Absorption, setting and drying

The surfaces of graphical and packaging products are printed and varnished to meet a range of promotional and functional requirements. An essential requirement is that the printed and varnished surfaces must be fully dry to withstand normal conditions of use without marking, scuffing, rubbing or smearing.

Gluing is used to join paperboard surfaces together, providing permanent shape. Gluing is also used to erect and close cartons and to provide several functions with graphical products. Gluability is therefore an important property.

Predictable and reliable interactions between the surface and the inks and adhesives is built into the paperboard by the careful selection of the coating pigments, as well as by the surface sizing system and interlaminar strength.

Printing During printing and varnishing the inks and varnishes require fluid mobility to facilitate their transfer from a duct or reservoir via a plate, cylinder or roll, to the surface being printed or varnished. The ink or varnish component which provides fluid mobility is known as the vehicle. Typical vehicles are drying oils which are chemically related to linseed oil, organic solvents and water. The choice of vehicle depends on the type of ink or varnish and printing process or other type of application system. If the surface is plastic coated or film laminated, the surface tension might be too low for printing. The surface can then be treated to achieve better printability properties. This can be done by a gas flame or corona treatment.

Measurable properties

Surface tension The surface tension of a specified liquid that, when applied to a surface (as a thin film) does not reticulate for at least two seconds, gives a measure of surface wettability. The surface tension of a plastic surface is normally too low for printing or gluing. The surface is therefore treated with an electrical corona discharge. This gives a slight oxidation of the plastic surface, changing the polarity of the surface. This can be observed by surface tension measurements.

Test method and equipment Pens containing solutions giving defined surface tension levels are used. To test the surface tension a wide line of solution is drawn on the corona-treated plastic surface. If the liquid film created by the test solution remains unchanged for more than 2 seconds a solution with higher surface tension is tested. If the time is less than 2 seconds a solution with a lower level is tried. By continuing systematically in this way the right level is found. The value is specified in dynes/cm.

Printing surfaces are either non-absorbent, such as plastic, metal or glass surfaces, or absorbent as is the case with pigment-coated paperboard surfaces. To achieve satisfactory drying of ink and varnish it is necessary to either remove the vehicle, for instance by evaporation, or change it chemically from a liquid to a solid state. In printing and varnishing there is therefore an important connection between the absorbency of the paperboard and the drying process.

During printing the degree of drying must ensure a dry print free from set-off or marking and, where necessary, meet specific end use requirements for the avoidance of odour and taint. At the subsequent stages of conversion, printed and varnished surfaces must be dry to ensure durability and the avoidance of rub-off in handling and finishing processes.

The end user requires fully dried printed and varnished surfaces in order to avoid rub-off during packaging and handling and from surface to surface friction during distribution. The end user is also concerned that the consumer does not experience ink or varnish rub-off during handling.

Adequate drying of ink and varnish is essential to avoid flavour or aroma changes in sensitive packaged products such as chocolate, confectionery and tobacco.

The paperboard choice If the paperboard is printed or varnished, especially in a high speed operation, the absorption and drying properties are vital. Insufficient absorption and unsuitable drying properties may lead to scuffing or smearing. The paperboard absorbency must also be uniform over the entire surface, to avoid printing problems which could cause colour variations or mottle.

The fibres, paperboard treatments, and coating composition are features which, to a high degree, determine the absorption properties of the paperboard. The composition of inks and varnishes also has an impact on absorption and drying.

Both Folding Box Board (bleached chemical pulp in the outer plies with mechanical pulp in the middle) and Solid Bleached Board (pure bleached chemical pulp) are good choices with regard to absorption and drying. This is mainly due to their predictable properties.
Absorption, setting and drying

Absorption and drying properties
Drying is achieved in one of several possible ways depending on the type of ink or varnish and the method of application. The fluid vehicle must either be removed or transformed to the solid state.

Drying by evaporation
Where the vehicle is composed of organic solvents such as aliphatic alcohols, esters, ketones, toluene, or water, heat can be used to remove the vehicle. Hot air is applied on gravure and flexo presses immediately after each printing unit so that solvent removal is virtually instantaneous leaving little scope for any absorption. When organic solvents are used on gravure presses it is necessary to ensure very high levels of solvent removal since in addition to the drying requirement there is an additional need to control residual solvent levels for odour and taint sensitive applications such as tobacco packaging.

Emulsion coating on sheet-fed offset litho presses where water is the vehicle has become popular in recent years with water removal being achieved by hot air and infra-red driers.

Once the vehicle has been removed by evaporation, the resins and, in the case of inks, the pigments, coalesce and become securely bound to the surface of the paperboard.

Drying by chemical change
Pigment coated and uncoated paperboard surfaces are absorbent to inks and varnishes. The absorption properties are particularly important where oil-based inks are used in the sheet-fed offset litho and letterpress processes. In these processes absorption is the first stage of the drying process. When the high viscosity ink is transferred to the surface of the paperboard, there is a rapid filtration and penetration of the less viscous components. This results in what is called “setting”. Setting immobilises the ink or varnish on the surface to a sufficient extent such that set-off is prevented. Rapid setting is the key to high speed printing of high quality work on such surfaces.

Setting is controlled by the paperboard manufacturer through:
• The formation and treatment of the layer of fibre to be coated.
• The particle size and shape of the mineral pigment (china clay, calcium carbonate).
• The type and amount of binder.

These features provide selective filtration by capillary attraction of the low viscosity components of oil-based inks. If the setting is too rapid, excessive penetration of the ink or varnish can occur, resulting in poor print impression (piling) and poor drying. Penetration is increased at higher temperatures when the viscosity of the ink or varnish is reduced.

Drying continues in the stack due to an oxidation polymerisation of the drying oils leading to durable rub-resistant print and varnish. Linseed oil itself dries unaided but very slowly. Oil-based inks today are based on synthetic drying oils supplemented by drying agents which accelerate the drying process.

Another range of inks and varnishes has been developed for use in the offset litho, letterpress, and gravure processes and in sheet varnishing, which do not have a specific vehicle component. These inks and varnishes can be viscosity-modified for application by all the processes listed and they are dried or cured virtually instantaneously by UV radiation on the press or varnishing machine. The process of drying is a cross-linking polymerisation of a resin system. The reaction has to be light-initiated using a compound which absorbs UV radiation and activates the cross-linking of the other monomers. It is important to expose the printed or varnished sheet to the UV radiation as quickly as possible after application. This is to ensure that any absorption by the substrate of the ink or varnish does not prevent the complete reaction of all the components.

Assessment of absorption and drying
Absorption is assessed by applying ink to the paperboard surface and evaluating the result. Printing and varnishing are operations which require a paperboard with uniform absorption properties.

Absorption and setting
Key absorbency properties
Paperboard either has a pigment-coated surface or an uncoated surface. In both cases the surface is absorbent to ink and varnish.

Absorbency is dependent on the fibre, sheet formation, treatment of the paperboard and, where present, on the pigment coating formulation, quality, application, and smoothness. These features of the paperboard also control the surface smoothness and surface wettability. These properties influence how the ink and varnish lie on the surface and influence absorbency on absorbent surfaces.

Uniformity in absorbency is important within an order and from order to order to ensure uniform printing and varnish results and to avoid absorbency-related mottle effects.

Key drying properties
Where drying takes place by oxidation polymerisation, i.e. offset litho and letterpress printing, the surface pH is an important property. If the surface pH is below 5.0 the drying process is inhibited.

The setting speed of oil-based offset litho and letterpress inks is an important property. It relates to the avoidance of set-off of wet ink and varnish on the reverse side of the sheets in the freshly printed or varnished stack.

Measurable properties
Surface pH
The surface pH gives a measure of the concentration of hydrogen ions in an aqueous surface extract. The correct level of surface pH is important for the ink-drying process and for inks containing metal pigments, such as bronze, low pH will affect the colour due to oxidation. Normally a pH of around 6–8 is required, where a pH below 5 is too low.

Test method and equipment
A drop of surface pH solution is placed on the paperboard surface and a pH electrode is placed in the middle of the drop. After 90 seconds the pH value is recorded. The test is usually carried out on both the print and reverse sides.

Key characteristics
Regardless of whether the system used for internal sizing of the paperboard is acid or neutral, the type of pigment used for coating plays the major role in determining the paperboard surface pH level.

Test methods
Ink absorption is assessed by applying a specified ink film to a surface and wiping off the unabsorbed part after a certain time. The amount of absorbed ink is measured as the brightness decrease caused by the ink. The higher this value is the higher the absorption.

The ink-setting property of an absorbing paperboard surface is generally tested by pressing a fresh paper surface to a newly printed one. The more ink that is transferred after a certain setting time the poorer is the absorption or ink setting of the printed surface. The test can be carried out using a laboratory press such as IGT or Prüfbau. Time spans involved are from 10–20 seconds up to 5–10 minutes.

Ink drying is tested by rubbing the printed area and noting the time needed until no ink can be rubbed off from the drying print. Drying times are normally from around one hour up to several hours. The shorter the time the better.

Test method and equipment
This test is performed according to the SCAN standard (SCAN-P 70:09) and generally known as the K & N test or Lorilleux Poroëtriqune test depending on the test ink used. The special testing ink is applied to the paperboard surface to an ink film thickness of 0.1 mm. After exactly 2 minutes any unabsorbed ink is wiped off. A grey coloured area where the ink has been absorbed remains.

The test area can also be used to visually evaluate the evenness of absorption over the surface. An even surface absorption is required. If the area is mottled or stippled, then there is a risk of mottle during printing, especially in large areas of solid print.

Key characteristics
Ink absorption is strongly influenced by the make up of the coating such as the type and size of pigment and type and proportion of binder. To obtain a mottle-free ink absorption both the baseboard and the coating must have uniform absorption properties.
Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability

Gluability