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EXPERIMENTAL INVESTIGATION AND MODIFICATION IN INKING ROLLERS OF OFFSET PRINTING TO ACHIEVE WCM APPROACH IN SMALL AND MEDIUM SCALE PRINTING INDUSTRIES

Bhoomkar M. M.[1], Likhite P. B.[2] and Navale L. G.[3]
[1]Mechanical Engineering, PVG's, C.O.E.T, Pune, India
[2]Printing Engineering, PVG's, C.O.E.T, Pune, India
[3]Cursowadia College of Engineering, Pune, India
E-mail: manmohan_bhoomkar@yahoo.co.in

ABSTRACT

Due to technology advancement and globalization policies technically perfect aesthetically attractive, quality products are available in the market. To meet expectations of quality the World Class Manufacturing (WCM) approach is need to be considered. In order to survive in the present global competition small and medium scale printing industries (SMPI) should also be world class, as it is directly related to advertising, packaging and newspaper industries. Printing is the process of uncertainty minute change in the process parameters like ink properties, paper quality, machine performance and operator skills may cause drastic variation in print quality. In this paper an attempt is made to experimentally investigate the trend of variation of print quality parameters to control the process variation and modification suggested in the machine to control the quality.

Keywords: printing, industry, quality, manufacturing, SMPI.

1. INTRODUCTION

In small and medium scale offset printing industries (SMPI) the printer faces lots of problem because of the temperature variation. As the printing process starts, printer sets the ink keys to achieve the correct ink film thickness but as the time passes during printing process heat is generated due to friction between surface contact driven rollers and oscillators. Which results into the transfer of heat into the ink. The rheological properties of ink changes with temperature, which results in change in, 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. These two settings are tedious and needs the time duration to set as machine speed changes. The most suitable and simple solution to this problem is to maintain the constant temperature of inking rollers. Cooling the inking rollers by passing either cool air or cool water can do this. As offset process is based on proper ink water balance therefore air leakage, which contains dust particles that may create problem, so water-chilled oscillators becomes suitable solution. [Bhoomkar, 2007].

2. BASIC OFFSET PRINTING PROCESS

Offset lithography is a Plano graphic printing process which requires an image carrier in the form of a plate on which photo chemically produced image and non-image areas are receptive to ink and water respectively. The image on the plate must be right i.e. it is oriented in the same way that the image will be printed.

2.1. Principle of offset printing

The basic principle of offset process is that the ink and water never mix each other (Figure-1).

Following are the basic steps involved in printing by offset lithography.

- Plate with photo chemically produced image and non image areas is mounted on a cylinder.
- Plate is dampened with a mixture of chemical concentrates in a water based solution which adheres to the non-image areas of the plate.
- Plate surface is contacted by inked rollers, which apply ink to only image areas of properly dampened printing plate.
- Right reading inked image on the printing plate is transferred under pressure to a rubber like blanket on which it becomes reverse wrong reading.
- Inked image on the blanket is transferred under pressure to sheet of paper or other printing substrate producing an impression of the inked image on paper.

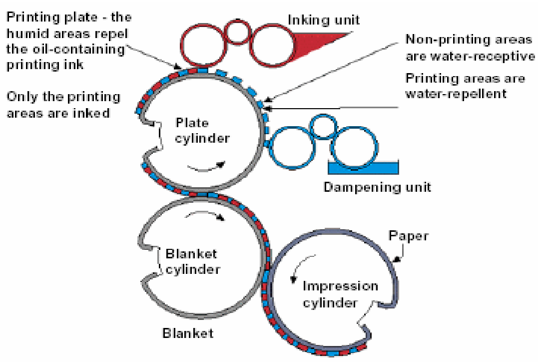

Figure-1. Basic offset printing process. [Eldred, 2001.]

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3. INKING SYSTEM OF GRAPHICA 771

The inking system or inker of the sheet fed press has four basic functions:

1. To move the ink from the ink fountain to the plate.
2. To break down the thick charge of ink into a thin, uniform film around the rollers.
3. To work the ink into printing conditions.
4. To remove image repeats on the form from previous printing cycle.

3.1. Inking system of sheet fed press

The inking system of most sheet fed presses usually consists of following parts:

- **Ink fountain**- A pan that contains ink supply.
- **Oscillator or Vibrators**- Gear or chain driven rollers that not only rotate but oscillate from side to side, distributing and smoothing out the ink film an erasing image patterns from the form roller
- **Doctor roller**- A transfer roller that alternately contacts the ink fountain roller and the first roller of the inking system, often an oscillator.
- **Form rollers**- A series of three to four rollers, usually of differing diameters, that contact the printing plate and transfer ink to it.

4. EFFECT OF TEMPERATURE ON PRINTING PERFORMANCE

Printing with an ink that is significantly lower than intended can lead to several different problems, first delivery from a bulk handling system can become difficult as viscosity increases at lower temperature. A significant increase in viscosity will restrict ink flow and can result in print density fluctuations or starvation because the correct volume of ink can no longer be delivered to the press. Print quality can also suffer as viscosity increase significantly. Ink transfer through the roller train can be impeded resulting in inconsistent or mottled print an increase in viscosity can also contribute to excessive linting [Todd, 1996].

High viscosity ink may also lead to problems with run ability. Ink with a low viscosity due to a high temperature can lead to a separate set of problems if ink viscosity is decreased due to high temperature over emulsification can occur generally as ink viscosity decreases emulsification rate increases the increase in temperature will cause the fountain solution conductivity to increase slightly. The increase in conductivity will also increase emulsification on press. This change could radically affect ink- water balance on press. There are various problems associated with over emulsification inconsistent solids, excessive dot gain, and interpage setoff may also occur.

A common problem in pressroom is ink dripping, misting, spitting the ink viscosity can be a factor to this. If the temperature varies hen these variables will also vary day to day in some presses in summers ink viscosity is increased so that due to increase in temperature ink misting or dripping will be reduced.

The temperature measurement in the ink roller train is a critical measurement, the roller temperature can be measured with a contact less temperature sensor if the rollers are set too tightly or are too hard, this will increase the friction in the unit which results in increase in the temperature of the roller train. From literature it is observed that if the temperature of roller is maintained between 25 to 27 degree Celsius than the results of print quality are up to world-class standards. [GRAICOL STANDARD].

The fountain solution plays an important part as the press is running the fountain solution backs its way into the ink roller train due to emulsification. The fountain solution acts as a coolant due to evaporation which results in the cooling of the roller train. The ink train temperature is critical in maintaining good printability. The rollers in the press must be cooled to make the process work, or else the plate starts printing in the non image areas

All of these above factors show that temperature control is an important step in providing consistency in the pressroom [Bohuslava, 2000].

4.1. Readings of print on inking system of graphica 771

Fgure-2 shows temperature across various sections of roller vs time (Temperature in degrees).

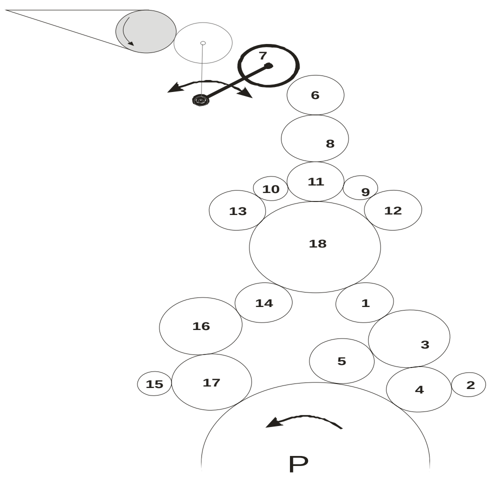

Figure-2. Inking system of Graphica 771.

[Offset Graphica Manual-Kandivali.]
Rubber oscillators - 5,6,11,12,13,17.
Copper oscillators - 3,7,8,9,10,12,15,18.
P - Plate cylinder.

From the Chrome plated ink fountain roller the ink is transferred to paper through the train of inking rollers to blanket through plate and finally from blanket to paper. Depending upon nature of image area, thin layer of ink film thickness is formed. Hence the critical analysis of the inking roller trains is performed and it is observed that

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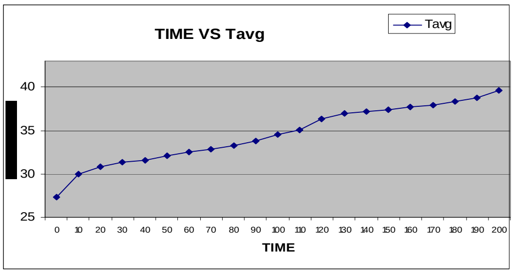
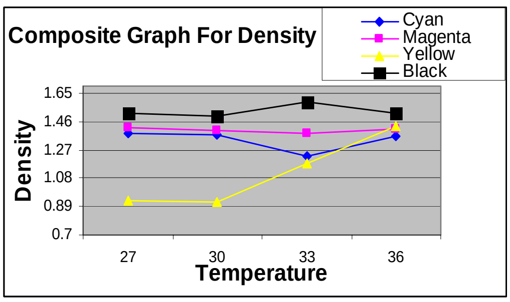
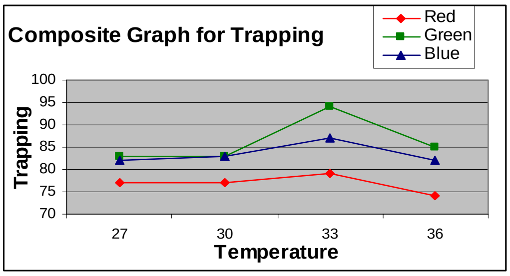
mainly due to the three copper coated inking rollers over which the ink film thickness is formed is the critical parameter which affects the print quality.

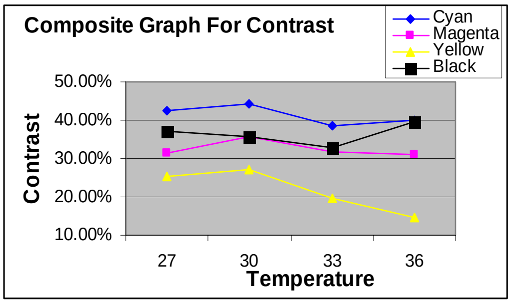
Readings of temperature across various sections on copper coated rollers of graphica 771.

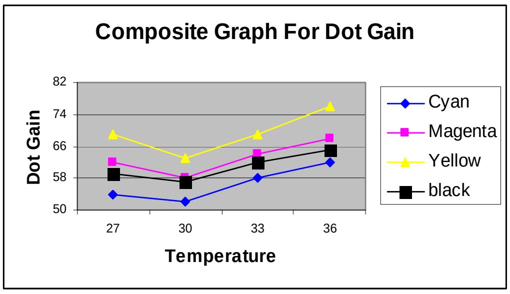
Time	T1	T2	T3	T4	T5	$T_{avg.}$
0	27.6	27.4	27.2	27.4	27	27.32
10	29.8	30.2	30	29.6	30.2	29.96
20	30.6	31	30.8	30.8	30.8	30.8
30	31.2	31.4	31.6	31.4	31.2	31.36
40	31.4	31.6	31.6	31.6	31.6	31.56
50	32	32.2	32.2	32	32	32.08
60	32.6	32.6	32.6	32.4	32.6	32.56
70	33	32.8	32.8	32.8	32.8	32.84
80	33.2	33.2	33.4	33.2	33.2	33.24
90	33.8	33.8	34	33.6	33.6	33.76
100	34.8	34.6	34.4	34.4	34.6	34.56
110	35	35.2	35.2	35.2	34.8	35.08
120	36.6	36.4	36.4	36.2	36	36.32
130	37.2	37.2	37.2	36.6	36.8	37
140	37.4	37.4	37.2	37	36.8	37.16
150	37.4	37.8	37.4	37.6	37	37.44
160	38	37.8	37.6	37.6	37.4	37.68
170	38	38	38.2	37.8	37.4	37.88
180	38.4	38.4	38.6	38.4	37.8	38.32
190	39.2	38.8	38.8	38.6	38.2	38.72
200	40	40	39.2	39.6	39	39.56











Observations

From the graph of density-Cyan and Magenta Density decreased as temperature increased from 27°C to 33°C but it increased as temperature rose to 36°C where as Yellow Density increased as temperature increased , Black Density behaves erratically as temperature increased. From the graph of dot gain-As Temperature increased, dot gain increased for all temperatures except at 30°C for CMYK inks. From the graph of Trapping-it is observed that trapping increased up to 33°C and decreased at 36°C for RGB colors. From the graph of Print Contrast, it is observed that Print Contrast of Cyan gradually decreased at 33°C and increased at 36°C. Whereas for Magenta and Yellow it only increased at 30°C and for Black it increased only at 36°C.

5. ROLLER DESIGN BY THERMODYNAMIC CONSIDERATION

It is the case of force convection.

It is assumed that temperature of water into the roller = 10°C.

Di = 25 mm

Do = 75 mm

Where, Di = Inner diameter

Do = Outer diameter

and temperature to be maintained = 25°C.

Taking thermo-physical properties of water at 10°C,

ρ= 999.7 kg/ m³

Cp = 4.191 KJ/ kg K
μ = 469.918 x 10^{-2}
Pr = 9.54 (Prandtl number)
ν = 1.306 x 10^{-6} m.Sq/sec (kinematic viscosity)
Re = ρVd/ μ = Vd/ ν (reynold's no.)

Now assuming velocity of water as 1 m/s,
Re = 1 x (0.025)/ 1.306 x10^{-6} = 19.142 x 1000
Also Pr = μCp/ K = 9.45 (from Table)
As Re > 4000, the flow has to be turbulent. Also fluid is heated.

Hence, we used the equation as
Nu = 0.023 x $(Re)^{0.8}$ x $(Pr)^{0.4}$
Nu = 0.023 x $(19.143 \times 10^3)^{0.8}$ x $(9.34)^{0.4}$
= 151.05 (Nusselt no.) As Nu = hd / k
h= Nu x k/d = 151.05 x 0.681 / 0.025
= 4030.014 w/m sq.°Cm = νρa
= 1 x 999.7 x 3.142 /4 x $(0.025)^2$
= 0.4907 kg/second

Now, heat gained by water = convective heat flow from surface to water
m.Cp (△Tmean) = hA x △T
m.Cp x (Ts + Tf)/2 = h (3.142 dl) (25- (Ts + Tf)/2)
L = length of roller
Cp = Specific heat of constant Pressure
m = Mass Flow Rate
d = Inner diameter of roller.
Ts = Surface Temperature of roller
Tf = Water temperature of inlet.
Therefore 0.5 x 4.19 x (10+ Ts)/2 = 4030.014 x 3.142 (0.025 x1.04) (25- 10+ Ts /2
2.095 x (10+ Ts)/2 = 329.177 x (25- 10+ Ts)/2 = (40- Ts)/2
6.364 x 0.001 (10+ Ts) = (40- Ts)
Therefore, Ts = 39.68°C
Therefore, Wall temperature of rollers = 40°C.

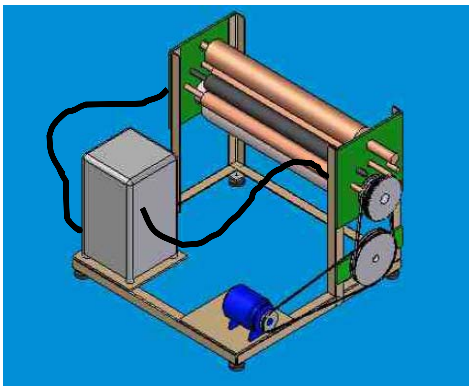
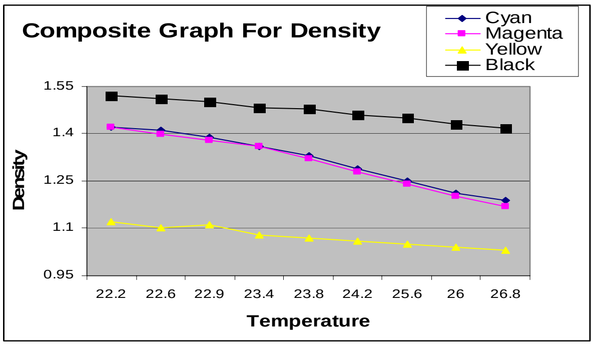
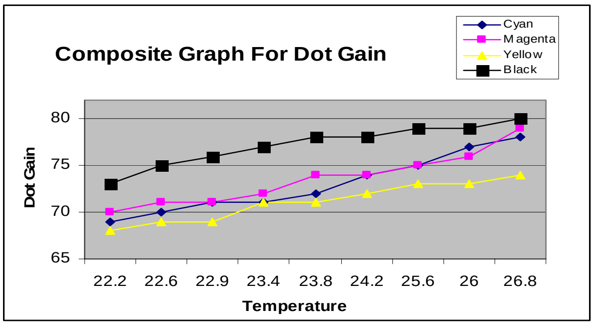
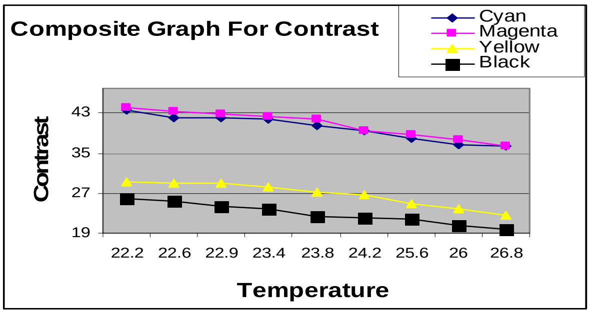


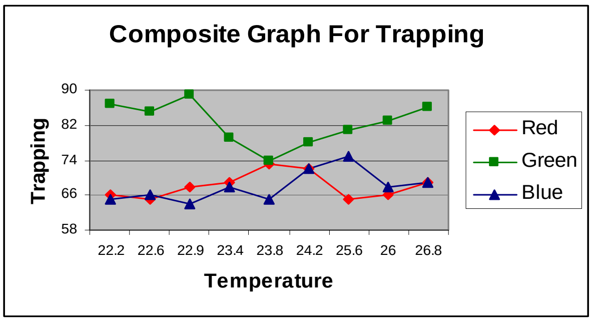
Figure-3. Proposed chilling system model for inking rollers Graphica 771 machine.

Composite graphs after implementing the chilling system









CONCLUSIONS

The inking unit temperature control device provides a constant temperature in the inking unit, thus increase the process stability, reduces the number of waste sheets despite higher machine performances and production speeds, reduced start-up times and less waste sheets at the beginning, uniform dot gain during start-up and over the entire run.

Density achieved under temperature-controlled condition is closer to the target densities. Higher output since the blankets needs to be washed less frequently, avoidance of scumming due to heat. To Control the effect of temperature on print quality in small and medium scale offset printing industries we suggest a water cooled oscillators system.

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