

Statistical Techniques For Quality Management at Harihar Polyfibers

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ABSTRACT

Harihar polyfibers, a unit of Grasim Industries Ltd. produces 70000 MT Rayon grade pulp employing pre-hydrolysis sulphate process using Eucalyptus as raw material. Industry introduced various energy efficient equipments, process modifications and emerging technologies for cutting down the cost and at the same time enhance the product quality with green environment. Industry is accredited with ISO 9002 and EMS 14001 certificates for its amicably laid & followed Quality & Environment Management system. To sustain & improve the product quality in this customer driven market, the industry adopted "Statistical Techniques" as a tool towards zero defects in production processes. Also Statistical Techniques indicated the need for process automation to reduce variation. In such cases, the system was automated & quality variations got reduced. This has improved product quality by reducing non-conformance in the internal processes from as high as 14-40 % to 12 % - Nil, which otherwise would have required frequent adjustment in the intermediate stages to achieve targeted final pulp quality at the cost of input chemicals & energy.

INTRODUCTION

Today all industries are passing through a difficult phase of fierce competition due to increased customer awareness. Quality has become the theme of today's survival & to have an edge over the competitors both in International & domestic field.

In this regard, industry found that "Statistical Techniques" is a tool for Strategic Quality Management & approached Indian Statistical Institute, Bangalore for guidance in 1994. Indian Statistical Institute imparted training for the operating personnel in phased manner to apprise the need for Statistical Techniques for establishing Quality System. This paper describes the steps taken by the unit in applying

Statistical Techniques for various process parameters and improve process control.

STATISTICAL TECHNIQUES

The techniques are identified as Statistical Process Control (SPC) and Statistical Quality Control (SQC) for controlling the variation & ensuring product quality. Rayon Grade pulp making involves numerous process variables such as raw material quality, input chemicals and stagewise process conditions in cooking,

Harihar Polyfibers

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washing, bleaching & drying.

METHODOLOGY FOLLOWED

- Training to apprise Statistical Techniques.
- Problem identification
- Purpose behind selecting the problem.
- Target setting.
- Constituting the task force with co-ordinator, leader & members.
- Macro & Micro flow chart of the process selected.
- Present performance w.r.t. specification.
- Plant study to evaluate process capability.
- Designing control schemes including Ready

Reckoner chart for controlling the process.

- Implementation, Review, Modify if necessary & freeze the control scheme.

With the above methodology SQC techniques were applied to various process parameter and results achieved are as under :

From these results it can be seen that the percentage non-conformance against quality specification reduced from as high as 14-40 % to 12% - Nil, Which other wise would have required frequent adjustment in the intermediate stages to achieve targeted final pulp quality at the cost of input chemicals & energy.

To demonstrate application of SQC methodology, 'ClO₂ solution' is identified as a case study and

TABLE-1

SL. NO.	PRODUCT PARAMETER	UNIT	SPECIFICATION	STATISTICAL TOOLS USED	% NONCONFORMANCE	
					BEFORE	AFTER
1.	ClO ₂ Concentration	gpl	5 + / - 1	Regression Analysis, Ready reckoner	35	nil
2.	Dewatered Pulp dry content	%	48 + / - 2	X - Chart Regression analysis, Ready reckoner,	16	nil
3.	SO ₂ solution	gpl	4 + / - 1	X - chart Beta correction factor,	40	12
4.	Fiter Water Turbidity	NTU	Max 5	X - chart. Regression analysis, Ready reckoner,	16	nil
5.	White Liquor Causticity	%	80.5 + / - 1.5	Run chart Regression Analysis, Ready reckoner,	14	10
6.	Hypo Solution Concentration	gpl	28.5 + / - 1.5	Zone Control Chart FMEA, Run chart.	25	4

detailed herewith.

CASE STUDY

REDUCTION IN VARIATION OF CHLORINE DIOXIDE SOLUTION CONCENTRATION

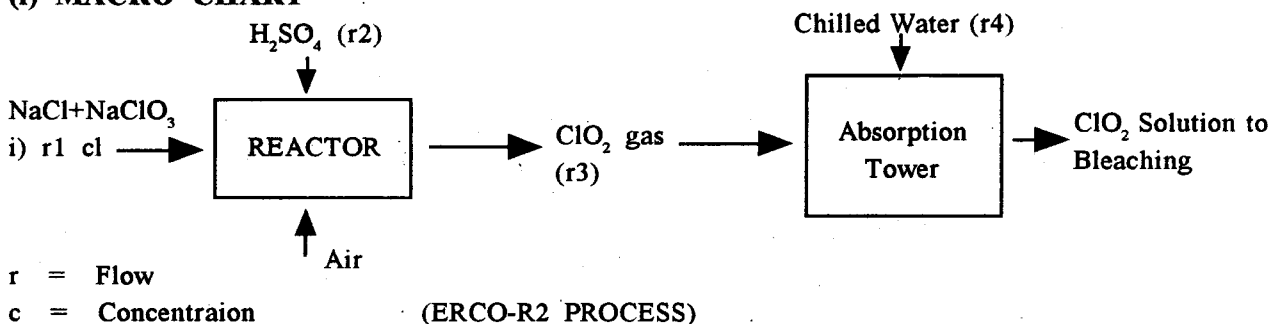
Mill employs CE/OHEDSO₂ bleaching sequence in its dissolving grade pulping process. The concentration of ClO₂ solution used in D-stage is one of the important parameters to control final pulp brightness. The variation in ClO₂ solution concentration was 5 + / - 2 gpl causing variation in

pulp brightness. In order to reduce the variation, the possibility of installing on line ClO₂ gpl control system was studied and found cost is high. Hence it was decided to use first SQC technique as a tool to reduce variation level, instead of installing the control system in the first phase itself.

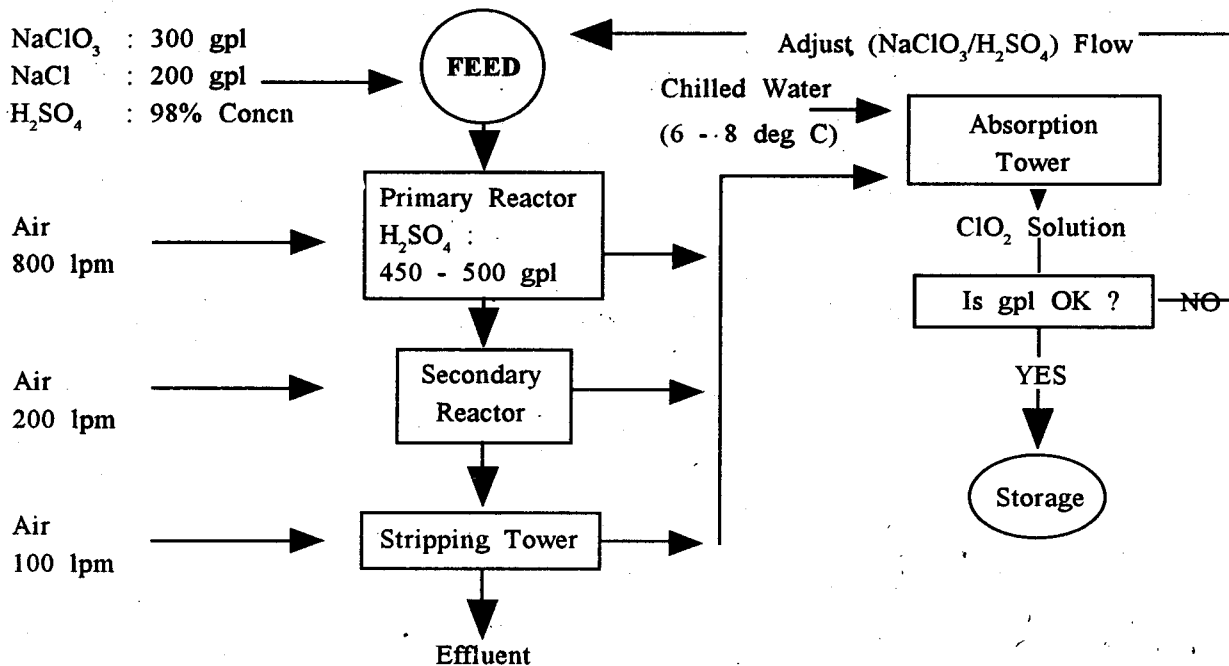
To start with, a task force comprising shop floor operators, supervisors and lab personnel was formed. Task Force members were imparted training on various SQC methods and their significance in process control.

The team identified ClO₂ solution concentration variation as a potential area for improvement and

(i) MACRO CHART



(ii) MICRO FLOW CHART



Vacuum.

Vent Fan : 300 mm WC

Reactor : 30 mm WC

prepare Macro and Micro Charts to arrive at the solution which is described as under :

(III) EVALUATION OF PROCESS CAPABILITY

Data from the process was collected and process capability study was carried out using \bar{X} -R method. The study inferred that the process is highly capable ($C_p = 2.73$), the R-Chart was under control, but close monitoring of the process was necessary to control ClO_2 solution concentration. Normally \bar{X} -R method is used for control purpose in process of above nature. But for using \bar{X} -R method minimum four tests per sample interval is required, whereas ClO_2 gpl testing in plant is done once in two hours. Hence \bar{X} -R method was not suitable. For suiting plant condition X-MR (moving range) method was selected.

(IV) DESIGN OF CONTROL SCHEME THROUGH REGRESSION ANALYSIS

Factors effecting ClO_2 gpl were identified and a theoretical model of the process was developed based on mass balance :

$$\text{ClO}_2 \text{ gpl} = \frac{(0.625 \text{ rlc1}) 1000}{0.625 \text{ rlc1} + 1000r4}$$

The regression model to be fit will be: $Y = B X$ where

$$Y = \text{ClO}_2 \text{ gpl}$$

B = Regression Coefficient

$$X = \frac{(0.625 \text{ rlc1}) 1000}{0.625 \text{ rlc1} + 1000r4}$$

Plant data on process parameter i. e. NaClO_3 flow H_2SO_4 flow, Chilled Water flow, primary reactor acid gpl and ClO_2 solution gpl were collected. For each value of ClO_2 gpl, corresponding value from theoretical model was calculated and regression analysis was carried out on ClO_2 gpl values obtained from calculation and plant data. The final regression equation is

$$Y = (0.979) X$$

$$\text{i. e. } \text{ClO}_2 \text{ gpl} = \frac{611.9 \text{ rlc1}}{0.625 \text{ rlc1} + 1000r4}$$

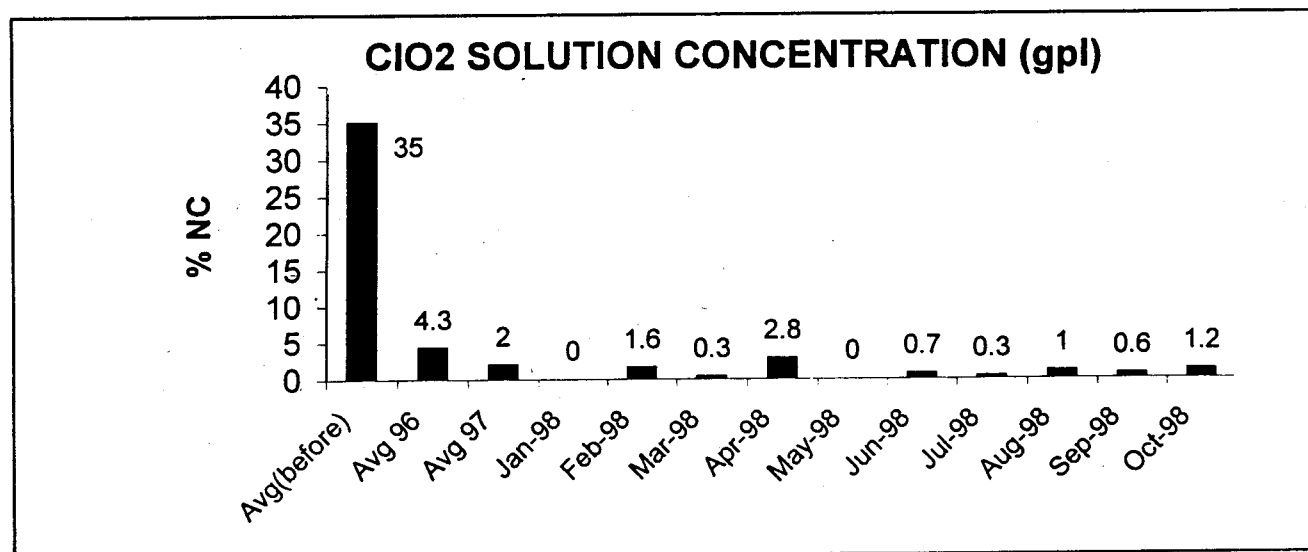
Ready reckoner chart for NaClO_3 , H_2SO_4 flow were developed to control ClO_2 Solution concentration at 5 gpl.

(V) IMPLEMENTATION

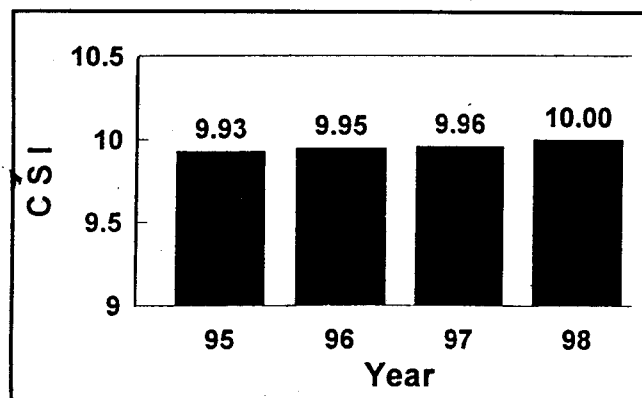
Control procedure includes initial setting and process adjustment procedure. ClO_2 gpl value was plotted on control chart and necessary adjustments to the process were initiated referring to ready reckoner charts, during out of control situations.

(VI) RESULT

The project was completed in 3 months. By



concentration variation was reduced from 5 ± 2 to 5 ± 1 . The non-conformance with respect to specifications reduced from 35 % to almost nil, as depicted below in graphical form:



GRAPH 1 CUSTOMER SATISFACTION INDEX (C S I)

CSI is an internally developed method and evaluated daily for assessing pulp quality based on Customer Specification. This takes into consideration quantity of pulp supplied and critical quality parameters such as pentosans, CaO, pulp solubility in 7.14% caustic (S 7.14- a measure of extent of

is 10. Five marks are allotted to supply quantity and 1 mark each to quality parameter. Total scoring indicates CSI.

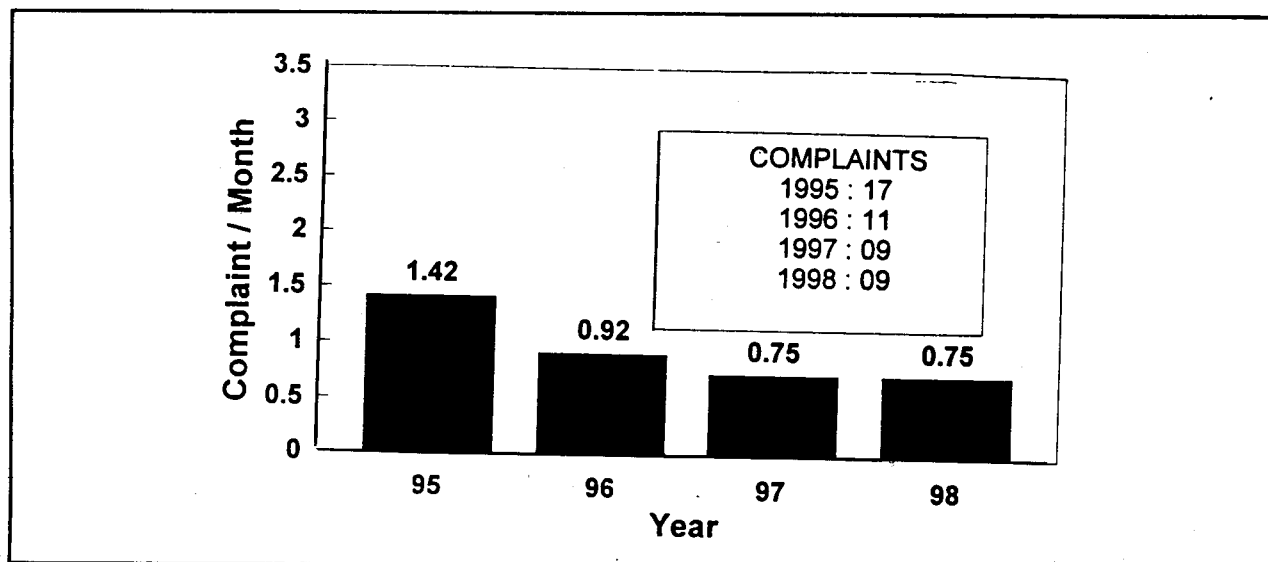
PROCESS AUTOMATION

The variation in unbleach pulp viscosity was significant due to large variation in wood quality. Added to this the batch operations of digesters was manual causing variation in quality due to manual intervention & errors arising out of varied adjustments in process conditions. Application of Statistical Techniques indicated the need for automation of

Unbleach pulp	Before Automation	After Automation
Viscosity, cP	25-35	28-32
Standard Deviation	5.42	3.45

digester operation to bring in uniformity. Accordingly batch digester was automated with the Fisher Rosemount RS-3 system. Unbleach pulp viscosity became more uniform making the process control easier in bleaching stages & ensured stable supply

GRAPH 2 CUSTOMER COMPLAINTS



cellulose degradation) and brightness. These parameters are individually ranked based on its conformity to specifications. The total marks allotted

of pulp to fibre plant adjacent to Pulp Mill. Improvement in Unbleach pulp viscosity with process automation is shown below :

OVERALL BENEFITS

The decrease in deviation from the specified norms due to continuous monitoring and control through statistical technique together with process automation/ modification in selected areas has led to consistent pulp quality and has benefited the customer to a large extent.

Graph 1 and 2 shown here illustrate the improved customer satisfaction index and reduced customer complaints respectively.

CONCLUSION

It has been established that application of

Statistical Techniques to critical processes can help in reducing product nonconformance and pave the way for superior quality and improve customer satisfaction with reduced complaints. Encouraged with the benefits achieved from Statistical Techniques on selected processes we have extended the technique to more advanced tools such as design of experiments (DoE) and Robust Engineering Techniques for process optimisation.

Harihar Polyfibers is marching towards its motto of achieving "Zero Defects" in all processes.