Using the most suitable polymeric materials used for printing on the liquid electrograph technique to achieve the printing quality (color "L,a,b", density and dot gain)

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Abstract:

Some documents face the problem of damage as a result of their short life span, and it is worth noting here that the global trend and also in the Arab Republic of Egypt recently is moving towards the use of polymers as an alternative to traditional paper materials in many important documents, and this corresponds to facing many challenges, including print quality when printing on Polymeric materials, and one of the most famous modern printing methods is liquid electro photographic technology such as Indigo printers, which combine the two traditional litho-offset printing methods in terms of using a rubber medium to transfer the image in printers and the electro photographic digital printing in terms of the mechanism of exposure to the image using the electrostatic image, so it is called digital offset printing. It was necessary to determine the most suitable polymeric materials used in the Arab Republic of Egypt to print on it using liquid electrophotography to obtain the required print quality (color measurement, density, point growth), and to achieve this goal, experiments were carried out using many polymeric materials on the HP Indigo 7800 printer, and results were reached. Experiments to that ores (special synthetics resin paper) SSRP, Poly art material does not accept liquid electro photographic printing, and it was the best print quality on Teslin polymers SP even though it was lower than the standard values of ISO 12647-2, although SYNAPS polymers OM gave good results in some quality measurements, as there are no reference values for the quality measurements of polymer materials, and accordingly the researcher concluded that it is not recommended to print on materials (SSRP, Poly art) using liquid electrophotography, as it is not acceptable to print on it with this printing technique, and that the best material is when using the liquid electro photographic technique using Teslin polymers SP, as it was the most suitable polymeric material used in the Arab Republic of Egypt to print on, with this technology in terms of quality.

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Research problem:
Determining the most suitable polymeric materials used in the Arab Republic of Egypt for printing with the technique of liquid electrophotography to obtain the required print quality (color measurement, density, dot gain).

Research objective:
Reaching the most suitable polymeric materials circulating in the Arab Republic of Egypt in terms of print quality when printed with liquid electrographic printing technology.

Research Methodology:
The research used the descriptive method to describe the used materials and printing techniques in the experiments studied by the research. It also used the experimental and analytical approach to reach the results, discuss them and draw conclusions.

Materials and methods used:

First: the polymer materials used in experiments
The experiments carried out in natural printing conditions in terms of natural white room lighting, humidity and temperature in normal rooms.
Experiments have been carried out on some types of polymer sheets for more than one company, **and they are shown as follows:**

1) Teslin polymers
Manufactured by the Japanese company Teslin® PPG. It is a single-layer polyolefin film with a unique synthetic polymer base silica and uncoated.

2) SYNAPS polymers
Made in Agfa Company in Japan and Belgium. It is a high quality opaque polyester paper with an opaque matte finish double-sided with an ink-receiving layer.

3) S.S.R.P polymers (special synthetics resin paper)
The manufacturer is SEMCO Corporation of Japan

4) Poly art polymers
The manufacturer is Arbojex.

Second: liquid toner inks for HP Indigo 7800 printers
They are inks based on liquid toner through the presence of (liquid / solvent) to transfer pigment or toner particles to the image, and this type of inks is called Electro Ink. Toner particles are very fine (1:2 micron).

Third: the design file
A PDF file was designed on Adobe Illustrator CS5 program that contains the design elements required to carry out experiments and to perform the required measurements. It contains linear elements (vector lines) and (Raster image) photos.

Fourth: The printing technique used in experiments (liquid electrophotography).
Liquid toner electrophotography (LEP) Trials were performed on HP Indigo 7800 printers, its technology is based on combining the two methods of litho-offset printing through the use of a rubber medium and electro photographic digital printing through exposure mechanism

(electrostatic image), so it is called digital offset printing, where the image is printed in three stages:

1. The image is first formed on the light conductive cylinder (PIP) Photo Image Plate.
2. Then it is transferred to a special hot rubber medium.
3. Transferring the image onto the printed material, and the image sticks to the material well, as it is cooler.

The color image is completely formed on the rubber media cylinder and then moves to the material in one step (which is the one on which the experiments were carried out), and in which the printed material does not need a long time to dry and if there is a desire the surface is treated immediately.

Fifth: the devices used in the measurement operations:

1) - spectrophotometer (SpectroEye X.rite).

2) - (Digital microscope ST 1000), a microscope used to photograph and enlarge printed items.

Tests and results:

Experiments were conducted on SP Teslin, Synapse OM, S.S.R.P, and Poly art materials. The experiments carried out on the HP Indigo 7800 printers showed the inability to print on both materials: (S.S.R.P, Poly art).

Table No. (1): Measurement of density of samples executed on the HP Indigo 7800 printers

Materials substrate	Face / back	C	M	Y	K
Teslin SP600	face	0.77	1.12	1	1.37
	back	0.78	1.07	0.98	1.24
Teslin SP700	face	0.97	1.2	0.99	1.43
	back	0.76	1.07	0.91	1.26
Teslin SP800	face	0.82	1.24	1.02	1.46
	back	0.77	1.15	0.97	1.3
Teslin SP1000	face	0.78	1.22	1	1.38
	back	0.78	1.1	0.96	1.31
Teslin SP1200	face	0.76	1.09	0.92	1.25
	back	0.78	1.14	0.97	1.31
Teslin SP1400 HD	face	0.76	1.18	0.99	1.34
	back	0.78	1.14	0.97	1.26
Synapse OM 135GM	face	0.79	1.11	0.94	1.28
	back	0.79	1.1	0.95	1.27
Synapse OM 170GM	face	0.78	1.12	0.93	1.26
	back	0.79	1.1	0.96	1.28
Synapse OM 230GM	face	0.77	1.07	0.93	1.22
	back	0.78	1.1	0.91	1.22
Synapse OM 300GM	face	0.99	1.12	0.94	1.22
	back	0.77	1.06	0.92	1.2

Table No. (2): To measure the dot gain by fixing the printing technology and changing the material for samples of materials and weights for each of the SP Teslin, SYNAPS OM executed on the HP Indigo 7800 printers.

Materials substrate	Face / back	C	M	Y	K
Teslin SP600	face	18	14	21	12
	back	21	16	22	15
Teslin SP700	face	20	14	18	13
	back	19	17	22	15
Teslin SP800	face	20	15	20	14
	back	18	13	17	12
Teslin SP1000	face	17	12	17	11
	back	18	15	20	13
Teslin SP1200	face	18	13	18	10
	back	19	14	20	12
Teslin SP1400 HD	face	16	11	18	10
	back	17	11	18	12
Synaps OM 135GM		22	19	22	17
Synaps OM 170GM		24	21	24	20
Synaps OM 230GM		22	17	24	16
Synaps OM 300GM		19	15	22	15

Table No. (3): To measure the color (L, a, b) by fixing the printing technology and changing the material for samples of materials and weights for each of SP Teslin, SYNAPS OM executed on the HP Indigo 7800 printers.

Materials substrate	Face / back	C			M			Y			K		
		L*	a*	b*	L*	a*	b*	L*	a*	b*	L*	a*	b*
Teslin SP600	face	62	-20	-38	54	66	-7	90	-5	81	28	0.4	0.7
	back	62	-20	-38	53	68	-7	91	-5	82	24	0.15	0.7
Teslin SP700	face	63	-20	-38	55	67	-7	92	-5	77	28	0.4	0.6
	back	62	-21	-39	51	69	-7	90	-6	80	22	0.15	0.5
Teslin SP800	face	61	-21	-39	52	71	-6	91	-5	82	21	0.06	1
	back	63	-21	-38	52	68	-5	91	-5	81	26	0.3	0.6

Teslin SP1000	face	63	-21	-38	54	68	-6	92	-5	80	26	0.3	0.8
	back	63	-21	-38.5	52	71	-5.6	92	-5	83	23	0.2	0.8
Teslin SP1200	face	63	-20	-38	54	69	-5	92	-5	81	27	0.4	0.6
	back	64	-20	-38	55	68	-5	93	-5	80	27.5	0.4	0.5
Teslin SP1400 HD		64	-20	-37	54	69	-3	93	-4	82	28	0.3	0.6
Synaps OM 135GM		63	-21	-37	53	71	-3.5	92	-4.6	84	25	0.2	0.6
Synaps OM 170GM		61	-19	-37	53	66	-4	90	-4.5	78	26	0.3	1.6
Synaps OM 230GM		62	-20	-36	54	67	-3	92	-4	81	26	0.3	1.7
Synaps OM 300GM		63	-20	-37	54	68	-4	93	-4	78	29	0.3	2
		63	-21	-37	55	67	-4	93	-4	80	29	0.3	2

Discussion and Conclusions:

The results of the measurements were analyzed for samples carried out on different polymeric materials and by using the technique of liquid electrophotography on the HP Indigo 7800 printer, and the results were compared with the standard values of ISO 12647-2 in the analysis of these results.

The results were compared with the standard values for the density of inks on the covered paper, because it is closer to the polymer material in absorbing the ink and penetrating into the material.

Table No. (4): Standard values for measuring density of ISO 12647-2

Substrate for printing	Solid ink density			
	K	C	M	Y
Gloss coated paper	1.85	1.50	1.40	1.30
Matt coated paper	1.85	1.50	1.40	1.30
Uncoated paper	1.50	1.30	1.40	1.10

First: Measuring the density of samples executed on the HP Indigo 7800 printers

Table No. (5) shows measuring the highest density values for (C, M, Y, K) inks by installing the printing technology and changing the material for samples of raw materials and weights for each of the SYNAPS SP Teslin and SYNAPS OM printers implemented on HP Indigo 7800 printers and comparing them with the standard values of ISO 12647-2

C		M		Y		K	
OM 300GM	**ISO 12647-2**	**SP1000**	**ISO 12647-2**	**SP800**	**ISO 12647-2**	**SP800**	**ISO 12647-2**
0.99	**1.5**	**1.24**	**1.4**	**1.02**	**1.3**	**1.46**	**1.85**

Second: Measuring the dot gain of samples executed on the HP Indigo 7800 printers

Table No. (6) measuring the lowest and highest dot growth values of (C, M, Y, K) inks by installing the printing technology and changing the material for samples of raw materials and weights for each of the SP Teslin, SYNAPS OM executed on HP Indigo 7800 printers and comparing them. In standard values of ISO 12647-2:

C				M				Y				K			
Highest value		lowest value		Highest value		lowest value		Highest value		lowest value		Highest value		lowest value	
OM 135gm	**ISO 12647-2**	**SP1400 HD**	**ISO 12647-2**	**OM 135gm**	**ISO 12647-2**	**SP1400 HD**	**ISO 12647-2**	**OM 135 gm**	**ISO 12647-2**	**SP1000**	**ISO 12647-2**	**OM 135gm**	**ISO 12647:2**	**SP1400 HD**	**ISO 12647-2**
24	**15**	**16**	**9**	**21**	**15**	**11**	**9**	**24**	**15**	**17**	**9**	**20**	**16**	**10**	**10**

Third: color measurement (L, a, b) by fixing the printing technology and changing the material for samples of materials and weights for each of the SP Teslin, SYNAPS OM executed on the HP Indigo 7800 printers.

Calculates both of the below:

$\Delta L^* = L^*_{act} - L^*_{ref}$

$\Delta a^* = a^*_{act} - a^*_{ref}$

$\Delta b^* = b^*_{act} - b^*_{ref}$

Therefore, ΔE^*_{ab} can be calculated for all of ink individual Cyan, Magenta, Yellow, and Black as follows:

$\Delta E^*_{ab} = \sqrt{\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}}$

ΔE^*_{ab} for Cyan = 21.4, ΔE^*_{ab} for Magenta = 8.6, ΔE^*_{ab} for Yellow = 9, ΔE^*_{ab} for Black = 13.16

So it becomes clear from the result that there is a very large deviation in the value of ΔE^*_{ab} for all inks Cyan, Magenta, Yellow, Black.

The study reached the following results:

1) Materials (S.S.R.P, Poly art) are not acceptable for liquid electrophotography printing.
2) The best color density of (C, M, Y, K) inks was on Teslin polymers SP even though it was lower than the standard values of ISO 12647-2, except for the density of Cyan ink, which was the best result for it on SYNAPS polymers OM.
3) The best dot gains of (C, M, Y, K) inks was on Teslin polymers SP although it was higher than standard values of ISO 12647-2.
4) The best color values (L, a, b) for (C, M, Y, K) inks were on Teslin polymers SP even though they were less than the standard values of ISO 12647-2, except for the density of the black ink which was the best result on SYNAPS polymers OM. It also notes that there is a very large deviation in the value of ΔE^*_{ab} for inks (C, M, Y, K) from the reference standard values for this ink on paper covered with the standard values of ISO 12647-2.

Recommendations:

Based on the previous results, the study recommends the following:
1) Not to print on materials (S.S.R.P, Poly art) using liquid electrophotography, as it is not acceptable to print on it using this printing technique.
2) When using liquid electrophotography, it is preferable to use Teslin polymers SP material, as it was the most suitable polymeric material used in the Arab Republic of Egypt to print on it with this technology in terms of quality.

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