ABSTRACT

This work is a theoretical and experimental study of the critical analysis of the performance measures for implementing the World Class Manufacturing approach in small and medium scale industry. The aim of the present work is to investigate thoroughly the possibility of performance improvement of the machines in small and medium scale industry. Since the printing is amongst the five largest industries in small and medium scale industrial sector the critical analysis of the performance measure is carried for Printing Industry.

Due to technology development and globalization the print quality standards being stringent at export level is the problem faced by medium scale printing industry. The increased raw material consumption cost is the problem faced by small scale industry. The offset machine is playing a vital role in graphic reproduction in printing industry. An attempt has been made to perform the critical analysis of the parameters affecting the print quality and modify the performance of the offset printing process.

The Design of Experiment is used as a research methodology to identify the variations occurring in the Print Density. The validation of the results is performed by Analytic Hierarchy Process and Genetic Algorithm. The first phase of experimentation results in finding out the main cause is the surface temperature of the inking rollers from which the ink is transferred to the plate cylinder. In support of the experimentation the multiple regression equation is obtained for most sensitive yellow colour out of four process colour inks viz. Cyan, Magenta Yellow, Black.

The printing run is carried out on Graphica 771 offset printing machine by using the optimal combination for a span of five hours continuously. It was observed that rise in surface temperature (from 25°C to 40°C) affects the print density which varies from 0.96 to 1.21. The print quality characteristics are observed for operating temperature range between 25°C to 40°C.

As the viscosity of the ink decreases, there is a greater tendency for the ink to be attracted to the silicon rubber non-image areas of the printing plate. For the efficient process it is necessary to use ink of higher viscosity. But as the viscosity of the ink increases the tack also increases. Hence ink manufacturer should use special high-viscosity low-tack inks during offset printing.

It is also necessary to cool down the printing machines after running continuously for longer period, especially during warm weather. Therefore for efficient working of process,
strict press and environmental control is required, otherwise the ink rheology breaks down and the printing plates start to accept ink in the non-image areas.

The rheological properties of ink are affected with temperature changing ink film thickness on the print. To compensate this effect and achieve correct ink film thickness printer has only two choices, either he has to change the ink keys setting or dwell-the length of time of docter roller which is in contact with the fountain roller. These two settings are tedious and have to set from time to time as machine speed changes. The most suitable and simple solution to this problem is to maintain the constant temperature of inking rollers. This can be done by cooling the inking rollers by passing either cool air or cool water. As offset process is based on proper ink-water balance to prevent air leakage problems in offset printing water chilled oscillators becomes suitable solution.

The CFD analysis of the problem of rotating cylinder with wire insert is performed and it validates the experimental results.

OUTLINE OF THESIS REPORT

Chapter 1 introduces the theoretical study of World Class Manufacturing approach and its implementation. As per the result of latest census 2001-2002, printing industries are amongst the five largest industry sectors in small and medium scale industry. Due to technology development and global competition of quality production there is a need to enhance the performance of printing machinery.

The up to date literature review is carried on World Class Manufacturing and Printing Process.

Chapter 2 focuses on the principle of offset lithography and the variables affecting the print quality. The state of art and challenges due to advances in industry are reviewed. The print quality measurement techniques with instrumentation is studied.

Chapter 3 explains the systematic analysis and research methodology adopted. The Taguchi’s Design Of Experiments are performed to optimize printing process parameters and quality of print. The results are validated by Analytical Hierarchy Process and the Genetic Algorithm for optimal combination.

Chapter 4 explains the result of experimentation I on offset printing machine. Experiments are carried out as per the procedure of Design Of Experiments in Offset laboratory. The multiple regression equation for yellow colour is determined.

Chapter 5 focus is on the critical analysis of inking system of offset machine (experimentation I). The critical rollers are identified from which the ink is transferred to the
plate. The print quality variations as a result of rise in surface temperature of rotating rollers is observed. The modification in the design of roller is done on the basis Load Stress analysis and Thermodynamic consideration. The rotating cylinders with wire insert are designed to enhance the rate of heat transfer due to length restriction.

Chapter 6 presents the experimentation with modified roller (experimentation II). This includes the link modification, rotary coupling selection, chiller unit selection and the rotameter for adjusting the mass flow rate at constant pressure during experimentation. By controlling the optimal Surface temperature, the print quality characteristics are observed.

Chapter 7 presents the CFD analysis of rotating cylinder with wire insert for validation of experimentation -II.

The conclusions are drawn on the basis of experimentation - I and experimentation - II which are Discussed in Chapter 8.