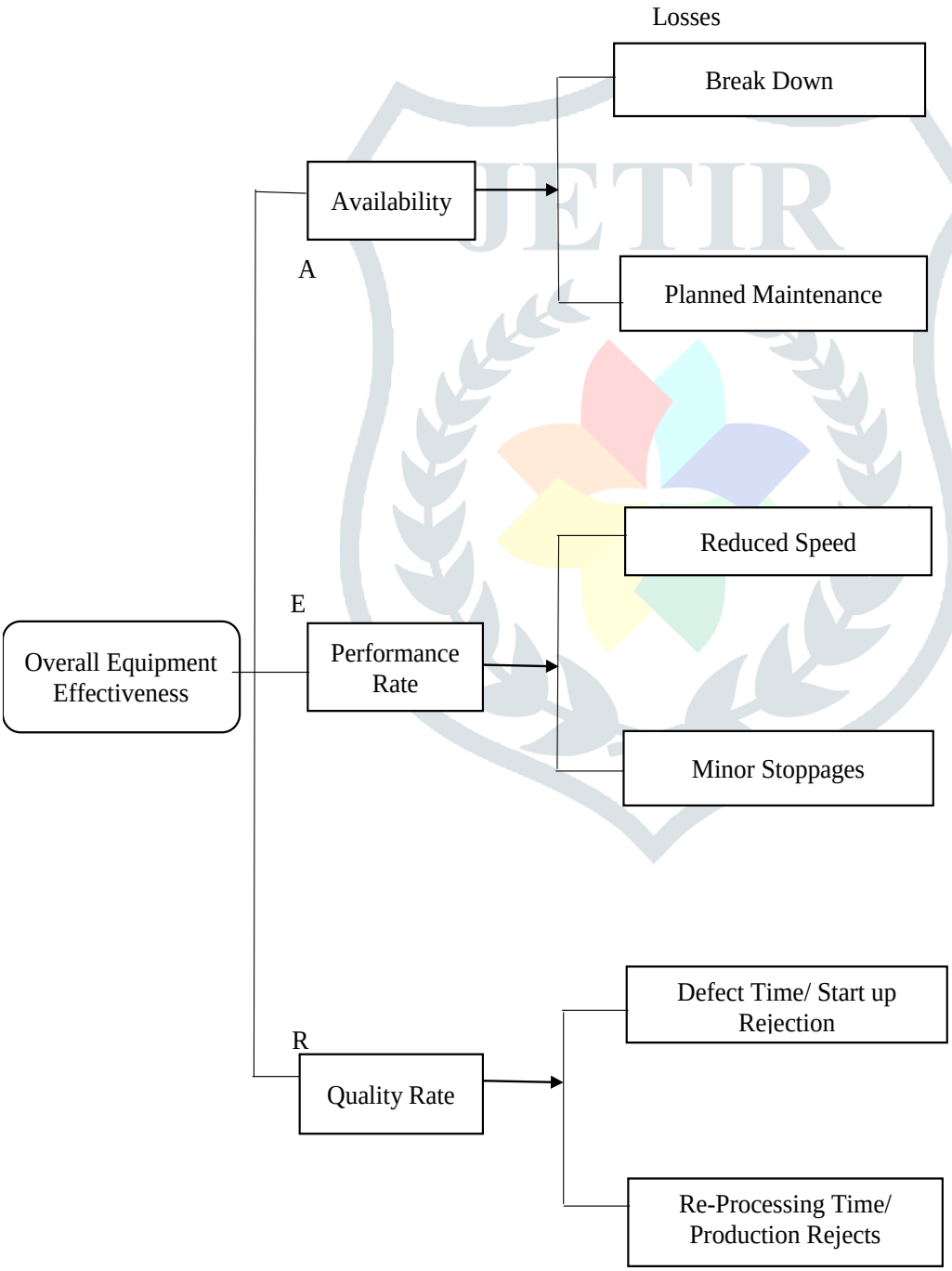
T – Operating Time (P-D)

Q – Rejection in Time (Defective Time and Reprocessing Time))

Equipment efficiency is measured as the product of the above mentioned metrics, using the equation

OEE = (A x E x R) x 100

Where- **OEE = Overall Equipment Efficiency**



OEE –Flow Chart

4. MONITORING AND MEASUREMENT OF DATA FROM RELEVANT SOURCES AND ANALYSIS

The manufacturing processes have log data which are filled up by relevant operators / chemists / officers on a regular basis. The information in these log data is collated on a daily / weekly basis for key parameters like breakdown and defect time and planned maintenance.

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The variance of each parameter like consumptions and efficiency factors are calculated and reported in weekly report. From the log sheet data and the weekly report the process OEE calculated. The summary OEE data shown in Table 20&21

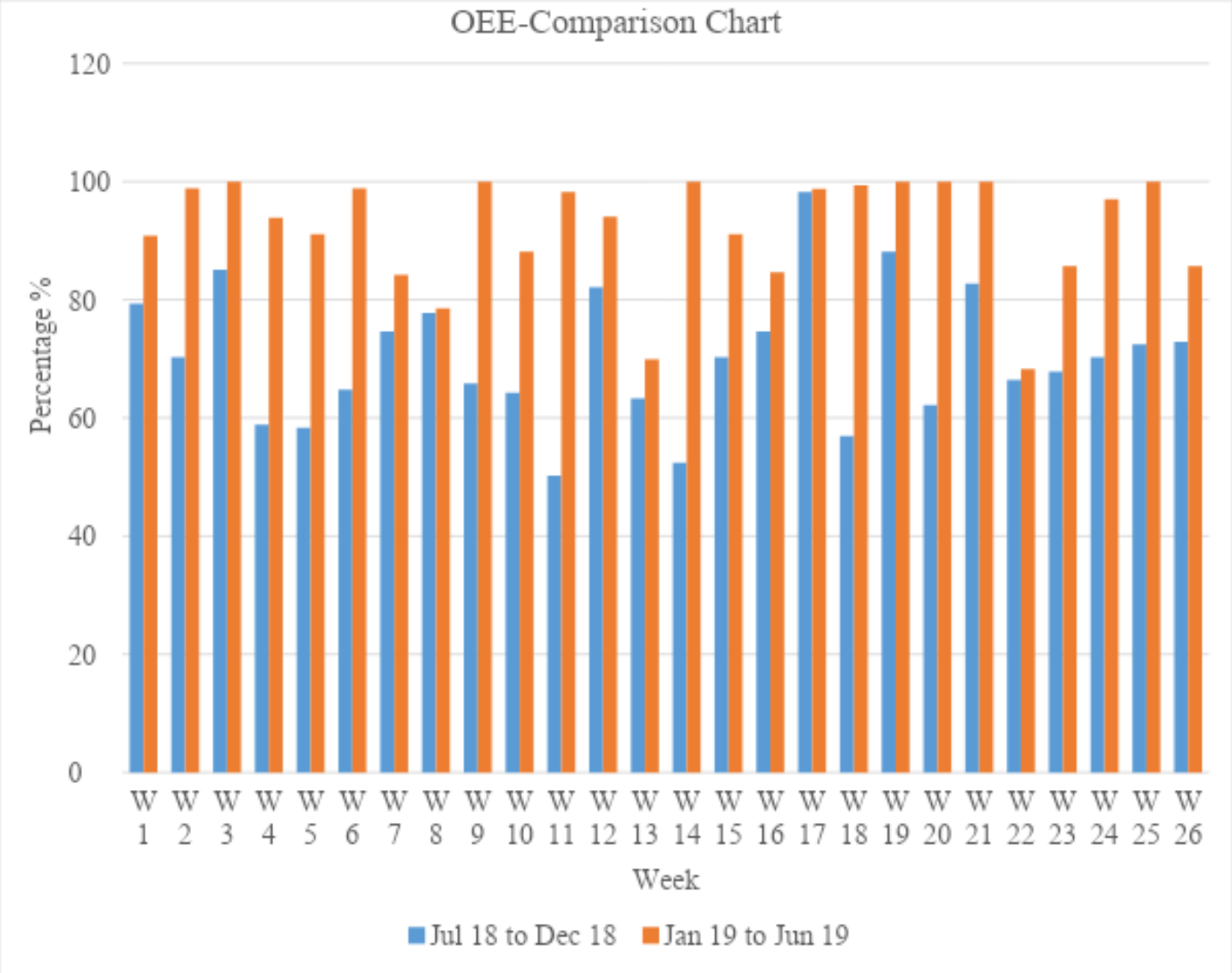
OEE data July 18 to Dec 18

Jul 18 to Dec 18												
Week	Total Time-(TT)	Design Capacity	Available time (P)= TT-Planned Maintena	Production Quanity (N)	Down Time-(D)	Operating Time (T)=P-D	Performance Loss-(L)	Rejection (Q)	Availablity A=T/P	Performance Rate E=(T-L)/T	Quality Rate R=(T-Q)/T	OEE= AxExRx100
UOM	Hrs	MT/Hr	Hrs	MT	Hrs	Hrs	Hrs	Hrs				%
W 1	168	41.66	158.00	5615	23.00	135.0	0.000	9.60	0.85	1.00	0.93	79.37
W 2	168	41.66	168.00	4917	50.00	118.0	0.000	0.00	0.70	1.00	1.00	70.24
W 3	168	41.66	168.00	5958	25.00	143.0	0.000	0.00	0.85	1.00	1.00	85.12
W 4	168	41.66	158.00	3875	45.00	113.0	20.000	0.00	0.72	0.82	1.00	58.86
W 5	168	41.66	168.00	4083	40.00	128.0	30.000	0.00	0.76	0.77	1.00	58.33
W 6	168	41.66	168.00	4703	40.00	128.0	15.000	4.80	0.76	0.88	0.96	64.74
W 7	168	41.66	138.00	4292	35.00	103.0	0.000	0.00	0.75	1.00	1.00	74.64
W 8	168	41.66	168.00	5539	35.00	133.0	0.000	2.40	0.79	1.00	0.98	77.74
W 9	168	41.66	168.00	4706	55.00	113.0	0.000	2.40	0.67	1.00	0.98	65.83
W 10	168	41.66	168.00	4608	60.00	108.0	0.000	0.00	0.64	1.00	1.00	64.29
W 11	168	41.66	168.00	3839	80.00	88.0	0.000	3.60	0.52	1.00	0.96	50.24
W 12	168	41.66	168.00	6164	30.00	138.0	0.000	0.00	0.82	1.00	1.00	82.14
W 13	168	41.66	158.00	4700	35.00	123.0	20.000	3.60	0.78	0.84	0.97	63.28
W 14	168	41.66	168.00	4107	50.00	118.0	30.000	0.00	0.70	0.75	1.00	52.38
W 15	168	41.66	168.00	5625	35.00	133.0	15.000	0.00	0.79	0.89	1.00	70.24
W 16	168	41.66	138.00	5013	35.00	103.0	0.000	0.00	0.75	1.00	1.00	74.64
W 17	168	41.66	138.00	6852	0.00	138.0	0.000	2.40	1.00	1.00	0.98	98.26
W 18	168	41.66	168.00	4963	70.00	98.0	0.000	2.40	0.58	1.00	0.98	56.90
W 19	168	41.66	168.00	7647	20.00	148.0	0.000	0.00	0.88	1.00	1.00	88.10
W 20	168	41.66	168.00	5684	60.00	108.0	0.000	3.60	0.64	1.00	0.97	62.14
W 21	168	41.66	168.00	7460	29.00	139.0	0.000	0.00	0.83	1.00	1.00	82.74
W 22	168	41.66	158.00	5900	30.00	128.0	20.000	3.60	0.81	0.84	0.97	66.43
W 23	168	41.66	168.00	6346	24.00	144.0	30.000	0.00	0.86	0.79	1.00	67.86
W 24	168	41.66	168.00	6687	35.00	133.0	15.000	0.00	0.79	0.89	1.00	70.24
W 25	168	41.66	138.00	5767	38.00	100.0	0.000	0.00	0.72	1.00	1.00	72.46
W 26	168	41.66	138.00	6040	35.00	103.0	0.000	2.40	0.75	1.00	0.98	72.90
	Total Available Hr		4178.00								Avg OEE	70.39

OEE data Jan 19 to June 19

Jan 19 to Jun 19												
Week	Total Time-(TT)	Design Capacity	Available time (P)= TT-Planned Maintenanac	Production Quanity (N)	Down Time-(D)	Operating Time (T)=P-D	Performance Loss-(L)	Rejection (Q)	Availability A=T/P	Performance Rate E=(T-L)/T	Quality Rate R=(T-Q)/T	OEE= AxExRx100
UOM	Hrs	MT/Hr	Hrs	MT	Hrs	Hrs	Hrs	Hrs				%
W 1	168	41.66	163.00	6167	15.00	148.0	0.000	0.00	0.91	1.00	1.00	90.80
W 2	168	41.66	168.00	6998	0.00	168.0	0.000	2.00	1.00	1.00	0.99	98.81
W 3	168	41.66	168.00	7000	0.00	168.0	0.000	0.00	1.00	1.00	1.00	100.00
W 4	168	41.66	163.00	6375	0.00	163.0	10.000	0.00	1.00	0.94	1.00	93.87
W 5	168	41.66	168.00	6375	0.00	168.0	15.000	0.00	1.00	0.91	1.00	91.07
W 6	168	41.66	168.00	6998	0.00	168.0	0.000	2.00	1.00	1.00	0.99	98.81
W 7	168	41.66	158.00	5542	25.00	133.0	0.000	0.00	0.84	1.00	1.00	84.18
W 8	168	41.66	168.00	5541	35.00	133.0	0.000	1.00	0.79	1.00	0.99	78.57
W 9	168	41.66	168.00	7000	0.00	168.0	0.000	0.00	1.00	1.00	1.00	100.00
W 10	168	41.66	168.00	6315	20.00	148.0	0.000	0.00	0.88	1.00	1.00	88.10
W 11	168	41.66	168.00	7333	0.00	168.0	0.000	3.00	1.00	1.00	0.98	98.21
W 12	168	41.66	168.00	7057	10.00	158.0	0.000	0.00	0.94	1.00	1.00	94.05
W 13	168	41.66	163.00	5206	44.00	119.0	5.000	0.00	0.73	0.96	1.00	69.94
W 14	168	41.66	168.00	7840	0.00	168.0	0.000	0.00	1.00	1.00	1.00	100.00
W 15	168	41.66	168.00	7293	0.00	168.0	15.000	0.00	1.00	0.91	1.00	91.07
W 16	168	41.66	163.00	6716	25.00	138.0	0.000	0.00	0.85	1.00	1.00	84.66
W 17	168	41.66	163.00	8094	0.00	163.0	0.000	2.00	1.00	1.00	0.99	98.77
W 18	168	41.66	168.00	8511	0.00	168.0	0.000	1.00	1.00	1.00	0.99	99.40
W 19	168	41.66	168.00	8680	0.00	168.0	0.000	0.00	1.00	1.00	1.00	100.00
W 20	168	41.66	168.00	8848	0.00	168.0	0.000	0.00	1.00	1.00	1.00	100.00
W 21	168	41.66	168.00	9016	0.00	168.0	0.000	0.00	1.00	1.00	1.00	100.00
W 22	168	41.66	163.00	6175	30.00	133.0	20.000	2.00	0.82	0.85	0.98	68.28
W 23	168	41.66	168.00	8016	24.00	144.0	0.000	0.00	0.86	1.00	1.00	85.71
W 24	168	41.66	168.00	9237	0.00	168.0	5.000	0.00	1.00	0.97	1.00	97.02
W 25	168	41.66	158.00	9111	0.00	158.0	0.000	0.00	1.00	1.00	1.00	100.00
W 26	168	41.66	168.00	8563	22.00	146.0	0.000	2.00	0.87	1.00	0.99	85.71
	Total Available Hr		4318.00								Avg OEE	92.19

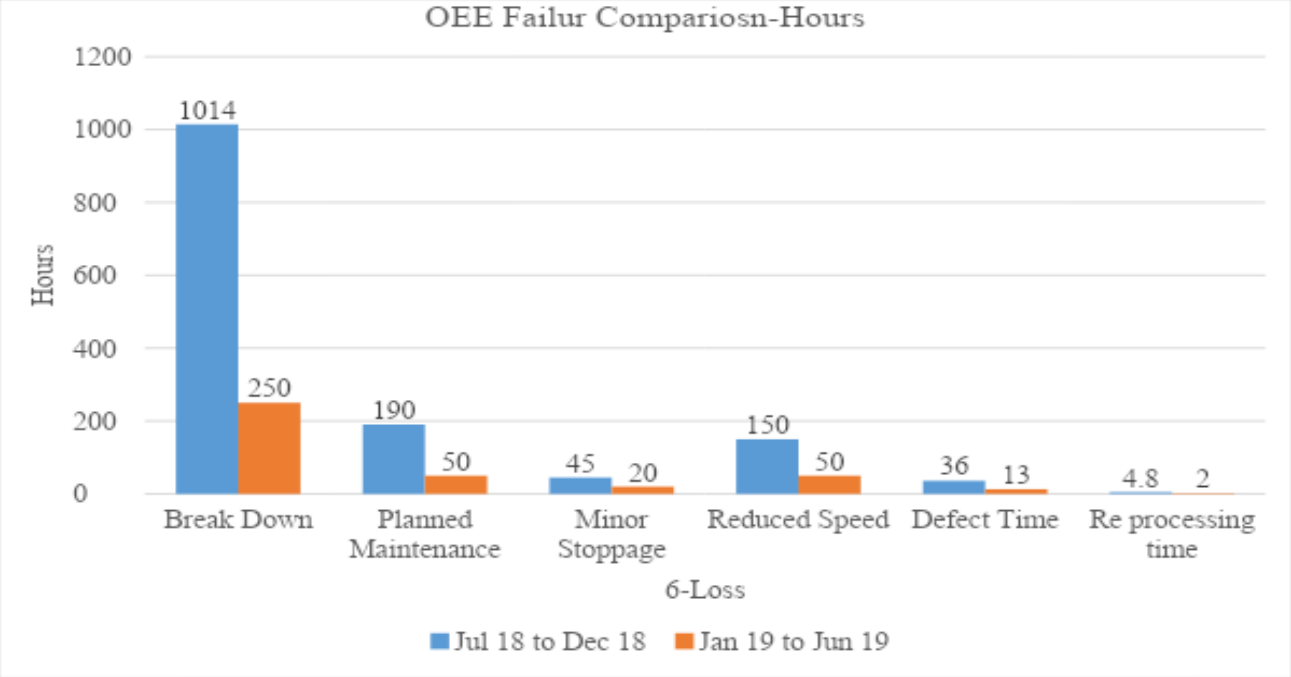
OEE Data Comparison Chart



OEE Equipment failures relative data

S.No	OEE	Loss of Nature	UOM	Jul 18 to Dec 18	Jan 19 to Jun 19
1	Availability (A)	Break Down	Hr	1014	250
2		Planned Maintenance	Hr	190	50
3	Performance Rate (E)	Minor Stoppage	Hr	45	20
4		Reduced Speed	Hr	150	50
5	Quality Rate (R)	Defect Time	Hr	36	13
6		Re processing time	Hr	4.8	2

OEE Failures hour's Comparative date



5. DATA ANALYSIS - CORRELATION COEFFICIENT-OEE FAILUR HOURS

Correlation

Correlation is defined as degree of relationship between two variables and it's a statistical measure which determines co-relationship or association of two variables and calculates the strength of the relationship between the relative movements of two variables. Correlation measures linear relationship. The value of correlation coefficient r lies between (-1 to +1). Example The value +1 implies that there is a perfect positive correlation.

OEE failures hour-Comparative data

S.No	Subject	UOM	Jul 18 to Dec 18 (**x**)	Jan 19 to Jun 19 (**y**)
1	Break Down	Hr	1014	250
2	Planned Maintenance	Hr	190	50
3	Minor Stoppage	Hr	45	20
4	Reduced Speed	Hr	150	50
5	Defect Time	Hr	36	13
6	Re processing time	Hr	4.8	2

Correlation Formula

$$r = \frac{\sum(x-\bar{x})(y-\bar{y})/(n-1)}{\sqrt{(x-\bar{x})^2/(n-1)}\sqrt{(y-\bar{y})^2/(n-1)}}$$

Correlation computation

x	y	$(x-\bar{x})$	$(y-\bar{y})$	$(x-\bar{x})\ (y-\bar{y})$	$(x-\bar{x})^2$	$(y-\bar{y})^2$
1014	250	774.1	185.84	143858.7	599230.81	34536.5056
190	50	-49.9	-14.16	706.6	2490.01	200.5056
45	20	-194.9	-44.16	8606.8	37986.01	1950.1056
150	50	-89.9	-14.16	1273.0	8082.01	200.5056
36	13	-203.9	-51.16	10431.5	41575.21	2617.3456
4.8	2	-235.1	-62.16	14613.8	55272.01	3863.8656
				179490.4	744636.1	43368.8
$\bar{x}$	$\bar{y}$	n-1				
239.9	64.16	5				

Compute table value to correlation formula

$$r = \frac{179490/(5)}{\sqrt{744636.03/(5)}\sqrt{43368.8/(5)}}$$

$$r = \frac{35898.0}{385.9X93.13}$$

$$r = 0.9988 \quad (-1 \le r \le 1)$$

r is Very Strong positive correlation so should continue corrective actions.

Square root of r = R^2 (Coefficient of Determination)

R^2= 0.997 means 99.7% of observed values fall on regression line

6. STRATEGIES FOLLOWED TO INCREASE OEE WITH REDECTIVE TOOLS & TRAINING

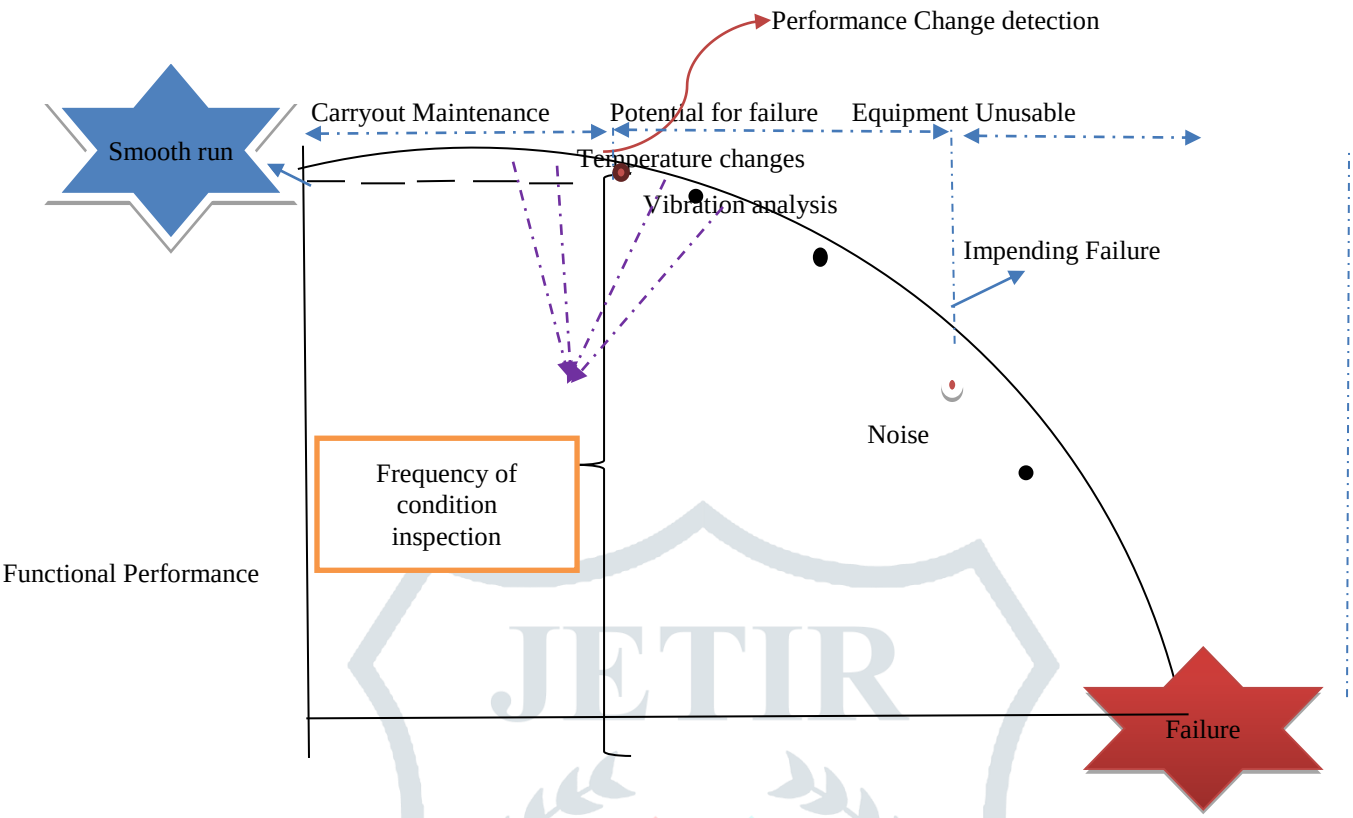
Increasing OEE leads to the increase in the standard of the manufacturing process and productivity. This directly contributes to the less breakdown, thereby increase in the profit margin. This also will fetch the better quality and reliable deliver to the customer

The strategies followed to reduce equipment failure:

Condition Monitoring (Predictive tools) means the use of advanced technology in order to determine equipment condition, potentially predict failure. It include technologies such as. Vibration Analyzer, Thermal Image, Laser belt alignment, Laser shaft alignment, Ultrasonic Leak detector.

Effectiveness improvement through predictive tools –Asset effectiveness of plant and equipment is defined as the ability to extract maximum profit from minimum investment. This is achieved through condition monitoring as enumerated below.

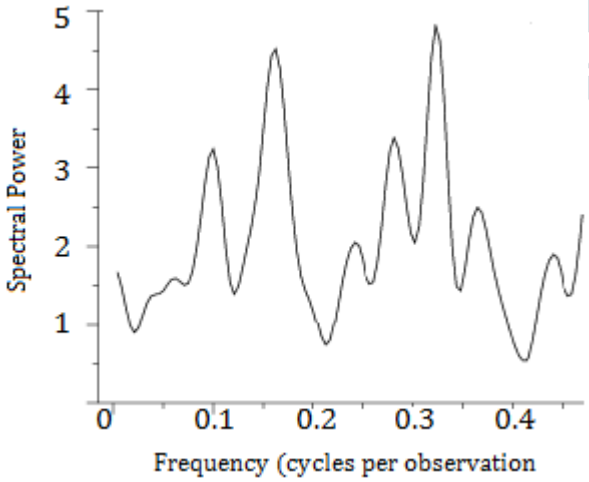
Graphical Representation of Condition Monitoring



6.1 Vibration Analyzer

It was used Boiler FD fan vibration analysis. Vibration analysis is forecast potential machinery problem and pinpoint their cause. Further it provide periodic condition monitoring using instrument. A database is established to record performance, establish machine histories, support maintenance diagnostics and extend machinery reliability. Problem detect include imbalance, misalignment, motor and electrical defect, gear train defects, and bearing defects. It is basically able to monitor the vibration signal from the machine and show you the value of these vibrations on your vibration meter or analyzer.

Typical spectra plot showing the spike



Above photo represent vibration more due to gear with damaged tooth. Acceleration response measured at various location through accelerometers are proceed in fast Fourier analyzer so as to get various statistical information like RMS.Average value etc.

On certain occasions. The damage to gears in a gear trail may be detected by means of extracting the vibration output through an accelerometer for the gear in question. The output of the mating gear or the drive gear output is triggered by tachometer input to the FFT analyzer. Both the output from the FFT are synchronized in the time domin.this enables the damaged gear identified exactly. The output is also averaged to get a reasonably good prediction.

The sensor is generating Voltage signal while it is shaking on the machine. This voltage signal is transferred through the cable to your vibration device. But your vibration device will not show you volts. It is smarter that volt meter. Vibration device is able to process the voltage signal and display vibration values such as acceleration and velocity.

FFT (Fast Fourier transform) Analyzer - The FFT analyzer is a device that uses the FFT algorithm to calculate a spectrum from a time domain signal, and is the most common type of spectrum analyzer available today. An FFT analyzer stores an input signal waveform as data by digitally (discretely) sampling it, determines the Fourier coefficients in a short time using FFT, and display the results of this analysis. Since FFT fundamentally involves determining a signal into simple frequencies by stating the value of frequency components (spectrum), the FFT analyzer is also called a frequency or spectrum analyzer. The FFT analyzer is a very convenient device and is available in a great variety of models with varying difficulty. It is the heart of an cccy machinery predictive maintenance program conceptual diagram showing the relationship between the results of the analysis of the composite vibration waveforms from this rotary machine obtained using an FFT analyzer and balancing unit.

6.2 Thermal Image

Infrared radiation (IR),electromagnetic radiation (EMR) with longer wavelengths than those of visible light. It is therefore normally unseen to the human eye, though IR at wavelengths up to 1050 nanometers (nm) s from specially pulsed lasers can be seen by humans under definite conditions.
Principle of Thermographic Measurement Using Infrared Portion

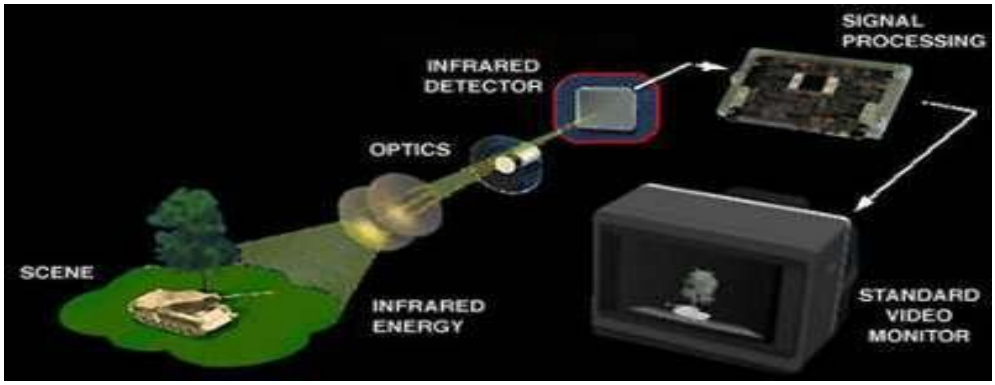
Normal sunlight has radiation of different wave lengths and thermography utilizes the infra
Radiation for the measurement of temperatures. Wavelengths of dissimilar radiations are given below

Radiation	Wavelength (Nano Meter)
Infrared	700 nm-1 mm
Visible	400 nm -700 nm
Microwave	1 mm – 1 m

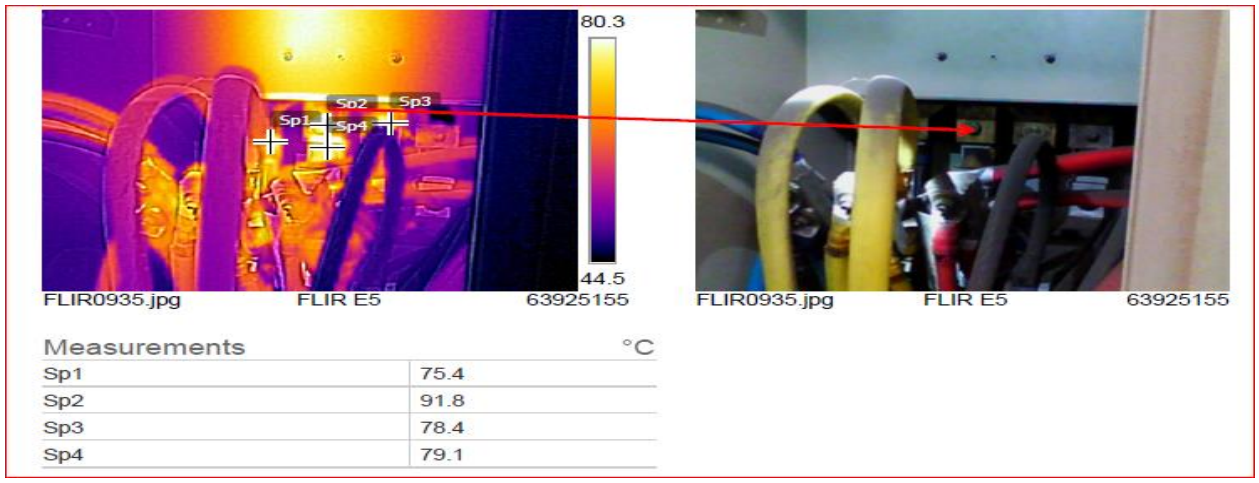
Infrared thermography is an effective means to identify excessive heat loss in system or material. Thermography was first utilized in the inspection of electrical equipment to locate resistance connection or faulty components. Thermography is now being also used for inspection of rotating machinery.it has been found effective in identifying faults in bearing, coupling, and shorts in motor cores.

Every object radiates electromagnetic energy invisible to human eye but visible to specialized equipments.Thermal imaging radiometers can detect and measure infrared ration, and produce a map of colour or varying shades the warmest temperature. And darker colour or shades the coolest.by analyzing the temperature signature of the equipment's, problem area are quickly identified and recorded along with all of the related temperature information. These work on principle of thermal energy emitted/radiated from objects. All object having a temperature above absolute zero, emit energy of radiation. Electromagnetic radiations, with wavelength from 0.75 to 1000 microns are called infrared radiation.
It regulates the temperature of the body's surface, and makes it observable for the human eye with a thermal image. This process is referred to as thermography. Following figure represent ACB bus bar circuit cable loosen.

IR Transducer View



ACB bus bar circuit bolt loosen



The amount of radiation emitted by an object increases with temperature; therefore thermography allows one to see variations in temperature. All objects emit a certain amount of black body radiation as a function of their temperatures. The higher an object's temperature is the more infrared radiation as black-body radiation it emits. A special camera can detect this radiation in a way similar to an ordinary camera does visible light. It works even in total darkness because ambient light level does not matter.

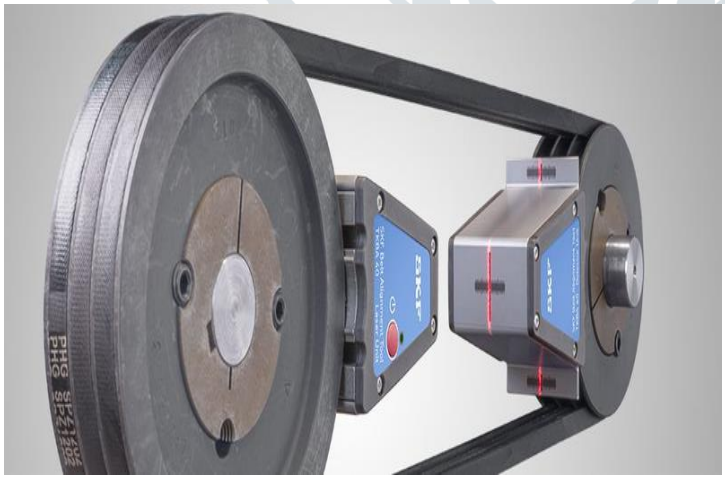
6.3 Laser belt alignment

The goal of belt alignment is to line up the grooves of the drive and driven pulleys so that the belts run with negligible wear. Belt manufacturers naturally recommend a maximum horizontal angular misalignment from 1.0 to 0.25°. This accurateness can only be attained with precision alignment tools such as laser equipment.

Belt arrangement or, more exactly, pulley alignment, is a principal maintenance activity. When pulleys are not aligned properly, additional loads are induced. The goal of belt alignment is to bring into line the grooves of the drive and driven pulleys so that the belts run with negligible wear. Proper alignment extends the service life of belts and bearings, reduces vibration and noise levels, and saves energy.

Belt position, or more precisely sheave alignment, is the process of attaining proper radial and axial alignment of the centerlines of sheave grooves, on top of which belts run. In history, belt or sheave alignment has not been consider a major concern in

Laser belt alignment Tools



The transmitter makes a laser plane parallel to the mention sheave. The detector reads the position in relation to the laser plane and provides a live digital display of both offset and angular value. This makes the alignment of the adjustable machine precise and simple. The accurateness of the digital figures also means that you can bring into line within agreed tolerances and rely on the result.

Maintenance, due to belt costs being relatively small. Though, if sheaves are not correctly aligned and tensioned, the below mention problems occur:

- Greatly reduced life of the belts
- Improved radial and axial loading of the shafts, and the bearings that should support them

- Improved wear and reduced life of the sheaves
- Increased noise, vibration, dust, and heat as a result of belt wear.
- In the past, sheaves were aligned using a straightedge or string, but this method cannot accurately measure parallelism of the shafts. A more precise method is the use of a laser sheave alignment tool.

6.4 Laser shaft alignment.

Shaft alignment, habitually called “coupling alignment”, is a procedure to make two or more rotating shafts co-linear, or in the similar straight line, both vertically and horizontally. Shaft alignment can be done utilizing several methods and tools, such as straightedges, calipers, dial indicators, optics, or laser systems. These, laser shaft alignment is the fastest and most precise.

The subject of alignment is of utmost importance in maintenance of plant and equipment especially in condition based maintenance. In an organization where maintenance systems are followed all alignments are done to 0.05 mm for equipment running below 3600 rpm and 0.025 mm for equipment running above 3600 rpm. There is a well-defined alignment standard explaining how to set up, clean and check for pipe strain and soft foot, etc. In a plant where alignment checks are carried out at regular intervals vibration level will be as low as 2.5 mm/s (unfiltered average).

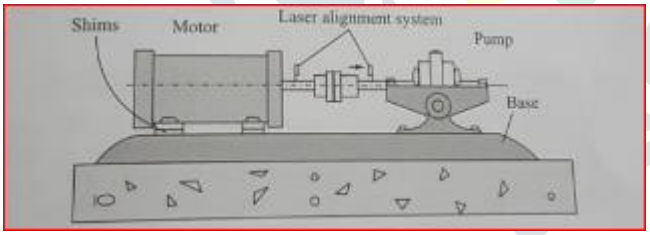
Laser shaft alignment systems normally consist of two sensors (laser emitters/receivers), a display unit. Most systems nowadays have Bluetooth Wireless fitted or some even have the ability to join directly over a downloadable app on a tablet or smartphone.

Laser shaft alignment systems can be altered with extended chains for bigger diameter shafts, and lengthier rods for aligning shafts with larger couplings or to avoid blocked laser paths. Earlier the sensors are mounted, a pre-alignment check must be completed. Pre-alignment comprises executing a rough alignment, reducing obvious soft foot, tightening bolts and doing a last soft check.

After the pre-alignment check is complete, the sensors are attached to both the fixed and movable shafts or coupling hubs, and the lasers beams are rotated on. The operator will then be prompted to run through a predetermined series of steps which include entering specified dimensions and selecting the necessary tolerances based on either the preset choices or customizing to the customer’s tolerance specifications.

The operator will next take alignment readings using a 180° minimum sweep (suggested for best results). These systems quantity at a great rate of speed and detect alignment differences in microns, with outcomes displayed directly to the nearest .0001”. When initial data is collected, the unit will then prompt the operator by the steps wanted to correct both horizontal and vertical misalignment.

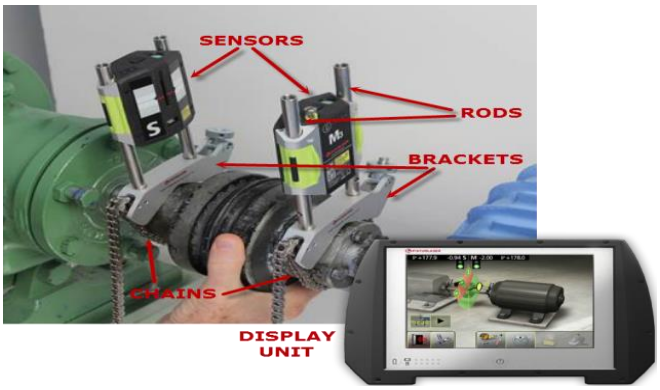
Shaft and motor alignment



The axes of rotation of both shafts should be co-liner when the machine is running under normal conditions.

The alignment condition can change once the machine is rotating. This can be for a number of reason’s including thermal growth, Piping strain, Machine torque, Foundation movement and bearing play. Since shaft alignment is usually measured with the machines cold, The alignment condition as measured is not necessarily the zero alignment condition of the machines.

Laser shaft alignment Tools



6.5 Ultrasonic Leak detector

Leakage is unintended discharge or oozing of fluids and gasses (both, external and/ or internal) from mechanical components, occurring because of increase in clearance or wear-out or erosion of parts like valve seats, poppets and spools etc or damage of seals and packing or because of incorrect selection/ fitting of seals and components or because of other reasons. Whatever cares may be taken, some leakages do take place sometime, which is an indication of generation of some defects/ deteriorations in some components. Occasionally thinning –out of oils and lubricants (decrease in viscosity or dilution by less viscous fluids) induces or increases leakage, which again is an indication of some defects or deteriorations.

Find leaks speedily and simply with Ultrasound technology, Ultrasound leakage detection covers a wide range of leakages: pressure or vacuum and any gas. Sound reliant on, ultrasound instruments identify turbulent flow produced as the fluid (liquid or gas) transfers from the high-pressure side to the low-pressure side of a leak.

Ultrasound leakages outcome covers a wide range of leaks: pressure or vacuum and any gas. Sound reliant, ultrasound instruments detect turbulent flow produced as the fluid (liquid or gas) changes from the high-pressure side to the low-pressure side of a leak. Ultrasound leak examination is particularly helpful in areas where there is a saturation of gases or where a varied variety of gases, pressurized vessels and vacuum processes exist. For this reason ultrasound leakage discovery is used in many facilities for safety, environmental, energy or quality guarantee programs.

Ultrasonic leak detector

As the name suggests ultrasonic leak sensors detect the ultrasonic sound of a leakage. You are probably familiar with the hissing sound a large leak makes. Smaller leakages also release sound, however the frequency is also high for our ears to notice it. Through a process named heterodyning, Ultrasonic Leak Detectors explains the ultrasonic hissing sound to a lesser frequency wherever it can be heard through headphones, and leads you to the cause. As you become closer, the sound becomes louder and/or the LED meter increases. Reduce the sensitivity as you close in on the leak to easily pinpoint its place. Few leaks can be heard from some feet away, So direct access to the leak is not always needed. As long as the leakage is turbulent, there will be adequate sound to be noticed ultrasonically. Ultrasonic's can detect pinhole leaks with as low as 1 psi. Though, the more pressure behind the leak, the extra turbulence there will be, and the easy it will be to locate.

Ultrasonic Leak Indicators are greatest sensitive to sounds around 40 kHz, that's double the frequency of the best human hearing. Any turbulent gas will make ultrasound once it leaks, so it does not matter what gas you are leak testing. Ultrasonic' s will sense air, nitrogen, new or old refrigerants, or even air as it rushes into a system below vacuum.

Leak Detectors are so sensitive to sound that it will let you hear the blink of the human eye, but yet again it is not gas specific. For example, a leak test can be complete in an encircled area which is saturated with refrigerant, and the only sign an ultrasonic will give you is the sound of the leakage. But because the ultrasound is focused on a specific band of sound... wind noise, voices, traffic, and most normal operational background noise will not be detected.

7. CONCLUSION

The aim of this work is analyzing the OEE due to equipment failure and increasing OEE by leveraging the Management system in the manufacturing Industry, The quality tools and predictive tools are used to identify and categorize the causes of failures. Availability and reliability was increased remarkably.

The equipment failure causes a major loss to the Industry by monitoring and reviewing the failure on a weekly basis in the management meeting is helpful to find the corrective action. The losses are categorized into controllable and non-controllable, which will give a clear idea about the opportunity to increase OEE.

The overall OEE was increased by 20% by the implementation of the CA & PA system. By implementing the various control measures, the program is a target to achieve 25% OEE and increase availability by Dec'19.

8. REFERENCES

1. Venkataraman K, 2017, "Maintenance Engineering and Management**"**, Eighth edition, Printing Sep 2017, PHI Leaning Private Limited, New Delhi.
2. Jayakumar V, 2005, "Total Quality Management", Second Edition, Lakshmi Publications, Chennai.
3. Besterfield. Dale H, Carlo besterfield-Michna, Mary Besterfield-Sacre, Glen H.Besterfield,Hemant,Urdhwareshe,Rashmi Urdhwareshe,2017, "Total Quality Management", Fourth Edition , Pearson, Noida.
4. Er.Sushil Kumar Srivastava**,** 2018, "Maintenance Engineering", Revised Edition 2010, S.Chand and Company Limited, New Delhi,
5. Pascal Dennis, 2018, "Lean Production Simplified", Third Edition, CRC Press ,Boca Ratan -US, ,
6. Dr.Jayakumar V, Dr Raju. R, 2017, "Total Quality Management", Sixth Edition, Lakshmi Publications, Chennai.
7. Vittal P.R, 2015, "Quantitative Techniques", First Edition Reprint 2015, Margham Publications, Chennai.
8. Aswathappa K, 2017, "Human Resource Management**"**, 8th Edition, McGraw Hill Education PVT LTD, Chenna**i**.
9. David M.Levine, Kathyn A.Szabat, Davit F.Stephan, Viswanathan P.K, 2017, "Business Statistics", 7th Edition, Pearson, Noida.
10. Srivastava T N,Shailaja Rego, 2016, "Statistics for Management", Third Edition, McGraw Hill Education India Pvt Ltd, New Delhi.
11. Farooq Umer, Khan Umar Khatab, Zahid Hassan, January-2017 , "OEE and Countermeasures": A Case Study of a Manufacturing Unit, International Journal of Scientific & Engineering Research, 585 ISSN 2229-5518