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EVALUATION OF THE CONTINUES WORKING SYSTEM IN TERMS OF RELIABILITY, FAULTS AND FAILURE MODE

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***Abstract*: Evaluate the continues working system of process industries in terms of Reliability. Study of the Reliability and its parameters like Mean time Between Failure (MTBF), Hazard Rate, Meat down Time, Operation Availability, Mean time to Repair and Inherent Availability. Plot the Bathtub Curve. Also study the faults and failure mode. Here in this paper the study is done on the RAC system of Gurukrupa Industry located at Santej, Ahmedabad.**

***Keywords:* Low carbon steel AISI 1019, ANOVA, Regression analysis, S/N ratios, MINITAB software.**

I. INTRODUCTION

Advance Techno System- Changodar Ahmedabad manufactures the Air condition and Refrigeration plant for the process industries like dairy industries, polymers industries, and metal & alloy industries, chemical industries. This Actual data is of Air-condition & Refrigeration plant of Gurukrupa Industries, Santej. Data is collected after successful installation of the plant on 30 Oct 2012 by Advance Techno System.
This plant is used exclusively to keep cool the process of printing on polyethylene bags.

Fig.1. Advance Techno System- Changodar Ahmedabad

Fig.2. Advance Techno System- Changodar Ahmedabad

II. OBJECTIVE

Study the terms and find out the Reliability from given data for the given time period (20 weeks) and its parameters like Mean time Between Failure (MTBF), Hazard Rate, Meat Down Time, Operation Availability, Mean time to Repair and Inherent Availability and Plot the Bathtub Curve.

III. BASIC TERMS & CALCULATIONS

a) **Reliability R (t):** The probability that a system or component will perform its desired function without failure under stated conditions for a stated period of time.
b) **MTBF:** The MTTF (Mean Time between Failures) is the expected time between failures of a repairable system. This system parameter can be calculated for the steady state. Lower and upper confidence levels for this parameter can also be calculated.
c) **MTBF** = Uptime (Ut)/ No. of frequency of failure (N).
d) **Hazard Rate:** The probability of system failure within time t and t + 1 units, given that the system is continuously operational until time t this system parameter can be calculated for specific points in time.
e) **Hazard rate (Hr)** = No. of frequency of failure (N)/Uptime (Ut) = 1/MTBF.

Months	Weeks	Duration	Total Time Hrs	Up Time Hrs	Down Time Hrs.	Frequency of Failure *
Nov	1st	2-9 Nov 2012	192	168	24	6
2012	2nd	10-16 Nov 2012	154	140	14	4
	3rd	17-23 Nov 2012	168	164	4	2
	4th	24-30 Nov 2012	154	140	14	1
Dec	5th	1-7 Dec 2012	168	168	0	0
2012	6th	8-14 Dec 2012	154	140	14	1
	7th	15-21 Dec 2012	168	162	6	1
	8th	22-28 Dec 2012	154	140	14	1
Dec/Jan	9th	29-4 Jan 2012/13	168	168	0	0
2013	10th	5-11 Jan 2013	168	166	2	1
	11th	12-18 Jan 2013	154	140	14	2
	12th	19-25 Jan 2013	168	166	2	1
Jan/Feb	13th	26-1 Feb 2013	154	140	14	1
2013	14th	2-8 Feb 2013	168	165	3	1
	15th	9-15 Feb 2013	154	140	14	1
	16th	16-22 Feb 2013	168	167	1	1
Feb/Mar	17th	23-1 Mar 2013	154	140	14	1
2013	18th	2-8 Mar -2013	168	165	3	2
	19th	9-15 Mar -2013	154	140	14	2
	20th	16-22 Mar -2013	168	167	1	3

* Frequency failure of above data included the tripping of the system

Table.1. Data of Air-condition/Refrigeration Plant

f. **Mean Down Time - MDT** = Downtime (Dt)/ No. of frequency of failure (N)
g. **Mean Time To Repair - MTTR** = 0.3 X MDT
h. **Availability:** The probability that a system or component is in an operable state at a specified time. Logistic delay times and administrative downtime for maintenance are not included in the calculation of availability. If you want to include these times, you would choose to calculate operational availability instead. Availability can be calculated for specific points in time. Lower and upper confidence levels can also be calculated.

   Av (in) = MTBF / (MTBF + MTTR)

i. **Operational Availability:** The probability that a system or component is in an operable state at a specified time. Logistic delay times and administrative downtime for maintenance are included in the calculation of operational availability. If you want to exclude these times, you would choose to calculate availability instead. Operational availability can be calculated for specific points in time. Lower and upper confidence levels can also be calculated.

   Av (op) = MTBF / (MTBM + MDT)

j. **Calculation:** The Calculation was carried out to find reliability parameters from the collected data. Table. 2 shows the calculations.

IV. SUMMARY OF TYPES OF FAULTS OBSERVED

Many common faults in a refrigeration system could be localized visually (without the use of instruments), by hearing, by feel, and sometimes by smell. Other faults can only be detected by instruments.

The location of all forms of faults on even relatively simple refrigeration systems is conditional on a thorough knowledge of such factors as:

Weeks	**Total Time Hrs**	**Up Time Hrs**	**Down Time Hrs.**	**Frequency of Failure**	**MTBF Hrs**	**Hazard Rate (Hrs)**	**MDT Hrs**	**Operation Availability Av(op)**	**MTTR Hrs.**	**Inherent Availability Av(in)**
1st	192	168	24	6	28	0.0357	4	0.8750	1.2	0.9589
2nd	154	140	14	4	35	0.0286	3.5	0.9091	1.05	0.9709
3rd	168	164	4	2	82	0.0122	2	0.9762	0.6	0.9927
4th	154	140	14	1	140	0.0071	14	0.9091	4.2	0.9709
5th	168	168	0	0	0	-	-	-	-	-
6th	154	140	14	1	140	0.0071	14	0.9091	4.2	0.9709
7th	168	162	6	1	162	0.0062	6	0.9643	1.8	0.9890
8th	154	140	14	1	140	0.0071	14	0.9091	4.2	0.9709
9th	168	168	0	0	0	-	-	-	-	-
10th	168	166	2	1	166	0.0060	2	0.9881	0.6	0.9964
11th	154	140	14	2	70	0.0143	7	0.9091	2.1	0.9709
12th	168	166	2	1	166	0.0060	2	0.9881	0.6	0.9964
13th	154	140	14	1	140	0.0071	14	0.9091	4.2	0.9709
14th	168	165	3	1	165	0.0061	3	0.9821	0.9	0.9946
15th	154	140	14	1	140	0.0071	14	0.9091	4.2	0.9709
16th	168	167	1	1	167	0.0060	1	0.9940	0.3	0.9982
17th	154	140	14	1	140	0.0071	14	0.9091	4.2	0.9709
18th	168	165	3	2	82.5	0.0121	1.5	0.9821	0.45	0.9946
19th	154	140	14	2	70	0.0143	7	0.9091	2.1	0.9709
20th	168	167	1	3	55.67	0.0180	0.33	0.9940	0.1	0.9982

Table.2. Calculation Table

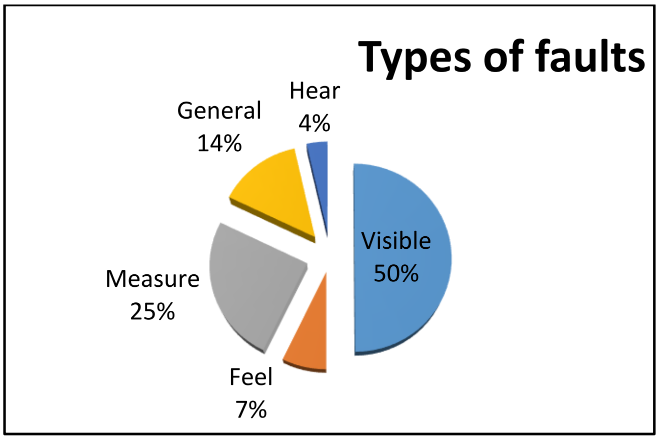


Fig.3. Pie Chart: 1 - Type of Faults

a) The build-up of all components, their mode of operation and characteristics.
b) Necessary measuring equipment and measuring techniques.
c) All refrigeration processes in the system.
d) The influence of the surroundings on system operation.
e) The function and setting of controls and safety equipment.

V. OBSERVATION & CONCLUSION

a) Plant had maximum failure rate immediate after installing (30^{th} Oct 2012 – 4^{th} Week of Oct), upto 3^{rd} week.
b) It can be say that this period is ‘burn off’ or ‘infant mortality’ period.
c) After the 3^{rd} week Nov 2012, failure rate decreased and became constant upto 17^{th} week, this period is constant failure rate region.
d) After 17^{th} week, again failure rate was started increases. This requires maintained of components or replacement of changes of filters of oil separator or compression or etc. Plants started trip off in this period.(annexure-1).

Failure Mode	Causes	Type of Fault	No of faults
1) System stopped via low-pressure control. 2) Low suction pressure or compressor cycling. 3) Oil drops under joints and/or oil spots on floor 4) low suction pressure or compressor cycling 5) Abnormally severe frosting 6) Air temperature in cold room too high	1) Receiver Value Closed 2) Liquid level too high. 3) Oil and refrigerant leakage. 4) Thermostatic expansion valve with external pressure equalization 5) Thermal valve superheat too low 6) Room thermostat defect	Visible Visible general Visible Visible Sense	1 2 1 3 4 1
1) Liquid level too low 2) Dew or frost on compressor inlet side 3) Blown fuses. 4) Air temperature in cold room too high.	1) Overcharged evaporator 2) Superheat at evaporator outlet too low 3)Overload on system or short-circuiting 4) Room thermostat defect	Visible Visible Visible sense	5 6 7 2
1) Condensing pressure too low 2) Liquid level too high	1) Water quantity too large. 2) Overcharged system	measure visible	1 8
Suction pressure too low (solenoid cool than tubing)	Solenoid valve sticks	Feel	1
system stopped	Overload on system or short circuiting, motor protector cut out	visible	9
Liquid and vapour bubbles in sight glass.	Insufficient liquid in system	Visible	10
System stopped.	Overload on system	General	2
Cut-out pressure controls or thermostats	Setting error, equipment error	General	3
1)Suction pressure too high 2) Suction gas temperature too low.	1)Thermostatic expansion valve superheat setting too low 2) Repair HE heat exchanger	Measure Measure	2 3
Discharge line temperature too high.	Leaking suction or discharge valves	Measure	4
Moisture indicator discolored Yellow	Moisture in system	visible	11
Liquid hammer	Knocking sound during operation, Oil boiling	hear	1
Air humidity in room too low.	Load on room too high because of Cold room poorly insulated	measure	5
Pure vapour in sight glass.	Insufficient liquid in system	visible	12
System stopped	Cut-out pressure controls or thermostats, setting error	general	4
Oil drops under joints and/or oil spots on floor	Oil and refrigerant leakage.	general	5
1) Filter drier cold 2) Increased condensing pressure, Reduced refrigeration output	1) Partial blocking of dirt strainer in filter 2) Dirt, e.g. grease or dust, sawdust,	measure visible	6 13
1)Suction pressure too low 2)Air temperature is too high 3) Fan stopped.	1) Filter drier partly blocked. 2)Room thermostat defect 3)Motor defect Maintenance required	Measure Feel visible	7 2 14

Table.3. Types of faults

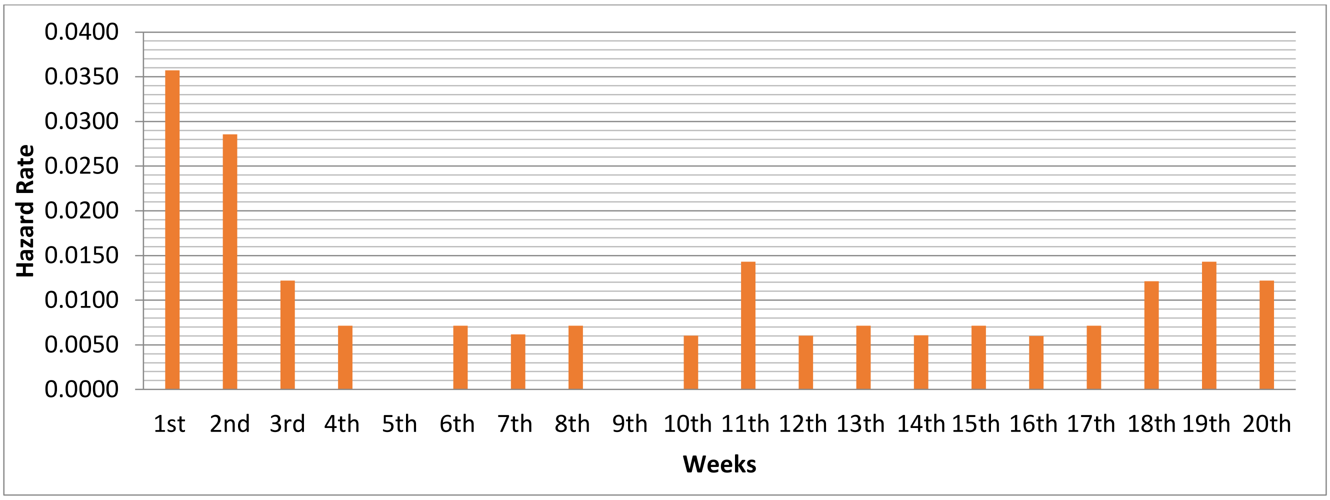
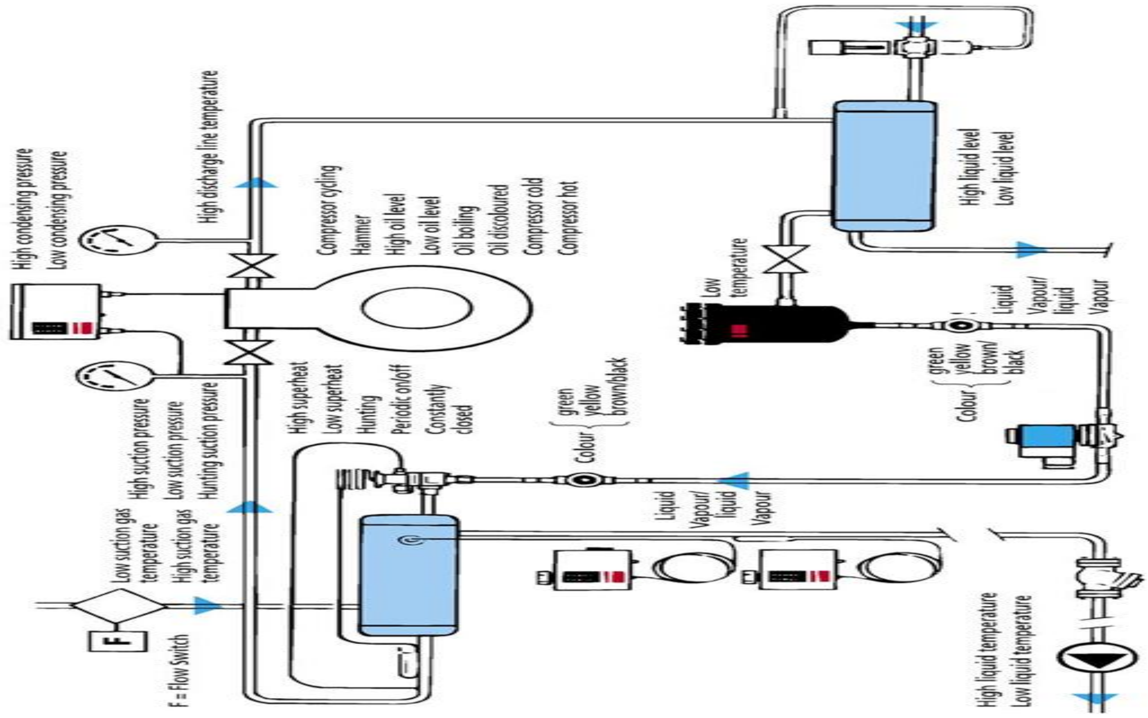


Fig.4. Graph: 1 BathTube Curve

Condition monitoring system suggested for this plant as there is near about 50% visible and 25% measurable fault. Routine Maintenance plan can be suggested

Annexure -1



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