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An approach to minimize carbon footprint for an environmental friendly printing by optimizing an offset machine in a printing facility

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Abstract

The growing demand for sustainable business practices, life-cycle analysis and environmental product disclosure will impact e-reader manufacturers, digital media companies and purveyors of print media. Sadly, print has allowed itself to be commonly seen as an environmentally destructive medium, despite the fact that much of print media is based on comparatively benign and renewable materials. This is particularly ironic in that print has incredible potential to be a far more sustainable medium than it is today… and to become the means for printing flexible polymer digital electronics as well. With environmental concerns playing a large role in all kinds of manufacturing industries, the concept of sustainability remains elusive. There are many common steps a print factory can take to reduce the impact that carbon footprint have on environment. It is only with truly holistic approach towards environmental protection we can effectively reduce CO\textsubscript{2} emissions and bring down carbon footprint. While CO\textsubscript{2} is created in manufacturing of the printing press and of printed products, there are other significant emissions involved in a print production. Process waste includes energy, printing substrates, ink, dampening solution, blanket and wash up solvents, anti- set off powder need special attention. This study helps to find out solutions to make print industry green, rather a new concept “CO\textsubscript{2} NEUTRALISED PRINT” under the mantra “Think economically – print ecologically”.

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Keywords: Anti-set off powder; CO\textsubscript{2} neutralized print; Optimization; Offset printing; Printing substrates; Wash up solvents

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1. Introduction

Printing is the step in the communication process where information is made visible and tangible to the users. The end product should of course be effective in its information and convey a feeling of high quality related to its purpose. Besides this it is of sheer importance that the production runs efficiently, as quick and smoothly as possible and at a low cost. In fact, the greater part of the effort in press optimization relates to an approach to minimize start up waste and methods which can cut down the power and substrate waste as much as possible, thus bringing down the carbon footprint for an effective environmental friendly printing with high print quality which is predictable and reproducible.

New printing techniques, materials, increased production volumes and press speed put higher demands on the substrates to facilitate good run ability, especially with the interactions between ink, fountain solution and printing substrate. The overall purpose with optimizing the printing process is to achieve a correct process standardized quality communication from creation of the original to the final printed product.

1.1. Environmental management

“Environmental protection and Climate change” is one of the widely discussed topic today. Ecological aspects have changed many industries considerably during recent years. However a substantial study has not been conducted in printing industry especially in India.

Creating an Environmental Management System and getting it certified is a good way to demonstrate that the print shop processes have been checked and found to be environmentally sound. An Environment Management System defines how environmentally relevant aspects are dealt with in the context of company’s regular management process. Environmental goals are formulated and their achievement is regularly monitored. This has the effect of reducing environmental impact through a process of continual improvement. Before signing out contracts many larger print companies require their suppliers to prove that they have certified environmental management system in place. Certification of compliance with the international ISO 14001 standard is most common. There is a clear trend in the printing industry towards sustainable services that improve not only the cost efficiency of print shops but also their environmental performance. Offset printing technology constitutes about 65% of complete printing industry, but very few in the printing community is aware of the environmental aspects. This practical experimental study explains the pros and cons of the topic, its importance in the print media industry, how the carbon footprint can be influenced and as a printer what need to be done to reduce carbon foot print in print process. A printing facility must be committed to taking a holistic approach to eco-friendly printing, giving consideration not only to eliminate the carbon footprint but also to reduce energy consumption, emissions and process wastes. Through this exercise of optimizing a press, it is possible to explain what the carbon footprint is and how it can be calculated precisely. Environmental protection must be made as an integral part of the company’s objectives from the date of its start. The print companies must work consistently and systematically to achieve this aim along the entire value added chain, from product development and production to their use by the customers. Focus should be on the possibility to make use of the opportunities for conserving resources to minimize carbon footprint.

The term “carbon footprint” refers to the amount of Carbon Dioxide (CO₂) that is emitted in a year by individual. CO₂ is produced from many sources and is the primary gas responsible for global warming and the resulting alarming changes in the climate. Nearly everything that is done in our modern society requires energy. This energy is generated primarily by burning fossil fuels. From all sources, the average American is responsible for approximately 19.00 – 21.00 tons of carbon emission annually, whereas an Indian is responsible for 1.00 – 1.50 tons of carbon emission annually. The US as a whole is responsible for emitting approximately 25% of all global greenhouse gas emissions every year while they are only 5% of the world’s population.
2. Methodology

The ambition of every printer is to print jobs quickly and efficiently to match the proof, to use as little ink as possible and to have a minimal amount of wastage. But unfortunately that isn’t always the case. Proofs don’t always match, jobs get pulled off press and clients who are impatient are asked to wait for more time. Why does this happen? The answer is a lack of optimisation within all the processes involved. The press, the proof, the incoming files and the CTP optimisation curves are not aligned to a specification. Usually the proof and the press are calibrated by the plate manufacturer or reseller. But to what target and what method, densities and dot gain values? In today’s colorimetric world, calibrating a press to densities and dot gain is antiquated and simply doesn’t fit into today’s colour-managed world. Problem starts from the moment press receives a client’s file. No two files are created equal and no two files will print equal. This experiment of optimising an offset printing machine is to minimize carbon footprint for an environmental friendly printing is carried out in 4 phases.

Phase 1: Optimising the Computer to Plate (CTP) unit to deliver process calibrated plate. Phase 2: Printing with process calibrated plate before the printing machine (SM 74 – 4P – L) is optimised. Phase 3: Optimising SM 74 – 4P – L.

There are multiple reasons for which this methodology has significant advantages. One of the main advantages is that press is printing to a target that is shared amongst all the creative and print buyers. This means that the monitors, laser printers, inkjets, proofers and printing machines are all aimed at one common condition. When all parties involved are working on the same visual model, the expectations are the same and by standardizing or harmonizing all incoming files being prepared for print, you are controlling the process. This step is the most complex and volatile of all the steps. Phase 4: Comparative analysis of CO2 release in Phase 2 and Phase 3 and inference.

2.1. Phase 1: Optimising the Computer to Plate (CTP) / Prepress department

At the beginning of the 90’s DTP took over the prepress almost overnight and has now almost completely replaced the specialized composition and image editing systems as well as photomechanical reproduction. Since 1995 computer to plate technology (CtP) had played an increasingly important role. These technological changes in prepress have also brought about fundamental changes in the types of job offered in prepress. The tasks of the three classical occupations of compositor, reproduction technician and plate maker, can today be carried out at one work place by a single skilled worker.

2.1.1 Conductivity test

Conductivity test is done for the chemistry that is used in the processor for developing the plate. This is to find out the amount of undissolved salts in the plate developer. Fresh developer showed conductivity of 51.9mS (micro Siemens). The developer in processor tank has conductivity of 47.3mS. These readings give an idea about the settings of replenishment. If the difference is >10% for conductivity it is an indication of weakness. The present difference is 8.8% which indicates the solution is good for use.

2.1.2. pH test

This test is carried out to find out the pH factor of the chemical in the tank. Again this reading gives us idea about the settings of replenishment. If the difference is >0.3% for pH, it is an indication that developer strength has weekend. Fresh developer has a pH of 13.85 and in the tank has pH of 13.81, thus the difference = 0.28%.
2.1.3. Processor dwell time setting test

This test will help to find out the exact time required for developing the plate. In service mode changed dwell time units from cm/min to DIP – NIP. Tolerance is 3 to 5% is healthy for single layer plates. If plate is 830°C - Dwell time (Dip – Nip) is 20 sec. Density of marked spot before developing is 2.16. After developing is 2.08 and the difference 0.08. Difference in percentage is 3.07%. Density of marked spot before developing is 2.16 and after developing is 2.07. Thus the difference 0.09 and the percentage of difference 4.16% which is within the tolerance level.

2.1.4. Matching field test

The objective of this test is to get the field match of the components in the image area. The plate is exposed through the laser (160 ml. watts) and the micro lines image is checked for its accuracy. The text matter which is of 0.5 point size is also checked for its sharpness with the help of 100X micrometer.

Plate quality test: To prove the repeatability accuracy, punch accuracy, dot sharpness, thermal laser exposure evenness, gradation quality and density this test has to be carried out. Observation is made when the dot % is measured through an IC plate dot meter. The reading at all the areas falls between 40% - 41.3%. Result on the plate is good and can be used for further processing. Left to right side % of dot is almost same throughout the plate, which will give ideal result on the paper during printing.

2.1.5. Laser focus and laser power test

The purpose of these tests are to find out if there is any variation in the plate graining i.e. in the peaks and valleys and power required for the laser during exposure on to the plate. Measured the 1X1 vertical line and recorded the lowest density for positive plate and highest density for negative plates. From this test it was found step A9 (Figure 1) has lowest density area. Thus it was concluded that the Plate can be exposed evenly. The laser head (Figure 1) has IDS (Intelligent Diode System). Of the 64 diodes failure of any of the diode can be compensated automatically to maintain the required energy. If the cylinder temperature is more the cylinder will expand by 0.5 mm. temperature controller is used to overcome this problem. Laser temperature on the catchment area is found to be 24°C. Focus depth is 100 microns and plate depth is 280 microns. This value entered in CTP user interface. This gives the conclusion that the plate can be exposed evenly.

Fig. 1. Laser focus test plate and laser head of CTP

From the experiment the correct exposure time of the plate used on press for printing can be determined. After the plate is developed the test strip at the gripper edge is checked. The test strip element
triangle mark must match each other at the specified point. If underdeveloped the matching will be toward the left side. Then power test has to be repeated to make the exposure stronger. If over developed the matching will be towards the right side, and the power test is conducted to reduce the strength of the laser. The correct developing time of the plate used for this experiment is found to be 35.5 seconds.

Linearizing the plate: On a calibrated linearized plate the dots on both the Linearization Strip and on the software will be same. i.e. 5% = 5%. If there is variation then adjustments are done on the linearization Software. This test helps us to find out whether the dot reading on software and exposed plate is same or not, which is of greater importance in offset printing. In the below Figure 2, it is noticed that on the right hand side there is no curve since the plate is linearized.

![Fig. 2. Test strip of a linearized plate](image)

**Stability test:** This test will prove whether there is exposure and developing consistency. About 50 plates are taken and maintaining all the earlier parameters, plates are exposed, developed and are checked at intervals of 5 or 10. Check the first plate for dot %, density, developing time and exposing time. If the measured readings are same throughout, it indicates the developing chemistry is consistent and good.

**Acetone test:** During the plate development process there is a remote chance that the residual chemistry remaining on the plate surface which may be taken up for printing. This residue cannot be viewed by naked eyes of the technologist. Acetone test will show if there are any residual chemicals on the exposed, developed and Gum Arabic coated plate. A drop of Acetone applied on the non-image area of the plate and the solvent spreading is observed. If there are any residual chemicals on the processed plate fringes at the periphery of the solvent drop can be observed.

**Gradient test:** To find out the amount of laser power required to produce 1% dot on multi laser facility, Gradient test is conducted. During the test, it was observed that each laser diode require 0.4ml Watts of power to produce 1% dot.

**Process calibration test:** This test is to find out the dot gain on the press during printing. Maximum deviation on individual color is 5% (i.e., if dot % on plate is 40% then on the printed sheet it can go up to 53%). If it is beyond this tolerance level then the input at the Prinect Meta Dimension software has to be adjusted. The Figure 2 shows process calibration curve on the right side of the strip.

![Fig. 3 Test strip of a process calibrated plate with graphic representation](image)
The process calibrated curve which indicates that the dots have been modified according to the image for printing, the graphic representation is given in the above Figure 3. The curves will vary according to the image and can be altered according to the guidelines by ISO 12647.

According to ISO 12647, dot gain for +ve working plate is 13% + / - 4% on 40% dot, 14% + / - 4% on 50% dot, 13% + / - 3% on 70% dot, 11% + / - 3% on 80% dot, and dot gain for –ve working plate 19% + / - 4% on 40% dot, 20% + / - 4% on 50% dot, 16% + / - 3% on 70% dot, 12% + / - 3% on 80% dot. On successful completion of these tests, an output is taken for four color test image which will later be mounted on the SM 74–4P- L to begin the next phase of experiment that is to print on substrate.

2.2. Printing before optimising the printing machine (Phase 2)

Heidelberger Druckmaschinen AG’s SM - 74 - 4+P offset printing machine is used to conduct this experiment. Papers used in this study are coated paper. In order to ascertain that findings are under standard printing conditions, the maximum image size was taken so that any variation in all the four corners as well as the center can be measured for different parameters. The test form selected was “PAN 4C Mischtestform 45” which has wide variety of quality determining elements to show optimum ink coverage, ghosting, moiré effect, $\Delta E$ values, smoothness, optical brightness of paper, trapping and contrast. This test form is shown in the left side of Figure 4 and on right side plate and blanket cylinder of the printing unit when this image is taken up for printing.

Fig. 4 PAN 4C Mischtestform 45 and plate and blanket cylinder on SM 47

Saphira Thermo Single Layer Plate with process calibrated curve was used so as to have recommended dot gain specified by ISO 12647 – 2 standards. The temperature and humidity has a great influence on the runnability of paper. During the experiment, the shop floor temperature is maintained at 23° C with Rh of 55%. A lot of 10 reams of 150 gsm C2S Art Paper (gloss) coated grade with long grain of size 505 x 735 mm was used for this test printing to get the desired color on the printed sheet. The variation in the Rh can easily affect the stiffness of paper ultimately affecting runnability. The moisture content in paper is also checked and temperature maintained at 23 degree centigrade with Rh of 60.6. Since the machine has to be set for smooth paper travel and precise impression, the paper thickness is measured with a micrometer and loaded on the press to set the nip pressure as 0.12 mm. Compatibility of ink and fountain chemistry balance is very critical in offset printing i.e. emulsification.

The emulsification differs from ink to ink and fountain to fountain. Printer must be very cautious to have just enough dampening solution with ink. Figure 5 shows excessively emulsified roller and properly emulsified inking rollers. The fountain solution is prepared with 10% isopropyl alcohol with 2% fount in 88% water with the hardness of 8 dH. The conductivity of the base solution is measured as 1058 micro Siemens when the temperature is maintained at 10.9° C. Variation in this chemistry proportion can bring down pH to acidic nature there by affecting the life of dots on the plate. This can also affect the drying of
ink as well as ink density on paper. Saphira HEI Premium ink, ideal for coated papers, was in use throughout the experiment. Ideal ink density value on the substrate was maintained as $Y = 1.69$, $C = 1.41$, $M = 1.52$, $B = 1.72$. These values are selected based on the below graph (Fig. 6) which has $\Delta E$ on the Y axis and density value on the X axis. These density values were chosen to have the $\Delta E$ to the minimum possible, which is recommended by the application software Prinect Meta Dimension.

Fig. 5 Over emulsified inking roller and properly emulsified inking roller

![Over emulsified inking roller and properly emulsified inking roller](image)

The inking sweep and dampening sweep which is responsible for the amount of ink supply on the inking rollers and moisture to plate is kept 30% and 35% respectively. The printing was carried out keeping these factors constant.

Fig. 6. Graph showing density values of Yellow, Magenta, Cyan and Black inks

Prior to the process of optimizing the press, the printer has to consider the shop floor ambient. The air conditioning equipment must be adapted to the pressroom-specific requirements. Good air circulation is necessary to obtain a healthy indoor climate and to reduce energy costs. This can be achieved by installing a ventilation and air removal system with heat exchanger and fresh air contents. A well-balanced and constant climate in the pressroom helps to minimize production shutdowns. General dust limit level for room air is <6 mg/m$^3$ (with particle diameters <10 $\mu$m). Ideal ambient air temperature is 20°C to 24°C. Minimum ambient air temperature is 15°C. Maximum ambient air temperature is 35°C. Ideal ambient air humidity (depending on printing material) is 50% - 58%. Steady temperature conditions must be ensured. Velocity of the ambient air in the pressroom (e.g. from air conditioning system) is <0.2 m/s (<0.65 fps).
The process of optimisation a printing press is a great task which the printer should know and put to practice. A series of experimental subsets needs to be accomplished. Large number of variables that are involved in this process also need to be standardised and same number of parameters has to be considered to get the best result. Those parameters are discussed in the following text.

**Determining the pH value of dampening solution:** Plain water pH should be between 6.8 to 7.2 and pH value for prepared dampening solution is 4.8 to 5.2. Conductivity of plain water can be between 300 to 500 micro Siemens. Temperature is about 10°C below the ambient temperature. The pH factor of the dampening solution for this experiment is 4.9 with the conductivity of 1058 micro Siemens at 10.7 degree centigrade which is ideal for this experiment.

**Testing the water – Total hardness:** Water hardness is determined mainly by the content of calcium and magnesium salts in the given solution. Hardness strips (Figure 7) are used to determine the water hardness, which should range between 8 – 12 dH. Ideal test strip should be 2 red and 2 green when dipped.

Fig. 7 Total hardness tester and pH strips to check the fountain solution

![Fig. 7 Total hardness tester and pH strips to check the fountain solution](image)

**Shore hardness of rubber rollers with durometer:** The inking and dampening rollers have to be checked for its compressibility for smooth transmission of ink and dampening solution to the plate. The recommended shore hardness is 24 to 30. Durometer is used to check the shore hardness and it is recommended to measure at 5 different points on the roller and the average value is taken. The inking rollers used here have a shore hardness of 26. Figure 8 shows how to check the shore hardness.

Fig.8 Checking the shore hardness of inking rollers with durometer.

2.2.4 Inking and dampening roller setting

On an SM 74, Inking and Dampening rollers together counts to a total of 21 nos. All the rollers should be set to correct contact pressure against each other as specified by the manufacturer for smooth transfer...
of ink and dampening solution. Figure 9 shows the method to use the strips. Rollers are set either manually with roller setting strips and or automatically set with Digi Nip. Even though, this is time consuming it must be done for better control of ink and dampening solution on the printing plate making a faster make-ready.

**Fig. 9 Roller setting of inking and dampening rollers with roller setting strip**

*Checking blanket evenness and setting packing thickness:* A single layer printing plate thickness is 0.28 mm, whereas undercut of the plate cylinder is 0.15 mm, thus making the plate 0.13 mm above the bearer. The thickness of a compressed blanket is 1.95 mm, the packing sheet thickness or underlay is 0.35 mm. The undercut of the blanket is 2.30 mm. This will make the blanket leveled with the cylinder bearer, but the printing plate is 0.13mm above the bearer which in turn gives a pressure of + 0.13 mm on the blanket to transfer ink from plate to blanket. During printing, the substrate thickness is checked. This thickness is the pressure that is acting between the blanket cylinder and the impression cylinder, making the ink to transfer smoothly from blanket to the paper surface. Three dial gauge (Figure10) is the instrument to check the level of blanket to bearer.

**Fig. 10 Three dial gauge used to check the blanket and bearer height.**

*Torque setting of blanket using Torque wrench:* A loosely wound blanket as well as an over tight blanket will always favor either dot gain or dot loss. In order to control this phenomenon, the blanket has to be tightened to the blanket cylinder with torque wrench. Required torque is print length in cm minus 10% (5 N/m) equals the torque in N/m (max.). i.e., if the print length is 50cm then the Torque is 45 N/m (max.). The press must run a few revolutions on impression. The tensioning process must be repeated 2 or 3 times. If the blanket tension is too high, the fabric may stretch and damage.

*Registration test:* While printing a multicolour job, it is mandatory that each colour must register exactly to one another. If not the print will not be accepted as the image becomes blur. To position the plate cylinders, registration test need to be conducted. For this, two different test grids are used.
Multicolor printing is done with 0.5 mm grid. If required, adjustments in registration are made laterally and circumferentially. Check the gripper bite. Check the gap between cylinders. It is again printed with 1.5 mm grid for fine tuning.

**Dry off set test:** To check the quality of blanket dry offset test can be conducted. During this test, the dampening unit is switched off. Only ink is applied to the plate to get a solid print (100% image). Start with Squeeze Pressure of 0.01 mm and observe the print for evenness of ink deposition. Gradually increase squeeze pressure till the optimum level of 0.100 mm. Check for blanket punch and ink density. Ink density on the color strip is found out with the help of densitometer. This experiment is done on all the printing units of the machine.

**Relative print contrast test:** Relative print contrast test brings out the difference in ink density between solid and half tone areas. The test image is shown in Figure 11. Keep all ink zones evenly open. Select the value of zone 10 in prepress interface. Maintain the ISO standard ink density value on zone 10 during printing. Allow the ink to dry for half an hour. Measure ink density at 100% & 75% patch. Apply SD – Sc D / SD x 100% which will give the relative print contrast value. Select the value which shows the highest contrast value. Record the value and this will be the suitable density for that particular ink substrate combination.

**Dampening test:** Offset printing technology has a unique science where printing is possible only if there is proper balance between ink and dampening solution.

This test helps to determine the optimum dampening solution to plate for achieving even ink density. Loosen the dampening pan roller on DS / OS. Print and check the density on both sides. Adjust the dampening pan roller (without adjusting the ink) till even ink density is measured on DS & OS. If density is less, tighten the pan roller, so that dampening solution is reduced and ink density is increased. The test
form (Figure 12) shows variation in the Magenta color which has more dampening solution opening. As the opening is brought to lower level the ink density will start increasing. Similar procedure is done on Yellow, Cyan and Black ink strips.

**Ink pre setting:** The objective of this test is to create characteristic curve thus to achieve correct ink zone opening according to the input material combination. Figure 13 is the test form used for this experiment. This test will be helpful to achieve faster sellable sheets by modifying the ink zone opening values based on the image area.

![Fig 13 Test image to determine ink pre setting](image)

On completion of the above tests the third phase of experiment begins. No changes are made on plate, substrate and consumables. Print result is tabulated on Table 2.

### 4. Results

On completion of 2\textsuperscript{nd} phase of the experiment the results observed is tabulated in the below Table 1. On observing the result table it is understood that, in order to obtain a consistent and stable printing the machine is run for 8 hours releasing 399.35 kg of CO\textsubscript{2}. Also we can see that the substrate and consumables used are of huge quantities to achieve the complete make-ready and consistency in color.

#### 4.1. CO\textsubscript{2} release and consumables in first phase

| Description                                      | CO\textsubscript{2} release |
|--------------------------------------------------|-----------------------------|
| Energy consumption for 51 x 74 format             | 36kw                        |
| Average CO\textsubscript{2} factor for electricity per kWh | 0.514 kg CO\textsubscript{2} |
| CO\textsubscript{2} for 36 kW for 8 hours         | 148.03 kg CO\textsubscript{2} |
| CO\textsubscript{2} in kg/kg material of IPA      | 3.8                         |
| IPA used                                         | 6.4 kg                      |
| CO\textsubscript{2} for 6.4 kg IPA                | 24.32 kg                    |
| CO\textsubscript{2} factor for blanket            | 6.5 kg/m²                   |
| For blanket size 0.484 m²x6.5 kg CO\textsubscript{2}/m² | 3.146 kg CO\textsubscript{2} |
| For 4 printing blankets                          | 12.6 kg CO\textsubscript{2}  |
| CO\textsubscript{2} in kg/kg Wash-up solvent     | 2.3                         |
| Wash-up solvent used                              | 1 kg                        |
| CO\textsubscript{2} for 2.5 kg                    | 5.7 kg                      |
4.2. CO₂ release and consumables in second phase

After the printing press has been optimized, there has been a considerable reduction on the power used which is just one hour. Also there is substantial reduction in the consumables and substrate usage. We can see that the CO₂ release in a non-optimized press is 399.35 kg and on an optimized press is 129.09 kg which is a CO₂ saving of over 50%. Details of the study is given in Table 2.

| Energy consumption for 51 x 74 format | 36kw0.514 kg CO₂ |
|---------------------------------------|-----------------|
| Average CO₂ factor for electricity per Wh | 18.50 kg CO₂ |
| CO₂ for 36 kW for 1 hour | |
| CO₂ in kg/kg material | 3.8 |
| IPA used | 2.6 kg |
| CO₂ for 2.6 kg | 9.88 kg |
| CO₂ factor for blanket | 6.5 kg/m² |
| For blanket size .772 m x .627 m | 3.146 kg CO₂ |
| For 4 printing blankets | 12.6 kg CO₂ |
| CO₂ in kg/kg Wash-up solvent | 2.3 |
| Wash-up solvent used | 0.5 kg |
| CO₂ for 0.5 kg | 1.00 kg |
| CO₂ factor for plate | 7.88kg/m² |
| For plate size .745 m x .605 m | 3.551 kg CO₂ |
| For 4 printing plates | 14.2 kg CO₂ |
| CO₂ in kg/kg fount | 2.0 |
| Fount used | 0.28 kg |
| CO₂ for 0.28 kg | 1.16 kg |
| CO₂ in kg/kg Ink | 2.5 |
| Ink used | 0.67 kg |
| CO₂ for 0.67 kg | 1.67 kg |
| CO₂ in kg/kg Substrate | 1.27 |
| Paper used = 10 reams x 14.72 /kg | 44.16 kg |
| CO₂ for 147.20 kg | 56.08 kg |

Total CO₂ release during this exercise 129.09 kg.
5. Recommendation and inference

Some of the common concerns of today’s printers are long make ready time, more wastage of sheets, gripper to tail variation, up to ups variation, sheet to sheet variation, press to press variation and finally form to form variation.

As part of research study this same experiment was conducted at one of the leading Commercial Printing Press of South India at a town Sivakasi. In addition to earlier mentioned phases of optimising the press, to know and understand the effect of optimisation easily, a commercial job was also taken up in addition to the test images. The result was amazing.

Figure 14 represents the print taken before optimising the press, and printing was done on SM 74 with 150 gsm C2S Art Paper (gloss) coated grade with long grain of size 505 x 735 mm. Detailed study of the print showed the ink coverage is more than required, dot gain making the print looks darker, ½ tone dots were smudged, the ΔE value shoot up as high as 7.00, the trapping factor was not proper and overall smoothness of print was questionable. All these factors resulted in prolonged make-ready, which finally resulted in more CO₂ release.

Same process calibrated plate was mounted on to the press after optimizing the printing press and the resulted sheet is Figure 15. One can see that all the above stated shortcomings of the press was compensated and OK sheet rolled out without spending more time on press and the first print itself was sellable thus reducing the Carbon foot print.
5.1 Purpose of Optimization

Optimization enables the printer to further minimize waste copies, make-ready time on the printing press, problems while printing of mixed forms, costs for material and time, improved quality of the printed product, tighter tolerances during print process, environmental assessments when new products and processes are developed, and comparison between different product alternatives. This results in increased production stability due to a smooth workflow.

5.2 Methodologies to practice

Everything, all materials, presses, and work processes must be described in such a way that people can work based on these descriptions rather known as SOP’s. Everyone who wants to work together must observe these descriptions (standards). Quantifying the emissions of carbon dioxide arising as a result of a specified activity or product is the first step in understanding and managing the carbon impact of business. One tool that is used in these experiments to find a product’s carbon footprint is LCA – Life Cycle Assessment. A Life Cycle Analysis - LCA - is an efficient tool for the evaluation of environmental aspects and potential environmental impacts related to a product, from raw material extraction until the product goes to waste or are recovered. With the results from the LCA, strategies can be developed to decrease a product’s carbon footprint.

6. Conclusion

Of the focus areas, substrates offer the greatest scope for savings, since it represents between 60–90% of cost and CO₂ emissions per job. To bring down these figures, optimizing the printing machine is the only option. Few recommendations and inference has been advised, which will significantly reduce start up waste and methods which can cut down the power and substrate waste by as much as 90%. The printer should have good knowledge about environmental issues, materials, their manufacturing, handling and distribution of packaging and graphic media products. Paper, Ink, Printing plates, cleaning agents and Energy has diverse impact on environment. There are multiple approaches for reducing/eliminating these impacts. It is the paper that provides by far the biggest opportunity for shrinking a print job’s carbon footprint. Depending on its properties and how it is made, paper accounts for between 60-80% of total CO₂ emissions. Therefore printer has to be very meticulous in selecting an appropriate stock.

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