BRADEN SUTPHIN
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Trap Rating Process Inks

Determining the proper trapping sequence of process inks is very important in the reproduction of multi color process printing. There are many criteria that need to be understood and considered by the ink maker and the printer when trapping sequences are being contemplated. The ink maker has several variables to establish specifications for and control when developing a set of inks for process printing. Printers have a different set of conditions to evaluate before making a final decision as to the proper sequence for a particular job.

The relationship of tack levels between inks is what controls trap quality. However, it is the tack relationship at the point of transfer to the paper that is important; this relationship may or may not correspond with the typically specified ink tack readings from laboratory tack measuring instruments.

The following will discuss the various ways that inks can be “Trap Rated” by the ink maker and some printing variables that can directly affect the outcome of a printing job.

Ink Variables

Tack, color strength, viscosity, and vehicle construction are important physical properties that have a direct influence on trap quality. The relationship of these properties from the first down ink through the last down ink is what the ink maker determines when developing a set of process inks.

Vehicle (varnish) construction controls things such as ink set speed and roller stability and also tack and viscosity. All these directly or indirectly affect the trap tendencies between two or more inks. An ink with a fast set speed on paper (See Technical Comments article on ink setting and drying) will, when printed on paper, increase in tack extremely quickly in the printed film. Roller stability affects the degree of tack increase of the ink as it transfers down the roller train from the ink fountain to the form roller, blanket, plate, and paper. Viscosity is a variable within the equation that determines tack.

Color strength directly affects the film thickness of ink required to achieve a given optical color density. Film thickness is also a variable in the tack equation.

Printing Variables

Paper type, the color gamut of the job, and overall image size are influencing factors on trap quality. Each can directly or indirectly influence the tack relationship between colors at the point of transfer.

The overall size of the image and the coverage of each color affect the area of contact of ink to blanket and surface. Area is a variable in the tack equation.

Papers have variable absorption characteristics and surface smoothness that affect the ink setting speed and applied film thickness. Faster or slower ink set speed directly influences the ink tack in the already printed inks. The degrees of coating porosity and the speed at which the coating pores allow ink "solvent" penetration are the major factors. These characteristics do not necessarily correspond with paper gloss levels, ink "hold out," or other macroscopic paper properties. Surface smoothness on a microscopic level affects optical printed density. Usually, the smoother the surface the higher the printed density will be for a given volume of ink applied to that surface. A less smooth paper will require a larger volume of ink to achieve a specific optical density resulting in a thicker ink film, indirectly affecting the tack of the printed ink film.

The paper coating formulations and the constituents used in them can also influence how smoothly an ink will print, ink set speed, gloss, and many other ink/paper interactions that can affect trapping. These ink/paper interactions are not well understood at this time and it must suffice to say that many unknown variables enter into the trapping function that may work with the characteristics already mentioned to produce good (or bad) traps.

Tack - What is It?

Tack - a function of the force required to split a thin fluid film between two rapidly separating surfaces. The equation that defines splitting forces for parallel plates immersed in a fluid is known as Stefan's Equation and is as follows:

$$F = \frac{\eta VA}{h^3}$$

Where: F = force required to split the plates (i.e., tack)
n = fluid viscosity
V = separation velocity (i.e., press speed)
A = area of the plates (i.e., ink coverage and blanket bead)
h = the distance between the plates (i.e., ink film thickness)

This model does not equate directly to ink film splitting from a blanket to paper but it serves to illustrate the strong influence of speed, film thickness, viscosity, and area of contact on tack.

Viscosity, speed, and area of contact contribute roughly equally to the equation. It is indicated that if any of them increase or decrease the splitting force will increase or decrease to a similar degree.

The formula shows that tack has an inverse cube relationship to film thickness. This suggests that extremely small variations in the film thickness will result in very large differences in splitting force and that film thickness is the most significant variable in the equation.

Viscosity and film thickness are the two variables that the ink maker has direct control over through manipulation of vehicle construction and printing strength. Separation velocity is dependent on the speed of the press and the geometry of the blanket and impression cylinders. Area of contact is dependent on the size of the image, area of ink coverage of each color, and the contact bead of the blanket (which in turn is dependent on the hardness of the blanket surface, impression “squeeze”, and compressibility of the blanket body).

Tack and Trapping - Realities

How does this relate to the typical ink tack specifications that are commonly used to discuss ink properties? The formula for tack contains four variables that need to be stipulated before any discussion of ink tack can have any validity. Since most tack meters are of similar design and use a fixed volume of ink that is usually consistent the variables of ink film thickness and area of contact are generally (but not always) consistent. All tack meters are variable speed and temperature so these need to be defined precisely in any discussion of tack. (Viscosity is dependent on temperature. Higher temperature - lower viscosity and vice versa.)

These instruments are designed to be used as control devices to assure consistent properties from batch-to-batch in the ink manufacturing process. The tests are done under standard conditions that remain constant and therefor may have little or no direct relationship to the actual conditions under which an ink is used. They often cannot predict what might happen in an actual press situation where speed, ink film thickness, viscosity, and area of contact vary frequently. They also should not be used to compare inks of differing formulation as the rheological properties for each formulation are unique (of which viscosity is only a part).

During the development of the inks for process printing, particular attention is given to rating the inks for proper strength (film thickness) set speed (tack increase upon printing), and viscosity so that when the inks are used under actual conditions they have the correct tack relationship and consequently trap well. Any set of inks is designed to provide acceptable trapping over a wide range of presses and substrates. Usually compromises have to be made to extend the range of conditions under which acceptable trapping results. During the development process tack, viscosity, and strength levels are decided on after testing under press conditions, then the lab instruments can be used to maintain those desired specifications.

The trapping performance of a set of inks is dependent on all of the previously mentioned variables, only some of which are under control of the ink maker and the printer. It must be expected then that trapping performance of a given set of inks will vary significantly as the job variations exert their influences. There will be jobs where ink should be changed to account for variations in coverage, paper surface or other job layout considerations. These occasional situations that fall outside normal operating parameters may require a specific set of inks or possibly only a change in the printing sequence but should not be cause for alarm.