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Examination of the Optimum Use of UV Lacquers and Inks in the Offset Printing

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UV products were introduced more than 30 years ago. During the following years, technology has gone through a metamorphosis resulting in significant improvements. UV technology offers an alternate compliance strategy to the problem of volatile organic compounds. Ink ands lacquers dried with UV curing are preferred to their rapid drying, brightness, frictional strength and high stacking characteristics. System has become preferred more than conventional-dried systems due to opportunities in investment, equipment, ink saving, printing on various material surfaces, higher quality, more rapid printing and high stacking.

Key Words: UV curing, Offset printing, UV ink.

INTRODUCTION

Offset printing is a commonly used printing technique where the inked image is transferred from a printing plate to a rubber blanket, then to the printing surface[1] (Fig. 1). UV inks are an alternative formulation system to more traditional inks (offset, solvent or water-based) drying mainly under an evaporation or penetration physical process of their diluting fraction. Based on acrylic acid chemistry derivatives, UV inks are cured under a chemical process of polymerization[2]. Since the early seventies, the radiation curable coatings technology has gained full acceptance in a number of industrial applications like wood coating or printing inks and varnishes[3-5]. UV-Curing inks are used in the printing of graphics[6]. UV curing requires considerably less energy and helps avoid the emission of volatile organic compounds. UV light at high curing speeds can cure inks for offset, screen and flexo printing. The curing of flexo printing inks by monochromatic UV radiation is particularly promising since the substrates used in this technology are mostly heat sensitive polymer foils[7]. Photoinitiated free radical polymerizations have been known in the literature for more than 50 years and have played a seminal role in the elucidation of the kinetics of the fundamental steps of free radical polymerizations. With the development of several classes of high quantum yield free radical photoinitiators, the use of these polymerizations was started to be considered in a variety of practical industrial applications. This gave rise to the rapid development of the field we now call UV curing[8,9]. Photoinitiated polymerization of multifunctional monomers and oligomers is one of the most efficient methods to produce quasi-instantly highly cross-linked polymer networks. A large number of commercial applications have been found, mainly in the coating and printing industry[7,10]. The selection of a photoinitiator blend is of primary importance in the design of UV curing systems, since the polymerization and/or crosslinking rates depend on the photoinitiator package and physical properties of inks and coatings such as exibility, hardness, scratch, rub and chemical resistance properties are dependent on the degree of cure of the system[11]. Viscosity, drying time, scratch resistance, skinning test, film thickness, gloss, non-volatile content, flexibility, impact resistance, salt spray chamber test, acid, alkali and water resistances and insulation measurements are carried out for the prepared varnishes[12-14].

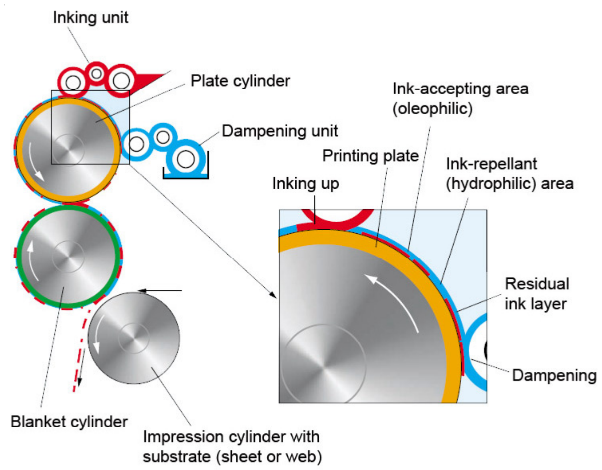

Fig. 1. Offset printing schematic diagram[15]

Components that are used in the UV system and effect the quality

Mechanism of UV drying and UV curable inks: "UV curing" is a term used in the context of making use of electro-magnetic energy-generally 250 in 400 nm band in order to turn a liquid film into a solid one. Another description of this process is crosslinking. It should be noted that, contrary to the energy accompanying the accelerated electron beam, UV light is not powerful enough to make the chemical reaction start directly. In order to start a chemical reaction, bonds between the adjacent atoms should be cut and recreated with a new arrangement. In general terms, an energy input which is more powerful than this bond energy to be cut needs to be available prior to this process.

UV energy corresponds to specific chemical bonds at its best. Thus, an altenative mechanism is a necessity to obtain the desired reaction. This mechanism to be used in the UV curing is photoinitiated radical polymerization. If a component is exposed to UV energy, it will break to pieces if it is sensitive to light sufficiently and these kind of components can be labelled as "light sensitive".

Energy need conditions are not disturbed as if bonds between atoms are tensed and energy needed in order to break the bonds is reduced. This process is called as disintegration of the light molecule and agents displaying reaction in this manner are known as 1st type photoinitiators. With disintegration of the initiator, components transmit their loaded energies to adjacent chemical bonds and initiate the reaction. Eventually, components will consume their energies, unite again or stick in the matrix surrouding them and reacting rapidly. These steps are named as initiating, spreading (while everything is proceeding strongly) and finishing in technical terms.

Another mechanism which is different in some way extracts atom from a second and contains a single light sensitive component. This is called as "extraction between molecules". Their results are similar except for two major differences. First of these is that these components are cheaper than the 1st type mixture but their chemical structure puts some restrictions on their use, which we will later on.

UV cured inks, on the other hand, remain open in the duct and on rollers. Curing only occurs on the substrate when ink is exposed to UV energy generated by the machine's UV lamp array. Without going into details regarding UV ink formulation, it is important to make a comparison between their composition and those of conventional inks[16-18] (Fig. 2).

Although UV ink looks similar to conventional inks in terms of their formation and their final appearance, their composition demands and the selection of raw materials satisfying UV curing requirements[17] (Table-1).

Ink/water balance in offset: Due to the fact that UV ink vehicles are more popular than those of conventional inks, it has been noted that, a simple change of pigment can raise difficulties of the ink/water balance on the offset plate[17] for a given UK ink vehicle.

Blankets: Printing blankets must also be adapted for compatibility with specific inks and substrates. Since UV inks are often printed on foils and other kinds of substrates, the printing blanket plays an important role. Both compressible and conventional blankets can be used for UV printing. It should be taken into consideration that all UV inks and solvents tend to swell the blankets and even a slight embossing of the printed image appears on the blanket. Compressible blankets with finer profile and higher filler loadings present less base polymers to inks and solvents and embossing and tackiness is minimised with compressible blankets. Usual benefits of greater dot definition, smash recovery and increased packing latitude associated with the compressible blanket still apply. Always use blankets with sealed edges that offer protection from solvent ingression[17,19].

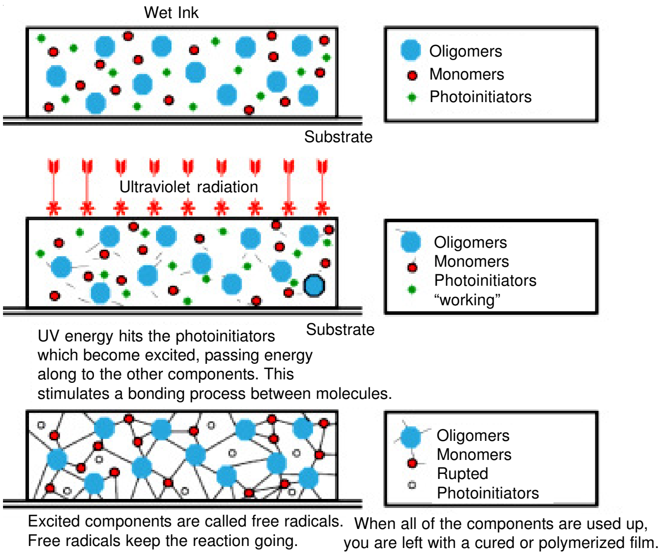

Fig. 2. UV ink reaction to UV radiation

TABLE-1
GENERAL COMPONENTS OF THE CONVENTIONAL AND ULTRA VIOLET INKS

Conventional ink	Ultra violet ink
Pigments	Pigments
Resins	Acrylic prepolymers
Vegetable oils	Oligomers
Mineral oils	Acrylic monomers
Drying agents	Photo-initiators
Additives	Additives

Dampening: Tank water concentrations prepared for the use with UV are also compatible with alcohol. This is natural development as most printings in the field of sheet-fed and web offset now are not equiped with dampeners coated with cloth. Behaviour of UV inks with the dampening solution: Ink-water balance. Early UV inks had a pronounced tendency towards Hydrophilic (Emulsification-Scum). Development of new UV curable vehicles has contributed to the creation of a new generation of UV inks whose "ink-water" characteristics are very close to those of conventional inks. Composition of the dampening solution varies according to the pressman's habits and may range from ordinary running tap water to water which contains acid additives and isopropylic alcohol (pH varying from 2-6).

Example: The following formula of dampening solution gives in practice very satisfactory results: Water 88 %, front solution 2 %, isopropylic alcohol 10 %, pH 4-5 %[17,20-22].

Advantages of UV dried inks

- There is no need for sprays to prevent the passage of ink to the lower subsrate as these sprays have such problems as dusty atmosphere, high prices and polishing
- There is no need for dryers such as furnice or hot air tunnel
- No solvent and reduced energy consumption
- Backside of the plate remains clean and the problematic process of powdering is removed
- UV printing inks are almost scentless after being dried and they are being used in food packages increasingly
- Energy saving
- Unavailability of volatile soluble emissions
- Too short operating cycle
- No need for heating
- It provides saving of space[18]

Conclusion

UV curing technology is applied to several separate processes in the printing industry. Acceptance level of this progressive and innovative curing method is indicated through the examination of the methods of utilizing UV curing in these various processes. It should be noted that the processes examined are not only those to which UV curing may be applied[23]. In today's fast changing and more digitizing world, the traditional printing methods need to compete with new emerging technologies. The industry faces demands of more ecological processes, more effective use of the raw materials and decreasing emissions[24]. The use of UV-curable ink with analog printing methods, including flexography, gravure, offset and screen process, is increasing at a rate that exceeds the growth rates for the use of these processes. As the use of UV-systems increases, environmental aspects of the chemical safety become more important because the use of UV curing reduces volatile organic compound emissions and also permits faster printing processes and saves energy[6,25,26]. The photophysical and photochemical properties of the photoinitiators are of paramount importance in controlling the reactivity and they should possess the following properties:

- High absorptivity in the region of activation
- High quantum yield for free radical formation
- Solubility and solubility ease in resins
- Nonyellowing
- Nonodour
- Low volatility
- Nontoxic
- Low migration
- Cost effective[27]

Some common causes of lacquer of curing

- Expiration of the effective lamp life
- Lamps not reaching full power
- Cross-contamination of UV inks by conventional inks and solvents
- Wrongly formulated ink
- Ink shelf life expired
- Dirt or deposits on the cooling tubes (IR filtration systems)
- Dirty or annealed reflectors
- Lamps overheating[17]

Environmental effect of UV inks: Offset lithography relies on the different surface chemistry and rheology of ink and fountain solution (mostly water) and their respective preferential interaction with a plate made up of a lipophilic (ink accepting) image carrying area and a hydrophilic (water accepting) non-image area. Protection of the atmosphere is increasingly becoming an important issue in most fields. Many processes that are currently used release massive quantities of solvents into the air. Evidence shows that the use of volatile solvents can have long-term adverse health effects. UV cured materials do not release solvents into the air. Strict guidelines apply to the manufacture of UV products to ensure safe usage by print personnel. Materials that are used have an extremely low impact on the human body. Accidental ingestion of UV ink has been demonstrated to have a non-cumulative effect. Further reference to this fact can be found under the heading of "Health and Safety". The use of UV curing technology is applied to several separate processes in the printing industry. After examining the methods of utilizing UV curing in these various processes, acceptance level of this progressive and innovative curing method is illustrated. It should be noted that the processes examined in this study are not limited to those to which UV curing may be applied[23,28].

"UV inks" have many advantages over conventional inks and perhaps, the most important of which is that they are virtually solvent free. However, there are also disadvantages associated with UV inks. For example, early experiences had been mixed with some concerns regarding health problems resulted from early formulations including respiratory sensitization[29]. There is an overwhelming pressure to reduce all the ink containing volatile agents. Many volatile agents evaporate and contribute to the increase in the greenhouse effect in the atmosphere. Furthermore, a substantial amount of carbondioxide (another gas having greenhouse effect) is generated at places where gas furnaces are used in order to cure these inks. UV inks are typically composed of such substances as acrylic ester and aromatic ketone (photoinitiator). These substances are decomposed at a relative ease through hydrolysis or oxidation. Thus, heavy metal and mostly cured UV inks are also solvent free in the long term and have an effective curing mechanism with a low energy need (from almost 20 % water-based systems).

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