Industrial Printing Inks
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5. MANUFACTURE OF PRINTING INKS

Reference 175

There are three general methods for the manufacture of printing inks: (1) grinding of a pigment in a vehicle using a mill, (2) heating a dye in a vehicle with stirring, (3) replacing water in the wet pigment pulp by an ink vehicle. The last is known as the "flushing" process and is conducted in a mixer.

MILL GRINDING

There are many types of mills used for the grinding of inks, three roll, five roll, two roll, colloid, ball mill, etc.; and there are variations in each of these mills.

Three Roll Mill

The popular mill for the manufacture of letterpress, offset, and silk screen inks is the horizontal three roll ink mill. It consists of three hard rolls made from an iron alloy. The rolls are manufactured in several sizes, such as 9 × 24 in., 12 × 30 in., and 16 × 40 in. The first number indicates the diameter and the second number indicates the operating length of the roll. On any one mill, the three rolls are exactly the same in size. Although the rolls are generally placed in a plane, they can also be placed in other positions.

The rolls are machined carefully so that there is a slight crowning (thicker) in the middle region. As the mill roll warms up, the contact is then even. At the edges, the rolls are rounded so that the expansion of the metal at these areas will not damage the rolls and make them thicker than the balance of the roll areas. The rolls are water cooled because the grinding operation develops considerable heat. The rolls are tightened manually. In order to be sure that the pressure can be equalized at the two edges of the same roll, hydraulic pressure gauges are attached. A typical mill has four gauges, two located at the front and two at the back; the middle roll is fixed and the front and back rolls are adjustable. The power is applied to the middle roll in the older designs, but is applied to the apron roll in the newer designs. As the mill warms up due to friction, the setting has to be changed to maintain the same pressure.

The floating roll mill is constructed differently. The middle roll, or "floating roll," is loose and the other rolls are adjusted to it.

Two large end plates placed near the outer edges of the back and middle rolls ride gently over the top of these rolls as they rotate. The plates can be raised or lowered so that they just touch the ink rolls. They serve as end gates to keep the ink from falling off the mill at the roll edges. The ink is thus confined between the end plates and rides on top of the back and middle rolls, which constitute a hopper.

These two rolls turn in opposite directions in such a way as to carry the ink downward between them. Some of the ink now travels around the back roll and returns to the hopper; the rest of it passes around the middle roll and is squeezed between the middle and the front rolls, which are moving in opposite directions, carrying the ink upward. Of this portion of the ink, some travels with the middle roll and goes back into the hopper; some moves with the front roll and on its downward course meets a flexible blade, which is placed at an angle tightly against the front roll. The blade scrapes off most of the ink on this roll as the ink travels downward with the roll. The ink that is scraped off the roll now goes from the blade to the apron, which is set at such an angle that the ink can continue flowing downward by gravity into a container such as a pan, kit, tub, or barrel.

It is important that the blade be set with proper and even pressure so that the maximum amount of ink can be scraped off without damage to the mill rolls or the blade. This setting is accomplished by means of a reducing valve in the air supply line and a special mounting of the blade against the roll.

In order to tear apart the hard agglomerates in a batch of pigment, it is necessary that the three rolls have different rates of revolutions per minute. Thus at the areas of contact there occurs a shearing action upon the agglomerates. A common ratio is 1:2.5:5; this means that the front roll revolves five times as fast as the back roll. The shearing effect upon the ink film increases with the ratio, but production decreases. As the ratio lowers, the shearing effect decreases and the production increases.

The reason the production varies with the ratio is as follows. If the blade can remove all the ink at the front roll, the production will be the same with a 1:3:10 ratio as with the 1:2.5:5 ratio based on the back roll. Because the blade cannot scrape off all the ink, the amount taken off in the high ratio mill is less than that taken off in the low ratio mill at the same mill setting. Of course, the production depends also upon the clearance at the areas of contact, and the clearance is determined by the mill setting as indicated by the gauges. It has been suggested (1) that a blade be placed on top of the center roll in a three roll ink mill to transfer the ink from the center roll to the apron roll. This increases the ink production. For laboratory use, a 5 × 12 in. roll mill similar to the one above in construction is quite useful. Smaller and larger sizes are also available.

Five Roll Mill

Two more rolls can be added to the three roll mill and placed in a horizon-tal or other desirable position. In order to obtain satisfactory production, it is necessary to use low surface-speed ratios of various rolls. This restricts the five roll mill to grinding inks that contain soft agglomerates. This mill can also be used to evaporate the residual water in a flushed lithographic ink, such as alkali blue. At this stage, the product is very difficult to stir as it is very short and extremely pasty. Here the total surface of the rolls that is exposed to air is much more important than the shearing action. Due to its extra surface, a five roll mill is selected rather than a three roll mill. It is also important to use an elevated temperature in order to speed up evaporation of the water but the temperature must not be too high because that may cause a color shift and a decline in color strength. When the water content reaches a low value, the stiff, short paste changes to a flowing useful ink.

Mixing and Grinding

There are three steps needed when making an ink on the roll mill: careful weighing, thorough mixing, and the actual milling. If the milling operation is poorly done, then many properties of the ink are affected, especially the color strength, printing qualities, and smoothness of the resultant print. Poor texture of ink due to improper grinding, can be the cause of screen fill-in and general specking. It can also yield a piling and caking on the printing plate or even on the lithographic blanket. There are other variables that contribute to these failures such as paper dust, paper fibers, and the nature of the pigments used. The weighing of the pigments and vehicles is generally conducted in large tubs placed on portable scales. It is not wise to weigh small amounts of ingredients such as driers, anti-skinning agents, ink com-pounds, etc. on large scales; these should be weighed on smaller scales that are more sensitive.

The mixing operation is designed to wet the surface of the pigment portion by the vehicle. If the mixing is thorough, the grinding effort is reduced. The average pigment that has been manufactured in water solution and sub-sequently filtered contains particles of very small size, most of which are less than 1/10 of a micron. A micron is approximately 1/25,000th of an in. During the removal of water by evaporation in the drying chambers, the pigment particles tend to stick together forming agglomerates. After the dried presscake is pulverized, many of these agglomerates are still more than 100 microns in size, large enough to fill in a coarse halftone screen. The mixing operation starts out with a partial wetting of the dry pigment agglo-merates but at the same time forms new types of aggregate masses of semi-wetted agglomerates. These new aggregates are made up of lumps, the outer layer of which consists of wetted agglomerates, the middle layer of semi-wetted ones, and the inner layer of almost dry agglomerates. If continued mixing is efficient, the aggregates are broken down and, in turn, many of the resultant wetted agglomerates are broken down into smaller units. The mixing is finished when no further change occurs. Recently, high speed mixers have been developed that are able to disperse the pigment very well. This definitely saves time and effort during the subsequent milling. Some of them operate at 1,725 R.P.M.

The pressure exerted by the mill rolls, as well as the shearing effect at the areas of contact, breaks down the agglomerates into still smaller units and forces the vehicle to wet and cover the surface of the broken-down units. It is doubtful that the roll mill is able to reduce the agglomerates to the sizes that existed just prior to the drying of the presscake. Although this would be desirable, it is not necessary. The degree of dispersion needed depends upon the type of printing, the size of the screen, if any, and other factors.

It is the relatively hard agglomerates that present a problem in grinding. In order to break them down to a satisfactory size, considerable shearing action is needed. That is why some mills have high ratios of rotating rollers, such as 1:3:10, and why the mill roll pressure is high, which means a small clearance. Frequently, high and top color strength of the ink can be obtained in one or two passes on the mill but more grinding is needed to crush the agglomerates down to a suitable reading on the grind gauge. It is evident from this observation and from other tests that they represent but a small percentage of the total pigment, frequently less than a fraction of one per cent. The large agglomerates tend to "hang back" during the grinding operation and pass over the mill near and at the end of the batch. Thus grinding effort and time can be saved if the ends are run separately and tightly over the mill many times before starting the next pass. Sometimes it is wise to discard the last portion of the batch without further treatment.

The dispersing action of the mill forces the vehicle to cover and adhere to the surfaces of the pigment particles which would be easy if the pigment particles possessed a smooth surface. They have, however, very irregular shapes and sizes. Considerable effort and time is needed for the vehicle to cover the irregular surfaces completely. The displacement of air and moisture on the surfaces continues after milling. It is for this reason that an ink that has stood for a while always prints better and also performs more satisfactorily in the lithographic process than does a freshly milled ink.

Testing the Grinding of Inks

One of the problems in testing the grinding of an ink is selecting of the sample or samples. If the mill rolls are tighter at the edges than in the center, the large particles will slip through more easily at the center. Therefore, samples should be taken at the two edges and at the center as the ink is scraped off the front roll by the blade. Samples taken at the beginning, at the middle, and near the end of the grinding run usually differ due to the above-mentioned "hang back." The most important samples would be those obtained near the center and near the end of the run. Thus six samples would be compared for the degree of grinding.

An ink gauge[2] is useful for testing the grinding of inks. It consists of a very hard steel bar [illegible] × 8 in. whose top surface is smooth and absolutely straight. Two ground paths are made on its surface 1 × 6½ in. These are separated from each other by a distance of ¼ in. The paths consist of small grooves, which are tapered in depth from 0 to .001 in. and are designated in equal steps of 0 to 10. Thus the reading of 5 corresponds to the depth of .0005 in.

Two ink samples are drawn down by a scraper 3¾ × 1½ in. over the two paths, starting at the deep end, position 10. The scraper is held at an angle, the *top* of which would be close to position 9 when starting at the bottom, position 10. If there are many scratches, the ink needs more grinding. If there are few scratches, then the ink film is examined immediately for speckled-appearance areas. The number corresponding to the beginning of this area is designated as the fineness of grinding number. The ink will need more grinding if the operator finds that the number is higher than that allowable for the type of ink and its usage. It is evident that a newspaper ink has a higher number than a halftone black ink. There are paint gauges available that read from 0 to .004 in. Because the scraper skims off the extra large particles on the ink gauge but catches them on the paint gauge, it is possible to find an ink that passes the ink gauge quite well but does not pass the paint gauge. For this reason a critical examination of an ink includes tests on both gauges.

Colloid Mill

The colloid mill depends upon mixing and shearing actions in the manufacture of relatively soft printing inks, such as newspaper inks.[3] It consists of a horizontal rotating disk that has a smooth outer surface which almost touches an adjacent stationary wall surface, which is also smooth and free from teeth or grooves. The outer edge is not perpendicular to the disk itself but is set at an angle to it. The disk therefore appears to have the shape of a frustum of a cone. This design permits a change in the clearance of .001 in. or more between the two surfaces.

A typical colloid mill for the manufacture of inks has a disk diameter of 15 in. The rotating disk has a speed of 60 revolutions per second or 3600 R.P.M.[4] The friction developed from the high speed generates considerable heat, and the mill is water cooled in order to maintain a controlled temperature. The premixed ink is forced to pass between the two surfaces while the disk is rotating at the high speed. The colloid mill is noted for large output in terms of power required. However, the grinding is not quite as fine as that obtainable on a three roll mill or in a ball mill. The colloid mill is very useful for preparing emulsions and for the manufacture of certain types of paints.

Two Roll Mill

The two roll mill is used to disperse pigments in resins. The large rolls do not touch each other but are kept a small distance apart. For best results the resin should be in powder form; one of the rolls rotates faster than the other. As the mill warms up due to friction, the resin softens sufficiently so that it is mobile. Hard resins and binders are frequently softened by adding drying oils or plasticizers; this reduces the operating temperature, which in turn has an effect upon certain pigments. After the product has cooled, it is powdered and soaked in the balance of the vehicle needed for the final ink. The pigment dispersion is generally so fine that the milling operation amounts to dissolving the resin. The high power cost and subsequent milling limits this method of making inks.

Morehouse Mill

This mill consists of two carborundum stones, one stationary and the other rotating at high speeds such as 3600 or 5400 R.P.M. The clearance between the two stones can be adjusted to a small distance. The premixed ink is fed in at the top and is ground as it passes outward laterally between the horizontal carborundum stones. Two runs are usually sufficient; after the runs, the ink travels downward into the final containers.

This mill is provided with a water jacket for either cooling or heating the mill plates. The use of the mill is limited to grinding soft flowing inks, such as flexographic and gravure inks.

The Kady Mill

The Kady mill depends for its grinding action upon moving the agglomerates present in the premixed ink at an exceedingly high velocity against a hard stationary surface. This action breaks up the agglomerates into smaller units and also disperses them in the vehicle. The premixed ink is fed at the top and the finished ink is removed at the bottom. Oil is used as the lubricant and the cooling medium. An outside tank, cooled by a water jacket, is used for the oil. This method of mill grinding is restricted to soft flowing inks.

Uni-roll Mill

The uni-roll mill consists of one metal roll and one or two metal bars. The premixed ink is placed in a hopper above the top of the single roll. The roll oscillates sideways slightly while it is rotated. The ink follows the moving roll which rubs against one or two metal bars placed a little way past the hopper. The ink becomes ground as it is rubbed against the bars. It is then scraped off the roll by a blade. The ink may need another run.

This method of grinding is limited to soft flowing inks. If a volatile solvent is used, the entire mill should be enclosed.

Ball Mill

Because volatile solvents are present in flexographic and gravure inks, it is necessary to confine them in some manner to prevent their being lost. This is accomplished by the use of a ball mill, which contains balls that perform the grinding operation. The large agglomerates of the pigment are broken down and pigment particles of all sizes are well dispersed in the vehicle as the balls roll over each other and against the wall of the mill. Optimum grinding with minimum wearing of the balls and wall occurs when the balls cascade over each other as they move down an inclined plane by gravity. They are returned to the high position by the rotation of the mill for another descent.

There are many sizes of ball mills, ranging from the small laboratory size, 5⅛ × 5 in.[5] to the extra large factory mill, whose dimensions are 9 ft. 6 in. × 12 ft.[6] The first number represents the inside diameter and the second refers to the length of the cylinder. There are many types of mills based on the composition of the wall surface and the balls. For light colored inks, such as whites, yellows, oranges, light reds, and tints, a porcelain-lined steel mill equipped with porcelain balls is used. If an unlined steel mill with steel balls is used, the light colored inks acquire an off-color due to the small particles of steel that are worn off the balls and wall, and have a darkening effect. Faster grinding occurs with steel balls than with porcelain balls of the same size, because steel balls have a higher specific gravity and exert greater pressure on the pigment particles. For best cascading they need more viscous vehicles than the same size porcelain balls need. Because they have a greater surface of contact during the grinding operation as compared to large balls, small balls yield faster grinding than large balls of the same material. The balls vary in size, from ⅝ in. to 3 in. diameter.

The ball mill should be about half full of balls. The ink ingredients are then added in a volume slightly more than enough to cover the ball charge completely. It is not always necessary to dissolve the binder or resin in the solvent prior to grinding the batch of ink for the resin will go into solution during the grinding operation. The factory mill is equipped with a large opening through which the ingredients are entered. This opening is fitted with a tight cover to prevent leakage. The mill is also equipped with an outlet for discharging the finished ink. For convenience, the mill is usually mounted high enough for easy handling of the completed ink. The latter is passed through a screen or magnetic separator to remove any extraneous material that may have entered the ink. For best performance, the mill wall and the balls should be made out of very hard materials, such as chrome manganese steel[7] in order to crush the large and hard agglomerates rapidly with minimum wear on the metal surfaces. The porcelain balls and lining should also be hard.

Because considerable heat is generated during the grinding operation, the mill should be equipped with a jacket[7] over the exterior so that both cold water or steam can be introduced, thus affording the means of selecting the proper temperature control to achieve maximum grinding. Precautions must be taken to prevent fires because of the combustibility of most gravure and flexographic solvents. All pieces of apparatus, including the mill, should be electrically well grounded. This applied also to the gravure and flexographic printing presses.

Grinding in a ball mill is generally very satisfactory because the resultant inks are fine enough to print screens having 150 or 175 lines per linear in. The ball mill can be used for grinding newspaper and other soft letterpress inks. Another important use is in the manufacture of paints. It has been used for pulverizing pigments, preparing paper coatings, show card inks, and a multitude of other products.

Sand Mill

Although the principle of the sand mill is similar to that of the ball mill, the operation is different. The silica balls, which are coarse (20–40 mesh) particles of sand, grind the pigment particles as the balls are rotated horizontally by means of a vertical shaft with horizontal arms. The finished ink eventually passes through a screen, which is fine enough to prevent the balls from passing through. For best results, the ink should be premixed and fed into the mill at the bottom at a rate governed by the results obtained. This method of grinding is restricted to soft flowing inks, such as flexographic and gravure inks.

MANUFACTURE OF DYE INKS

A dye ink can be made by mixing the dye with a suitable vehicle and grinding the mixture on a three roll mill or in a ball mill depending upon the type of vehicle used. The dye, however, can be dissolved in the vehicle by the use of heat and ample stirring. The temperature has to be controlled to prevent color shifts and loss of solvent. Open or closed glass-lined kettles are suitable for this simple method of making dye inks.

BASE INKS

A base ink is simply a coloring matter that is well dispersed or ground in a varnish. It can be either a dye base or a pigment base ink. From it can be made many finished inks by blending it with other ingredients, such as extending inks, driers, solvents, varnishes, ink compounds, etc.

High Color Strength

To obtain the greatest number of possibilities in blending from a given base ink, the color strength should be high. Thus it is possible to prepare process, lithographic, halftone, and other inks that need high color strengths because they are printed with thin films. Obviously, inks having low color strengths can be made by copious blending using the same base ink.

One Colorant

To obtain the maximum number of possibilities in formulating the finished inks, the coloring matter should be one colorant, either one dye or one pigment in order not to encounter restrictions due to differing characteristics. For example, a blend of a calcium lithol red with toluidine red does not make a good base ink. An outdoor poster ink made from this blend would not be satisfactory because the lithol red is proof neither to light nor to rain. A breadwrapper ink would certainly not be satisfactory if made from the blended base ink because the toluidine red bleeds readily in the paraffin wax. These difficulties disappear when the process is begun with single color base inks and not with blends.

If it should be necessary to make a blend in the base ink, then the colored components should have many similar properties so that restrictions like those mentioned above would not interfere. As an example, a blend of a calcium lithol rubine with a calcium permanent red 2B is frequently satisfactory since the two colorants have many properties in common.

Advantages

Base inks are excellent starting points for making finished inks, especially if one is in a hurry. They promote easy and rapid formulating, and require minimum operations to make the finished ink. Blending the base ink with other base inks or with other ingredients requires only a mixing and one loose run on the mill. It is more economical to blend base inks to fill small orders than to make these inks by dry grinding. On the other hand, it is more economical to make the inks to fill large orders by dry grinding rather than from base inks. If there is a hurry, they can be made from base inks.

Printing ink makers have gone one step further with base inks. They have developed a complete line of drying oil base inks of high quality for both small and large printers. Most of them contain a drier and as such are ready for printing. Any changes that may be needed can be made by an easy manipulation. Because these base inks have been manufactured in large batches but packaged in convenient small-sized containers, they are more economical to use than a small batch of ink that is ordered together with a match-up request.

The idea of base inks has been extended to many systems of printing inks. Some of them are ready for printing and are really finished inks, whereas others are simply coloring matters ground in a specific varnish.

FLUSHED INKS

It is possible to go directly from the wet pigment presscake to an ink by replacing the water in the presscake with a suitable varnish. This is known in the trade as the "flushing" process for making inks. They are in reality a series of base inks.

Flushing Operation

A flushed linseed ink is made in the following manner. The pigment pulp, which is obtained as a presscake, is transferred to the mixer. A chrome yellow pulp contains about 25 per cent water and a calcium lithol red pulp contains about 75 per cent water. The quantity of pigment pulp used should be sufficient so that a suitable-sized batch of ink will be obtained. A small batch of ink cannot be properly mixed and is uneconomical. Too large a batch will not mix properly either. Two large sturdy curved arms are used for the mixing operation. They revolve in opposite directions and travel upward at the sides and downward in the middle of the mixer.

If the final vehicle in the ink is a blend of two or more linseed varnishes, select the more viscous grade for the first stage of the flushing operation. Add to the pulp in the mixer between one-half and two-thirds of the total vehicle that will be present in the final ink. Start the mixing operation. After a few minutes, the varnish replaces much of the water clinging to the pigment particles. The liberated water tends to collect and eventually forms a layer on top of the mixture. By tilting the mixer, the bulk of the water can be poured off and discarded. The mixer is returned to its original position and the mixing continued. If more water forms, repeat the above procedure to remove the water. When no more water can be removed, add the balance of the vehicle and mix until uniform.

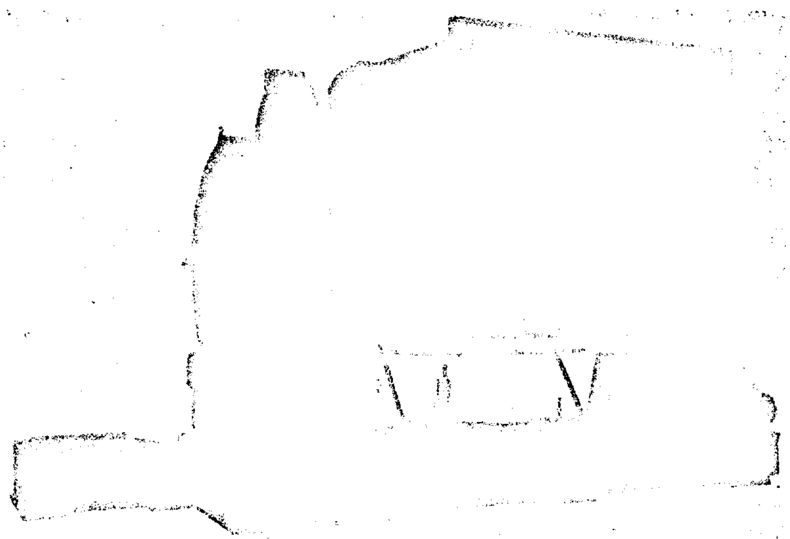

Figure 5-1. Baker Perkins mixer

There are now three ways to remove the residual water in order to complete the flushed ink manufacture. One method is to continue the mixing at a higher temperature and thus evaporate the water as the mixture is exposed to air. This process can be applied to pigments that yield neither livering and other body changes nor color shifts due to the elevated temperature. Another method consists in evaporating the water at a greatly reduced pressure with a mild increase in temperature. A tight cover is fitted over the mixer and the vacuum pump is started. This represents a popular method of removing the residual water while the mixer is running. When the water content of the ink reaches a low value, the mixture becomes a flowing ink. Frequently, the water content of "flushed" inks is lower than that of the corresponding inks made by dry grinding. The third method has already been described under the heading "five roll mill" where the alkali blue pulp-varnish mixture is transformed to an ink by the evaporation of the water on the mill rolls.

Flushing Aids

Occasionally, the pigment pulp-varnish mixture refuses to release the water and acts instead like an emulsion. There are a number of causes for this result, such as insufficient washing of the pigment to remove the soluble salts and the wrong pH. The following products may prove effective as remedies and should be tried in small amounts only using a sample taken from the mixer before applying it to the large batch.

(a) Acidic additives: lead acetate, alum, or cream of tarter (potassium acid tartrate).

(b) Alkaline additives: sodium bicarbonate, sodium carbonate, trisodium phosphate, or a sodium soap of a bodied linseed varnish.

(c) Synthetic wetting agents such as amines and substituted amines.

If the batch still refuses to release the water, then it will be necessary to resort to the use of an ink mill to break the emulsion and subsequently to remove the residual water by evaporation from the mill rolls.

The flushed inks should be given one run on a roll mill in order to be sure that all the lumps of the pigment pulp are crushed and that the ink is very smooth in appearance and uniform in color and consistency.

Properties of Flushed Inks

Although it is theoretically possible for the particles in a pigment pulp to grow in size, either they fail to do so or, if they do grow, they yield very soft agglomerates that are easily broken down during the flushing process followed by one pass on the roll mill. That is why flushed inks, on the average, show greater fineness than the corresponding dry pigment grinding inks.

Where color strength is concerned, there can be a difference in favor of the flushed inks. During the removal of water from the presscake in the drying chamber, the pigment can lose some of its color strength and can take on a relatively hard texture. It all depends upon the nature of the pigment and upon the care taken during the drying. Pigments that lose their color strength by acquiring a hard texture should be flushed in order to obtain the best results. Examples of this group are alkali blue, scarlet 2R, platinum violet, helio bordeaux, and victoria blue molybdate (and tungstate). If carefully manufactured and dried, most ink pigments show little or no color strength advantage due to the flushing process.

Because the average particle size in a flushed ink is smaller than that obtained by dry grinding on a roll mill, the following differences have been observed: the flushed ink has noticeably more gloss, greater smoothness, more transparency, darker masstone, better printing qualities, and better lithographic performance.

Although there are distinct advantages in flushed base inks, there are also some disadvantages. The most important one is the vehicle problem. In order to help solve this problem, flushed inks have been prepared from gloss, alkyd, lithographic, heat-set, mineral oil varnishes, etc. This now becomes both an inventory and a manufacturing problem. Small batches are uneconomical and, because of the cost of cleaning, single batches are also uneconomical. The great variety of vehicles needed in printing inks makes it impractical to manufacture and stock flushed inks of the main pigments in each of the vehicles. Thus the flushed inks are limited by the problem of vehicle formulation.

Uniformity and Cost. Another disadvantage of flushed inks is the problem of uniformity. It is a fact that manufacturers of dry pigments are obliged to keep a sizable inventory of various types of batches of the same pigments so that a blend with a new batch can be made to match the adopted standard for the pigment. A light masstone batch is blended with a dark masstone batch to equal the standard. If the flushed-ink manufacturer wishes to match a standard ink, he too will be obliged to keep an inventory of light and dark masstone batches, etc. But his inventory, which represents money tied up, will be larger because the varnish is now an additional item.

Basically, the flushing operation is cheaper than drying the pigment, pulverizing it and then grinding it into an ink. However, if for uniformity an additional inventory is required, there can be a question as to the amount of saving by using the flushing process. If only items that require little blending are manufactured and if the volume of these items is considerable, then flushed inks can be of interest costwise.

GRINDING MIXTURES OF PIGMENTS

Often blends of pigments, with or without extenders and opaque whites, are needed to match the color copy submitted by the printer. Other changes occur on the roll mill besides the usual breaking down of agglomerates and the dispersion of pigment particles in the vehicle when the ink is well ground.

Color Shifts

A carefully made blend of an anilid benzidine yellow base ink with a milori iron blue was prepared by the small order department for a printing trial. The printer accepted this ink and ordered the large batch for the printing run. The large batch of ink is made at the factory by dry grinding on the three roll mill.

Iron blue has a harder texture than benzidine yellow. Because of this difference, there are two color shifts possible as the grinding operation proceeds. The yellow grinds easily and reaches its normal color strength sooner than the blue. The second pass on the mill is normally bluer than the first because the blue lags behind. This color shift continues until the blue has reached its normal color strength. While this color shift is happening, the blue particles tend to break down the yellow particles to still finer sizes and the color strength of the yellow can now increase. Therefore, a shift toward yellow occurs. The composite color shifts make it difficult to duplicate the trial batch without an adjustment.

A sample of a shipment of dinitroaniline orange pigment was ground on the laboratory mill using linseed varnish. The resultant ink was mixed with bleaching white ink in the usual manner for evaluation. It matched the standard in all respects. This test was repeated on the muller with the same results. The production batch of an ink made from this shipment did not match the ink standard. The resultant ink was found to be more yellow and definitely higher in color strength. The discrepancy in the results was investigated. It was noted that the laboratory ink contained only the orange pigment, whereas the factory ink contained an equal blend of alumina hydrate with the orange. It was indeed a surprise to discover that the hydrate ground the orange, causing the color shifts.

It is in the manufacture of tints that the color changes during grinding present a real problem. A tint made from an opaque white, such as zinc oxide or titanium dioxide white, and toluidine red shows a relatively large increase in color strength as the grinding continues. The whites tend to grind the soft red and the color strength goes up on each succeeding run.

A case is known where a mill hand spend all day trying to get acceptance on a 500-pound batch of a toluidine red tint. Additions were made to adjust the color strength and the shift in hue. Finally the batch was approved by the inspector. By that time the batch of ink had grown to 800 pounds. It would seem that a better procedure in this case would have been to grind the colors separately, then transfer both inks to a mixer and mix until uniform. This would have to be followed by a loose run on the mill to remove the air bubbles formed during the mixing. A tight run at this stage must be avoided.

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