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## Review on Quality and Productivity Improvement in Small Scale Foundry Industry

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**ABSTRACT:** Today's competitive environment has, lower manufacturing cost, more productivity in less time, high quality product, defect free operation are required to follow to every foundry man. Mould shifting, Crushing, Lower Surface finish, Shrinkage, Porosity, Cold shut and Extra material are common casting defects due to these manual operations. These defects directly affect on productivity, profitability and quality level of organization. Casting process is still state of art with experienced people, but these experience needs to be transformed in engineering knowledge for the better growth of the foundry industries. This study is aimed to review the research work made by several researchers and an attempt to get technical solution for minimizing various casting defects and to improve the entire process of casting manufacturing.

**KEYWORDS:** Casting Defects, Process Mapping.

### I. INTRODUCTION

Foundry industries in developing countries suffer from poor quality and productivity to involvement of number of process parameters in casting process. Even in a completely controlled process, defects in casting process are also known as process of uncertainty which challenges explanation about the cause of casting defect (9). This diagnosis is done with the help of some techniques which are mainly classified into conventional and advanced techniques. For intricate designs, conventional method does not give correct solution; hence some advanced tools are used (2).

There are so many variables in the production of a metal casting that the cause is often a combination of several factors rather than a single one. All pertinent data related to the production of the casting defect is identified an attempt to eliminate the defect by taking appropriate corrective action is necessary for quality enhancement. The defects need to diagnose correctly hence Pareto chart and Cause and Effect Diagram have been used to identify and classify the reasons that are responsible for defective casting production and lower productivity of organization(3).

Casting process is also known as process of uncertainty. Even in a completely controlled process, defects in casting are found out which challenges explanation about the cause of casting defects. The cause of defects is often a combination of several factors rather than a single one. When these various factors are combined, the root cause of a casting defect can actually become a mystery. It is important to correctly identify the defect symptoms prior to assigning the cause to the problem. False remedies not only fail to solve the problem, they can confuse the issues and make it more difficult to cure the defect (5). This research is based on the results getting by implementing some of these techniques given by different author of various researches.

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## II. CASTING PROCESS

Production of casting involves various processes such as pattern making, moulding and assembly, sand preparation, core making and melting, pouring, shakeout etc (3). The overall casting process becomes very critical for complex parts. Based on various researches find best foundry process in which included all the activity.

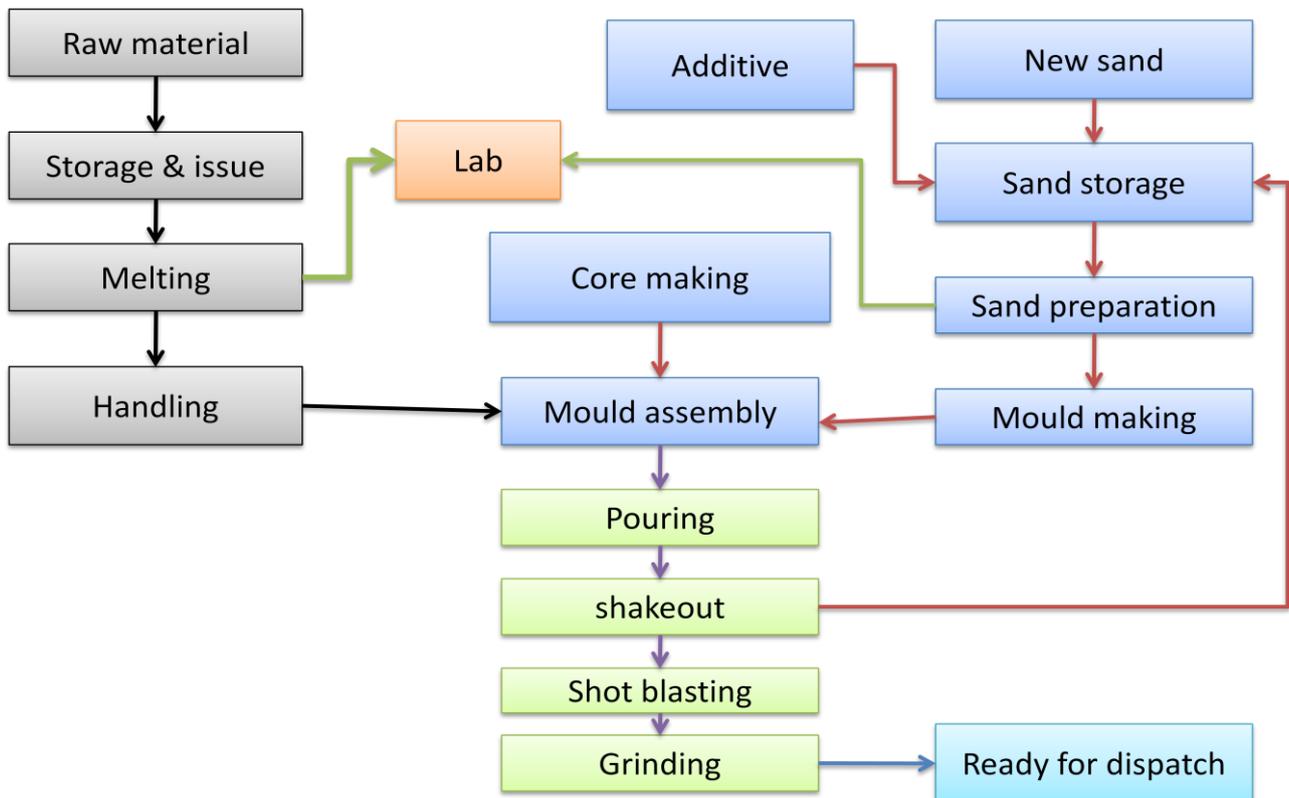


Fig.1 Various Casting Process from raw material to finish product .

Casting process is the most widely used process in manufacturing industries. The activities involved in casting process are, Pattern making for creation of mold box, Core making for insertion in mold assembly, fitting of pattern, gating system and sand for mold preparation, remove prepared mold and placed for pouring, fill the mold cavity with molten metal, allow it to solidify and at last, remove the cooled desired casting. These activities are commonly used because of its simplicity in process, economic to operate and easy to produce small size castings(3).

Casting is a process which carries risk of failure occurrence during all the process of accomplishment of the finished product. Casting process involves complex interactions among various parameters and operations related to metal composition, methods design, moulding, melting, pouring, shake-out, fettling, machining like grinding and inspection etc various operation carried out .

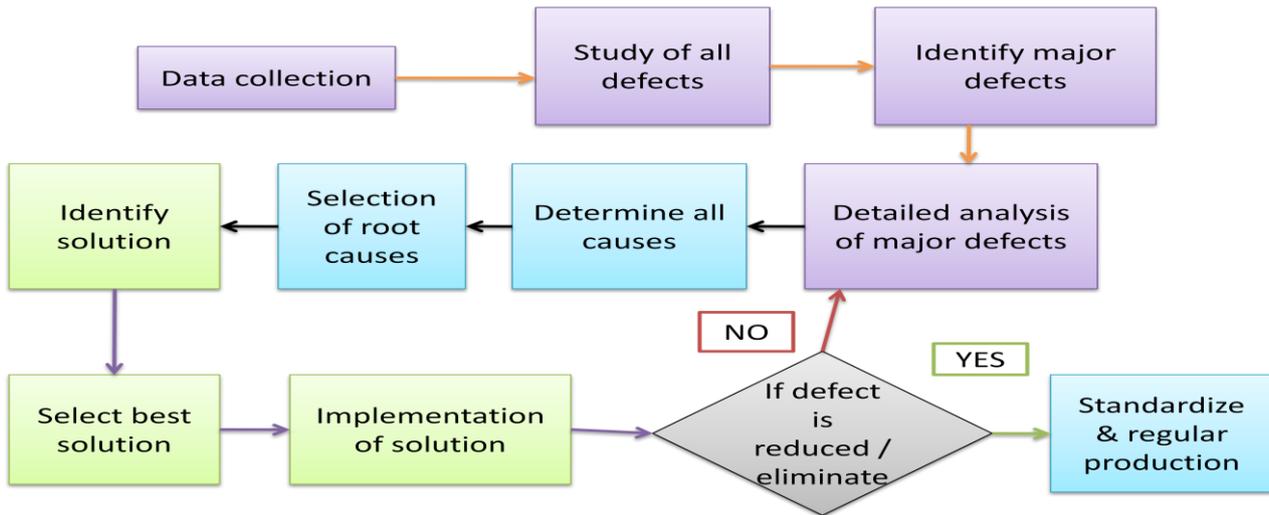
### General procedure for reducing casting defects:

The basic procedure for analyzing the casting for defects is taking place with the help of Defect Diagnostic Approach, as shown in the figure below (2), Different paper give different procedure for reducing defects out of best process select and try to implement further in project .

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**Fig.2 Procedure for Reducing Casting Defects and select best solution.**

**Figure shows** Casting defects analysis is the process of finding the root cause of occurrence of defects in the rejection of casting and taking necessary steps to reduce the defects and to improve the casting yield. **different activity like (a) Preliminary study** The study was made in a medium scale foundry producing many varieties of castings. **(b) Data collection** The rejection data for a month period were collected. **(c) Study of all the defects** The next step in the analysis is to study all the casting defects occur in the castings. **(d) Identify major defect** A Pareto chart is drawn using the rejection data of this **(e) Detailed analysis of the major defect** The detailed analysis of this major defect is made in this step. It is essential to know whether the porosity defect was occurring in particular days of production or it was distributed to all the days of production in the study period. **(f) Determine all causes** The possible causes for this defect due to various parameters and processes are found out with the help of Cause- Effect diagram. In this way root cause for the formation of defect is determined. **(g) Selection of Root cause** The detailed examination of rejected castings is required to identify the root cause for this major defect. For reducing this defect, the proper analysis of the component is required. **(h) Selection of the best solution** The best solution can be selected according to the available resources. **(i) Implement that solution in company.** **(j) standardize and regular production...(2)**

### III. LITERATURE REVIEW

Different Paper give idea about which tools and technique used in steel foundry industry and also give information about implementation of end solution in industry. Also given information about how to implement that tools in research work. And mention introduction of author and journal.

Table No -1 literature review

No	Name of research paper	Name of author	Name of journal	Tools & techniques used	Summary	Learning from paper
1	Foundry quality control aspects and prospects to reduce scrap rework and rejection in metal casting manufacturing industries	T.R. Vijayaram, S.Sulaiman, A.M.S. Hamouda, M.H.M. Ahmad	Elsevier Journal of Materials Processing Technology 178 (2006) 39–43 2006, Malaysia.	Quality control; (SQC); Quality circle; Quality assurance; Control charts; Captive foundries;(TQC)	quality control aspects are explained in a simplified manner to eliminate the unawareness of the foundry industrial	General quality control aspects in a detailed manner. How to use quality tools & their effect on end result.

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					personnel	
2	Quality control and Statistical Techniques used to improve Productivity and to reduce Rejections due to Casting Defects: A Review	Vivek Patil , Mahesh Sutar	International Journal of Research in Advent Technology Vol.3, No 4, April 2015 E-ISSN: 2321-9637 , 2015, India.	Defect Diagnostic Process, Ishikawa Diagram, DoE, JIT, SPC.	Use of various tools & technique, after implement which types of benefit occur.	Paper which types of data collection & how to analyze that data with the help of pareto chart & cause effect diagram.
3	An application of pareto analysis and cause effect diagram for minimization of defects in manual casting process	Aniruddha joshi, Pritam kadam.	International Journal of Mechanical And Production Engineering ISSN: 2320-2092, Volume- 2, Issue- 2, 2014, and India.	Pareto Analysis and Cause and effect Diagram	Pareto principle and cause effect diagram are used to identify and evaluate different defects and causes for these defects responsible for rejection of components at different stages .	Pareto chart & cause effect diagram, paper shows all defects cause effect diagram, & give information for reduce that cause.
4	Investigation of chill performance in steel casting process using Response Surface Methodology	K.Kanthavel, K. Arunkumar , S.Vivek	ScienceDirect Procedia Engineering 97 ( 2014 ) 329 – 337 2014 CRI Pump private limited India.	Design of Experiment; ANOVA; Response surface methodology.	Take one product and in that shrinkage occur, than take four parameter based on taguchi orthogonal array find solution.	Ball valve, due to Ms chills shrinkage cavity after find effect apply surface Methodology.
5	Casting Defect Analysis using Design of Experiments (DOE) and Computer Aided Casting Simulation Technique	Uday A. Dabade and Rahul C. Bhedasgaonkar	Science Direct Procedia CIRP 7 ( 2013 ) 616 – 621 , 2013 , India	Design of Experiments (DoE) and ANOVA Computer Aided Casting Simulation Technique	Taguchi based L18 orthogonal array was used for the experimental purpose, second part; shrinkage porosity analysis is performed using CST .	Process parameter with the help of ANOVA & Than shrinkage porosity analysis is performed using casting simulation technique.
6	Advance Techniques in casting defects and rejection analysis: A Study in an industry	Siddaling swami.S. Hiremath Dr.S.R. Dulange Professor.	[IJIERT] ,ISSN: 2394-3696 VOLUME 2, ISSUE 9, 2015, India.	Design of Experiment (DOE), and by using a Casting simulation software	Identification of defects for 4R cylinder block which is presently having a 40% or more percent rejection	Prefer 12 papers than identify which technique can be used for reducing casting defect.
7	Review on	Sunil	Int. Journal of	Quality	Sand process	Type of defect

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	Analysis of Foundry Defects for Quality Improvement of Sand Casting	Chaudhari, Hemant Thakkar	Engineering Research and Applications ISSN: 2248-9622, Vol. 4, Issue 3 (Version 1) pp 615-618, 2014, India.	improvement, Root Cause Analysis	parameters should be decided experimentally depending on quality of Sand.	occur when process parameter change, author prefer 1 research paper based on different defects.
8	Increasing Bottom-Line Through Six Sigma Quality Improvement Drive: Case of Small Scale Foundry Industry	Darshak A. Desai	Udyog pragati Vol. 36, No. pp 11-23, 2012, India.	DMAIC, Quality bottom line.	Practicing six sigma at small scale industry, every phase of six sigma successfully implemented & breakthrough improvement in quality of the product.	Define very briefly each phase of six sigma & also CTQ. Given advantage after implementation in industry.
9	Minimization of Casting Defects Using Casting Simulation Technique and Casting Defects Analysis Using Design of Experiment	Atul A. Bhujgade, Vijay B. Sabnis	(IJRASET) Volume 3 Issue VI, June 2015 IC Value: 13.98 ISSN: 2321-9653 pp 722-727, India.	Casting simulation and optimization, Yield improvement, Taguchi method, Parameter optimization.	DOE method such as Taguchi method can be efficiently applied for deciding the optimum settings of process Parameters, analysis of defects in existing casting.	Find defect shrinkage porosity, than draw new 3-d design with the help of DOE & ANOVA they optimize process parameter.
10	Review Paper on Improve Quality in Sand Casting Industry using Total Quality Management (TQM) Tool	shiroya nikunj r, j.b shah	International Journal for Scientific Research & Development  Vol. 2, Issue 10, 2014   ISSN (online): 2321-0613, 2014 India.	Total Quality Management (TQM) Tool,	Various aspects of an organized approach to understanding and development of Quality cost system in cast iron foundries.	Apply TQM in foundry manage all worker aware about TQM, after implement long term benefit will be occur like quality & productivity increase .
11	productivity Improvement of Metal Casting Industry	Aniruddha Joshi, Prof.L.M. Jugulkar	Discovery, Volume 25, Number 87 pp 18-22, NOV-2014, India.	Plant layout, Ergonomics, Process Flow, Manual operations,	Effective plant layout, automatic mould making operation and	Productivity improvement which types of parameter affect that

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				effective plant layout.	sequential process flow with Minimization of back flow of material helps to solve these problems.	identify & at last try to reduce it , like ergonomics , material handling etc
12	A Development of quality in casting by Minimizing Defects	PRASAN KINAGI, Dr. R.G MENCH	International Journal of Recent Research in Civil and Mechanical Engineering (IJRRCME) Vol. 1, Issue 1, pp: (31-36), Sep-2014, India.	FMEA, DOE, Taguchi methodology, Pareto analysis.	Defect analysis is carried using FMEA tool and Pareto analysis to know potential causes of failure and their effects along with correct actions to improve quality strength and productivity	FMEA that help identify probable cause for occurring defects than after pareto help draw major case , & how much amount of parameter taken for DOE
13	Implementation of Statistical Process Control Techniques in Industry: A Review	Pranay S. Parmar , Vivek A. Deshpande	Journal of Emerging Technologies and Innovative Research (JETIR)Volume 1 Issue 6 (ISSN-2349-5162) pp 583-587 , 2014 , India	Statistical Process Control, Control charts, 7QC Tools	Applicability of the SPC techniques in different manufacturing industries. Various research articles and case studies on the implementation of SPC.	SPC techniques can give the significance improvement to the quality. These tools and techniques are simple to implement.

### IV. SUMMARY OF LITERATURE REVIEW

Understand current scenario of foundry industry. in now a day's foundry industry produce product different types like ferrous and non ferrous , this case study mainly focuses on steel foundry , present china provide casting product good quality with less time .various types of casting process like melting , moulding , core making ,telting , pouring , shake out .

Study about various casting defects occur in foundry industry like shrinkage , blow hole , porosity , pinhole , sand inclusion , cold shut , miss run , surface discontinuity , mould break , flash etc . Give idea about how to occur defects and which types of precaution taken in future. process mapping means flow process chart – material types in which shows all activity from raw material to finish goods with time , find non value added activity and remove it .

Tools & technique used in foundry industry based on quality and productivity aspect like 7 QC –tools , DOE , Taguchi method , method study , TQM , TQC , just in time , casting simulation techniques , six sigma – DMAIC method etc . Understand implementation of this technique in foundry industry at last which types of benefits occur after implement methodology.

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### PREFERED PAPER OTHER THAN MENTION IN TABLE:-

- Shantanu Joshi, Prof. B.R.Jadhav “Casting defect reduction and productivity improvement in Automotive Component.” Technique is used to analyze the sand related defects in shell mould casting, Taguchi based L9 orthogonal array was used for the experiment purpose, and ANOVA results indicate that the selected process parameters significantly affect the casting defect and rejection percentage. How to implement taguchi method in casting industry, which parameter include when draw ANOVA table, how to this cause reduce(14).
- Yatin Damor, Hemant R Thakkar “A Literature review on Quality and Productivity Improvement in foundry industry” Six Sigma is one of the emerging techniques available to bring the breakthrough improvements almost in every sector through overall operational excellence. The implementation of Six Sigma resulted in understanding the problems from all aspects, qualitatively as well as quantitatively(15).
- Shashank V. Gulhane, Rahul M. Dahekar “To Improve Productivity for Casting Technology By Reducing Weight of Gating System” The typical changes in design and dimension of gating system play a crucial role during manufacturing of casting product, the small change in the dimension of gating system results large effects on the production cost(16).
- Bhupinder Singh\*Vikas Kumar\*\*Pradeep Kumar , “COST ANALYSIS OF FOUNDRY INDUSTRY IN FORM OF MISRUN BY USING SIX SIGMA” DMAIC has been considered as an approach to improve quality of product and process. Reduced rejection of industry. The DMAIC approach provides a suitable visible road map for entire work force to achieve new knowledge(17).
- Binu Bose V, K N Anil kumar “Reducing rejection rate of castings using Simulation Model” cylinder clamp casting of Milacron product, which is having high rejection rate in an Indian foundry, is taken and the defects of casting are solved using the proposed simulation model with Magma 5 software(18).
- Mayank Dev Singh, Swati Singh, Derasari Keyur , Soni Saumil, Patel Niki “Overall Productivity Improvement in Casting Industry by Using Various Industrial Engineering Techniques” Improper layout and unsystematic movements of man and material due to which the total travelling distance in existing plant layout are approximately , The storage problems are eliminated by providing storage and rejection rooms. Ergonomics requirements not fulfillment then they all are directly affecting the productivity(19).
- R. B. HEDDURE, M. T. TELSANG , “CASTING DEFECT REDUCTION USING SHAININ TOOL IN CI FOUNDRY – A CASE STUDY” Shainin tool it works on elimination process. It can be achieve 95% confidence level. This tool useful for quality improvement & by this tool eliminates the defect. Shining tool keeping rejection to a bare minimum is essential to improve the yield and increase the effective capacity of the unit(20).
- A Carrasco, D Peña and J Izaga “Net/gross yield optimization on high value added steel casting”, The feeding systems for any steel cast component can be successfully built with IN-EXO mini-risers, padding sleeves and well sleeves.Net/gross yield outperforming 60% has been achieved, although the right design criteria must be employed. Yield improvement exo thermic sleeve put in the riser than solidification time will be increase hence more amount of material going down(21).
- Anthony ANDREWS and Emmanuel GIKUNOO “Small Scale Foundries in Ghana: The Challenges” SSFs are profitable ventures and can serve as a source of employment to graduates who cannot obtain jobs in Ghana. The new technology comes with additional cost and therefore access to funding is inevitable for the growth of SSFs in Ghana. In foundry industry which types of problem are come like financial, human resources, raw material & how to overcome that issue(22).
- Rajesh Rajkolhe, J. G. Khan “Defects, Causes and Their Remedies in Casting Process: Review” Different research papers causes and their remedies are listed. These will help to quality control department of casting industries for analysis of casting defect. This study will definitely be helpful in improving the productivity and yield of the casting. Find defects and also written probable cause, further we focuses on those defects will be not occure(23).
- Gajendra Patidar , Dr. Devendra Singh Verma “IMPLIMENTATION OF STATISTICAL PROCESS CONTROL IN SMALL SCALE INDUSTRIES-A REVIEW” The methods and practices of process control in manufacturing help companies to continually meet and exceed the needs of their customers in providing high quality products at a low price. Successful factor for implement SPC in industry, which types of benefit after implement(24).
- Suraj Dhondiram Patil , M M Ganganallimath, Roopa B Math, Yamanappa Karigar , “Application of Six Sigma Method to Reduce Defects in Green Sand Casting Process: A Case Study” application of a six sigma DMAIC

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methodology to identify the problems in a casting process and solve the problem by determining the optimal operation parameters for reducing Sand inclusion defect. DMAIC methodology can be used in foundry industry and in each step how successfully implement with the use of SPC, 7-QC tool, DOE(25).

- Mrs. V. S. Deshmukh , Dr. S. S. Sarda “THE CRITICAL CASTING DEFECT IN CAST IRON: SAND INCLUSION – A REVIEW” Different techniques like Quality Function Deployment, cause and effect diagram, Design of Experiments etc. are also referred for finding the appropriate parameters responsible for sand inclusion. Corrective action should be taken on responsible parameters to eliminate the defect and improve quality of ferrous castings(26).
- Ratnesh Kumar Dewangan “CASTING DEFECTS ANALYSIS ON SMALL SCALE FOUNDRY” first phase, recognition of set of process parameters which are responsible for defects is done. Then these identified process parameters are examined using Design of Experiments approach. Signal-to-noise ratio is estimated, it is identified that the optimized values enhance the quality of product and minimize the reduction percentage. The optimal parameter values were applied to the process and further four experiments were Conducted(27).

## V. CONCLUSION

Modern method of casting components using various software and simulation technique is really a boon for the industrial sector. To compete globally, foundry men have to move ahead from the slogan of ‘satisfying customer’ and adopt and rigorously endeavor for ‘customer delight’. Meeting customer demands will not be sufficient, requirements will be to exceeding them through quality and productivity improvement.

After preferring paper select some of tools and technique for future work like SPC are quite expensive to implement in a small scale industries but this method gives better results than any other technique. These techniques can be useful not only to reduce the rejection but also in various other departments in industries like inventory control, at various machines in machine shop to get process variation and to identify optimum values of parameters etc (2).

Many researchers have conducted experiments to find the sand process parameters to get better quality castings. They have successfully reduced the casting defects considerably up to 6% by proper selecting sand parameters (9). DoE is the technique which can be implemented in any processing industry. In India there are number of small scale industries which can implement such techniques to improve the yield, give standard process parameter and increase the effective capacity of the unit.

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