Radiation curing of paints, inks and coatings

Inert gas ensures superior quality in UV and EB processes

Many materials today are printed or coated in automated systems. Substrates can include, among other things, paper and cardboard, fabric, metal, glass, ceramics, plastics, wood or composites. To cure the inks, paints and coating materials, more and more production operations are using ultraviolet light (UV) and electron beam (EB) radiation methods. Those methods offer major advantages over conventional drying methods. The optimal surface quality is achieved in curing chambers with an inert nitrogen atmosphere.

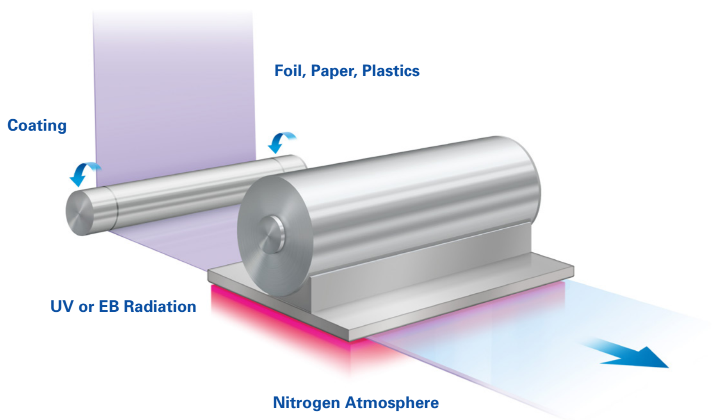
Drying of print and coating material

Conventional processes cure ink in a drying oven after printing or coating. This takes a lot of time and energy, tying up space and production capacity for extended periods. Applications that cannot use water-based coatings require solvents, which volatilize during the drying process and necessitate waste air treatment. And these traditional methods also do not always ensure optimal surface quality.

Radiation curing replaces drying

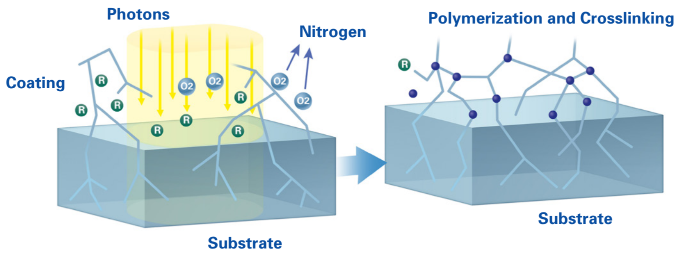
Modern coatings that are cured with UV light or electron beams need no environmentally harmful solvents. They do not pollute the atmosphere with volatile organic compounds, and the vapors and exhaust gas do not require treatment. Radiating the inks and coatings speeds up the process dramatically and enhances quality at the same time.

Two kinds of radiation are used for drying and curing: Ultraviolet light (UV) and electron beam (EB). In the still-liquid coating, both kinds of radiation trigger the chemical process of polymerization. The ink and/or coating material cures rapidly, forming a very uniform surface. Radiation curing can be applied on practically any substrate. It is also suitable for coating with silicone and cellophane as well as for lamination.



Liquid becomes hard – polymerization

The energy of the UV or electron beam activates the molecules in the liquid coating material. Free radicals are formed, which initiate a chemical chain reaction: Polymerization. Within milliseconds, individual molecules (monomers) bond together into long chains (polymers), cross-linking stabilizing interconnections between them at the same time. When this process follows its intended course, it very rapidly forms a dry, elastic layer that offers high mechanical strength and chemical resistance.



Disruptive influence of oxygen

Oxygen (O_2) exerts a strong attraction on free radicals. They react much faster with O_2 molecules from the surrounding air than with the monomers of the liquid coating material. Such reactions produce undesirable chemical bonds, including aggressive substances such as peroxides or nitric acid. They also disrupt the polymerization process: So-called "oxygen inhibition" interrupts the crosslinking process and adversely affects surface properties. The rate of polymerization slows, and the process takes much longer to complete. This means that certain substrates, such as heat-sensitive films, can no longer be processed. Moreover, more energy is consumed.

To counteract the disruptive influence of oxygen, the share of photoinitiators in the coating material can be increased. Some products then tend to yellow, however, and it makes the UV-cured printing ink much more expensive. A higher share of this additive also imparts an intensely unpleasant odor, which is objectionable in more than just food packaging. All of these side effects are eliminated, and additional photoinitiators become unnecessary, when the radiation curing is carried out in an oxygen-free atmosphere.

UV process

Curing by means of ultraviolet light (UV) is a photochemical process. It uses UV-reactive paints, inks or coatings with low photoinitiator content. The UV light initiates the crosslinking process, which is completed in milliseconds. UV-cured products have a fully dried surface, which is both high-gloss and elastic as well as highly scratch-resistant and chemical-resistant. They can undergo further processing immediately. Because no solvents are needed, the associated emissions and risks are eliminated. UV curing takes significantly less space than conventional drying systems.

EB process

This process uses an electron beam to cure the coating material. Electrons accelerated by electric voltage are directed towards the product to be dried. The resulting free radicals trigger the polymerization. The voltage level can be used to vary the speed of the curing process and the depth of the curing effect. The process can attain surface quality that even exceeds that of UV curing. It uses less energy and can be completed even faster. EB curing works without any photoinitiators whatsoever, but always requires an oxygen-free atmosphere. Because the process generally works at about 15°C, it is also suitable for use with heat-sensitive materials.

Nitrogen ensures quality

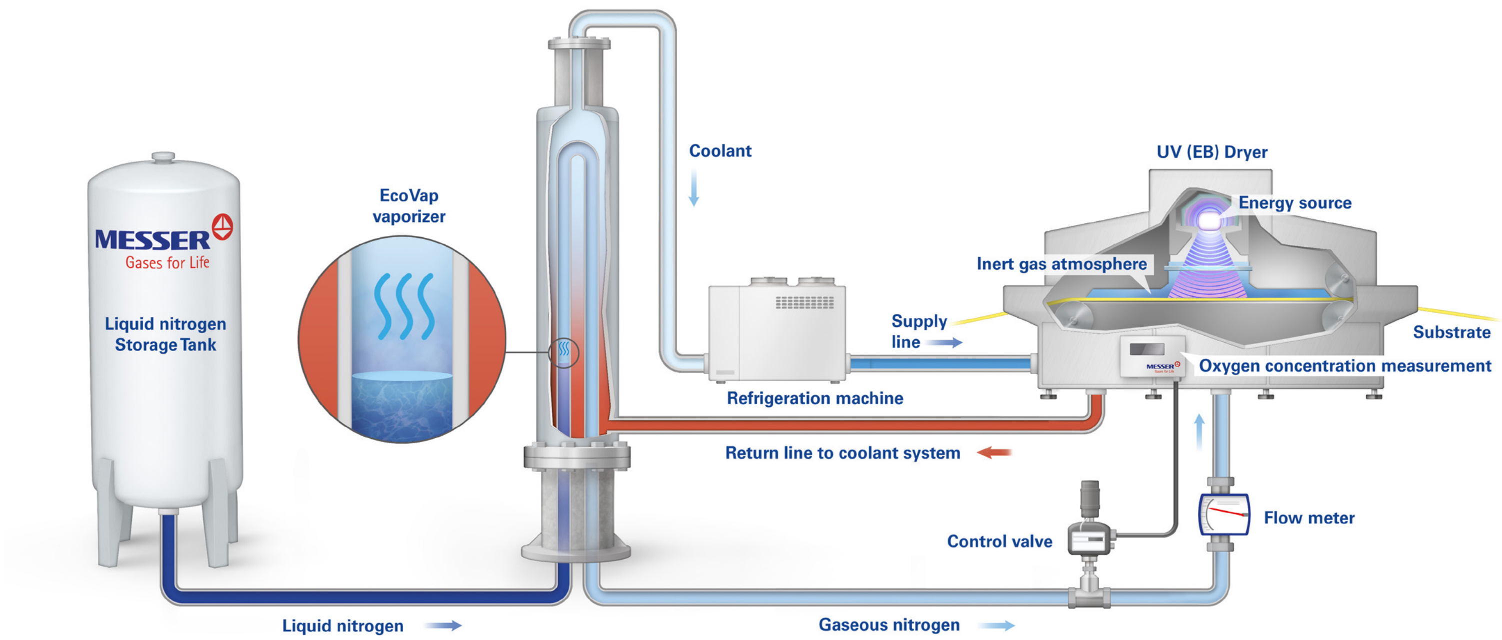
With the EB process, an inert atmosphere is absolutely essential. With the UV process, it offers major benefits and improves both product and process quality. The protective atmosphere is maintained by continuously supplying nitrogen (N_2) to the curing chamber. The inert gas displaces the ambient air, and with it, the oxygen. Undesirable reactions are practically eliminated and the free radicals can do their actual job unimpeded: starting the polymerization process. Unintended, harmful or downright hazardous byproducts such as ozone, nitric acid and peroxides never even have the chance to form. As a basic component of the natural atmosphere, nitrogen is completely harmless.

Messer installs nitrogen supply

High-purity nitrogen from Messer creates the desired oxygen-free or low-oxygen curing chamber atmosphere. On request, Messer handles the installation of the complete nitrogen supply system for the curing chamber. That also includes the instrumentation and control technology that monitors and regulates the atmosphere there. It ensures an optimal control of the inert shielding gas flow, thereby guaranteeing the high efficiency of this sub-process.

Added value: Free cooling energy

Liquid nitrogen (N_2) has a temperature of about -196°C. The cryogenic N_2 is evaporated in order to enter the radiation curing unit in gaseous form. This releases a large quantity of "cooling energy." With the EcoVap system from Messer, a heat exchanger uses that cooling energy to cool rooms, processes or coolants. This saves considerable amounts of energy that would otherwise be needed to power conventional, electrically driven refrigeration systems. Those savings also reduce the CO_2 footprint of the operation.



Your benefits at a glance:

- Accelerated printing and coating processes
- Improved surface quality
- Financial and ecological benefits
- Up to 40 percent less energy consumption
- Lower share of photoinitiators (in UV processes)
- No ozone emission (EB processes)
- Low curing temperature does not harm the substrate
- Delivery and installation of the nitrogen supply technology from a single source
- Cooling capacity as added value (optional with EcoVap

Test first, then install

Messer's experienced experts support you with comprehensive know-how. We determine the data for the detailed engineering under actual operating conditions. With on-site tests, we ensure that the theory also works in practice: Optimal performance at reduced operating costs.

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