UV

NAZDAR®

Ultraviolet Curable Inks

Technical Manual

Inks

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Nazdar
8501 Hedge Lane Terrace
Shawnee, Kansas 66227-3290 USA

Toll Free: 800.767.9942
Phone: 913.422.1888
Fax: 913.422.2296

www.nazdar.com

Preface

This manual is an introduction and general overview of the basic chemistry and uses of Nazdar's ultraviolet curable inks. Nazdar manufactures a complete line of high quality UV ink systems for diverse applications, each formulated to optimize productivity while meeting the specific performance requirements for screen printers.

In the curing process of screen inks, application of UV energy is recognized as perhaps one of the most technological advances in recent years. Nazdar's complete line of UV curable inks provides rapid cure times, conservation of energy and space, and air pollution control as well as superior printing performance.

Nazdar has been the leader in the development of the UV process which has contributed significantly toward overall improvements in quality and productivity for the screen printing industry. Nazdar UV inks are formulated under the screen printing undustry's most rigid standards of quality control, in a wide range of lead-free colors including the base colors used to stimulate the Pantone Specifier 1000.

Nazdar stands behind every UV ink with the most comprehensive technical support in the industry. Nazdar's Customer Service and Technical Service departments are staffed by professionals, ready to support each customer with fast, reliable information on all of Nazdar's UV products. These highly trained specialists are problem solvers who can assist in defining performance specifications, and help in selecting the right product to meet any special requirements.

If you have questions, or if you need technical assistance, contact Nazdar Technical Service, or Customer Service Department at: 1.800.767.9942

Chemistry of UV Inks

Basic Chemistry

All screen printing inks including solvent-base, water-base and ultraviolet-curable are formulated from base resins specifically chosen for their performance on a range of substrates. Resins such as vinyl, acrylic, urethane, epoxy, polyester and alkyd are formulated into a printable liquid at the viscosity and rheology applicable to the screen printing processs. The method of formulating these resins varies significantly in solvent, water, and UV chemistry. Each of these inks has different chemical requirements for conversion from a liquid into a dried or cured film.

Solvent-Base Inks

Once printed, a solvent-base ink must go through a solvent evaporation stage before a dry print is obtained. In a simple screen ink, the resin and pigment dispersions are left behind as a dry deposit on the substrate. Drying is accomplished by either forced heating or by lengthy air drying which allows complete dissipation of the solvent. Such inks are thermoplastic in nature and will readily dissolve in solvent, if so treated. Typical examples include poster inks, lacquers and acrylics.

More specialized screen inks are formulated from certain resins that cross-link or cure to produce enhanced chemical and physical properties. Considerable amounts of heat energy and/or time are usually required to drive this curing reaction to completion. Such inks are thermosetting and will not readily dissolve when treated with solvent. Typical examples include enamels and various one and two part systems for plastics, glass and metals.

Water-Base Inks

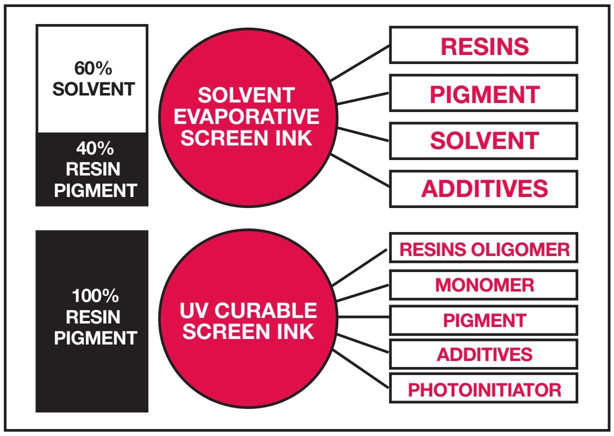
In water-base inks, many of the same generic resins are solubilized, dispersed or emulsified with water rather than solvent. In many cases, a co-solvent is used in small amounts to aid in film formation and to improve the print and drying processes.

The method of converting the liquid ink into a dry or cured ink film is similar to the solvent systems, requiring the extraction of the solvent and water.

UV-Curable Systems

A typical UV ink consists of the following major components:
1) Oligomers
2) Monomers
3) Photoinitiator
4) Colorants
5) Modifiers and Additives

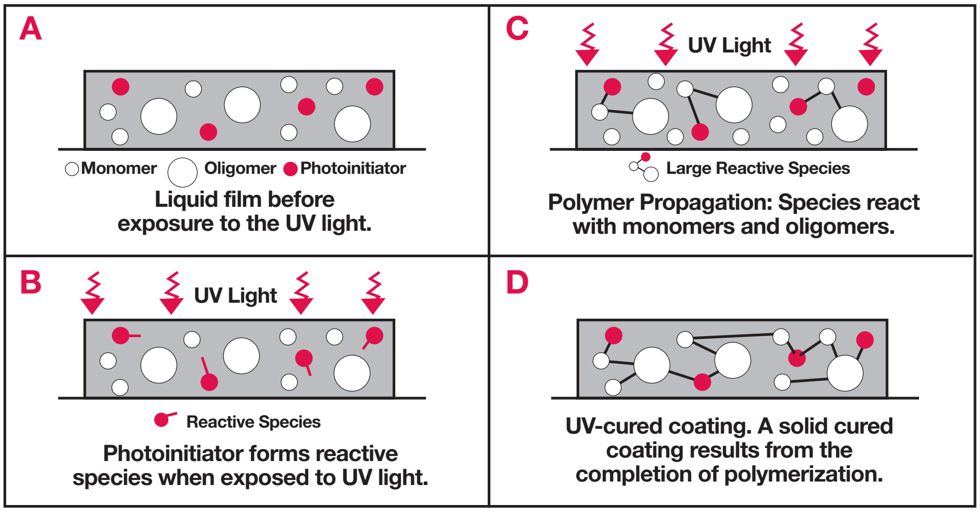
UV inks are 100% solids, meaning that there are relatively no volatile compounds (nothing to evaporate). When proper cure is achieved, all of the chemistry is polymerized.



As with water and solvent-base inks, generic resins are used in the formulation of ultraviolet curable ink systems. The resins that make up this system are called oligomers, which contain lower viscosity components called monomers.

Olgomers and monomers are reactive chemicals. A high dose of ultraviolet light triggers a photoinitaiator (catalyst) that causes the oligomers and monomers to couple together (polymerize). The photoinitiator serves as an antenna which absorbs UV energy in the wavelength range of 200-400 nanometers. Upon absorption of UV light, the photoinitiator undergoes a chemical reaction which leads to the production of reactive species. These species initiate a rapid polymerization. Upon completion, the oligomers and monomers co-polymerize to form a solid cross-linked ink film.

Effective cure, or cross-linking, is dependent on ultraviolet light penetrating the ink film. To ensure that UV light penetrates the ink film, it is critical to maintain the proper thickness of pigment density. Too much pigment density will prohibit light penetration resulting in poor cure or polymerization.



Nazdar's award-winning chemists have spent years developing Nazdar's UV ink technology. The result is a complete line of UV inks that are designed to provide maximum shelf life and cure speed with a minimum of age-related side effects.

Since all UV inks consist of reactive chemicals, it is important to maintain the recommended storage conditions regarding temperature, exposure to light, and type of storage container.

Health Hazards & EPA Regulations

Health Hazard Comparison: Solvent-Base, UV and Water-Base Products

While there are significant differences in the three types of ink chemistry, all are considered chemistry and should be processed and disposed of accordingly. The following outline shows the primary differences in the three ink types and their respective health hazards.

I. Solvent-base product hazards

A. Inhalation– Primary route of exposure. May cause headaches, drowsiness, dizziness and other central nervous system effects.

B. Skin contact– Drying to the skin. Some solvents can be absorbed through the skin causing the same types of effects as listed above.

C. Health hazards– Health hazards associated with certain heavy metals (i.e. lead, chromium, cadmium, and mercury) may occur if a dust is created and inhaled or if the metals are ingested.

II. UV product hazards

A. Inhalation– Considered low toxicity. The product does not readily vaporize at room temperature like the solvent-base products.

B. Skin contact– Primary route of exposure. May cause blisters and burning of the skin. Can sensitize the skin with repeat contact. UV products do not dry like solvent-base products. It stays wet on the skin or within clothing until removed.

III. Water-base product hazards

A. Inhalation– same as solvent-base products. Lower solvent percentage than solvent-base inks.

B. Skin contact– same as solvent-base products. Lower solvent percentage than solvent-base inks.

IV. Personal protection to be used with solvent-base, UV or water-base products

A. Keep containers closed. Store products properly.

B. Keep skin protected with impervious material (gloves, aprons, goggles). Remove ink fom the skin immediately with water.

C. Avoid cleaning skin with solvents and avoid using soaps/lotions containing lanolin if using UV products.

Environmental Hazard Comparison: Solvent-Base, UV and Water-Base Products

The following outline focuses on the environmental impact of the three types of screen printing inks.

I. Solvent-base product hazards

A. Land– May contain hazardous heavy metals (i.e. lead, chromium and cadmium) and can cause problems for disposal due to regulatory controls.

B. Air– High Volatile organic compounds (VOC) content.

C. Water– Solvent content and hazardous heavy metals content prohobit disposal.

II. UV product hazards

A. Land– Most landfills will be able to accept dried UV products (liquids are prohibited in U.S. landfills). Check with local facility. There are no hazardous heavy metals (i.e. lead, chromium or cadmium).

B. Air– High Volatile organic compounds (VOC) content.

C. Water– Solvent content and hazardous heavy metals content prohobit disposal.

III. Water-base product hazards

A. Land– Same as UV products.

B. Air– Low (VOC) content.

C. Water– Some water-base products may be accepted by water treatment facilities. Check with local facility.

IV. Environmental protection

Always check with local regulations and local facilities before disposing of any solvent-base, UV or water-base products. The Environmental Protection Agency (EPA) will levy heavy penalties/fines against violators. Ignorance is not an acceptable excuse.

Note: Consult Nazdar's Regulatory Department for assistance regarding any questions relating to the use or disposition of any Nazdar product.

Environmental Protection Agency (EPA) Hazardous Waste Regulations (40 CFR 261 Subpart B)

I. Classification of hazardous waste

A. Characteristic hazardous waste
- 1. Ignitability
  - a. Flash-point< 140˚ F
  - b. Strong oxidizer
  - c. Friction sensitive
- 2. Corrosivity: pH < 2 or > 12.5
- 3. Reactivity
  - a. Reacts violently with water
  - b. Produces a toxic gas
- 4. Toxicity: Toxic Characteristic Leaching Procedure (TCLP)

B. Listed hazardous waste
- 1.F= Non-specific sources
  (example: spent solvent)
- 2.K= Specific sources
  (example: K086 waste ink)
- 3.P= Discarded commercial
  chemical products
- 4.U= By-products of commercial
  chemical products

II. Types of generators (Federal EPA classification. State regulations vary)

A. Conditionally exempt small quantity generator
(< 100 kg or 220 lbs. per month)

B. Small quantity generator
(100-1000 kg or 220-2200 lbs. per month)

C. Large quantity generator
(>1000 kg or 2200 lbs. per month)

III. Requirements for handling hazardous waste

A. Labeling of hazardous waste

B. Training of employees

C. Transporting hazardous waste

D. Treatment, storage and disposal facilities

As a leading manufacturer of screen printing inks and related chemistries, nazdar manufactures a complete line of solvent-base, water-base and ultraviolet-curable inks – all of which are composed of resins, pigments and various additives. Each of these ink chemistries should be handled, processed and disposed of within the guidelines of federal, local and regional governmental agencies.

Nazdar is dedicated to the health and safety of our employees, distributors and customers around the world. As part of this long-term commitment, Nazdar has made the proper handling and usage of potentially hazardous materials an integral part of the company's mission by creating a Regulatory Compliance Department, responsible for meeting all of OSHA and EPA regulations.

The Regulatory Compliance Department works directly with all Nazdar departments on safety, health, environmental, and transportation related issues. The Department also provides specific written information for the handling, use, and shipping of Nazdar products, in addition to responding to our customer requests for information regarding these issues.

All employees should be made aware of safe handling procedures. The following points should be emphasized:

I. Skin contact

UV inks do not dry unless exposed to UV energy in a curing unit; therefore, like any wet solvent, they can cause irritation if they are allowed to remain in contact with the skin. For protection, operators should wear impervious gloves, aprons, and footwear when working with UV inks and when washing screens and tools.

All workers should thoroughly clean hands with soap and water after printing with UV inks. All foods, beverages, and smoking materials should be kept out of the workshop.

If ink comes into contact with the skin, wash the affected area right away with lukewarm water and soap or cleansing compound – but not with a cleaning agent that contains lanolin.

Do not try to remove UV inks from the skin by using the ink's wash-up solvent or thinner. This can increase the risk of health hazard.

II. Eye contact

We recommend protective safety glasses that completely surround the eyes to discourage operators from accidentally rubbing their eyes.

If ink comes in contact with the eyes, flush the eyes with water for 15 minutes and get medical care. Consult your ink's material safety data sheet for explicit first aid instructions.

III. Clothing contact

If garments or protective clothes become soiled with any quantity of UV ink, they should be laundered or dry-cleaned. Wash them in hot water, separately from other garments.

Impervious aprons, footwear, etc. may be wiped clean with small amounts of the ink's wash-up solvent. Make sure this is done in a well-ventilated area, preferably the same area used for cleaning screens with this solvent.

IV. Storage and disposal

Use only polyethylene plastic containers for mixing and storing. Make sure the storage area is well ventilated, away from sources of combustion or ignition, and that it has a temperature below 90˚ F.

Keep containers tightly closed when not in use. Allow at least 10% air space between the surface of the ink and the container lid; this air pocket extends the ink's shelf life.

Never subject a UV ink to high temperatures or bright light. Keep the ink container away from the light emitted by your curing unit. Keep inked screens away from direct sunlight.

Avoid contaminating the ink with foreign chemicals – especially strong acids, strong alkalis, reactive metals, metal salts and peroxides.

Finally, make sure your disposal procedure for unused UV inks, contaminated clothing, used tools, and soiled rags complies with all regulations (local, state and federal) that apply to waste material management in your area.

The screen printing market is extremely diverse in substrate and end-use applications. Since there are many solvent-base, water-base and UV base products that provide performance on a given substrate, the determining factor in selecting the proper ink will be dependent upon processing capability, processing economics, end-use and customer preference.

Over the past 15 years, the use of UV chemistry has grown significantly in the screen printing industry. Nazdar has developed a wide range of UV formulations for a variety of substrates used in the graphic screen printing market. However, the use of UV inks in the textile markets has been prohibited due to the porous nature of woven materials and the specific curing requirements of UV inks. For the most part, UV chemistry will perform on semi-rigid or rigid substrates, and those that have low porosity.

UV inks are the first choice for graphic markets using a variety of plastics, vinyls, and paper or card stocks for decals, plastic containers, book covers, glass, nameplates, membrane switches, compact disc and other substrates. Properly cured UV inks offer better overall chemical resistance, abrasion resistance and a higher gloss than most solvent-base formulations.

Choosing the Correct UV Formulation

Nazdar's UV inks, like their solvent-base cousins, offer exceptional performance on a wide variety of substrates. But, care should be taken in choosing a UV ink that is formulated to meet specific printing needs, as well as the performance characteristics demanded by the end user.

Keep in mind, ultraviolet inks will continue to cross-link (cure) with multiple layers and, therefore, may increase the density or hardness of the cured ink film. When multiple layers of ink overlap on a substrate, the flexibility of the printed substrate is further compromised. The substrate should be evaluated for flexibility after the maximum number of ink layers for a given job are determined.

With the diversity of substrates used in screen printing and the wide range of end-use performance characteristics required of the printed piece, thorough testing prior to a production run is highly recommended.

Because of the variety of inks available and the individual performance characteristics of each on a wide range of substrates, it is necessary to ask pertinent questions to select the proper ink for your printing needs. Of course, by identifying the end-use of the screen printed product first, some of these questions may be eliminated.

The following 18 questions should be asked prior to selecting a UV ink for production:

1) Is this ink suitable for the substrate?
2) Will this ink meet my flexibility needs?
3) Do I need an ink that exhibits outdoor durability and light fastness?
4) Will I need to die-cut the ink?
5) Will the substrate be scored through the ink film?
6) Will the print be double-sided and require a non-blocking ink?
7) What are the production speed requirements?
8) What kind of product/chemical resistance will be required from the ink?
9) How many layers of ink or number of passes through the cure unit?
10) Is a high gloss or flat finish desired?
11) Will the ink need to go through vacuum forming?
12) Will the ink be needed for first surface or second surface printing?
13) Will adhesives be used in contact with the ink?
14) Will premasking be done over the ink?
15) Will the printed substrate be subjected to constant weather/humidity exposure?
16) Will the printed substrate be subjected to constant heat exposure?
17) Will heat sealing be used with the ink?
18) Will embossing be done through the ink film?

The following table outlines the major market applications for screen printing inks and provides answers to the 18 questions. This simple guide should help you more clearly define your performance needs when selecting a UV screen printing ink.

NUMBERED QUESTIONS (Refer to the 18 question process)

Market Segments	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Fleet Marking	•	•					•		•	•							•	
Decals	•	•	•	•			•	•	•					•	•			
Container	•	•	•	•		•	•		•	•		•	•	•	•	•		•
Nameplate	•	•					•	•	•	•					•			
Membrane/ Automobile	•		•						•	•		•	•	•	•	•		•
P.O.P.	•	•	•	•	•	•	•	•	•	•	•	•	•		•			
Textile	•	NOT UV SUITABLE																
Banner	•	•	•			•	•		•	•					•			

The numbers of questions on pg. 10 will correspond to the specific performance requirements in each of the above market segment applications. This chart is only a suggested guideline and will not necessarily imply success due to the endless variables in chemistry between the ink and substrate. Pre-testing the complete process is always the best assurance of consistent performance.

Nazdar manufactures many different series of UV inks, each formulated for optimum performance on the substrates for which they are designed. Nazdar has many years of application experience and offers technical assistance in the proper selection of a UV ink that will meet your specific performance needs.

Substrate Compatibility

Ink Performance Testing

Adhesion to the substrate is the primary yardstick for judging the performance of a UV ink. If the chemistry is wrong for the substrate, or the substrate has some form of surface incompatability, the ink will not perform properly.

Some of the variables that affect proper adhesion of UV inks include:

- Proper cure of the ink
- Surface tension of the substrate
- Surface contaminates on the substrate including moisture, mold releases, plasticizers, UV inhibitors, dust, waxes, and certain fillers in paper or wood

UV inks cure much more quickly than solvent-base inks. This means that any chemical interaction ("bite") between the UV ink and the substrate will be very short. When printing with UV inks, one should allow for the best mechanical adhesion. Mechanical adhesion will be enhanced on porous or permeable substrates by wetting the surface. Some substrates, such as uncoated paper, may be too porous, allowing the ink to penetrate the substrate when UV light cannot properly cure the ink.

Once the UV ink passes the tests for printing, curing and adhesion, the ink and substrate are ready for further testing.

In a multicolor application, the basic adhesion test should be conducted with at least one extra layer of ink. The same color printed on top of itself will usually suffice. This additional film thickness will help indicate possible integrity problems between the ink and substrate.

When testing the UV ink on thin guage plastics, multi-layers of cured UV ink may actually be stronger than the substrate. This may inhibit cohesiveness and flexibility leading to delamination or chipping. Occasionally, the flexibility factors of the ink and substrate simply may not be compatible.

It is important to test every performance requirement prior to production printing. While the adhesion may be excellent, other factors such as die-cutting, scoring, pre-masking, laminating or forming may not be adequate for your needs. It is important to determine this before production printing has begun. Remember – assistance from a Nazdar technical representative is just a phone call away.

Substrate Variables

Most substrates are manufactured from synthetic, petro-chemical derivatives. In most cases, these substrates are not manufactured solely for compatibility with the screen printing process; consequently, the composition of these substrates may vary.

If an ink that has been used successfully for printing on a particular substrate suddenly poses printing or adhesion problems, try the ink on another batch or type of substrate. If the ink performs properly on a different batch or substrate, then the printing problem is being caused by your orignal substrate and not the ink.

Adhesion To Substrate

The performance of a UV ink is usually judged by its ability to adhere to a given substrate. When conducting an adhesion test, it is important to consider the variables that may influence adhesion, including type of UV ink, completeness of cure, substrate and wettability of the printed surface by UV ink.

In some cases, pretreatment of the substrate may aid in the performance of a UV ink. For example, polyethylene and polypropylene that have been treated with corona discard, a flame or a chemical overcoating, have been successfully printed with UV inks. In metal decoration, the proper choice of pretreatment is also important to the successful performance of UV inks. Printing with UV inks on bare metals and glass may depend on specialized ink formulations and careful precleaning of the surfaces.

Other Substrate Effects

Besides affecting adhesion, a substrate may also enhance the cure speed of a UV ink. This occurs when substrates that reflect unabsorbed UV light back into the ink, helping to promote the curing process. White and lighter colored substrates have the highest reflectivity of UV light. An increase in cure speed of up to 20% can be expected when printing on white substrates compared to black substrates.

UV ink printed on transparent substrates with a reflective support may also cure faster. This is especially advantageous in the printing of halftones and discontinuous solid patterns.

Curing Equipment

The most economical and proficient means of converting a liquid UV ink into a cross-linked solid polymer is with the use of a fixed focus mercury vapor lamp capable of generating from 125 to 300 watts of light per inch. There are other lamp types available; however, in all cases the end result requires UV energy between 200 and 400 nanometers for effective cure.

These lamps are normally contained in shielded housing, utilizing an elliptical reflector to focus the light (UV) energy onto the conveyor in a band between one-half and one and one-half inches wide.

A two hundred watt lamp will generate three basic bands of energy – infrared (heat), visible, and ultraviolet light. The infrared portion generates a band between 1400˚ and 1800˚ F. Selecting a UV-curing unit that is designed to dissipate these extreme temperatures is critical for effective ink and substrate processing. While UV inks respond much better at 100˚ F than they do at 50˚ F, excessive temperature will significantly degrade the substrate and/or cure of the ink.

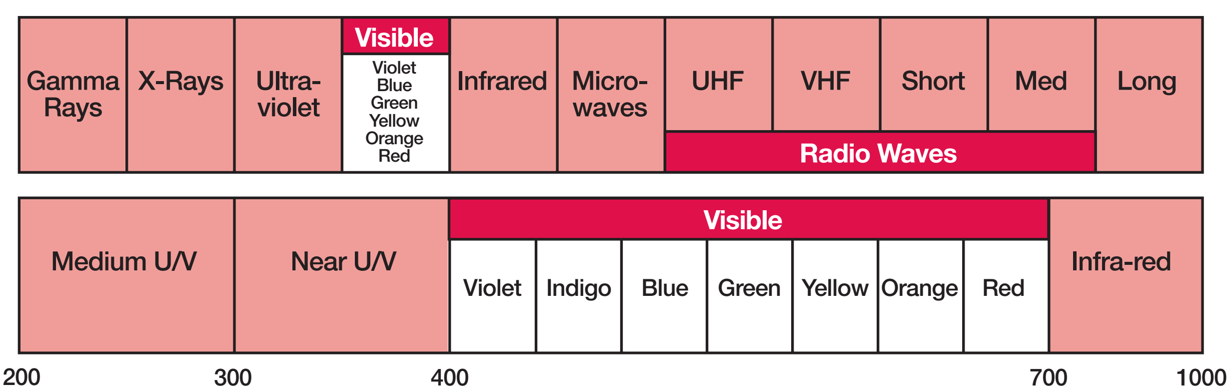
What Is Ultraviolet Radiation?

When sunlight passed through a prism, it is separated into the colors which form the visible part of what is known as the Electromagnetic Spectrum. The spectrum consists of radiations which are characterized by wavelengths, ranging from Gamma rays having very short wavelengths, to radio waves having very long wavelengths. Ultraviolet light falls within the range of radiation wavelengths from about 4,000 angstroms, on the border of the X-ray region.

The photoinitiator in a UV ink serves as an antenna which absorbs UV energy in the wavelength range of 200-400 nanometers. Upon absorption of UV light, the photoinitiator undergoes a chemical reaction that leads to rapid polymerization, forming a solid cross-linked ink film.

Various units of measurement, such as microns and angstroms, can be used to describe these wavelengths; however, the unit of nanometer will be used to describe wavelength in this text.

1 meter = 1,000,000 microns
1 meter = 10,000,000,000 angstroms
1 meter = 1,000,000,000 nanometers



1 nanometer (rm) = $\frac{}{1,000,000,000}$ meter

The UV region may be considered as being divided into smaller sections:
(i) Medium UV i.e. 200-300 nm (ii) Near UV i.e. 300-400 nm

UV curing inks generally respond to radiation from medium section of the UV region

Overview

Nazdar UV inks offer a wide range of lead-free colors. Each pigment has been carefully selected to provide brilliantly clean inter-mixable colors.

The most popular UV colors are concentrated versions of the base PANTONE®* shades used with the Nazdar formula guide to simulate the Pantone Color Specifier 1000. These colors have been independently formulated from Nazdar's 60 Series toners, rendering the most consistently accurate PANTONE duplications in the screen printing industry.

Nazdar's UV inks in the base PANTONE colors contain higher pigment concentrations than any other UV inks currently available. Higher pigment concentration means more opacity or color density, allowing stronger color capabilities, improved outdoor durability, and easier color matching.

Color Variables

The diversity of press mechanics, stencil selection, mesh, squeegee and substrate create many variables in ink deposit which may affect the color value of the ink.

All Nazdar PANTONE formulas were matched through a 390 plain weave mesh, using an 80 durometer, sharp squeegee. The deposit of ink for these formulations avaraged 0.5 mil.

When printing a large print area using the same 390 plain weave mesh, it is not uncommon for the ink deposit to reach 0.9 mil or more. This is due to variables such as squeegee, off contact, flood control and ink viscosity. If excess ink deposit occurs, the color may be reduced by adding Mixing Clear, or by adjusting the print mechanics to reduce the deposit.

Ideally, the press mechanics should be adjusted to provide an average 0.5 mil ink deposit. This will significantly increase the ink mileage while providing a much higher resolution print.

The depth, brilliance and opacity of color is dependent on uniformity of the ink deposit. Poor mesh tension, squeegee control, off contact, pressure, etc., contribute to orange peel, mottling, and non-uniform color development. A screen printing ink should flow out immediately after the print stroke to form a smooth, uniform finish that provides optimal color performance.

Efficiency In Use

A high percentage of the colors used by Nazdar customers are special matches that have been requested by the end user. To cost-effectively create these special colors, it is critical to understand the proper way to create a color match.

* PANTONE® is Pantone, Inc's check-standard trademark for color.

When matching any special shade of color, always start with a small amount of ink in a clean, wax-free container. If the color is not obtained after the addition of three different colors, throw the container away and start again. Keep the formulas as simple as possible, and never start matching a color in large containers until the formula has been approved. If color matching is not properly planned, considerably more ink is made for the production run than is required.

When matching PANTONE colors, it is important to consider that all Nazdar PANTONE formulas employ percentages totaling 100% by weight; therefore, the use of a scale is required for accurate color matching.

It is not uncommon to have extra ink after a print run, the remaining ink, now recorded with formula and printed sample, may be used to create another color that is close in shade. Remember to keep both a formula and an approved printed color sample of all special colors.

Frequently, leftover inks sit on a shelf without any formulas, and for periods of time often exceeding their useful shelf life. With today's environmental regulations, the disposition of these leftover inks can be very expensive and add significantly to overall ink costs.

INK USAGE ESTIMATE GUIDE

CHART 1

1. Print Area 8" x 9" = 72 sq in/sheet
2. No. Sheets 5,000 x 72 = 360,000 sq in
3. 360,000 sq in ÷ 144 (sq ft) = 2,500 sq ft

Ink Usage Estimate = 2,500 sq ft

INK FORMULA **Special Color**

Example: 100% solid UV ink with estimated 3,000 sq ft per gallon

1. 1 gallon	= 9.5 lb. average
2. 2,500 sq ft of ink	= 83% of the expected 3,000 ft
3. 83% of 9.5 lbs	= 7.89 lbs

COLOR FORMULA **Pantone 246C**

UV26 Mixing Clear	39.98 = .3998 x 7.89 = 3.15 lbs
UV65 Purple	34.59 = .3459 x 7.89 = 2.73
UV64 Rhodamine	25.43 = .2543 x 7.89 = 2.01
	100.00

Guidelines For Exterior Performance In Color Matching

All Nazdar standard colors in most ink lines are color formulated to render optimum exterior performance. Significant alteration of the base color with mixing clear, large amounts of white, etc., will degrade the durability of the color. Letting an opaque color down to achieve a translucent or transparent shade will not only impair the exterior performance but, due to lower pigment load, result in poor color development and mottling. For applications requiring translucent or transparent color, use a transparent or single pigment toner as supplied in most UV ink systems.

Nazdar UV inks are manufactured and quality controlled to provide consistent performance every production run. To ensure optimum performance, it is essential to follow a few basic guidelines for using, handling, and storing Nazdar UV inks.

Storage/Handling

All UV ink chemistry is affected by changes in temperature. A UV ink at a temperature of 50˚ F will not only exhibit very poor print and flow characteristics, but will drop in effective cure speeds by as much as 50%. Likewise, UV inks at very high temperatures will exhibit a lower viscosity which may result in poor print quality and less color development (film thickness). For ideal performance, all UV inks should be used at a comfortable room temperature. Store all UV ink in a clean, plastic, light-proof containers in temperatures not to exceed 95˚ F.

Mixing

UV inks are normally lower in viscosity than solvent-base inks and have multiple ingredients that tend to settle-out easily. This is particularly noted with clear (non-pigmented) formulas, which often have even lower viscosities. An ink that has been left to stand in the container for a period of time may be prone to separation, leading to poor print or cure performance. To ensure uniformity within a UV ink, mixing well with a high-speed mixer prior to production printing is highly recommended.

Proper Ink Flood

Most screen printing mechanics require the use of a flood coat prior to the print (squeegee) stroke to assure consistency in color development and print resolution. At the proper printing viscosities, UV ink will have excellent flow characteristics; therefore a heavy flood will significantly add to the amount of ink deposited. To prevent excess ink deposit, a tight (minimal ink) flood is recommended.

Lighting Of Work Environment

Since UV inks cure very quickly when exposed to UV light, the printing area should be monitored for excessive outside or overhead UV light interference. For example, on a bright, sunny day, flourescent lights with strong UV emissions and/or mercury vapor floods will generate enough UV energy to start the cure or cross-linking process of a UV ink. This reaction is a slow process that will appear as if the UV ink is drying in the screen.

Partially cleaned screens should not sit for any period of time near or around high UV output lighting. UV lighting may cause permanent cure or cross-linking, rendering the screen totally unusable.

It is important to regularly check the UV lamp and reflector by measuring the UV output of the bulb at least once a week with radiometer. A dirty reflector or lamp can reduce the effective cure by over 50%.

Squeegee Control

A sharp squeegee with the proper amount of pressure is required for optimum print resolution for most UV applications. The squeegee blade must also be maintained at the correct angle to assure proper ink transfer.

Use Of Metallic Powders

Metallic powders may be used with UV resin systems with two basic limitations. Exceeding these limitations will most likely lead to post-print problems.

1) LIMITS OF SCREEN MESH

The normally recommended 390 mesh for UV applications will not perform with most metallic powders because the metallic particle size is larger than the open areas of the mesh. Meshes ranging from 260-305 are recommended for UV metallic printing.

2) LIMITS OF METALLIC POWDER

Due to the high reflectivity of metallics, inks with metallic powder will cure at much greater film thickness than regular colorants, provided the correct amount of powder is used. To optimize print, cure, adhesion, intercoat adhesion, and post performance, the following percentages of powder to mixing are recommended:

Silver 8% by weight into clear
Gold 20% by weight into clear

Loading of powder beyond these recommended limits will significantly affect print, cure, adhesion and exterior performance. For applications requiring long-term exterior durability, the use of an overprint clear is highly recommended.

Stencil Recommendations

Since UV chemistry is 100% solids, the volume of ink that is used for printing is nearly the same volume that ends up on the substrate. Because of the high solids content of UV inks, finer meshes should be used to provide a smaller ink deposit. The same is true for stencils. To maintain finer print resolution while lowering the film thickness of the cured ink, the use of a thin film capillary or high solids direct emulsion (both of which produce a low stencil profile) is recommended.

Proper exposure of any photographic stencil is required to assure the proper print resolution, maximum resistance to the ink and squeegee, and optimum durability. The use of an exposure calculator is highly recommended to achieve maximum exposure while maintaining the highest possible resolution. This is particularly important when using a 100% solids UV ink in combination with finer meshes.

Frame

To achieve high quality print resolution it is essential to maintain proper mesh tension. Because wooden frames may warp and swell, they often provide inconsistent tension and poor print resolution and registration.

A high quality metal (aluminum) frame, or a pre-tensioned frame is highly recommended with UV inks. Proper tension allows minimal off-contact printing which enhances the resolution of the print.

Ink Cost

Evaluating Ink Costs

There are many variables involved in determining the cost of using a specific ink. The cost of an ink is not simply the invoice cost per unit. A more accurate measure may be gained by calculating the cost of an ink as a percentage of the overall production cost. This is difficult to calculate if the details of the entire processing and production are not specifically known.

The easiest way to calculate the cost of an ink is to compare the unit cost with the square footage it provides. No two ink formulas will print the same or yield the same coverage even using the same mesh, squeegee and press.

While most UV inks are 100% solids, there are significant variables in the way resin systems transfer through the mesh. The most significant differences in color development, film thickness and yield are caused by the mechanical variables in the squeegee, mesh tension, off contact and press.

The efficiency of a 100% solids UV ink can be calculated by comparing the yield (coverage) as it relates to film thickness as follows:

Mil Thickness Deposit	Microns	Sq. Ft. Per Gallon Yield
1.0	25.41	1,600
0.8	20.30	2,000
0.6	15.20	2,640
0.4	10.20	4,000
0.2	5.10	8,000

Using this chart, it is possible to calculate ink cost based on overall ink yield. For example, if printing with the recommended 390 plain weave mesh with press mechanics optimized to yield 0.4 mil of ink, square foot cost would be $0.03125 using a UV ink that cost $125 per gallon.

Using the same mesh but with inconsistent press mechanics, the cured film deposit could easily reach 0.06 mil. This would yield a square foot cost of $0.04734 using the same ink. The actual cost of the ink would then be $188.75 per gallon. From this example

Production Cost Of UV Ink

UV inks offer two significant cost advantages over solvent or water-base products. For one, UV inks allow high-speed printing and are capable of curing (drying) in a very short time compared to solvent or water-base systems. the space and/or energy required for drying solvent or water-base inks is typically double that of UV inks.

The other cost advantage of UV ink comes from increased productivity. Since UV inks contain no volatile solvent or water, the viscosity does not change during the printing process, yielding greater consistency in print quality. In addition, UV ink does not dry in the screen, eliminating costly wash-ups after breaks. This gain in productivity has been documented by many screen printers who have changed from solvent-base to UV printing. Typical increases in productivity range from 15-25%.

Troubleshooting

Screen printing is one of the most complex means of image reproduction because of the many variables in substrate, ink chemistries, and application techniques. Because of these changing variables, it is necessary to make continual adjustments to consistently produce high quality prints.

It is easy to compensate for most screen printing variables by observing a few basic procedures. Of course, Nazdar's experienced technical service staff stands ready to assist you with any problems you may have.

PROBLEM: Incomplete cure, ink soft

a. Is UV lamp emitting proper UV energy?
b. Is reflector clean?
c. Is bulb clean or going bad (turning white)?
d. Is there too much ink deposit? (check mesh.)
e. Is a bad squeegee creating too much ink deposit?
f. Do you have tight flood?
g. Is color too opaque for UV light to penetrate?
h. Is the mesh too coarse creating too much ink deposit?
i. Does the substrate have a surface contaminate?
j. Is the conveyor speed too fast for proper cure?

PROBLEM: Poor ink flow, craters, orange peel, pin holes

a. Check for excessive off-contact.
b. Is screen tension too low?
c. Ink viscosity may be too high. Do heavy inks flow slowly?
d. Dull squeegee – not cleaning the screen properly.
e. Surface condition on stock – try another stock.
f. Has the ink been properly mixed?
g. Too much squeegee pressure – squeegee bending due to too much pressure produces a poor print.

PROBLEM: Blocking, offsetting

a. UV inks are non-thermoplastic when properly cured; however, some inks that are formulated for flexibility (softer cross-link) may create a tacking, blocking or offsetting condition on some stocks. Are you using the proper formulation of ink/

b. Are you curing with too much power? Is your conveyor too slow for the amount of lap energy?

c. Check lamp. Are you getting the proper UV output (use radiometer) or is it mostly infrared (heat)?

d. Is the ink properly cured or does it have a tacky surface when stacked? Sheets may be stacked too hot.

e. Too much ink deposit – improper cure.

f. Is the heat from the UV unit softening the coating on the substrate? i.e., coated paper or card.

PROBLEM: Poor adhesion

a. Check for proper cure. Run sheet through UV unit one or two more times.

b. Color density may be too great for proper cure.

c. There may be surface contaminates on substrate. Check another substrate or wipe a section of the substrate with isopropyl alcohol and print again to check for surface contamination.

d. Are you using the proper ink system?

e. Check lamp and reflector.

PROBLEM: “Drying in the screen” appearance

a. Check stencil. Is mesh clean?

b. Check overhead lights over screen. Many light sources have enough ultraviolet light emission to begin cross-linking (cure) the ink in the screen while printing. Most Nazdar inks offer very fast cure speeds, therefore, outside light, or too much UV from artificial lighting can create a premature cure.

Glossary of UV Terms

Ink Chemistry

Resin
The basic binder in an ink – usually synthetically manufactured from petro-chemical derivatives.

Monomer
Single unit molecule, usually thin in viscosity, used in forming polymeric chains in combination with oligomers and pre-polymers.

Oligomer
Base resin used in UV inks. A molecule (or chemical compound) of a complicated structure consisting of several monomeric units in chemical union.

Photoinitiator
A substance which absorbs light and is directly involved in the production of initiator radicals for polymerization (UV curing).

Pigment
Substances that impart color. Finely divided solid, organic or inorganic coloring material insoluble in the medium in which it is applied. Pigments must be bound to the receptor surface by dispersing in a vehicle binder, such as resins in screen printing inks.

Polymerization
A chemical reaction initiated by a catalyst, heat or light, in which monomers and/or oligomers combine to form a polymer.

Reactive Dilutent
Monomer or mixture of monomers used to reduce the viscosity of an ink.

Solids
The components of an ink formulation, other than the vehicle, which are not removed from the film by the drying process.

Printing

Flow
The ability of the screen ink to spread uniformly on deposit for the purpose of covering the intersections left in the printing film by the threads or strands of the screen fabric at the instant of printing.

Adhesion
A mechanical or chemical reactive bond between surfaces.

Cure
The effective polymerization of a UV coating.

Orange Peel
Irregular surface in the cured ink film due to improper cure.

Post Cure
The continuation of polymerization process within a UV ink after initial exposure to UV radiation.

Window
The limits of a material within which a reactive process can take place.

Webbing
Fine filament produced by the ink between the screen fabric and substrate being printed, exhibiting a cobweb-like appearance on the finished print, usually created by the resin not being effectively doctored through the mesh.

Intercoat Adhesion
The adhesion of one ink to another with regard to compatibility, strength and quality of the bond.

Post Print

Jelling
The thickening of an ink or other liquid, which cannot be reversed by stirring. Premature polymerization of a UV ink.

Dark Reaction
When a UV ink forms into a gel-like substance apart from any light initiation due to premature polymerization.

Blocking
The undesired adhesion between layers of material, and/or ink, placed in contact under pressure or temperature in storage or use. Usually observed in printed material which is stacked.

Chemical Resistance
The resistance of an ink film to deteriorating effects resulting from exposure to, or immersion in, chemicals of specified types under specified conditions.

Abrasion Resistance
The ability of a surface to inhibit deterioration or destruction by friction.

Support Equipment

Fabric Plain Weave
A uniform pattern of weaving fabric with one over and one under in each direction.

Fabric Twill Weave
A weaving pattern of the fabric that was one over two under configurations. Twill weave deposits approximately 20% more ink than a plain weave in the same mesh.

Curing Unit
An ultraviolet reactor housing a UV emitter used for polymerization of UV inks.

Focal Distance
The optimum distance between UV lamp/reflector and substrate.

Irradiator
The lamp housing and reflector assembly in a UV reactor.

Mercury Vapor Lamp
A type of illuminant high in actinic value.

Quartz Tube
A UV lamp typically filled with mercury vapor, and made from quartz.

Radiometer
An instrument for measuring UV energy inside the curing unit.