DRYERS

When buying new printing equipment the first question considered is normally. "What type of printing machine do I need?" "How fast will it cycle?" "How big does it have to be?" Flat bed, fixed bed, moving bed, belt drive, cylinder, reciprocating, etc etc. Then what ink systems do I need and then will the dryer fit in. The dryer is often an after-thought. The focus being on the printing machine. This can be a costly mistake. The rate of development of dryers is much faster than that of screen printing machines. It is quite reasonable to use a printing machine that is well a maintained ten year old but a ten year old dryer will cost you a lot of money in slower production and energy usage.

A 10-year-old dryer is likely to use 30% more energy than a current model and the heat generated will be substantially higher.

This is not supposed to be a paper on Dryer Technology, it is to emphasise the point that dryer selection is critical. Energy costs can be huge and a faulty dryer can create rejects faster than you can print them. Work out the business case before you make the decision as to the type of dryer that you need.

Modern dryer technology can be divided into two distinct areas Ultra Violet Curing systems and Drying for Solvent based inks. There are other systems such as Radio Frequency (RF) Curing, Microwave or Electron Beam Curing but they are rarely used in screen printing.

DRYING SOLVENT BASED INKS

For the majority of solvent-based inks the purpose of the dryer is to remove the solvents from the ink and allow the resin systems in the ink to bond to the substrate. That being the case a high airflow across the surface of the printed substrate is the most effective means of drying. If that air is also heated the speed of drying will increase, too much heat will cause problems.

Most solvent-based inks will dry eventually if the printed sheets are racked at ambient temperatures. Clearly this is fine for low speed printing but where output rates are required the substrate needs to carried away by a conveyor. This is where we move into the characteristic tunnel dryers seen in most screen printing shops. The questions are: Is it the right dryer? What happens inside the dryer? On what principle does it operate?

The simple answer is to ask the manufacturers. We are fortunate in the UK to have two of the worlds' leading dryer manufacturers in Natgraph Limited and Trumax Limited within them and others there is a vast pool of knowledge available to the market. They in turn talk with the ink manufacturers. Unfortunately often the customer has fixed ideas and simply won't ask the experts. The dryer determines the speed at which you can print, the inks that can be used and the stability of the substrate, which in turn affects registration.

JET DRYERS

Jet air dryers use a combination of heaters and fan driven high-pressure air. On start up, they will use full power but then once up to temperature the heat generated by compressing the air will reduce the need for full power on the heaters. The high flow rate of the air means that lower temperatures can be used to drive solvents from the ink. All this adds up to much lower energy costs and superior substrate stability.

As well as applying the energy to drive off the solvents it often also necessary to cool the substrate to bring it back to the correct size. This can take the form of ambient airflow or even refrigerated air. The higher the print rate the more likely the need to cool the substrate. Modern dryers have very sophisticated sensors and controls that adjust the output of the dryer to suit the speed and loading. They are divided into zones and a PLC Controller can adjust the conditions at different parts of the dryer. Account has to be taken of the substrate as a 50 micron film will behave quite differently in its passage through the dryer than 5mm fluted board.

One of the key considerations is where the solvent laden air goes from the inside of the dryer. Attaching a piece of flexible ducting on the outlet and sticking it through the window is definitely not the right approach. Airflows out of the exhaust dramatically affect the efficiency of the dryer. Listen to the recommendations of your dryer supplier, better still let them survey the site and specify the exhaust requirements. While we are talking about specifications be sure that you have sufficient power available to run the units. Don’t forget the peak demand on start up.

WICKET DRYER

Ideally you want to use as little heat as possible to dry most solvent-based inks. An alternative for some applications is a Wicket Dryer. These are typically

Used where substrate stability is paramount but they also have the benefit of being very efficient. Printing of ceramic decals on release paper is an example of such an application, here small variations in moisture content will effect the stability of the substrate and hence registration. A typical comparison would be for the same through put a Two Stage Conveyor Dryer with Cooler section would use 48Kw whereas a Wicket Dryer would use 5 Kw. The down side of a wicket dryer is that they will only take a maximum number of sheets in one pass and generally requires more floor space. Wicket dryers do not have the flexibility of conveyor dryers but they can be the optimum solution for some applications. With both systems the more time, which equates to a longer unit and the lower the temperature the better.

There are some inks commonly known as “Baking Inks” where the ink has to be elevated to a trigger temperature for the curing to start and sometimes held at that for many minutes to affect a complete cure. The addition of Jet Air will often accelerate this cure but it may still need time in a static oven, as a conveyor oven could be unacceptably long. Discussions with your dryer manufacturer and ink manufacturer involved are often critical to the success of a project.

Don’t fall into the trap of thinking that drying solvent inks is a thing of the past. As printing increases its penetration into the industrial field the adoption of the correct drying technology becomes paramount. It is all too easy to just see it as a printing application when it is in reality the modification of surface features to achieve a change in electrical, mechanical or reactive characteristics. The materials used in this area cannot always be formulated for use in Ultra Violet curing chemistries.

CATALYTIC CURING

A technology that appeared to have real promise was Catalytic Curing. It operates as follows: an electrical element preheats a porous bed to between 450°C and 650°C. Natural gas is brought into contact with the bed and reacts with oxygen to produce CO_2, water vapour and heat. This reaction occurs at temperatures under 700°C, the ignition temperature for natural gas. No flame is produced which means that the process can be used where there is a risk of explosion. One exponent of the system used to carry out a pretty dramatic demonstration of throwing petrol into the catalytic element without causing an explosion. With one or two exceptions it is not used in screen printing applications. One of the reasons being the initial cost of the system and the preference for electrical heating in the industry. This does not preclude it from gaining in popularity.

GAS DRYERS

Working on the principle of “If you know nothing say nothing” all I hear about gas driers is that they claim to have 12% of the operating costs of electric dryers and claim to be 2 to 6 times faster. Users comments would be appreciated.

INFRA RED DRYING

The advantage of infra-red is that it only heats objects that are placed directly in its path, focusing its energy where it is needed without the need to heat up the air in between. Infra Red Drying comes in three wavelengths, Short, Medium and Long.

SHORT-WAVE INFRA-RED

The emitter operates white-hot. It is sealed in a quartz enclosure, which may be tubular or shaped like a spot lamp bulb. Tubular emitters are available in a range of lengths and require an appropriate reflector system (focused or diffusing) to concentrate the heat on the target. The spot lamp types have integral reflectors. Short-wave emitters are very responsive. They may be switched on and off within seconds but generally require electronic control. Industrial installations may be designed with very high power densities and these give correspondingly high rates of product heating. They are colour sensitive and work best when the ink is darker than the substrate.

MEDIUM-WAVE

The emitter operates at bright red heat. It is generally located in a quartz tube but is not sealed. Some designs use metal emitters on an insulating panel. Tubular and 'cassette' emitter configurations are available. Recent designs of cassettes provide much better performance than earlier linear types. Response times vary considerably between different designs.

LONG-WAVE

The emitter operates at dull red or 'black' heat. Several designs are available including tubular metal clad types or ceramic plaques. Metal clad emitters are very robust but energy intensity is limited and response times are relatively slow. These are not colour sensitive as experienced with Short Wave Infra Red.

With all types of infra red it is important to remove the solvents driven off from the ink, so you will still need extraction. Often the combination of Jet Drying and Infra Red give the ideal solution particularly in industrial applications where high temperatures are required. Baking inks are an example.

ULTRA VIOLET CURING

With UV curing technologies there are two main categories. Conventional Mercury Vapour and Metal Halide or Flash Curing.

Paper, board, a wide range of polymers and some metals are ideally suited for UV curing technology. This takes in most of the graphics industry and other display applications.

The curing level of UV inks is crucial from an adhesion to substrate point of view and inter-coat adhesion. Insufficient cure and ink will not stick to the substrate and too much cure will mean subsequent layers of ink will not stick to each other. Over curing can also making the ink brittle. Having said that current UV ink formulations can be used on vacuum formed components.

Cure is affected first by the relationship of the spectral output of the lamp to the spectral range requirement of the photoinitiator in the ink. If they do not match no amount of UV energy will cure the ink. The output of the lamp is determined by its chemistry. The two common types are Mercury Vapour and Metal Halide. There is a range of variations on a theme, which in UV parlance is known as “doping.” This is where traces of Gallium, Lead, Iodides or Iron are added to the bulb. They will all produce different wavelengths of UV light (Spectral Outputs). The issue of their working life is important. Each lamp type will have recommended working lives ranging from 500 hours to 1500 hours. Once passed their working life the amount of useful energy in the required spectral output would have reduced substantially and you are left with an excess of Infra Red energy, which is heat, resulting in size variation of the substrate. Infra Red energy is not all bad it is the excess that is a problem. A certain amount of heat helps the chemical reaction and encourages the ink to flow out before it hardens. Once the reaction is initiated by the UV Light it takes time to fully cure this can be up to 24 hours. Applying heat will accelerate this final cure.

The majority of current inks and coatings are cured by exposure to energy at the 254nm and 365nm regions.

Some new coatings and special applications call for other wavelengths such as 385nm and 417nm. Doping can create these and other radiation bands.

FLASH OR CONVENTIONAL

You then come onto the issue of the pros and cons of Flash Curing (Pulsed UV) against Conventional Lamps (Continuous Wave). Nobody has yet done a full scientific comparison of the two methods when used in screen printing. In both cases they set off the chemical reaction (Polymerisation) in progress by stimulating the photoinitiators in the ink.

Flash curing was developed in the screen printing industry as a means of drying UV inks on multicolour lines. The need was to surface dry the inks between colours so the next colour can be over printed. Drying should take place within the cycle time of the print. As well as the fast dry the amount of heat generated is kept to a minimum. In spite of the low heat levels produced during the flash there can be a tendency for heat to build up over time and affect the stability of the substrate. The addition of fan cooling within the drying unit has virtually eliminated this build up. To affect a complete cure of the multiple prints the printed substrate is passed underneath Conventional Lamps (Continuous Wave) at the last station.

Ink manufacturers and suppliers of Flash Curing units have worked very well together to produce inks that perform effectively with these systems. It is fair to say that they are at their best when working with transparent process colour inks. If opaque line colours are to be printed these are best done at the final station so they can be cured by the conventional lamps.

The alternative to Flash Curing is to use Conventional Lamps that move across (Scan) the printed substrate. These lamps can cure standard UV screen printing inks without need for modification. It is claimed that the Scanning system uses more electrical power than Flash Curing. How the business case pans out between capital cost, spares costs, energy consumption and ink costs I am not in a position to state in this article. This must be fully examined before you make the purchase decision. If you buy a Scanning System you can use the same inks. If you buy a Flash Curing system it is likely you will have to change or modify your inks. This assumes you were using UV curing inks in the first place. An environmental and Health and Safety is Flash Curing does not produce ozone.

COMBINATION UNITS

Manufacturers will provide Infra Red, Jet Air, Ultra Violet and cooling in a single line. These are extremely flexible systems that are ideal for a printer wishing to use a range of ink types.

CARE OF DRYING UNITS

Keep them clean: reflectors, quartz filters, casings, belts, exhaust outlets, and control panels. Maintain: safety devices, belt, belt drive mechanisms, fan bearings, control circuitry and human interfaces.
Replace as required: UV lamps (emitters)

THE AWFUL TRUTH

On one particular visit where a customer was complaining about his "faulty" dryer the engineer found the reflectors were dirty, the bulbs had been run for 1500 hours, the belt was worn and jerky, inside of the casing was filthy and the exhaust was restricted. When the owner of the company was quizzed and asked if he had ever serviced the dryer he said "Never". When do you service your car? Asked the engineer. About every six months. Why don't you service your equipment? "It's only a bl***y dryer" was the reply.