Section A-Research paper

Comparative analysis of Solid Ink Density on Conventional and Bio-based plastics using Gravure Process

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ABSTRACT:

Utility of plastics cannot be ignored in any aspects of our day to day life. But plastics have also created numerous issues at global level and compelled to ponder over its alternative. Plastic takes many years to get decomposed which is its major issue. So, bio-based plastic has emerged an alternative for the key problems aroused due to conventional plastic. Printing on conventional plastic has been common process to meet our daily requirements. But exploring the feasibility for printability on bio-based plastic is challenge in recent time. Therefore, an attempt to print on bio-based plastic is made in this direction. The major objective of this paper is to study a comparative analysis of solid ink density on Conventional and Bio-based plastics using Gravure process.

Keywords: Solid Ink Density, Plastics, Bio-based plastics, Gravure process, Printability

Introduction

Plastic is an accidental invention in 1907 that made many applications to simple and converts many complex processes light. Now, it is very difficult to think any process or application without the presence of plastics. The spectrum of application spreads from local packaging to high complex, light weight intricate plastic parts. It is only a generic term which covers all various kinds of synthetic or natural material, using for tremendous applications.

The word plastics widely used because of the easiness of usage. The popularity of plastics and its compatibility for day to day requirements leads to the invention of various endless application. But it has many flaws also. Main arguments against plastic are the life cycle of plastics. Plastic takes hundreds of years to decompose. Its production as well as destruction will result the emission of toxic chemicals that can harm the environment. Though it has many recycling methods, all are very expensive. Any form of waste plastic is quite harmful to short span of period, plastic wastage become a problem for the society as a whole. So, the governments across the globe are complelling to go before strong policies to make aware that public as well the stake holders about the hazardous of plastic waste. All these policies aimed to minimize waste production, improvement in waste segregation and management, waste recycling, waste hierarchy management and to find alternate options of plastics which are environment friendly. Based on this in 2016, government forwarded the national waste Policy provided to deliver effective approaches to waste issues on national level. It detailed with expiation how to avoid the waste generation, waste reduction, reuse and proper waste management approach to generate economics, social and environmental benefits.

New technologies are allowing the development of new materials that minimize this impact by manufacture of bio-polymers or bio-degradable polymers. It is enough for printing, packaging and containers, the degradation period being estimated at a maximum of six month for 90% if the materials. Decomposition can be carried out by aqueous medium, soil, marine, environment compost, various enzymes or by combination of heat, humidity, light or mechanical stress which would act as degradation catalyst.

Plastics derived from fossil source are considered as conventional plastics and have excellent print characteristics, while alternative plastics are obtained from bio-based sources or from nature friendly sources, may be compostable or bio-degradable in nature. Printing on bio-based materials / bio-plastics is under research/ trail by various research groups.

Gravure Printing Process is high-quality, high volume, printing process primarily used for long-run jobs suitable for printing on plastics for packaging applications. Gravure process is known for its ability to produce consistent and high-quality printing even on low grade substrates. It has another excellent advantage to printing upon any very thin plastic films, foils along with paper of any grade. However, Gravure process has many advantages, but it has some operational difficulties with substrates having less tensile strength / problem with stretch ability.

Conventional plastics have excellent print suitability on Gravure printing process, even on thinnest films like - PE, PP, PET (Polyester), while bio- based plastics like –PLA, PHA, PBS

are yet to establish their printability with different printing process as well as gravure process.

Printability can be defined as the substrates ability to reproduce text, picture and pattern in single or multi-color. Solid Ink density (SID) is one for the important parameter of printability in conventional printing. It refers to measurement of the optical density or colour saturation of a solid patch printed on substrate. It is used to measure the reproduced colour to ensure consistency of print. Measurement of SID can ensure matching of solid ink output with desired colour value of original which help to maintain consistency across print runs in multi-color job.

Printers use SID as important parameter to adjust ink densities to achieve accurate and consistent colour reproduction in multicolor jobs. SID is measured by densitometer or spectrophotometer. During measurement device measures the amount of light absorbs or reflects by the solid ink patch and provide numerical value commonly known as density. Higher value of density indicates denser or more saturated ink patches and vice –versa. To measure the SID, typically background density is measured first and then patches of various colors are measured after calibration of instrument.

Research Objective

The main objective of the study is to comparative analysis of Solid Ink density on Conventional and Bio-based plastic substrate using Gravure process.

Materials and Methodology

To study comparative analyses of solid ink density and other printing attributes on conventional and bio-based plastics first and foremost a master test chart for gravure was developed by incorporating technical elements for measuring print quality aspects. In order to explore the printing possibility on bio-based media, selection of substrates was done which included LDPE, BOPP, PET (Polyester) and PLA categorized under the Conventional and Bio-based category. The printing process opted for analysing printability was gravure process under standard press room conditions. Afterwards, colorimetric measurement was carried out using x-Rite exact spectrophotometer. Printing on selected plastics were done on gravure proofing machine as trial of PLA Bio-based was failed on printing machine due to stretch ability of the substrate. Hence it was decided that samples of all media/plastic should be printed on same proofing machine as proofing is done before sending image carrier for final printing in any printing process.

Data Analysis

During research experiments, the data was collected for different printing attributes. In order to compare Solid Ink density on conventional and bio-based plastic using gravure process the collected data is presented as below:

1. **Comparison of Solid Ink Density:** Comparative analysis of Solid Ink density on Conventional and Bio-based Plastic using Gravure Process is presented in figure 1, 2, 3 and 4 shown as:
   i. **Solid Ink Density of Cyan Color:** The findings of Cyan Color ink density are presented in figure 1. Ink density for LDPE, BOPP, PET (Polyester) and PLA were found that in the range of 1.62 to 1.7217; 1.2514 to 1.483; 1.4573 to 1.6917 and 1.2482 to 1.2998 respectively for the gravure process. Data revealed that ink density of cyan color on PLA (Bio-based) was in trend with BOPP. Also, BOPP and PLA (Bio-based) have identical ink density values at many points.

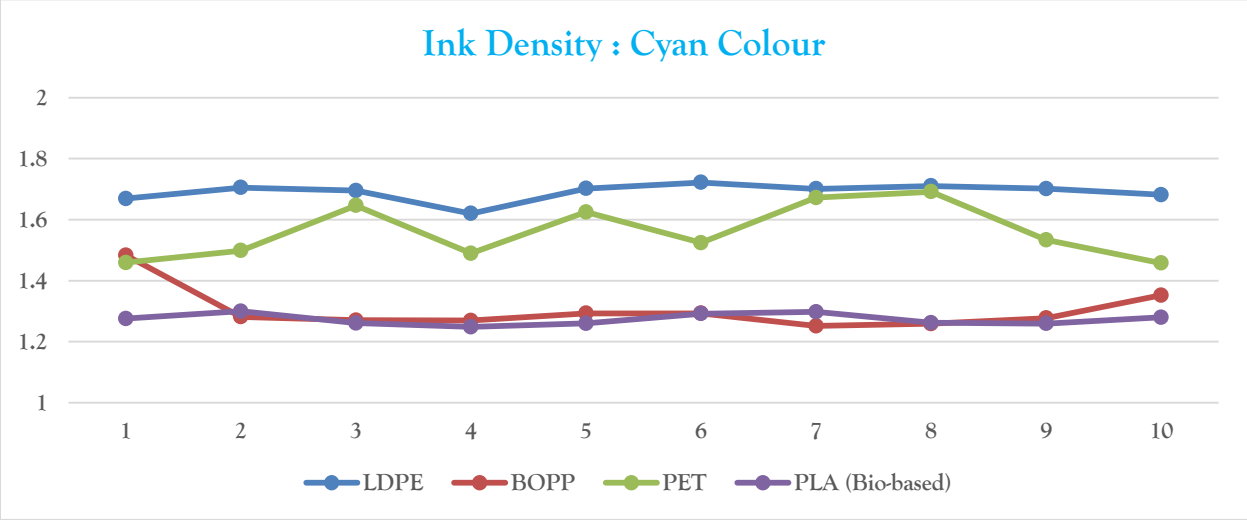

Figure 1: Cyan Color (SID) on Conventional and Bio-based Plastic

   ii. **Solid Ink Density of Magenta Color:** Magenta Color ink density observations are depicted in figure 2. During observation for magenta color the range of ink density on LDPE, BOPP, PET (Polyester) and PLA were found in range of 1.2896 to 1.3322; 1.2138 to 1.3099; 1.3263 to 1.782 and 1.2778 to 1.3346 respectively for gravure process. The haphazard behaviour was observed in case of magenta ink density on PLA (Bio-based). In contrast to it remaining substrates i.e. LDPE, BOPP, PET (Polyester) have similar trends for ink density of magenta color.

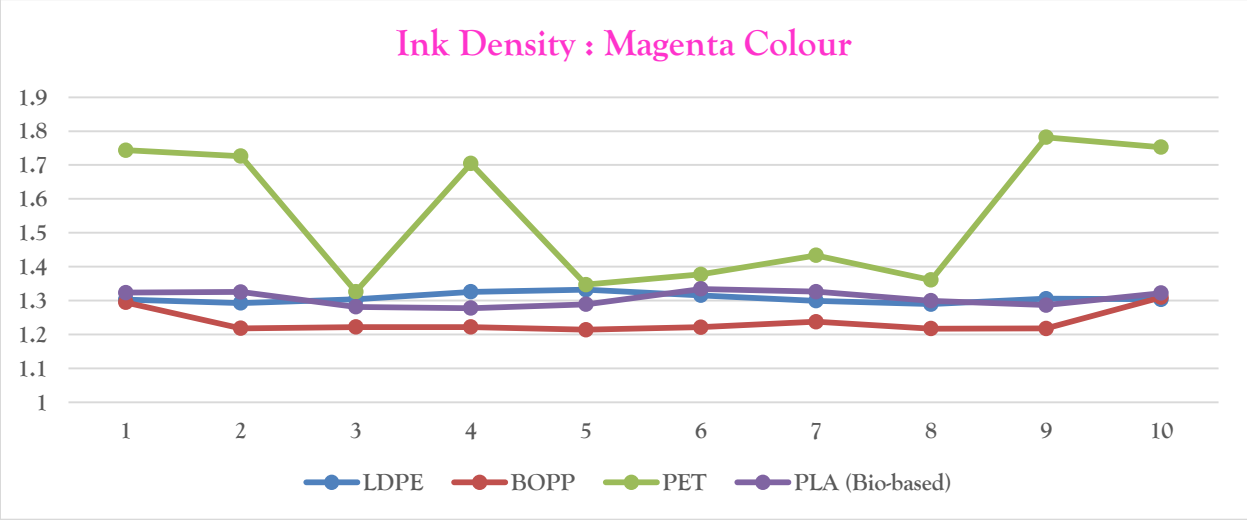

Figure 2: Magenta Color (SID) on Conventional and Bio-based Plastic

iii. **Solid Ink Density of Yellow Color:** The findings of Yellow Color ink density are presented in figure 3. The value of yellow color density were remained in the range 1.6235 to 1.7063; 1.3988 to 1.5365; 1.2293 to 1.5074 and 1.4816 to 1.5155 for LDPE, BOPP, PET (Polyester) and PLA respectively for gravure process. It was found that in case of yellow color, PLA (Bio-based) demonstrated the ink density towards lower side and it was bit similar with BOPP at some points. Also, LDPE possessed high ink density among all plastics.

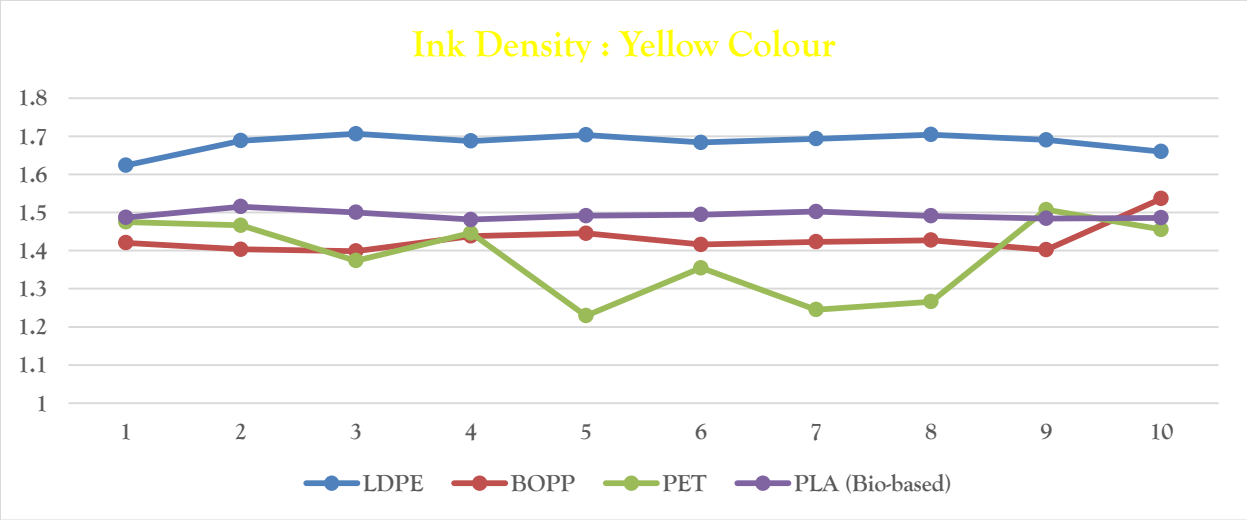

Figure 3: Yellow Color (SID) on Conventional and Bio-based Plastic

iv. **Solid Ink Density of Black Color:** Black Color ink density observations are depicted in figure 4. Data revealed that the black color density on LDPE, BOPP,

PET (Polyester) and PLA for gravure process were found in range of 2.0282 to 2.1432; 1.5492 to 1.6716; 1.2896 to 1.9934 and 1.5694 to 1.6098 respectively. The density trend for black color in case of PLA (Bio-based) was somewhat similar BOPP and PET in lower regions. Also, LDPE demonstrated highest ink density among all plastics.

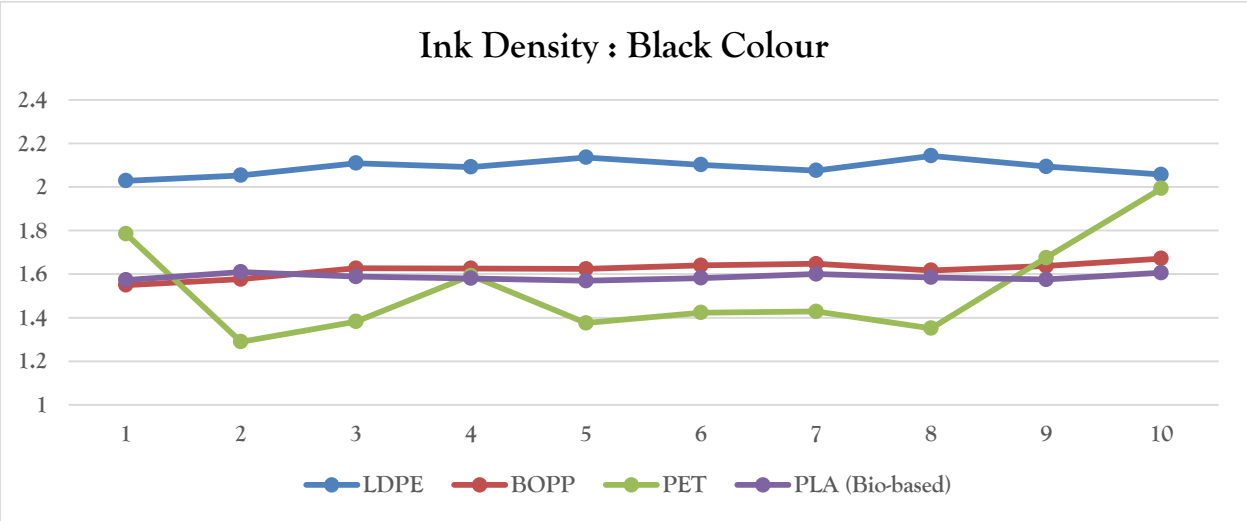

Figure 4: Black Color (SID) on Conventional and Bio-based Plastic

Results and Discussion

As per the data collected it was noticed that the value of ink density on LDPE, BOPP, PET (Polyester) and PLA media using gravure process for process color i.e. cyan, magenta, yellow and black were keep on repeating again and again whose summary is tabulated in Table 1.

Ink Density Value	Cyan		Magenta		Yellow		Black	
	Mini.	*Max.*	*Mini.*	*Max.*	*Mini.*	*Max.*	*Mini.*	*Max.*
LDPE	1.62	1.7217	1.2896	1.3322	1.6235	1.7063	2.0282	2.1432
BOPP	1.2514	1.483	1.2138	1.3099	1.3988	1.5365	1.5492	1.6716
PET (Polyester)	1.4573	1.6917	1.3263	1.782	1.2293	1.5074	1.2896	1.9934
PLA (Bio-based)	1.2482	1.2998	1.2778	1.3346	1.4816	1.5155	1.5694	1.6098

Table 1: Ink Density on LDPE, BOPP, PET and PLA using Gravure Process

Conclusion

It is already established that conventional plastics have excellent printability and during study it was found that PLA (Bio-based) has also very good printability specially in case of four-color process printing in gravure proof press. Bio-based plastics shows at most similar printability properties on gravure proofing machine. While printing on gravure proofing machine on bio-based plastic four color shown printing trend similar to conventional plastics. For solid ink density and substrate behavior was inline with conventional substrates and were compatible with existing printing standard.

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