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Improving Overall Productivity by Using Quality Tools

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Abstract—The aim of this report is how to apply different quality tools in pharmaceutical industry to improve productivity. This research study gives brief introduction about Fishbone analysis, Check sheet & Pareto chart to reduce product cost & improve productivity. To achieve big success, in today's highly competitive industrial environment industry must have to supply superior quality of product with lowest to lowest cost of product & shortest delivery period of product .High product cost ,Quality of product & Time required for manufacturing of product are the main problems in pharmaceutical industry. In This research study different quality tools & basic calculations of mechanical study used to reduce raw material cost, chilling plant operation cost ,boiler operating cost .This all activity resulted in to increase efficiency of organization.

Keywords-*Quality Tool, Fishbone analysis, Check sheet, Pareto chart, Histogram, Cause &Effect Diagram, Boiler, VCS System*

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I. INTRODUCTION

To survive in today's business world industry requires making of product in minimum cost maintaining its quality and & reducing losses in industry. This is where the main problem starts, which leads to high product cost, quality issue and customer complain etc. The Quality Tools are much helpful for detect this all problem , analysis of this problem & better solution of all this problem .They are basic seven quality tools which are Check Sheet, Fishbone Diagram, Process flow Diagram, Control Chart Histogram, Pareto Diagram & Scatter Diagram .

II. LITERATURE REVIEW

To study the seven quality tools i have selected following papers to study how to use Quality tools to more & efficient way to increase efficiency of organization.

Yogesh K More, Prof J. N. Yadav et al (2017) this paper briefly explains basic concept Of Quality Tools. This Paper explains how to use Cause & effect diagram, control chart & Scatter diagram to Improve Quality of the Product. Deepak, Dheeraj Dhingra et al (2016) in this paper a Case study has been conducted in a bicycle industry in Ludhiana for improving the quality of bicycle rims. The Quality Tools such as Pareto chart, Fishbone diagram had been applied in this paper to improve the quality of the products. This paper shows the how to reduce the cost per components by reduction in monthly rejection of components. Pareto chart, cause & effect diagram used in this research paper. Ahmed Al-Kuwaiti, Thennarasu Maruthamuthu et al (2016) this research Paper briefly explains to build a model for performance measurement and improvement with regard to the appropriate utility of quality tools. This paper also helps the quality management personal to work efficiently and effectively towards improvement .In this research paper control chart is the primary tool used for measuring performance. Lim Sanny, Ria Amalia et al (2015) This paper analyze the factors that cause defect in production & ways to reduce the number of defects that occur in the manufacture of the product by using Quality tools.

III. COMPANY PROFILE

All relevant data of this Case were collected from M/s AARTI DRUGS LIMITED, the leading manufacturer of Active Pharmaceutical Ingredient in India. Aarti drugs Limited (plot no: E-21) built in 2006 at Tarapur .Mahaashtra, India. Among the huge list of their products ornidazole is chosen for the detailed study. ornidazole is a well characterized and effective medicine used to treat people who have certain types of urinary tract, Intestinal infections or some specific infections which caused by anaerobic bacteria (bacteria that don't use oxygen). It is also used for infections during surgical procedures & protozoan infections. Ornidazole is a quick moving product. Monthly almost twenty four batches is produced to meet the market demand. The batch size of ornidazole 1000 kg's &1 batch per day is produced. Capacity of plant is 24 TPM per month.

IV. PROBLEM DEFINITION

Aarti Drugs limited facing main problem in high cost for product like raw material high cost, high cost for chilling plant, high cost for boiler & other element. This problem sorted out in this study.

V. PROPOSED METHODOLOGY

Aarti drugs Ltd product cost is the main problem. For Elimination of this problem I followed this stepwise methodology which includes problem identification, Impact of problem, Analysis of problem, causes of problem & their best solution.

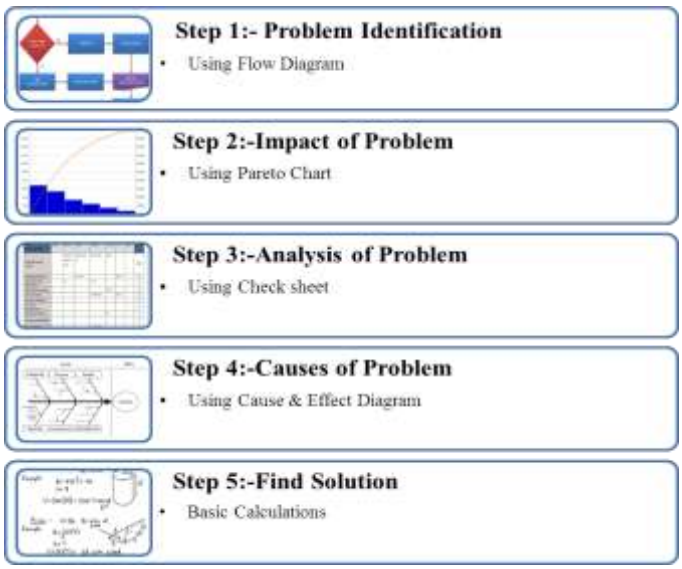

Figure 1. Stepwise Proposed Methodology

Step 1:-Problem Identification.

It's decided to collect data & exact process flow diagram of ornidazole to identify the problem. To eliminate the high product cost it's important to understand the how the product process flow is going on. To make product process flow It's decided to visit raw material store department ,production area, physical processing area, packing area, quarantine area, chilling plant, boiler shed, account department, human resource management, purchase department, sales department & maintenance department. By visiting all department it's easily understandable how's the product process flow going on & which are the main factor responsible for high product cost.

Process flow diagram description: - M/s aarti drugs limited monthly production capacity is almost 23000 – 24000 Kg of ornidazole . . The batch size of ornidazole 1000 kg's &1 batch per day is produced. This process flow diagram represents data for 1000 kg of ornidazole production per one day one batch. There are five materials which included in raw material which are as oil ornidazole, liquid NH3, methanol, charcoal& water. In Utility there are three types of utility included which are Chilling & Cooling to remove heat from product, low pressure steam (Heating) to provide Heat. For chilling utility they are using chilling plant, for cooling purpose they are using cooling tower & for heating utility purpose they are using boiler. This process is classified into eleven stages. Each stage details are as follows

Stage one:-Material Charging.

Oil ornidazole used as raw material charging. In 1000 kg of ornidazole batch require 850 litre of Oil ornidazole ,1040 litre of water & 15 kg of charcoal for color improvement for this stage. After the material charging 3 Hrs heating provided to reactor.

Stage two:-Basket Filter filtration.

After the stage one this material transfer through basket filter to remove charcoal which is used in stage one for color improvement. In this stage waste charcoal dispose to Mumbai waste management ltd.

Stage three: - pH Precipitation

Oil ornidazole & this solution is highly acidic. Thus it is requires to reduce acidic level of oil ornidazole solution, thus liquid NH3 used to reduce acidic level of oil ornidazole.Liquid NH3 pH range is basic in nature, thus it highly usable for pH precipitation stage. NH3 required for this stage 680 litre& cooling applied to reactors jacket for 1 hr to reduce temperature of solution. Then again 2 Hr chilling provided to reduce the temperature of solution. Cooling firstly provide to solution to prevent equipment damage then after chilling applied to solution.

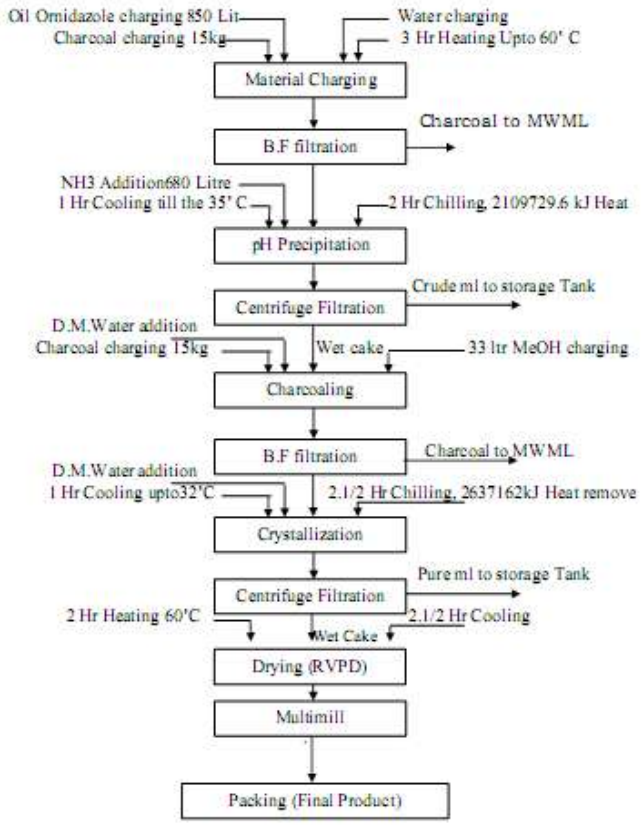

Figure 2. Process flow diagram of ornidazole

Stage four: - Centrifuge filtration

After the addition of NH3 it's required to separate NH3 & solution thus with the help of centrifuge. Oil ornidazole solution & crude ml are separated in this stage . separated Crude ml stores into storage tank & Oil ornidazole solution goes for stage five

Stage five: - Charcoaling

In stage three addiction of NH3, thus Oil ornidazole solution gets some yellowish color. To improve color once again charcoal used for color improvement. In this stage again 15 kg of charcoal used. Water also added for centrifuge filtration.

Stage six: - Basket filter filtration

After the stage five again here basket filter used to remove charcoal which is used in stage five for color improvement. In this stage waste charcoal dispose to Mumbai waste management ltd

Stage seven: - Crystallization

In this stage the stage six oil ornidazole solution added in crystalize reactor .After that water added in this solution. Then it's required to reduce temperature of material to perform crystallize formation of material . Thus again 1 hr cooling provided & after that 2.1/2 hr chilling provided.

Stage eight: - Centrifuge filtration

After the addition of water it's required to separate water & solution thus with the help of centrifuge. Oil ornidazole solution & pure ml are separated in this stage . separated pure ml stores into storage tank & Oil ornidazole solution goes for drying stage.

Stage nine: - Drying

After the stage eight materials got the form of wet cake. Thus its required to provide drying to wet cake. With the help of boiler low pressure steam heating provided for 2 hr , then after that to reduce temperature of product cooling provided for 2.1/2 hr.

Stage ten: - Multimill (Reduction in size of material)

In this stage material size reduced in upto certain micron according to customer requirement. For this operation they are using multimill. Final product ready with this stage.

Stage Eleven: - Packing

After the stage ten material packed in bags . after the baging formation then material kept in drum . After this labeling done with the help of label.

This are the eleven stages performed by M/s aarti drugs Ltd to produce ornidazole.

To find out the cause of high product cost it need to know exact consumption per month. Thus data collected for monthly consumption. Monthly required cost classified as per raw material cost, utility cost, packing cost, packing charge cost, labor cost &other cost with the help of their available record.

Sr No	Description	Consumption Qty	Rate (Per ltr or Kg)	Rupees
1	Raw material			
a	Oil Ornidazole	20600 Litre	230	4738000
b	Methanol	800 Litre	37	29600
c	Liquid NH3	16320 Litre	70	1142400
d	Charcoal	720 Kg	22	15840
e	Water	25000 Litre	0.013	325
	R.M. Total			5926165
2	Utility cost			
a	Chilling plant			
a.1	Electricity Consumption	23040 kwh	9	207360
a.2	Water Required	20000 Litre	0.013	260
a.3	Ammonia Required	50 Litre	70	3500
	Total of Chilling plant Cost			211120
b	Boiler plant			
b.1	Electricity Consumption	6650 kwh	9	59850
b.2	Water Required	73617 Litre	0.013	957
b.3	Fuel (Furnace Oil) Required	26131Litre	33	862323
	Total of Boiler plant Cost			923130
c	Cooling Tower 75 m3/Hr			
c.1	Electricity Consumption	800 kwh	9	7200
c.2	Water Required	10000	0.013	130
	Total of Cooling Tower Cost			7330
	Utility Total cost			1141580
3	Packing Charge Total cost			139840
4	Labour Cost			1017000
5	Other (Stationary, In plant Electricity)			80000
	Total Cost In September(For 23 Ton Productin)			8304585

Figure 3. Monthly actual cost for ornidazole

Step 2:-Impact of Problem.

By classified cost into sub section now impact of this subsection find out with the help of Pareto chart .Pareto chart X-axis shows sub section for responsible of cost while Y-axis shows the Rupees & % impact of subsection. With the help of pareto chart we can easily identify he impact of subsection. Raw material cost is 73.36%, utility total cost 13.75%, labour cost is 12.25%, packing charges1.68% &other cost like stationary is0.96% responsible for total monthly cost. We can easily identify that raw material cost, Utility cost are the main factor which affects badly to total product cost of product. Thus it important to focus on this two subsection. The detail analysis, causes of high total cost

& their effect & solution for that problem is carried out in further steps.This two problem categories as

Problem 1:- High Raw material cost & wastage in Raw material

Problem 2:- High Utility cost

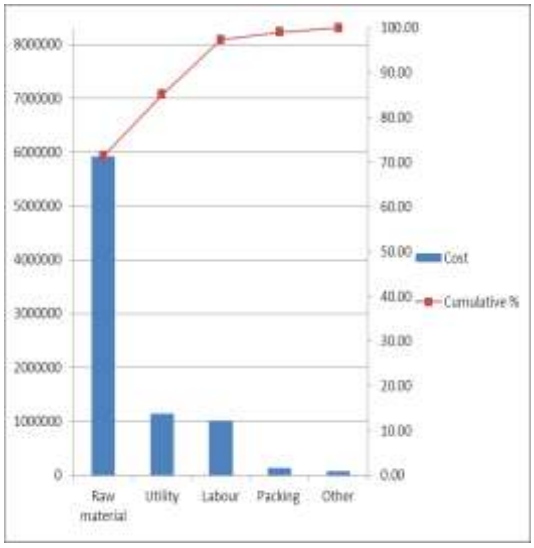

Figure 4. Pareto Chart shows impact of problem

Step 3.1:-Analysis of Problem 1(High raw material cost & wastage in Raw material)

By step two it's easily found out that three main problem those highly responsible for high product cost. This problem analysis is studied in this step with the help of check sheet.There are five materials which included in raw material which are as oil ornidazole, liquid NH3, methanol, charcoal& water. Oil ornidazole used as basic element of raw material which is used to convert into ornidazole. To identify where causes & losses of problem are, it's decided to compare between as per actual monthly cost & as per process flow diagram cost with the help of check sheet.

Sr No	Description	Raw Material Consumption			Losses
		As per PFD(Day)	As per PFD(Monthly)	Actual Monthly	
1	Oil Ornidazole	850 Litre	20400 Litre	20600 Litre	200 Litre
2	Methanol	33.33 Litre	800 Litre	800 Litre	No Loss
3	Liquid NH3	680 Litre	16320 Litre	16320 Litre	High cost
4	Charcoal	30 Kg	720 Kg	720 Kg	No Loss
5	Water	1000 Litre	25000 Litre	25000 Litre	No Loss

Figure 5.Check sheet shows losses of raw material

With the help of check sheet & process flow diagram it is easily understandable that oil ornidazole required quantity per day is 850 litre.It means for for month (24 days) production required quantity is 20400 litre but in actual it is required 20600 litre per month. It mean's there is 200 litre loss in oil ornidazole cost. Also by data collected it been traced out there is high cost required to purchase Oil ornidazole (230/-Rs per litre) & Liquid NH3 required (70/-Rs per litre). Thus Oil ornidazole cost & loss in quantity of oil ornidazole & high cost of liquid NH3 main factor which contributes high cost of raw material.This problems sorted out in next step with the help of cause & Effect diagram & check sheet.

Step 3.2:-Causes of problem 1(High Raw material cost & wastage in Raw material)

By analysis in step 3.1 there is loss in material quantity of oil ornidazole. To find out this problem there is necessary to understand their departmental study , storage system ,environment system .By visiting each department related to loss in material this are the problem found.

Figure 6.Fishbone diagram shows causes of raw material loss

With the help of cause & effect diagram causes & their effect easily seen to management. To eliminate this problem apply solution to each causes in next step.

Step 3.3:-Solution for Problem 1(High Raw material cost & wastage in Raw material)

Figure 7.Fishbone diagram shows causes of raw material loss

Sr no	Causes	Effect	Solution
1	High Temperature of store room	Loss in Material	Air Handling System required
2	Not proper material handling	Loss in Material	Racking system required

3	Expiry date of material	Loss in Material	Use FIFO system
4	Not Proper Packing	Loss in Material	Use check sheet to inspection
5	Selection of Vendor	High cost product	Use check sheet to compare cost

The causes which are identified in cause &effect diagram, for those causes solution provided in this stage.by applying solution to all causes there are significant improvement in raw material consumption.

Sr No	Description	Improvement In Consumption	
		Qty before Implementation	Qty After Implementation
	Raw material	(Sepetember)	(October)
1	Oil Ornidazole	20600 Litre	20420 Litre
2	Methanol	800 Litre	800 Litre
3	Liquid NH3	16320 Litre	16320 Litre
4	Charcoal	720 Kg	720 Kg
5	Water	25000 Litre	25000 Litre

Figure 8. Improvement in raw material consumption.

Improvement by Check sheet (Cost of product):-Selection of vendor on the basis of cost & quality is responsible for High cost of Oil ornidazole & NH3 thus check sheet format provided with the help of purchase department.

Sr No	Description	Vendor details	
		M/s A.B Enterprises	M/s K.V ltd
1	Stagewise Inspection Provided	No,Final Inspection Only	Yes,Provided
2	Packing Quality	Low	High
3	Expiry of Product	4 Month from Packing	6 Month from Packing
4	Analysis report	Not Provided	Provided
5	Basic cost	240/-Per litre	235/-Per litre
6	Discount Received	10/-Per litre	15/-Per litre
7	Discounted Total Cost	230/-Per litre	220/-Per litre
8	Packing & Forwarding Charges	Included	Included
9	Transportation Charges	Included	Included
10	GRAND TOTAL	230/-Per litre	220/-Per litre
11	Delivery Period	3 Weeks	2 Weeks

Figure 9.Check sheet for oil ornidazole to selection of vendor

Sr No	Description	Vendor details	
		M/s Acuro Organics Ltd	M/s Arrow Fine Chemicals
1	Unadulterated NH3	No	Yes,Provided
2	Quality	Low	High
3	Reactive	Highly Reactive	Highly Reactive
4	Chemical properties	Unstable	Stable
5	Basic cost	75/-Per litre	70/-Per litre
6	Discount Received	5/-Per litre	5/-Per litre
7	Discounted Total Cost	70/-Per litre	65/-Per litre
8	Packing & Forwarding Charges	Included	Included
9	Transportation Charges	Included	Included
10	GRAND TOTAL	70/-Per litre	65/-Per litre
11	Delivery Period	1 Weeks	1 Weeks

Figure 10.Check sheet for NH3 to selection of vendor

Thus by using check sheet cost of product reduced down. This is the main application of check sheet which helps to reduce raw material cost.

Sr No	Description	Improvement In Purchase	
		Rate before Implementation	Rate after Implementation
	Raw material	(Sepetember)	(October)
1	Oil Ornidazole	230	220
2	Methanol	37	37
3	Liquid NH3	70	65
4	Charcoal	22	22
5	Water	0.013	0.013

Figure 11. Improvement in raw material purchase cost.

Result:- By applying different quality tools there is following improvement in material consumption &material purchase cost . This two factors lead to total saving of 327200 Rs/-

Sr No	Description	Rs Before Implementation	Rs After Implementation
	Raw material	(Sepetember)	(October)
1	Oil Ornidazole	4738000	4492400
2	Methanol	29600	29600
3	Liquid NH3	1142400	1060800
4	Charcoal	15840	15840
5	Water	325	325
6	R.M. total cost	5926165	5598965
7	Total saving In cost		327200

Figure 12. Overall Improvement in raw material cost.

Step 4.1 Analysis of Problem 2 (High Utility cost)

Utility cost means during the production, product requires heating, chilling & cooling for chemical reaction. Utility cost classified into three sections which are Boiler plant,

Chilling plant & cooling tower. Thus High utility cost categorize into two sub category.

1 Chilling plant consumption

2 Boiler plant consumption

Step 4.2 Analysis of chilling plant consumption

From the process flow diagram it clears that chilling plant works for 4.5 Hours. Chilling plant in M/s Aarti drus was 150 TR. Chilling plant consumption mainly depends upon the electricity consumption, NH required in month as per maintenance schedule & water consumption. Thus it important to understand which are the factors are the responsible for Electricity consumption & why NH3 required this much .Data collected from monthly consumption of chilling plant to study the causes.

Sr No	Description	Consumption Qty	Rate (Per ltr or Kg)	Rupees
a	Chilling plant			
a.1	Electricity Consumption	23040 kwh	9	207360
a.2	Water Required	20000 Litre	0.013	260
a.3	Ammonia Required	50 Litre	70	3500
	Total of Chilling plant Cost			211120

Figure 12 . Monthly actual cost for chilling plant

Step 4.2.1 Impact of problems in chilling plant consumption

In this step with the help of pareto diagram its easily found that electricity consumption & NH3 required is the main factors which directly proportional to High chilling plant cost.

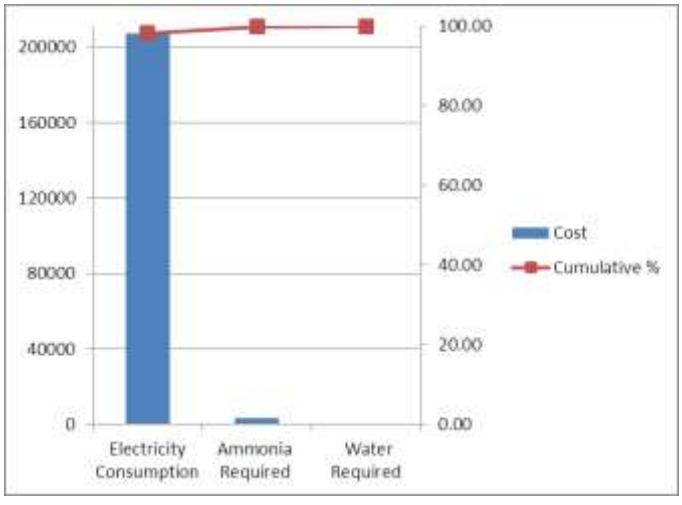

Figure 13 . Pareto chart for chilling plant

With the help of Pareto chart it need to focus on electricity consumption of chilling plant & NH3 required for chilling plant .

Step 4.2.2 Causes of Problem

In Chilling plant there is high electricity consumption shows un data .Electricity consumption mainly depends upon environment (where is the chiller , condenser & compressor location) If high temperature in surrounding it effects the chilling plant but in M/s aarti drugs ltd it is found under shed area thus there is no environment factor which affects the high electricity of consumption. Motor , Pump capacity effects the highly electric consumption thus it need to check motor rating of each pump .In chilling plant mainly compressor Motor , chilling plant circulation pump ,condenser cooling circulation pump &chiller to tank circulation pump . Periodic maintenance of chilling plant also main factor which affects the electricity consumption & NH3 Consumption . Mainly there is no monthly NH3 required but with the help of data it is found that there is need to fill 50 litre of NH3 per month Thus it need to find out the causes of this problem .

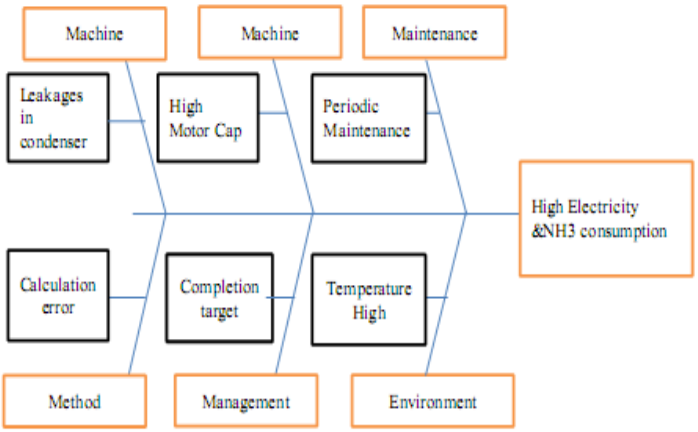

Figure 14 . Cause & Effect diagram for High electricity Consumption & NH3

Causes for high electricity consumption & Monthly NH3 consumption easily explained with the help of Cause & effect diagram.

Step 4.2.3 Apply solution to Problem

With the help of cause & effect diagram there is need to verify each causes thus making check sheet to verify this causes are responsible for high electricity consumption & more NH3 consumption

Sr No	Description	Effect	Observation
1	Surrounding Temp of Equipment	High electricity consumption	All equipment's under shed, No effect
2	Calculation error	High electricity consumption	Need to verify by calculation
3	High Motor Capacity	High electricity consumption	Need to verify by calculation
4	Leakage in NH3 Receiver	More NH3 consumption	Periodic maintenance

Figure 15 . Check sheet for verify causes of High electricity consumption &NH3

With the help of check sheet there is need to calculate Motor capacity . Thus calculation for motor capacity is the best solution to eliminate the high electricity consumption .

Calculation for Motor Capacity :-

Terms used in calculation & their unit :-

H:- Heat(KJ) ,

h:- Heat flow rate (KJ/sec),

t;- Time (sec),

m:- Mass flow rate (Kg/sec),

Cp:- Specific Heat constant pressure (KJ/kg'c),

ϱ :- Density of fluid (Kg/m3),

Q:- Volumetric flow rate (m3/sec),

H;- Head (Meter),

n:- Efficiency of Pump (%),

g: specific gravity (m2/sec),

T1:- Initial temperature ('c),

T2:- Final temperature ('c),

P:-Power required to motor(KW).

For chilling plant circulation pump motor Calculation :- In PFD it is given that for 2 Hour required heat to remove from material is 2109729.6(KJ) & for 2.1/2 Hour it is given that 2637162 (KJ)

H1:-2109729.6 KJ,

H2:- 2637162 (KJ),

Thus for 4.5 Hour total required Heat is(H)

H = H 1 +H 2

=2109729.6+2637162

H=4746891.6(KJ)

Now it need to calculate heat flow rate ,h

h= H /t

=4746891.6/(4.5*3600)

h=293.018(KJ/sec),

But, h=m*Cp*(T1-T2),

m=h/Cp*(T1-T2),
m=293.018/4.18*(10-5),
As specific heat of water :-4.18KJ/kg'c,
T1 Initial temp of Water ;-5'c
T2 Final temp of Water ;-10'c
m=14.02 (Kg/sec)

But, Q=m/ ϱ

Q=14.02/1000,
Density of water :-1000KJ/kg'c
Q=0.01402 m3/sec,
Now we are calculating power of motor
(P)= ϱgQH/(3.6*10^6*n),
Efficiency motor assumed :-75%,
Head for motor is :-30 Meter,
Gravity g:- 9.81 m2/sec,
(P)=1000*9.81*0.01402*3600/(3.6*10^6*0.75)
(P)=5.5 KW

Thus Power required for motor is 5.5 KW But in actual motor Capacity is 25 KW.

Similarly, we can calculate other motor Capacity. To verify this made a table of actual Motor Capacity & motor capacity as per Process flow diagram.

Sr No	Description	Chilling plant Consumption(kw)		Losses(kw)
		Actual	As per PFD	
1	Compressor Motor load(kw)	129	129	0
2	Condenser Circulation Water Motor load (kw)	25	11	14
3	Cooling tower fan Load(kw) 300 m3/Hr	9.32	9.32	0
4	Chiller Water Circulation Motor Load (kw)	25	7.5	17.5
5	Chilled water Circulation In plant Motor Load (kw)	25	5.5	19.5
6	Total consumption per Hour	213.32	162.32	51
7	Total Daily Consumption (kw) for 4.5 Hr	959.94	730.44	229.5
8	Total Monthly consumption (kw)(24 days)	23038.56	17530.56	5508
9	Total cost (9/-Per Kw)	207347.04	157775.04	
10	Total saving in cost (In Rupees)	49572		

Figure 16. Table shows variation in capacity of motor as per actual & as per PFD(Calculation)

By doing periodical maintenance & removal of Leakage of NH3 receiver NH3 consumption reduced upto 30 litre . Thus total Improvement in chilling plant operating cost Thus Total Improvement in chilling operating cost is51685/- rupees per month .

Sr No	Description	Rs Before Implementation	Rs After Implementation
	Chilling plant		
1	Electricity Consumption	207360	157775
2	Water Required	260	260
3	Ammonia Required	3500	1400
6	Chilling plant total cost	211120	159435
7	Total saving In cost		51685

Figure 16. Table shows Improvement in chilling plant operating cost .

Step 4.3 Analysis of Boiler plant consumption

In PFD there is 5 hours heating required for formation of oil ornidazole into Ornidazole during chemical process.The Boiler capacity in M/s Aarti drugs Ltd is 2800 Kg/Hr steam produced at pressure 10.56 kg/cm2. This Boiler is oil fired boiler. Boiler cost mainly depend on types of fuel used in boiler & efficiency of boiler.

Data collected from monthly consumption of boiler plant to study the causes.

Sr No	Description	Consumption Qty	Rate (Per ltr or Kg)	Rupees
1	Boiler plant			
2	Electricity Consumption	6650 kwh	9	59850
3	Water Required	73617 Litre	0.013	957
4	Fuel (Furnace Oil) Required	26131Litre	33	862323
5	Total of Boiler plant Cost			923130

Figure 17 . Monthly actual cost for Boiler plant

Step 4.3.1 Impact of problems in Boiler plant consumption

In this step with the help of pareto diagram its easily found that fuel consumption cost is the main factors which directly proportional to High boiler plant cost.

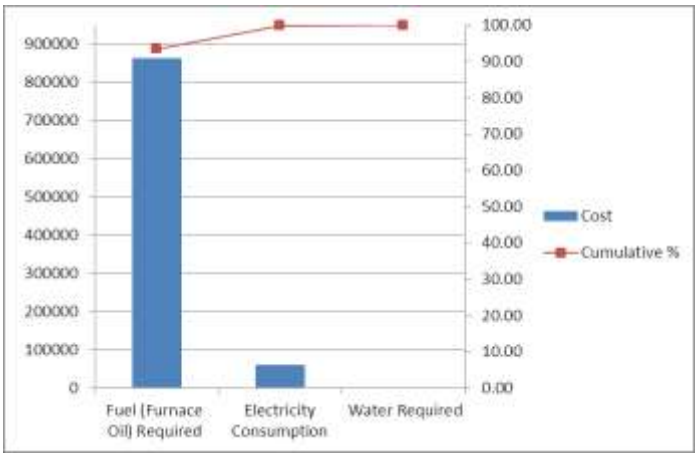

Figure 18 . Pareto chart for Boiler plant

With the help of Pareto chart it need to focus on Selection of fuel & Efficiency of boiler for boiler plant .Electric consumptions is the main factor but changing the motor of ID fan, F.D. fan, P.A fan will affect the efficiency of boiler thus Electric consumption of boiler is not carried out in this study. Boiler cost reduction is carried out in two problems which are as selection of fuel & Efficiency of boiler.

Step 4.3.2 Causes of Problem(Selection of fuel)

By the impact of the problem it is clearly seen in previous step that fuel consumption is the main factor which affects the high boiler cost of fuel. Thus it need to find out the causes of selection of fuel.

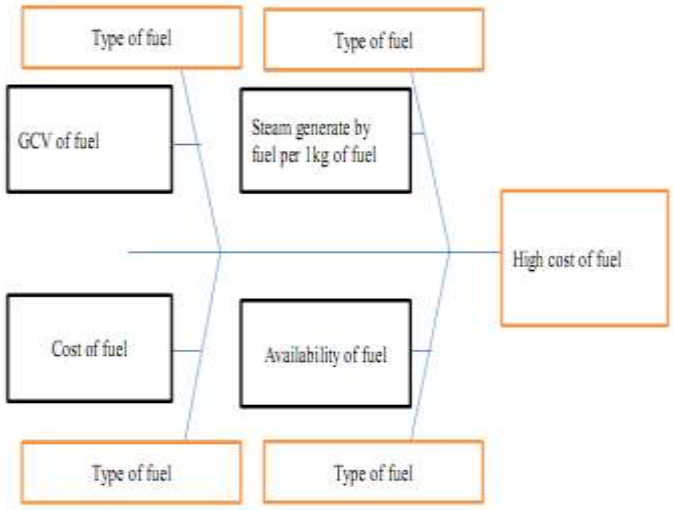

Figure 19 . Cause & Effect diagram for High cost of fuel(selection of fuel)

Causes for high cost of fuel easily explained with the help of Cause & effect diagram. Thus selection of fuel must be done on the basis of GCV of fuel, Cost of fuel per 1 kg, steam generated by fuel per 1 kg of fuel.

Step 4.3.3 Apply solution to Problem

With the help of cause & effect diagram there is need to verify how's the each causes affect the cost of fuel. Thus two more fuel selected to compare with the furnace oil fuel ,which is currently used in M/s Aarti Drugs Ltd.

Boiler Efficiency calculation by direct method :-

Terms used for calculation :-

η:- Boiler Efficiency,

Q:-Quantity of steam generated per hour(kg/hr),

q:- Quantity of fuel used per hour (kg/Hr),

GCV:-Gross calorific value of fuel (Kcal/kg),

H:-Enthalpy of steam (kcal/kg),

h:-Enthalpy of feed water (kcal/kg).

Thus, Boiler efficiency by direct method is , η

η =Q*(H-h)*100/(q*GCV)

But ,here ,

Q=Quantity of steam generated per day=13945.71(kg/day), (By using steam flow meter)

Boiler working 5 hours per day ,thus

Quantity of steam generated per Hour(kg/Hour)=13945.71/5

Q:-Quantity of steam generated per hour=2789.142(kg/hr),

q:- Quantity of fuel used per day=1080 (kg/day),

q:-Quantity of fuel used per hour (kg/Hr)=1080/5=216(kg/Hr),

GCV:-Gross calorific value of Furnace Oil =10000 (Kcal/kg),(By using fuel analysis report)

H:-Enthalpy of steam =665(kcal/kg) at pressure 10.56kg/cm2(g) (with the help of chart)

h:- Enthalpy of feed water =35(kcal/kg).(Because feed water temperature is 35'c) (with the help of chart)

η =Q*(H-h)*100/(q*GCV)

=2789.142*(665-35)*100/(216*10000)

η=81.35%. - (1)

Selection of fuel

1)Calculation for furnace oil :-

GCV:-Gross calorific value of Furnace Oil =10000 (Kcal/kg),(By using fuel analysis report)

Thus 1 kg of furnace oil how much steam generate ,Q

Q= η*q*GCV/100*(H-h),

=81.35*1*10000/100*(665-35),

=12.91 kg steam

Thus by calculation 1 Kg of furnace oil generates 12.91 kg of steam.

Total required steam per month =total fuel consumption per month* 1 kg of furnace oil how much steam generate .

total fuel consumption per month =26131kg of furnace oil ,(By data collected in M/s Aarti drugs Ltd)

1 kg of furnace oil how much steam generate ,Q=12.91 kg steam,

Total required steam(Per month) =26131*12.91

Total required steam(Per month) = 337351.21 Kg - (2)

Thus total cost required per month =Total required fuel per month * cost of fuel per 1 kg

1 Kg of furnace oil cost=33 Rs/-,(By data collected in M/s Aarti drugs Ltd)

Thus total cost required per month =26131 * 33 ,

Total cost required per month for furnace oil=862323 Rs/-- (3)

2) Calculation if fuel will Coal :-

GCV:-Gross calorific value of Briquette =4700 (Kcal/kg),(By using fuel analysis report of Imported coal)

Thus 1 kg of Coal how much steam will generate ,Q

Q= η*q*GCV/100*(H-h),

=81.35*1*4700/100*(665-35),

=6.07 kg steam

Thus by calculation 1 Kg of coal generates 6.07 kg of steam.

Total fuel will required per month= Total required steam per month /1 kg of coal how much steam generate .

Total steam required per month =337351.21kg, (By 2)

1 kg of coal how much steam generate ,Q=6.07 kg steam,

Total fuel will required per month=337351.21/6.07,

Total fuel will required per month=55576.8 kg of coal

Thus total cost will required per month =Total required fuel per month * cost of fuel per 1 kg

1 Kg of Coal cost= 8 Rs/-,(By data collected incurrent market value)

Thus total cost required per month =55576.8 * 8 ,

Total cost will required per month for coal=417708.55 Rs/-- (4)

2) Calculation if fuel will Briquette :-

GCV:-Gross calorific value of Briquette =3800 (Kcal/kg),(By using fuel analysis report of Briquette)

Thus 1 kg of Briquette how much steam generate ,Q

Q= η*q*GCV/100*(H-h),

=81.35*1*3800/100*(665-35),

=4.90 kg steam

Thus by calculation 1 Kg of briquette generates 4.9 kg of steam.

Total fuel will required per month= Total required steam per month /1 kg of briquette how much steam generate .

Total steam required per month =337351.21kg, (By 2)

1 kg of briquette how much steam generate ,Q=4.90 kg steam,

Total fuel will required per month=337351.21/4.90,

Total fuel will required per month=68847.19 kg of briquette

Thus total cost will required per month =Total required fuel per month * cost of fuel per 1 kg

1 Kg of Coal cost= 7 Rs/-,(By data collected incurrent market value)

Thus total cost required per month =68847.9 * 7 ,

Total cost will required per month for coal=481930.8 Rs/-- (5)

Analysis of fuel selection on the basis of calculation & with the help of check sheet . In the check sheet Fuel cost per Kg mentioned as per data collected in M/s Aarti drugs ltd & current market. Steam generation per 1 kg of fuel , Total required fuel to complete monthly steam,Total required cost to produce monthly required steam in M/s Aarti drugs ltd , Total saving in cost per month this observation mentioned with the help of above calculation.

Sr no	Description	FO	Coal	Briquette
1	GCVof fuel(kcal/kg)	10000	4700	3800
2	Steam generate per 1 kg fuel(kg)	12.91	6.07	4.9
3	Fuel required per month to produce261621.96 kg steam	26131	55576.8	68847.19
4	Cost of fuel per Kg(Rs/-)	33	8	7
5	Cost required per month (Rs/-)	862323	444614.45	481930.8
6	Total saving per month(Rs/-)	0	417708.55	380392.2

Figure 19 . Check sheet for Analysis of selection of fuel.

Thus with the help of check sheet we can easily identify that current fuel (furnace oil) used in M/s Aarti drugs Ltd id costly comparatively other fuel .Thus if fuel is coal selected then it will saving per month is 417708.55/-. Thus this proposal send to management to change the fuel .

VI. RESULT

By the applying Pareto diagram, Check sheet ,Cause &effect diagram &basic calculation their reduction in total cost required to M/s Aarti drugs Ltd .Saving in Raw material done by reducing loss in storage &purchasing the material with the lowest cost with the help of check sheet. Saving in utility Cost consumption is done by with the help of Fishbone analysi & basis calculation. Thus there is large reduction in total cost consumption per month . This Study will help to M/s Aarti drugs Ltd to improve overall productivity of organization.

Sr No	Description (Rs)	Rs Before Implementation	Rs After Implementation
1	R.M. total cost	5926165	5598965
2	Chilling Plant	211120	159435
3	Boiler Plant	923130	505422
4	Cooling Tower	7330	7330
4	Packing charge	139840	139840
5	Labour Cost	1017000	1017000
6	Other	80000	80000
7	Total cost per month	8304585	7507992
8	Total saving In cost per month		796593

Figure 20 .Overall results in total cost per month

Thus by applying Quality tools there will be reduction of 796593 rupees per month . this will help a lot to improve efficiency& productivity of Organization.

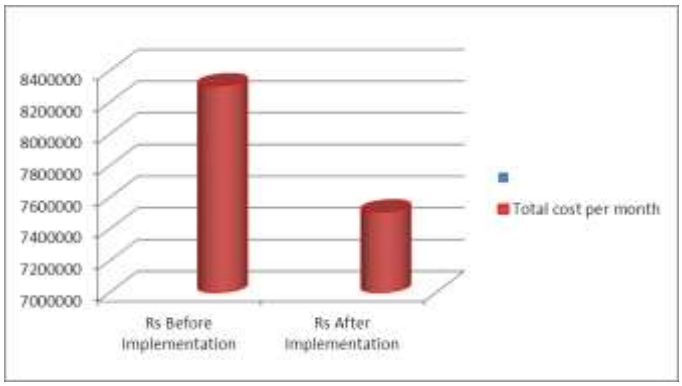

Figure 21 . chart shows Overall results in total cost per month

VII. CONCLUSION

This research study represented in brief the following points How to increase Efficiency of Organization Increases with the help of Quality tools & Basic calculations, How to reduce Material consumption & Material cost , Utility consumption with the help of Quality tools, How to improve Productivity with the help of Quality Tools ,reduce the loss with the help of Quality tools. By implementing different Quality tools there is Improvement in productivity is verified by this research. Thus this quality tools are most helpful to achieve Productivity improvement. The continuous use of this quality tools upgrades the personal characteristics of the people involved. It enhances their ability to think generate ideas , solve the problem & do the proper planning.

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