Bulgarian Chemical Communications, Volume 47, Special issue A (pp. 60 – 63) 2015

Improvement of the physical-mechanical and optical properties of printing production with biodegradable overprint varnishes

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Received August 1, 2014; Accepted February 23, 2015

Due to limited fossil resources and an increased need for environmentally friendly, sustainable technologies, the importance of using renewable resources in ink and coating industries will increase in years to come. Other than traditional water-based coatings, which are based on petroleum derivatives, biodegradable coatings focus on resins and waxes from nature. Biodegradable coatings are based on natural resources for more than 90% and are biodegradable more than 75%, which makes it possible to dispose coating remains and washing water directly in a clarification plant, after approval from corresponding authorities. To be able to fully replace the conventional water-based coatings, which main components are acrylate and styrene acrylate polymers, the biodegradable coatings should be able to cover the main quality requirements – stable running characteristics on the printing press, scuff and scratch resistance, wet block resistance and satisfying optical properties. The current research highlights the primary quality differences between biodegradable and conventional coatings and their optical, chemical and physical characteristics.

Keywords: *biodegradable coatings, water-based coatings, physical-mechanical characteristics, optical properties*

INTRODUCTION

Nowadays we can classify the overprint varnishes into 4 main groups, depending on their contents, applications and drying methods – oil-based, solvent-based, water-based and UV [4, 5].

They are applied on special coating units that are coupled in-line to the printing press or on off-line coating machines, outside the printing press or even printing house.

The following qualities of the printed product are achieved by coating with a dispersion varnish: abrasion protection, scuff resistance in a wet condition (labels), high gloss, silk finish, or matte effects, hot-seal resistance, gliding quality, deep freeze resistance, fixing of metallic inks. [6]

In recent years an increasing interest is observed in development of eco-friendly materials. Oil-based polymers are slowly being replaced by such from renewable resources. Biodegradability and compostability play very important role for environmental sustainability. Some biodegradable polymers possess excellent mechanical properties, thermal and UV resistance; however production capacity, processing challenges, adhesion, barrier properties and the price are not yet on a sufficient level for the demands of the packaging and printing industries. Biopolymer dispersions find use in various applications, such as adhesives, inks, coatings, etc. From the Biopolymers family only few cover the performance requirements for applying on printing products. Because of their biodegradability, the suitable biopolymers can be used mainly on printing products with limited durability requirements.

The Biopolymers Family can be classified in 4 main groups (Fig.1) [7].

Polymer dispersions are stabilized water-borne emulsion polymers with colloidal particles in water.

Film formation results from the coalescence of the individual particles held apart by stabilizing forces. These forces are overcome by the evaporation of the continuous phase [7].

The goal of this study is to compare 2 types of polymer dispersions, their properties and characteristics, used for the preparation of water-based printing varnish – the reference dispersion, based on synthetic polymer – acrylate dispersion and second one, based on biopolymer.

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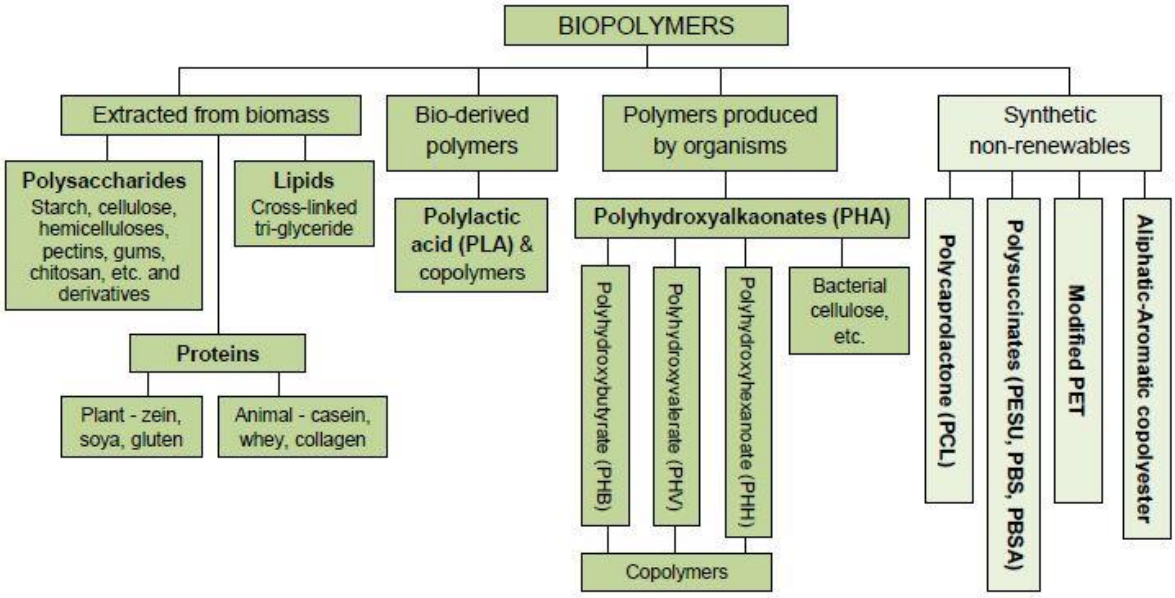

Fig. 1. Classification of biopolymers.

EXPERIMENTAL

Materials. As a reference has been used acrylic water-based multipurpose, gloss varnish with fast drying speed and high wet block resistance – ACTEGA Terra Wet GlossG9/535 (45 sec).[8] The tested varnish was water-based gloss coating, based on renewable resources - ACTEGA Terra Green Gloss G5/200 (45 sec).[9]

Methods. Both varnishes were applied on offset printing press HEIDELBERG CD74 4+L, under same conditions and initial parameters:

- Material – Carboard – LWC 220 g/m^2
- Ceramic Anilox roller – Zecher, 100 L/cm, 60 ^{o,} 35 μ, 13 cm^3/m^2
- IR Lamps power – 15 %, hot air – 100 %
- Temperature in stack – 35^o C
- Equal press speed – 8 000 sheets/hour
- Applied quantity – 3,5 g/m$^{2.}$

RESULTS AND DISCUSSIONS

The researches over both varnish types - acrylic water-based ACTEGA Terra Wet GlossG9/535 (45 sec) and water-based gloss coating from bio-polymer, based on renewable resources - ACTEGA Terra Green Gloss G5/200 (45 sec), in real production conditions, clearly show their characteristics and performances, when applying on printed packaging production. The results are given in Table 1 and Table 2.

Table 1. Properties during coating process.

	G9/535 - acrylic	G5/200 - bio
Runability	Very good	Very good
Drying	Very good	Good
Crackling tolerance	Very good	Very good
Foaming tolerance	Excellent	Acceptable
Two-sided coating	Excellent	Poor

Table 2. Properties in dry condition.

	G9/535 - Acrylic	**G5/200 - Bio**
Gloss (Gloss meter–60^o)	65/73 GU	53/61 GU
Rub resistance	Good	Good
Slip angle (COF)	23^o	21^o
Wet block resistance	Excellent	Good
Cobb $_{(60)}$	5.90 g/m^2	7.33 g/m^2
Whiteness/Yellowness - R 457	80.10/- 4.50	79.50/-2.80
Heat resistance	Up to 120^o C	U to 150^o C

The obtained results in Table 1 and 2 determine that both varnishes have similar key performance parameters during the coating process in the printing machine and don't have significant influence on the normal overall production process. The biodegradable varnish can be used for coating of packaging products without any specific preparations and equipment. Its usage doesn't have any further interference over the printing machine's exploitation. However the results in table 2 are showing obvious performance differences

in water absorption test and in optical characteristics – gloss and whiteness/yellowness, wherefrom can be concluded, that the biodegradable varnish, in this form, cannot meet the criteria for printing packaging from highest quality.

Table 3. Performance during further processing

	G9/535 - Acrylic	G5/200 - Bio
Counter glueing	Excellent	Good
Hot foil stamping	Excellent	Excellent
UV varnishing	Very good	Good
Foil lamination	Good	Satisfying

The printed product, coated with both varnish types is used for the production of food packaging, therefore it needs further processing. Table 3 is showing the performance of the acrylic water-based varnish and the biodegradable varnish during Postpress processing. The research in real production environment shows, that the biodegradable varnish doesn't have significant influence over the production process and its performance is similar to the acrylic varnish. Both varnishes have stable runability parameters and can be used when Postpress finishing is required for the printing production.

When exposed to aging, the printed production, coated with both varnish types shows similar behaviour in their optical characteristics alteration, which can be neglected, when talking about food packaging, because of the limited products expiration dates (cf. Charts 1 and 2).

CONCLUSION

As a result from the tests can be concluded, that the biodegradable varnish covers the main quality criteria, required from a water-based overprint varnish:

– good runability on the printing press
– satisfying properties in dry condition
– sufficiently good performance during further processing,

However the results clearly show that biodegradable varnishes still have to face some

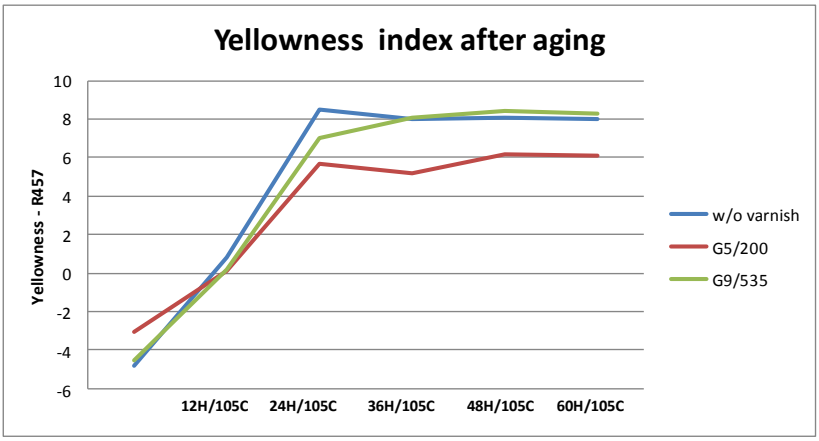

Chart 1. Yellowness after aging.

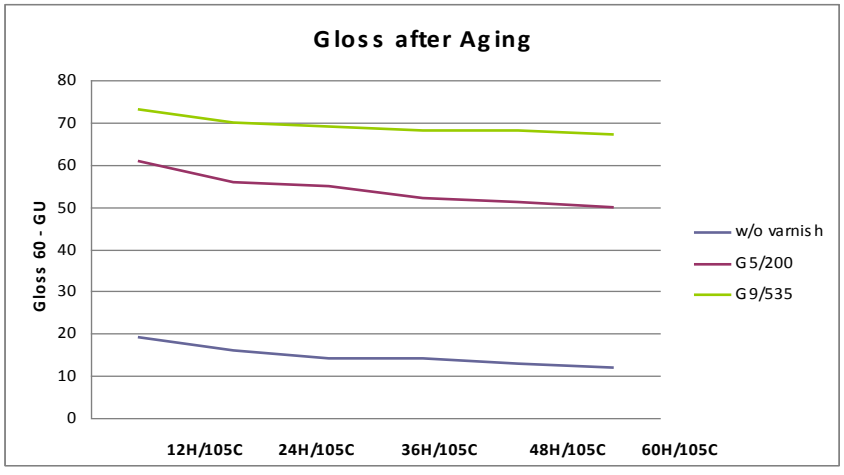

Chart 2. Gloss after aging.

challenges, in order to fully replace the conventional water-based varnishes.

The next step in this direction is the improvement of the optical, adhesion and barrier characteristics of the varnish by modifying the binders or implementing of new additives.

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ПОДОБРЯВАНЕ НА ФИЗИКО- МЕХАНИЧНИТЕ И ОПТИЧНИ ХАРАКТЕРИСТИКИ НА ПЕЧАТНАТА ПРОДУКЦИЯ С БИОРАЗГРАДИМ НАДПЕЧАТЕН ЛАК

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Постъпила на 1 август, 2014 г.; приета на 23 февруари, 2015 г.

(Резюме)

Поради изчерпване на фосилните ресурси и нарастващата нужда от екологично чисти, устойчиви технологии, необходимостта от използването на възобновяеми източници в производството на мастила и лакове ще нараства през идните години. За разлика от традиционните лакови покрития на водна основа, които са на база петролни деривати, биоразградимите лакове се фокусират върху смоли и восъци от природата. 90% от компонентите на биоразградимите лакове са от природни възобновяеми източници, които са биоразградими на повече от 75%, което прави възможно изхвърлянето на остатъците директно в канализацията, след одобрение от съответните власти. За да бъдат в състояние напълно да заменят конвенционалните лакове на водна основа, чиито основни компоненти са акрилни и стирен-акрилни полимери, биоразградимите лакове трябва да са в състояние да покрият основните изисквания за качество – стабилни характеристики по време на нанасяне в печатната преса, устойчивост на надраскване и изтриване, влагоустойчивост и удовлетворяващи оптични свойства. Настоящето изследване подчертава основните разлики в качеството между биоразградимите и конвенционалните лакове на водна основа, техните оптични, химични и физични характеристики.