SOLUTIONS FOR
WOOD COATING

May 2019

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1. Wood coating in general

The coating of workpieces made from wood makes special demands on coaters. This document "Solutions for Wood Coating" by WAGNER offers information about coating processes and technical demands.

Wood, a "living" material

One type of wood is not just like another - they vary widely. On the one hand there are naturally grown woods and on the other hand composites such as MDF, chipboard, multiplex - each of them with different characteristics and requirements. Wood objects to be processed can be small or large, in parts or assembled, curved or flat, vertical or horizontal, with complex or simple shapes.

The coating process must fit to the wood type and the production process. Therefore, detailed planning of the application and right choice of material are the keys to successful coating and economical production.

Numbers and challenges of wood coating in the European furniture industry

In Europe, about 118,000 furniture-makers generate an annual turnover of approx. EUR 88 billion/year[1)]. The main growth markets today are to be found in Asia and especially in China[2)]. The challenges for the numerous small to medium sized businesses as well as for larger companies remain: Imports from low-wage countries and increasing raw material prices are impacting on profit margins. In addition, the furniture industry often cannot cover the need for new qualified staff[3)]. On top of that is the high environmental and health consciousness of consumers as well as the increasingly strict legal regulations, in respect to solvent-based coatings[4)].

Many furniture manufacturers ask themselves the question of where they can find suitable, cost-efficient coating methods for wooden furniture. Here, the focus is primarily on solvent or water-based liquid coatings. But the powder coating of MDF panels and solid wood is an interesting alternative for certain application areas. Cost optimization in both areas is possible.

This can be achieved with different approaches:

- *Efficient material usage and low material waste*

Modern coating technologies have excellent transfer efficiency rates. Minimal volumes of paint are required to coat wide areas. This is saving material and money.

- *Fast color change, shorter cleaning times*

Due to fast color change processes and shorter cleaning times, the coaters can produce quicker. This results in improved production efficiency, which increases the profit.

- *Rapid further processing thanks to short drying times*

Modern coating systems enable the quick curing and drying of the coated parts. Therefore, the production gets faster, and the assembling of furniture is possible within shorter time.

- *Efficient work processes*

Processes are optimized by new technology and reducing the number of passes. This reduces labor operation, cost and time.

- *Higher automation level*

A lot of manual handling has been replaced by automatic processes such as color changes and cleaning. These procedures are saving time and increase process stability.

At the same time, the coatings need to satisfy the respective quality and decorative demands of the customers - such as hardness, durability, numerous colors, different surface structures, soft feel surfaces or chemical and mechanical resistance surfaces.

All these requirements must come together in a single efficient overall coating concept. The varieties and possibilities of liquid coating and powder coating will be explained on the following pages.

1) European Furniture Industries Confederation (April 2019): The Industry. Available at: www.efic.eu
2) https://info.pra-world.com (April 2019)
3) European Furniture Industries Confederation (2016): Major Challenges. Available at: www.efic.eu/Industry.aspx?view=major_challenges
4) Philipp, Claudia (2010): The future of wood coatings. In: European Coatings Journal 1/2010.

2. Liquid coating

Liquid coating is the most widely used type of application for wood objects. It is the ideal solution to achieve high-class surfaces with excellent gloss level. Manual and automatic liquid coating processes offer several benefits such as fast color changes, custom coatings, low start-up costs, a great range of suitable materials and colors, including metallics and high gloss.

Efficient coating equipment is the key to success

To increase possible savings with liquid coating, some general considerations need to be made first. Here we have to consider choosing the right liquid application technology. It's centered around the following factors:

- *Type of wood*

Each kind of wood material has its own characteristic. Porosity, surface or density vary from type to type. These parameters must be considered to choose the most valuable and efficient coating technology.

- *Object geometry*

Coating a flat panel is by far easier than coating a shaped part with openings and rounded edges. The numbers and types of parts in production and the best coating method need to be clarified.

- *Type and viscosity of the paint*

Different types of varnish can show different flow behaviours. Coating guns and pumps must be able to handle these characteristics in all circumstances.

- *Training and expertise level of the employees*

The simpler to handle a technology, the better the result. Employees must be able to handle the chosen coating technology and should be trained to work with any new processes.

- *Application method*

The output of products, the variety of parts and forms and the degree of capacity are key elements to decide the proper kind of liquid coating system. Depending on the demands, you can choose between manual coating and automatic coating. One of the key factors for the decision is the existing or future volume of production.

- *Targets and requirements of the furniture manufacturer*

Each solution is a decision for the future. In case of production increase, the chosen coating system must handle more items and faster production in the future. Environmental issues as restrictions for solvents or the usage of environmentally friendly varnish must be considered as well, before any decision for the coating method is made.

An optimized paint material feeding system saves a lot of money

An optimized application and feeding system specially customized to the application situation is usually more cost-effective than generic systems, which are not configured specifically to the customer demands. Additionally, every liquid coating system offers optimization where further costs can be saved:

- *Requirements of the paint chemistry*

Paint and varnish suppliers know which pump system is the right solution for the chosen product.

- *Consideration of coating parameters*

Parameters such as paint viscosity, number of workpieces and production speed significantly determine the paint feeding system. The color changes per day should also be calculated in advance.

- *Paint variety and consumption*

Calculate accurately the quantity, color variety and shapes which will be used. The more colors, the more complex the handling.

- *Framework conditions during operation*

Is the painting shop planned within existing buildings or is it a new installation? Which conditions are considered for placement, space etc.? The answers to these questions will lead to an optimal paint-spray line.

- *Legal specifications and regulations*

Each country has their own regulations and legal specifications. Take care to fulfil all regulations, especially concerning environmental demands.

2.1 Manual liquid application

Several approved coating technologies are available for the manual coating process. Each of them is a harmonized combination of coating gun and pump system.

Using gravity spray guns has proven itself effective in wood coating when applying small amounts of wood stain or low-viscosity paint with low-pressure technology. High-value liquid coating spray guns offer evenly distributed atomization and a wide selection of suitable nozzles and air caps. They are specially designed for applying smaller material amounts. As the color container is directly on the gun, the area to be cleaned is minimal with a correspondingly low use of solvents and little material remainders. The following will show an overview of different atomization technologies.

Atomization technologies

Airspray process

Manual airspray gun

In this process, the atomization air flows out of a ring-shaped opening formed by a bore in the atomizer head (air cap) and the paint nozzle positioned centrically within it. The spray jet shape is controlled by flat jet (horn air) bores. The air emerging from these bores converts the spray jet with a nearly circular cross section that is vertical to the jet axis into a jet with an elliptical cross section. The compressed air is produced by compressors or radial fans.

The air atomizing processes can be differentiated into low-pressure, medium-pressure and high-pressure processes, depending on the atomizing air pressure used.

HVLP technology operates with an atomizer pressure of max. 0.7 bar/10 psi. In contrast to the low-pressure technique, the medium-pressure technique works with a high atomizer air pressure that lies in a range from 1 to 3 bar. The high-pressure technique works with an atomizer air pressure of 3 to 8 bar. Today the medium pressure is the technology which is the most used and gives the best result in 80% of application.

Airspray technology provides control, i.e. easy and precise adjustments of the atomizing air and of the fan width, for maximum application versatility and finishing quality.

AirCoat process

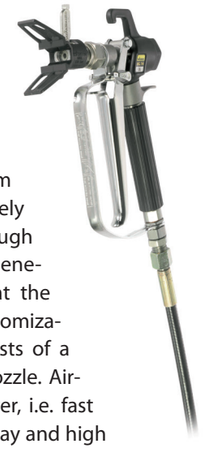
Manual AirCoat gun

The right combination of airless and airspray technology together with the unique WAGNER know-how results in AirCoat technology: perfect finishing, high productivity, soft spray pattern and very high transfer efficiency at a moderate level.

In the AirCoat spraying process, a piston or diaphragm pump is used to atomize the material at an operating pressure between 30 to 120 bar or higher. This relatively low material pressure produces good basic atomization, although streaks occur at the spray jet perimeter until the additional air is added. The paint is atomized finely with a low air flow rate of at least 90 l/min and at low pressure ranging from 0.4 bar to at most 2.5 bar. The central air supply, which is located directly next to the nozzle hole, supports the atomization and further enhances it over the entire width. The extremely low operating pressure of the AirCoat method compared to the airless process has the advantage that the paint particles move at a very low forward speed, generating a „soft“ spray jet with less overspray. This effect is enhanced by keeping the quantities of compressed air that support the atomization process.

Airless process

Manual airless gun



This process is an airless atomizing paint spray method. A pneumatic powered pump feeds the spray medium from the intake to the nozzle. The pump puts the material under medium pressure and pushes a relatively large amount of material through a small nozzle opening. This generates the dynamic pressure at the nozzle that is necessary for atomization. An airless system consists of a pump, hose, filter, gun and nozzle. Airless technology provides power, i.e. fast application speed, low overspray and high transfer efficiency.

Feeding pumps for manual liquid coating

The pump technology plays an important role for the efficiency of manual liquid coating. Piston pumps and diaphragm pumps are the best known and most valuable technologies. Parameters as varnish viscosity, flow behavior, number of color changes or the combination of primer, varnishes and top coat (2K) define the best pump system for the liquid coating of wood.

Piston pumps

Piston pump

High durability and reliability make piston pumps the ideal choice for low, medium and high pressure applications and for applying water and solvent-based paints. High efficiency air motors ensure smooth operation. The motor and its special exhaust geometry completely prevent icing up and the associated malfunctions. Best coating results are thus guaranteed.

Diaphragm pumps

The diaphragm pump technology combines a small internal volume with high stroke frequency to high pump capacity and very low consumption of flushing agent for color change or cleaning. In addition, the material is conveyed very gently, since no packing or friction interferes with the material flow. Due to the hermetically sealed design, almost all materials commonly used in coating technology can be processed without any problems.

Cobra 40-10

- Ideal solution for small quantities
- Up to 3 guns (depending on nozzle size)
- For quick & frequent color changes
- Excellent for any kind of critical material such as shear sensitive, reactive, moisture or temperature sensitive fluids

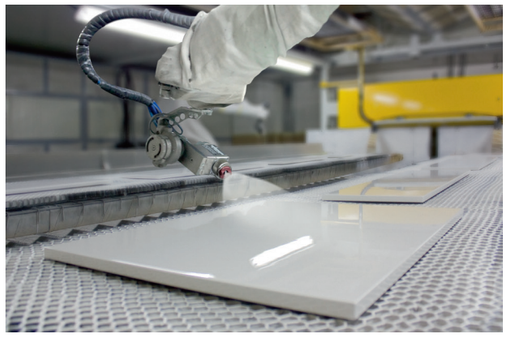
Cobra 40-25

- For bigger material consumption
- Multi-gun operation
- Bigger nozzle sizes
- Excellent for any kind of critical material such as shear sensitive, reactive, moisture or temperature sensitive fluids

Examples of diaphragm pumps

2.2 Automatic liquid application

Another option to save costs and increase productivity are automated coating systems. They are available with different technologies and are put together individually according to size and the number of workpieces. Usually, automatic coating is used with medium to large batch sizes and simple object shapes. However, some businesses with smaller batch sizes and skills shortages partially count on relief in the form of automation. In general, automated coating systems offer the advantage of applying coating very precisely, in an evenly distributed way and in reproducible quality.



In general, the automatic coating of wood follows the same rules as manual coating and uses more or less the same technology. The difference is the capacity to process large amounts, the ability of automized color change and the space needed for the installation. It is essential to count on the support of experts to plan an automatic liquid paint installation. This is a must to achieve economic, high-quality results.

From the beginning of the planning process, all participants such as application manufacturer, conveyor supplier, oven manufacturer and varnish and chemistry suppliers must be on board. This ensures to get a fully integrated technical concept.

Automatic spray guns

The same range of atomization technologies for manual spray guns also applies to automatic guns - the customer can choose between airless, airspray and AirCoat technology. All automatic spray guns are designed for high transfer efficiency. To be mounted in automatic systems, they are designed in a compact way. This makes them easy and flexible in use and maintenance.

Examples of automatic guns for liquid coating

Feeding pumps for automatic liquid coating

A wide range of pump systems is available for automatic liquid coating. This enables an adaptation to all kinds of applications and paints available in today's market. For the customer it is important to contact the paint and application manufacturer to find the ideal pump system.

Examples of pumps for automatic liquid coating

Time is money

Like in every industry, the same applies to wood coating: time is money. The faster individual work steps are completed, the higher the productivity. Therefore, many furniture manufacturers put their trust in electronic dosing and mixing units. Unlike with manual mixing, this does not just result in saved time. The quality is also higher due to the uniformly reproduceable color composition. Ideally, mixture ratios in the dosing and mixing units can be saved and called up via the display.

Generally, ergonomic, easy-to-clean equipment reduces costs, as less time is required. This way, dosing and mixing units with automatic rinsing can be used, the cleaning of which is done at the touch of a button. For pumps, combining a small pumping quantity with higher frequency is worthwhile. Here, the cavity to be cleaned remains relatively small, which reduces material loss, solvent use and cleaning time. The possible savings cannot be underestimated, as the following sample calculation shows.

Sample calculation comparing different pumps

Comparison of two pumps with 65 cm^3/double stroke (Pump A) and 10 cm^3/double stroke (Pump B) Savings potential thanks to automation of the coating

	Pump A	Pump B
	Pump volume 65 cm^3 / double stroke	Pump volume 10 cm^3 / double stroke
	Max. speed 30 double strokes/min	Max. speed 200 double strokes/min
Unused material (liters per color change)	0.4	0.1
Solvent consumption (liters per color change)	4.0	1.2
Time for color change (in minutes)	7	3

Savings

Cost of material waste (per year in Euro)	3,000	750
Cost of solvents (per year in Euro)	5,000	1,500
Labor costs (per year in Euro)	4,375	1,875
Waste costs (per year in Euro)	550	163
Overall costs (per year in Euro)	12,925	4,288
Annual savings (in Euro)	**8,637**	
Time savings per day (in min.)	20	
Time savings per year (in hours)	84	

Costs – General

Paint (per liter in Euro)	6
Solvent (per liter in Euro)	1
Waste disposal (per liter of solvent in Euro)	0.10
Workdays (per year)	250
Labor costs (per hour in Euros)	30
Number of color changes per day and final cleaning	4+1

2.3 Electrostatic liquid application: The economic alternative for complex geometries

For many years, electrostatic liquid coating has been an established coating method and can therefore be applied for wood coating. The basic principle of electrostatic coating is the power of attraction between negatively charged particles and the grounded material, i.e. the wooden object. This technology is especially suited to coat complex geometries such as window frames and shutters, rounded component parts, chairs, tables, beds, fences and rattan furniture.

Conductivity of workpieces

Proper grounding of the workpieces is essential to prevent the powder from being transferred to the painter. Moreover, the paint material must be suitable for electrostatic coating. Ask the supplier for suitability – especially regarding the paint resistance.

A conductivity of less than < 1MΩ is good enough to use electrostatic effectively. Even wooden objects can be coated if they contain a certain amount of residual humidity (> 7%). For wood application, the humidity (10 to 12%) located in the part is used to create ground conductivity. The existing air humidity of the spray area improves the effect of the electrostatics additionally.

The principle of electrostatic application

Atomized drops of paint are charged at the atomizer (i.e. the spray gun) and follow the field lines to the conductive and grounded workpiece. Due to the electrostatic charge, the paint particles repel each other. This produces extremely fine atomization which results in very homogenous material application and high-quality finishing. These fine, negatively charged paint particles are attracted by the grounded workpiece, generating a wrap-around effect. While coating the front, the overspray is attracted by the rear of the workpiece. This enables enormous savings in material and time.

Between a negatively charged electrode and a positive pole there is an electrical field with defined oriented flux lines. The strength of the field is depending on the voltage difference between the two poles and the kind of material in between (dielectric).

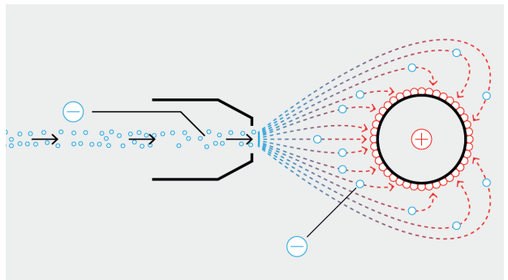
Ionizable material which is close to the electrodes will be charged and attracted by the other pole along the field lines. Since this pole is properly grounded the field strength remains constant because the disposed ions will be discharged, and the voltage difference stays constant. Otherwise the voltage between the poles will decrease permanently.

The advantages of electrostatic coating are:

- Higher application efficiency
- Wrap-around effect
- Minimized droplet size
- Better spray pattern
- More homogeneous film thickness

"Wrap-around effect" for best coating results

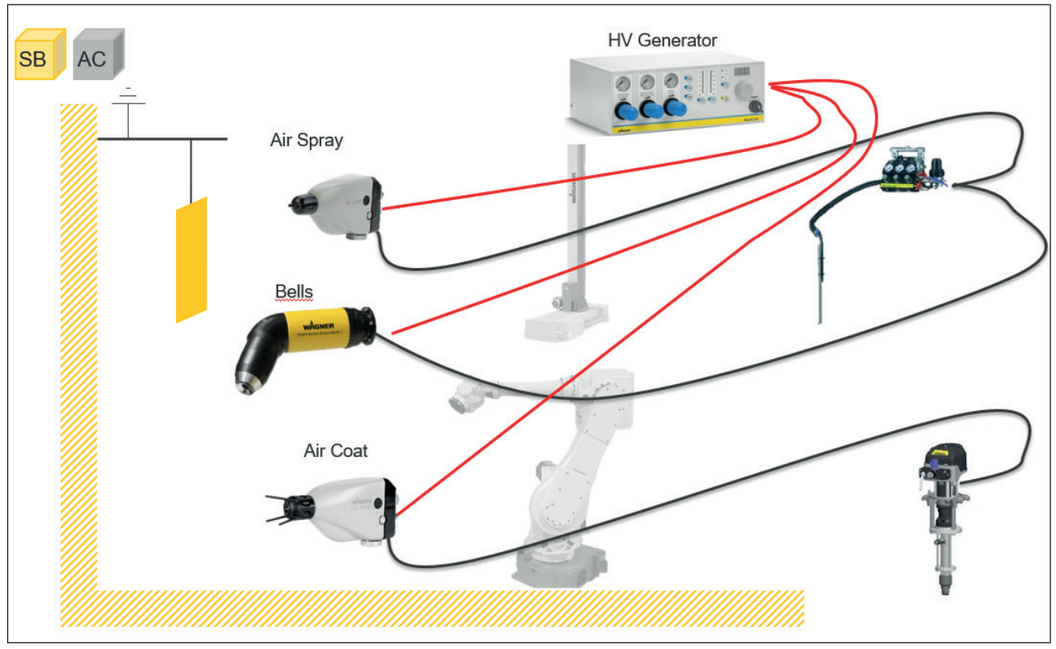
By fact of the field lines being distributed smoothly around the object the wrap-around effect is caused. Objects can therefore be sprayed from one side only. Wrap around is created by means of the electrical attraction force along the field lines. Round shaped or lattice shaped work pieces can be sufficiently coated from one side only under ideal conditions.



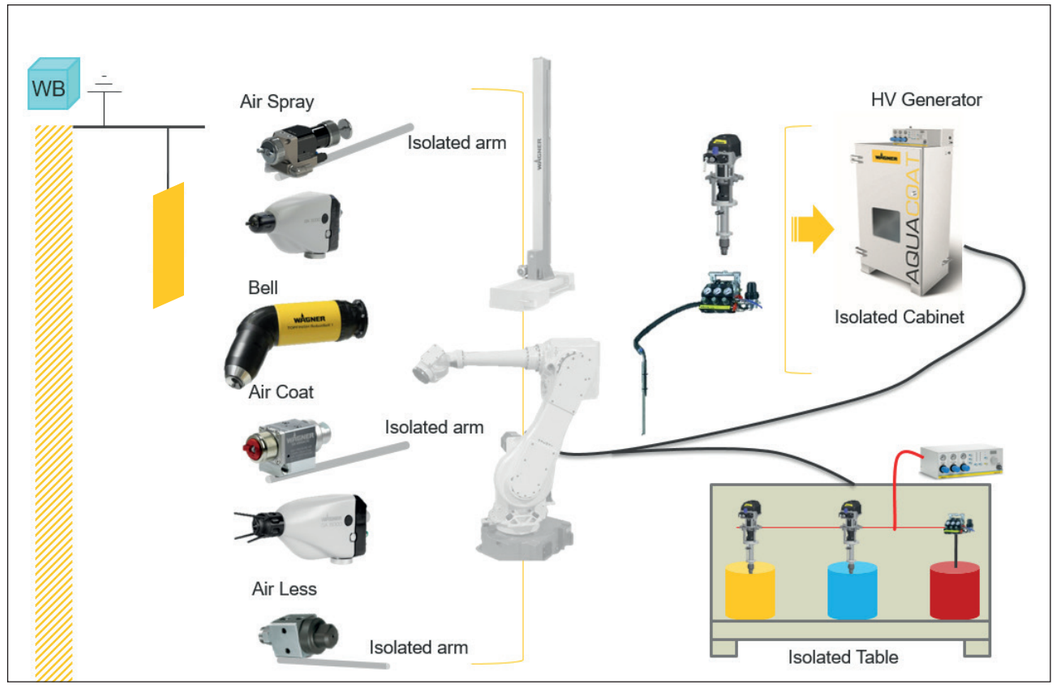
Wrap-around effect: due to the negatively charged color particles, the overspray is attracted from the rear of the workpiece

High safety and best result for water-based paints

With the electrostatic painting procedure, water-based paints can be applied. Special systems with insulation units are required for this. High safety standards make sure that the operators are protected against high voltages. These so-called AquaCoat systems are available with manual or automatic guns and for the high and low-pressure area. In addition, further solutions like automatic color change systems for mono-component paints or automatic systems with electronic mixing and dosing systems are provided which can bring about increased efficiency.



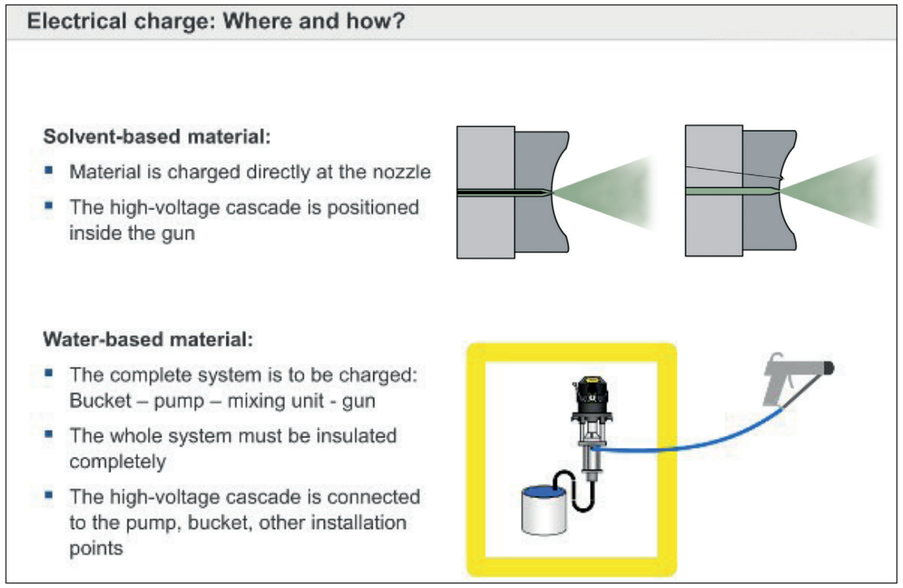
The build-up of an electrostatic automatic application (SB = solvent-based paint, AC = acid catalyst)



The build-up of an electrostatic automatic application with isolated components for water-based material (= WB)

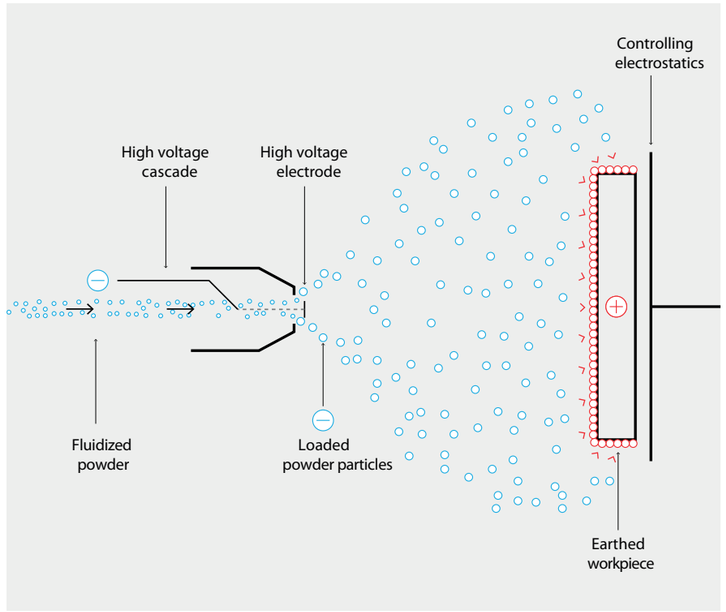
Ionization (i.e. electrostatic charging) of solvent-based paint takes place directly at the paint outlet in front of the nozzle. The high voltage cascade is mounted inside the gun. In case of airspray guns the electrode is located inside the material flow. AirCoat guns have the electrode positioned sidewise close to the nozzle in order to effectively charge the already atomized material drops.

Systems for water-based paint must be charged completely including all components. The cascade is no longer positioned inside the gun but close to the paint supply to charge the paint bucket, pumps, mixing units and all other components being in contact with the conductive material. Very important: the entire system including material hose and gun must be safely insulated against the environment to avoid any damages.



3. The powder coating process

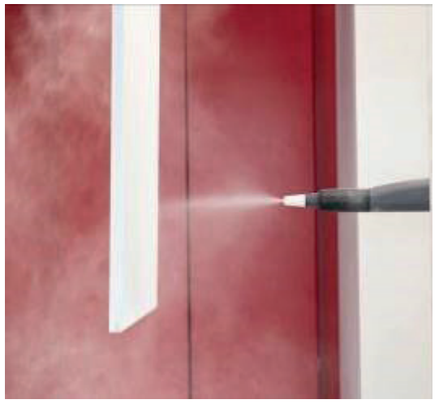
Another option for protecting the surface of wooden furniture is the electrostatic powder coating application. Powder coating of wood means mainly the coating process of MDF (medium-density fiberboard) material and is based on electrostatic, which has been explained before.



Powder coating offers the possibility for durable coatings and enables thicker and specialty finishes. It has less environmental impact due to the lack of VOC in the coating material, and ensures high material utilization thanks to the recovery of the powder.

As per today, also solid woods are feasible to be coated. A lot of effort is made by powder manufacturers to improve the application powders to be used on solid wood without restrictions. This paper, however, only focuses on the MDF powder coating process.

In general, the MDF powder coating procedure is more suitable for larger batch sizes. Both simple and complex forms can be powder coated. When it comes to the size of the items of furniture, the powder coating booth is a limiting factor. It needs to be large enough for the workpieces which are to be coated, but also small enough so that fast, and ideally automatic, cleaning is possible.



Modern powder coating plant for wood coating (Source: Karl Bubenhofer AG)

The powder coating process of MDF boards

The powder coating of MDF is a specific method. Several aspects must be harmonized to achieve high quality results. These are explained below.

Moisture control in MDF boards

Too high moisture content in MDF plates will result in edge cracking during the curing process. Less moisture content reduces the conductivity which prevents a good coating result. Conditioning rooms specially made for MDF are conditioning the boards to 4.5 % to 6.5 % moisture content. Due to changing indoor humidity between winter and summertime, the MDF boards must be controlled frequently to avoid production problems.

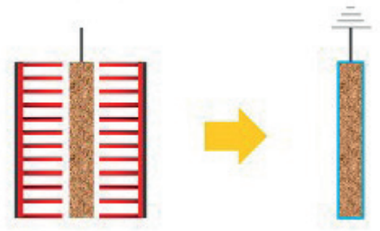
Forced conditioning of MDF boards in a conditioning room to a moister content from 4.5 % to 6.5 % for 8 hours

The powder for MDF coating is specially manufactured for low curing within 90 – 135 °C, depending on the curing system. This temperature range is much lower than for metallic parts, where the objects are cured often up to 180 °C and more. Established powder manufacturers made great progress in developing specific powder types for MDF coating.

The powder coating process of MDF boards consists of several single steps:

Infrared preheating to increase conductivity

Right before the application process, the MDF board must be preheated by IR activating up to 70 °C for one minute. The moisture in the MDF board is moving to the surface which improves the conductivity, especially at the sensitive edges of the object. Within this process the board core must not be heated up. Therefore, a very accurate IR-oven technology is essential.

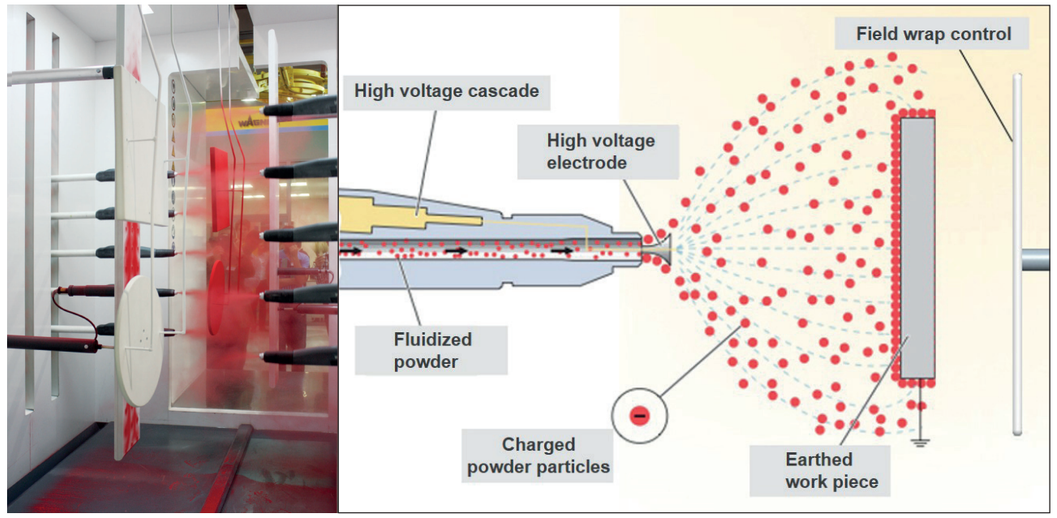


Increase of the conductivity of the MDF surface by means of IR radiation for 1 minute with 65 °C

The electrostatic powder coating application

The mixture of coating powder and air is transported from a powder center to the guns. These are moving up and down on a reciprocator, harmonized with the conveyor speed. This results in a very constant and even powder layer.

The powder application is controlled by the so-called "Corona Field Control". This "field wrap control" is a patented WAGNER solution to manage the thickness of powder on the workpiece and powder wrap automatically.

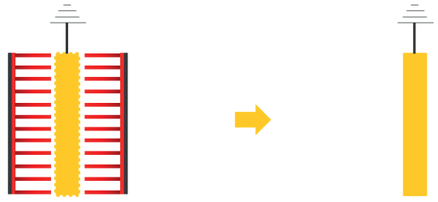


** Field wrap control is a patented WAGNER solution to manage the thickness of powder on the workpiece automatically*

Curing the powder on MDF boards

The electrostatically applied powder is attracted onto the MDF plates which are moving now in an infrared oven or an oven combined with ultraviolet and infrared curing. The powder is baking-on within a short time, jells and adheres with high stability to the MDF board.

Curing of the powder (IR or IR + UV):

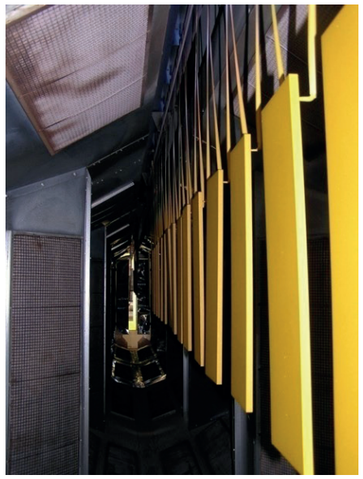


The curing temperature must be adhered to exactly according to the powder manufacturer's specifications.

Cooling down the coated MDF boards

Immediately after the curing process the MDF boards cool down with cold air blowing for approx. 6 minutes. After the cooling process, the MDF plates can be removed from the conveyor line and used in the assembling.

Cooling down can also be made by hanging the parts at room temperature for about 25 minutes.



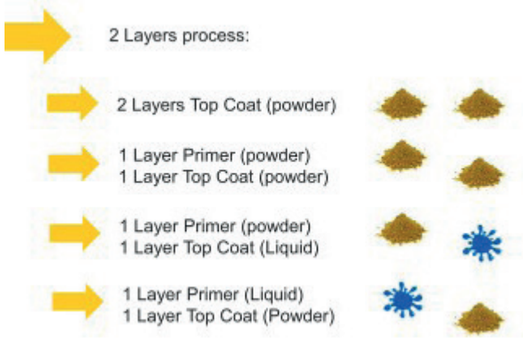
Jelling and curing by infrared radiation
Left picture: Gas-catalytic IR oven / Right picture: Cured MDF parts

Various application alternatives with powder

Various powder application processes have been established within the last years, which differ mainly between single and double layer application.

For the single layer application only one layer of powder is coated.

The double layer process is divided in several sub-processes:



Advantages of powder coated MDF parts

When you compare the powder coating of standard MDF boards to traditional processes such as liquid coating, lamination or foil coating, the facts speak for themselves. The costs are reduced by around 25 %, materials by around 20 %, and CO^2 emissions by 3.8 kilograms per square meter (in high volume production, compared to traditional liquid coatings). You also get seamless, all-round coating with a uniform, scratch-proof surface that can be worked on immediately. Powder coated parts are especially effective against water damage for furniture in wet areas like bathroom or kitchen.

Advantages:

- Energy-saving coating process
- Solvent free application material
- Powder recovery
- Coating of 3D structures
- Seamless all-round coating
- Workpieces can be immediately processed

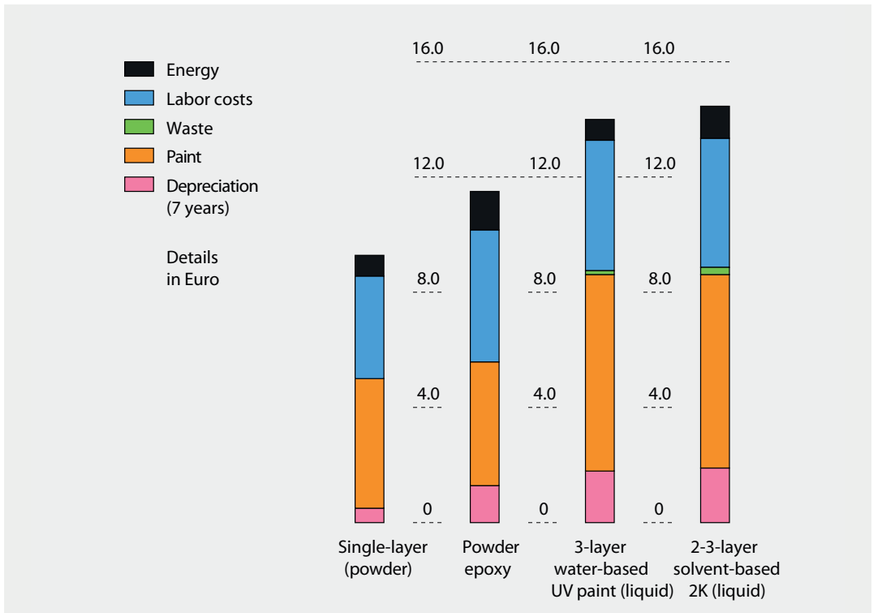
The electrostatic powder coating of MDF and wood material is especially useful for a wide variety of shapes. The powder protects edges and openings much better and makes the products more reliable than liquid coating. Milled-out portions, cutouts and holes are coated all around. A main advantage is the high protection of edges and profiles, even at small radii.

Powder coating enables therefore a high degree of creativity in design and production. Even Inkjet printing on powder coated MDF is possible without difficulty.

Another main advantage of powder coating compared to liquid coating is the renouncement of polluting solvents.

Not adhering or surplus powder particles fall to the booth floor from where they are automatically recovered and leaded to the powder feed circle. This results in a very low material waste with an efficiency of up to 98 %. Material recovery is not possible in liquid coating, where wasted paint is completely lost. The material recovery makes electrostatic powder coating an extremely economical coating process.

Sample of cost comparison between powder coating and liquid coating (different coating types for 1 m^2)



4. Summary

There are many opportunities for optimizing the coating process of wooden material and the costs associated with it. But irrespective of the mode of coating, i.e. liquid or powder, manual, automatic or electrostatic, it is recommended to contact experts to find the most suitable system. Application manufacturers usually provide comprehensive, competent advice in order to put together the optimum system for the respective requirements.

Liquid or powder coating?

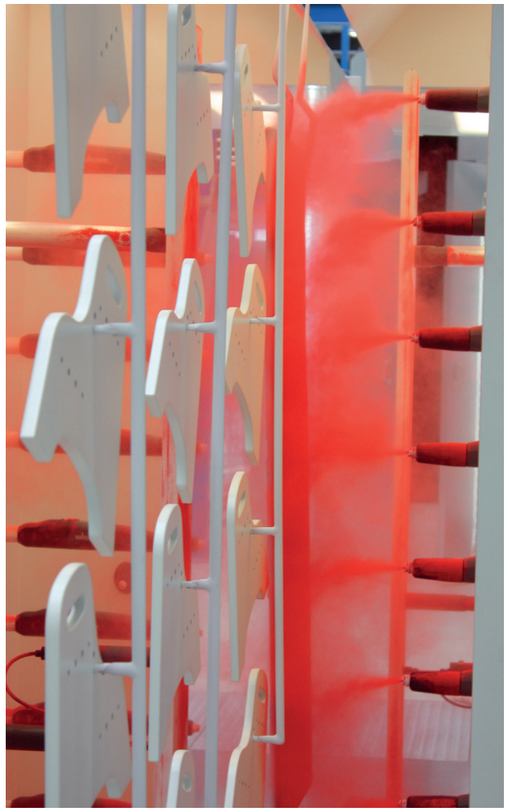
The decision between liquid or powder coating is depending on various factors. Where liquid coating is the standard coating process with a wide range of options for wood manufacturing, powder coating has become a suitable alternative when it comes to coat MDF boards or solid wood.

Benefits of liquid coating include[1)]:

- Great range of applicable materials
- Almost endless range of colors, including metallics and high gloss
- Fast color changes and customized coatings
- Low start-up costs

Benefits of powder coating include[1)]:

- More durable coatings
- Capabilities for thicker and specialty finishes
- Higher eco-friendliness
- High material efficiency



No matter which type of coating process is chosen, relevant cost savings can be made only by selecting suitable equipment. More and more furniture manufacturers are realizing this and are taking advantage of the support of retailers and manufacturers in order to put together a system customized to their requirements or to optimize their existing system.

1) https://www.thomasnet.com/articles/custom-manufacturing-fabricating/powder-coating-pro-con/ (April 2019)

About WAGNER

J. Wagner GmbH is one of the world's leading manufacturers of equipment and systems for surface coating with powder and liquid lacquers, paints and other liquid materials. The WAGNER Group portfolio also includes bonding, sealing and encapsulation technology including injection moulding with the brands WAGNER, Titan, Walther Pilot, Reinhardt-Technik and CA Technologies. The beginnings of the company go back to the year 1947. Today the innovative coating technologies of WAGNER are used in industry as well as by craftsmen and do-it-yourselfers and set standards in the industry. The WAGNER Group is represented worldwide by around 1,600 employees in 15 operative companies and around 300 agencies. Owners of the WAGNER Group are the Josef Wagner Foundations, which pursue exclusively charitable goals.

More information can be found at www.wagner-group.com

The experts of WAGNER have great experience in all coating areas, from liquid to powder coating. They are happy to provide you with the best customized solution and latest coating technology, to fulfill your specific demands for economical and future-proof wood coating.

If you have any questions about the various application solutions for wood and MDF coating presented in this paper, please do not hesitate to contact the following person:

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