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Check list for
problem-free
powder-coating process

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1 Scope

This VdL check list for a problem-free-powder coating process is meant to be a tool for the operator of a powder coating plant with injector delivery, to name and detect the most frequent problems, to find possible causes, and to take remedial action.

The coating is applied to the substrate by electrostatic spraying. A powder coating, in the context of this VdL check list, is a coating of powder coating materials. Thermosetting binders are used almost exclusively for the manufacture of these powder coating materials.

2 Requirement profiles of a problem-free powder coating

The quality of the powder coating mostly depends on the requirement of permanent optimal operation of the plant components and the requirement profile of the powder. Problems with the coating process can be avoided if both requirements are respected.

In the context of a quality assurance system the modes of operation of plant components are to be tested by a reliable maintenance. Maintenance directions of the components are provided by the manufacturers of the plant or the respective contractors (see instruction manual). The following recommended maintenance work should necessarily be included in the maintenance directions:

Daily maintenance:

- air-clean spraying elements and check for sinter deposits
- check adjustments of spraying elements
- check deliver pressure of spraying elements
- check injectors (sinter deposits, grinding)
- air-clean injectors and hoses
- clean plant, recovery unit, and surroundings
- check extraction resistance of the recovery unit

Weekly maintenance:

- check earthing control
- check pressurized air (clean, dry, oil-free)
- check spraying components and voltage supply
- check powder hoses for sinter deposits and kinks
- check stroke movement
- check filters, sieves

Further maintenance work is indicated in the maintenance directions or the information given by the manufacturer. Maintenance operations executed on a regular basis are prerequisites for a problem-free coating process. Thus, downtimes and services by the plant contractor can be minimised. Should there be any problems which causes cannot be detected, the plant contractor's service department in charge is to be asked for information.

The requirement profile of the powder is to be coordinated with the manufacturer of the powder in the context of a quality assurance system. The following properties to be checked are included in the requirement profile which influences the separation, circulation, and film formation behaviour:

Particle size distribution, density, melting behaviour, resistance to caking, composition, moisture content, fluidization ability, flowability, and stoving conditions.

Problems which possible causes are attributed to the properties of the powder, should be reported to the manufacturer of these powders, so that appropriate remedial actions can be taken.

3 Problems during application			
Problem	Identification	Possible cause	Remedial action
Fluidisation	Intermittent or no delivery from the application equipment	Fluidisation properties of the powder insufficient, too little fluid air; fluidised bed blocked	Increase pressure of fluidisation air; check fluid bed tile. Contact powder manufacturer
	Visually detectable local blistering and cratering in the fluid container	Compressed air too moist, contains oil; relative humidity is too high inside the room in which the powder is processed. Powder is moist	Check drier is switched on. Check drain valve on drier is open.: check oil and water separator
	Poor fluidisation of the powder	Fluid bed base tile clogged or damaged	Clean or replace fluid bed tile
		Air temperature too high in the coating plant	Comply with storage conditions and climatic processing conditions recommended by the powder manufacturer
		"Lumps" in fluidised powder	Increase vibration of powder container
		Reclaim powder too fine; Reclaim system filters blocked. Powder circulation not working effectively	Increase ratio of virgin powder to fluidised bed. Check powder recirculation plant working effectively.
Problem	Identification	Possible cause	Remedial action
Build up of sintered deposits in hoses and injectors.	Powder cloud from spray unit looks very irregular	Air speed too high; powder ejection too high	Reduce air speed; Balance powder feed across the spray unit using forward and atomising air controls.
		Wrong spraying nozzle attached	Use appropriate spraying nozzels or spray nozzel attachments
		Inappropriate hoses (hose material, dimension, installation, kinks, narrow radius)	Use appropriate hoses, note installation and length of hoses

Build up of sintered deposits inside and on spray nozzle gun tips.	Powder cloud output reduced from nozzels	Backwashing air too low, mechanically damaged or worn parts	Increase backwashing air, clean injectors, baffles, and nozzles so that the surfaces will not be roughened or damaged
		Circulation powder too fine; insufficient metered feeding of virgin powder into the circulation	Continually automatically feed/add virgin powder
		Powder too moist	Check operation of refrigerant type drier in regard to compressed air: check oil and water separator
		Pressure of conveying air too high	Reduce pressure of conveying air
		Pressure fluctuation inside the pressurised-air system	Check compressed-air system
		Room temperature too high, relative humidity too high	Respect climatic processing conditions
Problem	Identification	Possible cause	Remedial action
Irregular distribution of film thickness on the object	Colour difference due to different substrate coating	Irregular conveying of powder, space between spray pistol and object not balanced	Optimise plant parameters
	Surface appears irregular	Relation between line speed and conveying speed of the spray pistols not optimised (sine curves); high voltage fluctuations	Optimise "sine curves"
Check high voltage			
		Particle size distribution not optimal	Optimise particle size distribution
		Powder column on the venturi tube fluctuates heavily	Provide for consistent feeding from the fluid bed container
		Construction of object (Faraday cage) and/or jigging inappropriate	Change construction of object and/or jigging
		Pressure of conveying air too high; powder coat is blown off due to air speed that is too high	Reduce conveying pressure
		Earthing insufficient	Check earthing

Problem	Identification	Possible cause	Remedial action
Powder coating material adheres insufficiently (powder coating falls off) on flat object	Colour differences due to different substrate coating	Objects insufficiently earthed; field strength too intense	Optimise plant parameters, clean suspension/jig
	Surface appears irregular	Forward and atomising air not balanced correctly	Balance set-up between forward and atomising air
		Voltage of spraying pistols and their distance to object not optimal	Change voltage and space between spray pistols and object
		Voltage too low	Increase voltage
		Output of powder too high	Reduce powder output
		Particle size distribution not optimal	Optimise particle size distribution
...on objects with corners and recesses	Parts of the object remain uncoated	Inappropriate hose material	Use appropriate hose material
		Wrong spraying element (nozzle?) attachment	Use the right spraying element (nozzle) attachment
		Speed of conveying air too high inside the spraying element	Reduce speed of conveying air
		Geometry of object and object suspension inappropriate for coating process	Change construction of object and/or suspension
During TRIBO applications	See above	Insufficient charging because of:	Permanently measure stray current or specific TRIBO-charge of powder respectively
		powder throughput too high	Optimise plant set-up
		wrong particle size distribution	Make particle size distribution consistent with plant and object
		worn friction element inside the spraying element	Replace worn friction elements
		powder insufficiently compatible with TRIBO	Use TRIBO powder

Problem	Identification	Possible cause	Remedial action
Edge design	Noticeable pads on corners and edges of objects	Powder cloud too large	Change powder cloud purposefully
		Distance too large between objects	Eliminate conveying of powder into suspension gaps (use gap control); minimise space between objects; shield suspension gear constructionally
		Coarse particle content of powder too high	Optimise particle size distribution
		Total film thickness too high	Reduce total film thickness
Picture frame effect	Surface appears irregular, border area differs	Different deposition behaviour on the surface of the objects	Use appropriate spray nozzels or spray nozzel attachments
		Output of powder too high, voltage too high	Reduce conveying pressure and high voltage
		Inappropriate distance between spraying elements and object	Contact plant manufacturer or contractor
Sudden escape of powder from the coating booth	Powder dusts from the booth and contaminates surroundings	Suction performance too low	Make powder ejection consistent with suction performance
		Most common cause is draught inside the plant due to open windows and doors	Close windows and doors
		Filters inside the recovery unit are clogged	Check pressure gauge differential on filters
Problem	Identification	Possible cause	Remedial action
Discharges	Sparking	Insufficiently conductive hose material	Use hoses recommended by the plant contractor
		Injector insufficiently earthed	Pay attention to earthing of injectors
		Objects insufficiently earthed	Clean hangers/jigs; remove coating from jiggs regularly
		Usage of metallic powders	Use appropriate spray nozzel attachments
	Discharge (electric shock) on persons	Spraying enclosure insufficiently earthed	Wear conductible protective clothing

			Check positive earthing grips on the hand-spray pistol
4 Problems on the coated object			
Problem	Identification	Possible cause	Remedial action
Insufficient mechanical properties (adhesion, elongation, surface hardness); insufficient corrosion resistance and resistance to chemicals	Specification profile of the coating is not fulfilled	Film thickness beyond nominal values	Comply with nominal values of film thickness
		Insufficiently cross-linked powder	Check crosslinking/curing, comply with stoving conditions
		Heating rate too low	Increase heating rate
Insufficient intercoat adhesion in two-coat procedures (peeling)	Insufficient mechanical properties	Insufficient pre-treatment of objects (phosphating, chromating)	Optimise pre-treatment
		First coating overbaked	Set up temperature of object and holding time optimally (temperature-time-diagram)
		Inappropriate powder; film thicknesses extremely high	Coordinate assembly
		Use of a directly heated gas oven	Use different heating
Problem	Identification	Possible cause	Remedial action
Levelling (orange peel)	Specification profile of the coating is not fulfilled (nominal value of levelling)	Film thickness of powder coating too high or low	Optimise powder output

(all areas or parts of the object)		Temperature profile on the object not optimal	Optimise temperature on object
		Usage of inappropriate powder (too reactive, too high-viscous)	Use appropriate powder
		Particle size distribution of powder inappropriate	Use powder with changed particle size distribution
		Incompatibility with other powders	Clean plant thoroughly, do not mix different powders
		Back-spraying (ionisation?) effect (voltage too high, temperature and relative humidity at the plant location changed)	Reduce film thickness, reduce voltage; check air conditioning; divert "superfluous" charge by means of special spraying elements or additional equipment such as rings for diverting ions (e.g. Super Corona, Corona Star)
		Powder stored too long/too warm	Check storage conditions
		Relative humidity too low	Increase relative humidity
Problem	Identification	Possible cause	Remedial action
Gloss deviation	Specification profile of the coating is not fulfilled (nominal value of gloss)	Stoving conditions are not being adhered to	Set up temperature of object and holding time optimally (temperature-time-diagram)
		Special stoving technology (heating with gas direct, infrared, near-infrared, inductive heating)	Use appropriate powders
		Bad levelling (powder stored too long/too warm)	Optimise stoving conditions, use new powder
		Incompatibility with other powders	Clean plant thoroughly, do not mix different powders
		Powder thermally instable	Use thermally-stable powder
		Film thickness too high, too low	Optimise film thicknesses
		Emissions from the powder or the substrate in the course of the stoving process	Use appropriate powders, check substrate/pre-treatment

		Deposit or condensate (from the air inside the oven)	Clean oven, increase amount of outlet air if necessary
Problem	Identification	Possible cause	Remedial action
Contaminated surface	Nominal values of surface assessment are not fulfilled	Missing or too large mesh in reclaim sieve	Use sieve with correct mesh size in machine
		Insufficient sieving	Use sieves with small mesh size
		Dirt from the air inside the plant hall is deposited on the coated object due to air flow	Use screening machine with various sieves; use screening machine with automatic dirt and deposit discharge
		Dirt from the conveyor	Clean conveyor
		Dirt from the jig	Use conveyor with dirt trap
		Emissions from the powder inside the oven	Clean oven regularly; increase amount of outlet air if necessary
		Polluted air is being sucked into the booth or the oven	Provide for separation of coating plant from other factory floors; supply coating area with high-pressure filtered fresh air
		When operating two or more booths mutual suction of the powder-air mixture (especially during cleaning processes)	Provide for spatial separation of the booths
			Check afterfilter regularly
		Powder hose insufficiently cleaned after change of colour	Clean powder hose with pressurised air and stopper
Problem	Identification	Possible cause	Remedial action

Continuation contaminated surfaces		Clothing fibres are being sucked in by the recovery unit	Use special clothing
		Fibres from the filter of the recovery unit	Use filters that will not leave fibres
		Adhering dirt particles on the object prior to the coating process	Provide for clean objects before the coating process
		Objects "cleaned" with fluffing cloth	Do not use fluffing cloths
		Powder contains contaminations when delivered	Contact manufacturer of the powder
Problem	Identification	Possible cause	Remedial action
Colour deviations	Objects do not match in terms of colour	Stoving conditions changed (recirculation temperature / time diagram, overstoving during breaks or downtimes, IR contribution)	Set up stoving conditions correctly
		Combustion products in directly gas- heated ovens	Use stabilised powders
		Film thickness beyond nominal values	Comply with nominal values of film thickness
		Object or operation mode changed (dimensions, mass)	Sort objects
		Insufficiently degreased or pre-treated objects	Optimise degreasing, pre-treatment
		Irregular film thickness of a priming coat	Apply primer with uniform film thickness in order to achieve even substrate in terms of colour
		Mixture of two powders	Separate powders strictly; clean plant thoroughly when changing powders
		Requirement profile of the powder insufficiently defined	Check or specify requirement profile together with contractor of powder
Problem	Identification	Possible cause	Remedial action

Blisters (closed or burst), "pinholes"	Specification profile of the coating is not fulfilled	Stoving conditions not optimal (heating rate)	Optimise stoving conditions
	Weak spots when stressed	Surface of objects not cleaned sufficiently (grease residues, rust, water, emissions from the substrate)	Clean surface of objects perfectly; contact manufacturer of pre-treatment
		High film thickness (air pockets, emissions from the powder, e.g. water)	Reduce film thickness
		Surface of the object has cavities (cracks, indentations, overlaps)	Improve surface of objects, change construction
		Blow holes on surfaces with hot-dip galvanized coat; porous surface, e.g. die casting	Temperature de-gass objects, use appropriate primer
		Specification profile of the powder	Use powders for outgassing substrates
		Incompatible powders mixed together (contamination)	Separate powders strictly; clean plant thoroughly when changing powders
Problem	Identification	Possible cause	Remedial action
Craters	Specification profile of the coating is not fulfilled	Objects not sufficiently degreased, pre-treated	Optimise degreasing, pre-treatment
	Weak spots when stressed	Incompatible powders mixed together (contamination)	Separate powders strictly; clean plant thoroughly when changing powders
		Influences of products containing silicones	Avoid products containing silicones within the coating area (check air ducts of connected production units)
		Blow holes on surfaces of cast parts, hot-dip galvanized or zinc-sprayed coatings; porous substrates as e.g. die casting	Temperature de-gass objects, use powders suitable for outgassing substrates, use appropriate primer
		Oily dirt from the conveyor chain	Clean conveyor chain
		Oil from the pressurised air	Use and check oil separator, refrigerant type drier

		Condensates from the oven	Clean oven, increase amount of outlet air if necessary
Problem	Identification	Possible cause	Remedial action
Drop formation	Specification profile of the coating is not fulfilled	Film thickness too high or irregular	Optimise film thickness distribution
	Fitting accuracy is not fulfilled	Stoving conditions not optimal (heating rate, object and oven temperature)	Optimise stoving conditions
		Geometry and surface profile of the objects (powder-drawing areas)	Introduce individual coating processes of objects
		Requirement profile of the powder defined insufficiently	Define requirement profile of powder
		Wetting disturbance: "slipping" of the powder coating	Clean substrate residue-free (salts, oils, greases, residues of rust and separating agents)
5 Specific characteristics when using metallic powders			
Problem	Identification	Possible cause	Remedial action
Insufficient levelling, rough surface	from insufficient film thickness to finely textured surface	Insufficient deposition	Increase high voltage, check spray nozzels
		Output of powder too low	Increase powder ejection
		Blowing-off effect	Reduce amount of air
		Ejection of powder too high in combination with high voltage too low	Reduce powder output, increase voltage
		Insufficient charging during TRIBO application	Use appropriate charging method (corona charging)
Colour deviations	"greying", missing metallic effect	Wrong or different charging procedure, hence a different alignment of metal effect pigments	Corona charging recommended, in any case the same procedure is to be used

		Powder being used is not correctly bonded and can not be reclaimed; results in separation of powder base and metal effect pigments	Use powder that can be reclaimed (bonded); ensure that the ratio of virgin powder to reclaim meets the powder manufacturers recommendations ; motto "Stop messing about with half measures, and do the thing properly."
	Objects do not match in terms of colour or effect		Use powder "spray to waste" (costs, disposal!)
		Batch change during a job	Use same batch of powder during a job
Problem	Identification	Possible cause	Remedial action
Continuation colour deviation		Powder separating in powder hopper	Use fluidised bed hopper to avoid partial separation
	Objects do not match in terms of colour or effect	Colour differences between automatic and manual coating process	If possible, do not use manual coating after automatic application but manual coating prior to automatic application
		Different substrates	Produce colour standard and colour tolerance standards on different substrates
		"Differences" with the customer regarding the colour	Agree upon colour specimen and limiting specimens
"clouding"	Appearance of irregular light-dark effects on substrate	Wrong space between spray pistols , different charging, improper sine curve, insufficient earthing	Optimise coating plant parameters
		Obviously different film thicknesses	Minimise variations in film thickness
		Automatic coating process with subsequent manual application	Chose manual pre-coating

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