A comparative study of Nano inks and conventional inks in printing Industry

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Abstract:

Nanotechnology is being launched as a new technological revolution, so that it will have a positive impact on all aspects of the life of human society. These effects are certainly positive. In the printing industry, the use of nanoparticles is gradually being introduced and research is developing to increase this in order to increase innovation and competitiveness. So the Research Problem back to In the printing Egyptian market there are no benefits from a new Nano ink technology because there is no study on the new Nano ink technology compared with the conventional inks technology and the Research Aim to Study the characteristics of conventional inks compared with Nano inks to explain the differences and its effects in packaging industry. Printing inks consist mainly of binder, pigments or dissolved dyes and solvents as volatile organic solvent or water. Inks should remain liquid and with the ability to wet the substrate up to the transfer to the substrate, once on the substrate they should dry, this means become solid, This means, the printing inks structure must be adequate to rapid drying and anchoring on the substrate after printing and drying, in the same time avoid to drying on the press during press operation or short standstill periods. So we found The Nano ink is a new technology and opens up a new category of printing. The Nano ink combined with water-based ink properties and oil based inks in Nano technology. Nano inks is better than conventional inks in productivity, substrate range, and print qualities and cost**.** Nano inks are prepared from the synthesized Nano pigments with similar physical proprieties than the conventional inks. Nano inks have wide range of color gamut more than conventional inks because Nano pigments having a particle size from 20 to 200 nm in diameter, due to the aggregate formation during the dispersion process, particle size in conventional inks is more than 5µ.

Keywords:

Nano ink - pigment – offset printing- solvent base- water base- color gamut – particles

Introduction:

Word Nano means a draft that is very small we know a scale of length meter (m) when we divide m to 1000 parts its ,millimeter (mm) when we divide mm to 1000000 parts its micrometer when we divide micrometer to 1000000000 its Nano meter particles which have size of several nanometers a few tens of nanometers sometimes hundred nanometers are called as Nano sized particles or Nano composites that Nano particles can have quite unusual physics and chemical properties that open new ways for creation and development

of new substances that done in the printing industry is to progressively introduce products using Nano materials like Nano inks

Research Problem:

In the Egyptian market, there is no advantage of the inks of nanotechnology because of the lack of studies to the difference between the Nano inks and conventional inks

Research Aim:

Comparative study of the properties of Nano inks specifications and traditional inks and its impact on printing industry

Research Limit:

The Egyptian printing market

Research Method:

The researcher used both of description and analytical methods for collecting data about Nano inks and conventional inks and compare between them and analysis the results.

Literary Survey:

Printing inks consist of four major components: solvents, polymeric binders, additives, and coloring components. Printing inks mostly contain pigments as coloring component. Pigments are insoluble, dispersed particles which absorb a fraction of the visible light and, Consequently, appear colored.

1- Conventional inks

1-1 drying of the ink

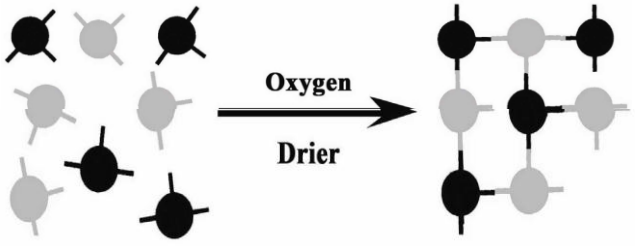
There are three methods of drying inks

1-1-1 chemicals drying

The resin is the main component of the inks. It is based on the formation of the film and the drying of vegetable oils and alkyds has an important advantage as it polymerizes when exposed to oxygen to form a flexible film so that the chemical drying of the ink can be described as cross-links of the components and it takes several hours until the ink reaches full dehydration.

The drying time depends on the quality and quantity of the catalysts that begin the drying process and must be supplied with sufficient oxygen to achieve the cross-links of the ink layer on the printed materials.

In this type of drying it takes 2-4 hours to achieve complete dry ink

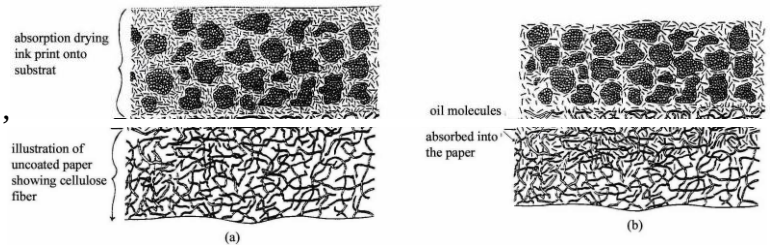


(Figur1) chemicals drying

1-1-2: Absorption drying

Ink drying occurs by absorption when printing on porous surfaces such as cardboard. Where the drying is done by penetrating the liquid components into the surface layer of the printed backing

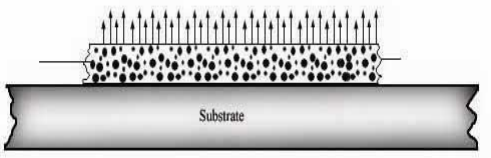
And the penetration of the ink into the papillary paper tubes paper, leaving the gelatin ink surface layer of printed material. This type of drying method depends on the viscosity of the carrier to the ink, and the ability to absorb the surface layer in the printed stent
It is then dried first by penetration and then the final drying is done by oxidation.



(a) Ink just printed (b) Ink nearly dry
(Figure 2) Absorption drying

1-1-3: Evaporative Drying

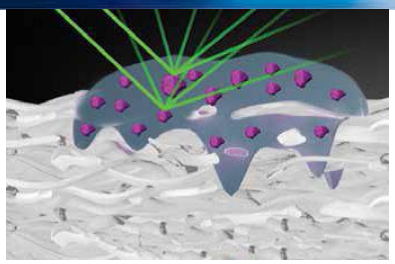
Another type of drying depends on evaporation of solvents or water in the wet ink film.
After evaporation, the solvents that leave the resins and other materials to bind the colors with the printed materials achieve as much resistance as possible.
This type of drying can be completed by passing hot or cold air on the surface to be dried very quickly by evaporation of solvent or water.
Before the ink reaches and contacts the next print unit, it must be dried to allow the machine to operate at high speed without drying problems.



(Figure 3) drying with evaporating

1-2: Separation effect

The separation of the components of the ink from the pigment and binder material from vehicle material on the surface of the paper and the process of separation depends on the Porous of paper fibers and fibers bonding. where the more bonding degree get less spaces between porous, allowing only the carrier to get throw porous and keep The colored material and the bonding material set on the surface and this gives a high quality of color but in case of the expansion of porous, it allows the pigment and bonding material penetrating inside the paper porous causing low color values.



(Figure 4) separation effect in conventional inks

1-3: Rub resistance

Rub resistance is the ability of printed ink film to resist the effects of rubbing.

Rub resistance depend on the kind of additives and the type of resin the famous resin is Teflon was and the kind of paper has an effect on rub resistance. Glossy paper is better rub resistance than matt papers

1-4: Gloss

understanding glossy depend on optical and physical characterizes of paper surface according to the degree of reflecting light beside these factors picking and rub resistance have big effect on glossy degree the better ink film layer set on paper give higher glossy the paper surface has more effect on glossy because matt paper give low glossy but glossy paper give high glossy degree

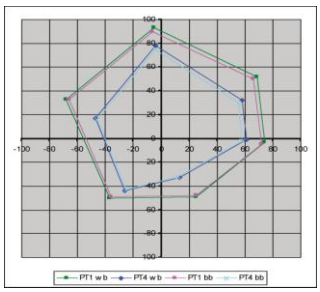
1-5: Ink film thickness

Color values have been printed with a very thin ink layer thickness which can often only roughly be achieved in regular/standard printing. so the final film thickness is 2-3 µ

1-6: Color gamut

The colorimetric description of inks with CIE L*a*b* values has standard values. The color values for the process colors cyan, magenta, yellow and black are specified in the ISO 12647-2 standard. However, this standard describes the values ink under certain printing parameters it describe The color space which achieved in sheet fed offset printing, this standard based on standard inks as defined in ISO2846-1.the standard values of L*a*b* shown in table

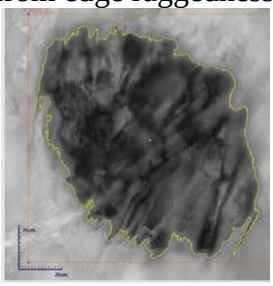
Colorimetric solid (full-tone) values in sheet fed offset printing to ISO12647-2:2004 Amd1:2007 for the production run, measured on a black backing				
Paper grade	1+2	3	4	5
	L*/a*/b*	L*/a*/b*	L*/a*/b*	L*/a*/b*
Black	16/0/0	20/0/0	31/1/1	31/1/2
Cyan	54/–36/–49	55/–36/–44	58/–25/–43	59/–27/–36
Magenta	46/72/–5	46/70/–3	54/58/–2	52/57/2
Yellow	87/–6/90	84/–5/88	86/–4/75	86/–3/77
Red	46/67/47	45/62/39	52/53/25	51/55/34
Green	49/–66/24	47/–60/25	53/–42/13	49/–44/16
blue	24/16/–45	24/18/–41	37/8/–30	33/12/–29



(Figure 5) — Color gamut for conventional ink

1-7: dot shape

The dot shape of conventional printing inks have not sharp edges when we magnify the dot because the drying method effect in the dot shape and the fiber of paper and transfer the inks from blanket to paper it also suffer from edge raggedness due to ink capillarity.



(Figure 6) — Dot shape for conventional ink

1-8: Conventional inks and environment

The most important factors in which the inks are evaluated are the environmental factors in terms of pollution and its effects on the environment.

Therefore, many aspects are taken into consideration in terms of the way in which materials and manufacturing methods are used for the products we use in our lives.

The most important of these articles, which are closely related to print inks are:

- Volatile organic compounds VOCs
- Dyes and additives containing heavy metals,-

Heavy metal in the printing inks

Heavy metals can be defined as metals with a density greater than 3.5 - 5 g / cm3.

So more than half of them are about 90 naturally occurring chemical elements

And heavy metals. These include elements that are considered toxic to the environment and / or health because heavy metals tend to accumulate in organs such as the liver and thus become a health hazard.

Heavy metals are found as pigments and additives in inks in previous times, and today are banned from inks.

1-9: Interaction between packaging and contents

The transfer of the components of the packaging materials to the foodstuffs should be minimized, since the ingredients that may threaten human health, especially in food packaging inks, should not be used, where the so-called abandonment

Migration is a comprehensive transfer of packaging materials into packaged foods.

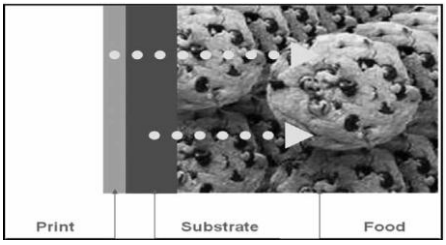
This transfer can take place between the packaging and the contents via:

• Migration through materials
• Invisible clearing
• Migration through the gas phase

Migration through materials is influenced by the following parameters:

• Diffusion rate in the film
• Partition rate of the migrating substance in the packaging layers and the food
• Molecular weight of the migrating substance

• Temperature during life of the packed product
• Time of contact



(Figure 7) Interaction of packaging and foodstuff – migration

Invisible set-off during the production process, packaging materials are stacked or rolled onto a reel. This causes the printed side of the packaging to be in contact with the food contact side. This means there is a possibility of (invisible) transfer. This transfer is known as "invisible set-off". These substances can transfer to the food once the packaging has been filled.

Volatile substances of the packaging can transfer to the food through the gas phase. This type of migration generally relates to absorbing foods such as dry foods. Such transfer requires evaporation into the gas phase and re condensation into the food, which only occurs with substances of a significant vapor pressure.

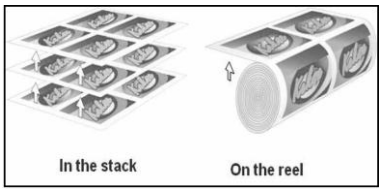


Figure 8: Interaction of packaging and foodstuff – invisible set-off

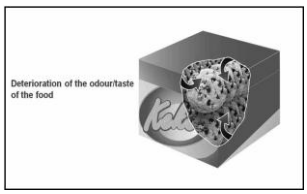


Figure 9: Substance transfer through gas phase

2: Nano inks

Nano pigments developed by scientific researches. Nano pigments are metis materials gained by combination of organic dye molecules and clay nanoparticles, in a special characteristic, Nano pigments have features of dyes and pigments, such as bright colors, wide color gamut, and avoiding their faults, like bleeding, low light fastness, low stability against oxygen, temperature, UV radiation, However, Nano pigments combination of two important materials modifies physical-chemical parameters of the polymer and giving color. Nano pigments are obtained in a simple process with two main steps.

First step: Nano clays must be dispersed in a solvent, like deionized water. This causes the Nano clay to get bigger. This increases the distance between clay sheets this step reduces the ionic bond force of the counter ions of the clay. step2, a dye solution is added to the dispersion. Then the ionic exchange takes place: Dye molecules replace counter ions of the clay. This gives color to clay nanoparticles and makes them compatible with the polymer. At

this moment, Nano pigment is formed but dispersed in the deionized water. In order to isolate and purify the Nano pigment we have to, firstly, wash and filter the dispersion

2-1: drying ink:

A lot of the parameters of the Nano graphic Printing process are obtained by reducing the sucking of the liquid ink carrier by the printed substrate. As each ink droplet set on the heated blanket, it spreads and loses its water very quickly by evaporation drops becoming very thinner than when it dropped. When water evaporation process complete the ink layer becomes an ultra-thin, this dry polymeric ink film on the blanket pressed into contact with the printing substrate upon transfer, this thin 500 nm ink film layer set on printed substrate without penetration.

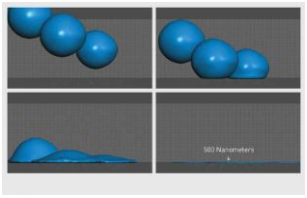


Figure 10: Nano ink drying

2-2: Separation effect

The printed film layer is very hard, rub resistant, does not need any treatment for more drying and don't leave any remaining ink on the blanket so it reaches to the surface of paper as polymeric film from the blanket so it doesn't have any separation or penetration effect in the fibers of printed paper

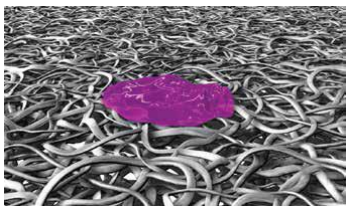


Figure 11: Nano ink separation

2-3: Rub resistance

Drying mechanism gives us penitents to print on double sides got very easy and very simple and the printed paper can be finished immediately, even on the hard finishing equipment, because the printed film has very good scratching resistance immediately after printing.

2-4: Gloss

The Nano-sized pigments particles allow absorbing much more light than other conventional sized pigments, and thus allow getting images with ultra-sharp dots of high resolution, high gloss appearance more contrast image and more high quality printed image.

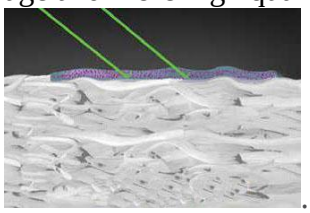


Figure 12: Glossy of Nano inks

2-5: Ink film thickness

Nano ink have very small pigment particles this allow to print very thin ink film layer this because the particles of Nano pigment size be from 20 to 200 nm in diameter the film thickness is about 0.5 microns as shown in figure 13.

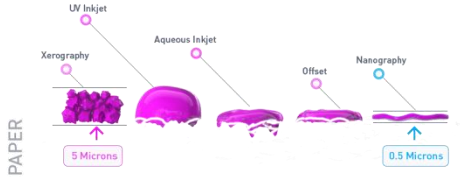


Figure 13: Ink film thickness of Nano inks

2-6: Color gamut

Because of Nano Ink pigments are ultra-small size so the light dynamic range obtained by the Nano Ink film layer is greater than conventional printing ink film layer and covers wide range of Pantone colors than conventional inks. This achieve wide range of gray levels Additionally, Nano Ink obtain printed solid areas with more lightness depth (density) values compared to any other conventional printing inks. So Nano inks cover at least 15% more Pantone colors than conventional printing inks

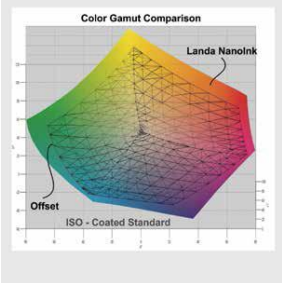


Figure 14: Color gamut of Nano inks

2-8: dot shape

ink film layer consist of droplets of Nano ink when this ink film layer set on the printed substrate it dry very quickly and it doesn't like conventional wet film layer so there is no penetration into paper fibers so this type of ink conforms to materials with rough surface and it is more suitable to produce dots with ultra-sharp edges and dots are round shape without any shifting shape

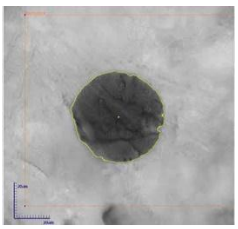


Figure 15: Dot shape of Nano inks

2-9: Nano ink and environment

Environmental exposure varies on the basis of conditions such as the way in which materials are handled in the workplace, the transfer of Nano materials in each of process phases and the levels of the sources but can expect less the effect of Nano inks on environment is limited because the amount of pigment is less than others and consumptions of inks is very low because we use very thin film of inks to produce image there is no effect for heavy metals because Nano pigment depends on days for coloring Nano polymers so we don't have any toxic effect compared with conventional ink in addition to the ink is water based volatile organic compounds so (VOC) are not used it is the big source of pollution..

2-10: Interaction between packaging and contents

The printed area on food packaging must contain advertising data and product data for customer and must be printed on serves of paper so the migration problem must take place but with Nano inks can avoid this problem because there is no penetration of ink through paper fibers and ink film laser set AL mostly dry when transferred to the surface paper so avoid set off with any degree and we avoid exposure of the consumer to nanoparticles from the dried and cured ink layers because the hardness of ink film layer is very hard. Nano scale pigment are completely covered with polymer particles of the printed and dried ink films so they are completely covered with binder material.

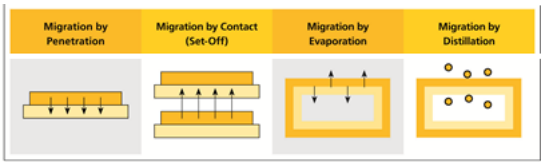


Figure 16: Migration of Nano inks

Results:

Comparison between Nano inks and conventional inks

	Nano ink	**Conventional ink**
Particle size.	20 to 200 nm	More than 5µ.
Gloss.	Super high glossy	High glossy
-Tack	8 g/m	9-12% g/m
-Viscosity	8 +or-3	60-80%
- CIE Lab Color,	L*,a*, b* values as shown in figure (14)	Less than the Nano ink L* a* b* as shown in figure (14)
Brightness	44 %	35%
- Fluidity	27 cm	31-38 mm
Film thickness	500 Nano = .5 µ	2-3 µ
Drying time	10 min	2-4 hours
Dot shape	Super sharp	sharp
Tone value sum	400	340%
Surface tension	30 mN/m	45 mN/m
vehicle	water	solvent
Density (g/cm3)	1.23 (g/cm3)	1.7 (g/cm3)

Conclusions:

1. The Nano ink is a new technology and opens up a new category of printing.
2. We can combines with water-based ink properties and oil based inks in Nano technology
3. Nano inks is better than conventional inks in productivity, substrate range, and print qualities and cost
4. Nano inks are prepared from the synthesized Nano pigments with best physical proprieties than the conventional inks.

4. Nano inks have wide range of color gamut more than conventional inks because Nano pigments having a particle size from 20 to 200 nm in diameter, due to the aggregate formation during the dispersion process, particle size in conventional inks is more than 5µ.
5. Nano pigments obtained with selected dyes have a good behavior as raw material for making Nano printing ink.
6. Film thickness in Nano inks is very small compared with film thickness in conventional inks it prevent many production problems like set off and minimize drying time
7. Dot shape with Nano inks is very sharp more than dot shape in conventional inks it gives us more good quality in printing
8. Glossy in Nano inks is more than glossy in conventional inks so we can print without varnish
9. Interaction between packaging and contents (Migration) in Nano inks is very limited compared with conventional inks
10. Nano ink and environment the side effects on environment and human health in Nano inks is very limited compared with conventional inks
11. The amount of ink used from Nano inks creates a film of about 500 nm that is about half the thickness of conventional inks and uses less ink for the same image.
12. the a very thin layer of ink in Nano inks allow printing at very high speeds more than printing with conventional inks

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