Abstract:

Method and system (1) for powder coating non electrically conductive elements (2), preferably brake pads, wherein upstream of an electrostatic powder coating (5) deposition station (4) and a baking station (6) for melting and polymerizing the powder coating in order to form a coating layer (9) on a surface to be coated, there is a pre-treatment station (3) which causes the elements to be coated to conduct electrically by uniformly wetting said elements by means of creating poorly mineralized water covalent bonds on at least one surface (8) to be coated, in an amount aimed at producing a measurable weight increase in the non electrically conductive elements (2), which then causes them to conduct electrically; the water adsorbed and/or deposited is subsequently eliminated within baking station (6).
POWDER COATING (ELECTROSTATIC PAINTING) METHOD AND PLANT FOR NON ELECTRICALLY CONDUCTIVE ELEMENTS, AND IN PARTICULAR BRAKE PADS.

Technical field

The present invention relates to a method and process for powder coating non electrically conductive elements, and in particular brake pads made with NAO ("Non Asbestos Organic" i.e. asbestos-free organic friction) friction materials.

State of the art

Friction materials utilized as the lining in drum brake shoes of drum brakes and in the brake pads in automobile disk brakes and other devices (for example in clutch plates) are manufactured with a compound (mixture) comprising a fibrous or fiber material, an organic binder (usually a phenolic synthetic resin) and a bulk or "filler". Instead of asbestos as the fiber material, which has been legally banned as a substance dangerous to the environment, mixtures of other organic and inorganic materials are utilized, such as rock wool, aramid and carbon fibers, metal fibers or powder such as copper, tin, iron, aluminum, and other metals or metal alloys such as bronze or brass. EP1227262 for example, indicates the use of a friction material of the above described type.
containing approximately 10% copper fibers by volume,
between 0.1 and 15% tin and/or tin sulfide -by volume, and between 4 and 9% bronze fibers by volume.

NAO compounds, due to their composition, have an electric conductivity not sufficient to ensure a good painting thereof; things are even worse if the copper is eliminated (due to environment care compounds without copper are more and more requested).

Even though in brake pads the compound is manufactured as a plaque or pad assembled on a metal plate in order to form the actual brake pad, painting brake pads made with non electrically conductive materials presents numerous problems-. In particular, it is presently impossible to utilize currently used powder coating plants built to coat/paint brake pads that are electrically conductive.

More generally it is also known that in order to powder coating (a painting technology requiring use of electrostatic charges) non electrically conductive elements such as for example mechanical components manufactured with plastic polymers, a conductive primer is applied to the surface of the non conductive element to be painted. However, conductive primers are based on organic solvents which are noxious and dangerous to the environment.

Attempts to powder coat brake pads made with non conductive compounds have not been successful up to now; this
is because, when at all possible, (thanks to the presence of the metal base support for the plaque in a non conductive compound), the preparation, finish, and thickness are not satisfactory: brake pads manufactured using this method are therefore unable to pass standard corrosion tests.

The only alternative available therefore is the use of other coating technologies, which are however more expensive and require large specially devised plants that call for an unacceptable investment considering present manufacturing volumes.

Summary of the invention

The object of the present invention is to provide a powder coating method and process for non electrically conductive elements, and in particular NAO brake pads, which will lead to optimal application, coverage and surface finishing, comparable to that which can be achieved with plants that are currently in use and that have been designed for treating electrically conductive brake pads manufactured using metal containing compounds; all of this while utilizing presently existing plants with minimal modifications and without the use of conductive primers.

The invention therefore relates to a powder coating method for non electrically conductive elements, in particular brake pads, as defined in claim 1. The
invention further relates to a powder coating plant for treating non electrically conductive elements, in particular brake pads, according to claim 8.

According to a main aspect of the invention, upstream of an electrostatically charged painting powder coating/deposition station and of a baking station used to melt and polymerize the coating powder in order to form a coating layer on the surface to be coated of the non conductive elements, a pre-treatment station is present in order to make the elements to be coated temporarily electrically conductive by uniformly wetting the same by adsorption and/or deposition of water, preferably poorly mineralized water, on at least the aforementioned surface to be coated with an amount that is sufficient to produce a measurable weight increase in the non conductive elements, which will then cause said elements to become electrically conductive. The adsorbed and/or deposited water is subsequently eliminated within the baking station.

Within the scope of the present invention, "poorly mineralized water" or "low mineral content water" shall be understood to be water which is devoid of ions which would be potentially chemically reactive with iron compounds and that has a dry residue and an electric conductivity which are quantitatively comparable to those of bottled water.

In particular, according to an aspect of the invention,
the water to be utilized according to the method of the
invention and the plant to implement thereof must possess a
chemical composition devoid of ions which would be potentially chemically reactive with iron compounds and such
that the water possesses a value of the specific electrical
conductivity measured at 20°C comprised between 1 and 5,000
µS/cm and preferably comprised between 10 and 700 µS/cm [in
the Metric System "S" is the symbol for Siemens].

Furthermore, according to the applicant's technician's
findings the water must be adsorbed and/or deposited on
each non electrically conductive element to be made
conductive in an amount that will cause a weight increase
in each electrically non conductive element of between
0.15% and 0.30%.

In this manner the electric resistance of brake pads
manufactured, with asbestos-free organic friction compounds
changes from an order of magnitude of 1,000,000 MΩ (Mega
Ohm) before pre-treatment, to values around 0.011 MΩ after
pre-treatment, and then back to pre-treatment values at the
end of the baking phase, which is commonly carried out in a
tunnel oven. Hence pre-treated brake pads can be coated by
means of traditional powder coating methods by depositing
the coating powder electrostatically by means of the same
steps already in use for brake pads manufactured with
electrically conductive compounds.
According to additional aspects of the invention, the plant for implementing the method of the invention may be realized according to two separate embodiments.

In a first embodiment the pre-treatment station comprises a superheated steam generator operating with a low mineral content water, for instance well water; a plurality of delivery nozzles for a superheated steam towards the non electrically conductive elements; an air/steam mixing means suitable for producing an air/steam flow with an air/steam ratio of between 15 and 30 m³/kg aimed at the non electrically conductive elements, when the elements are located on a transport mechanism upstream of the electrostatic powder coating station; and cooling means where the non electrically conductive elements are driven by the transport mechanism downstream of the air/steam mixing means and immediately upstream of the electrostatic powder coating station.

In a second preferred embodiment, the pre-treatment station comprises a motorized roller rack for tidily conveying the non electrically conductive elements; a plurality of nozzles for delivery high pressure jets of low mineral content water towards the non electrically conductive elements, said nozzles being suitable for creating a mist all around the non electrically conductive elements; at least one supply pump for the nozzles; and an extraction hood facing the nozzles.

According to this embodiment, the entire pre-treatment
station laid out along its longitudinal axis, that is to say in the direction of advancement of the brake pads to be coated, occupies overall a section of only 45 mm (equal to the length of the motorized roller rack), implements the pre-treatment stage in only 10 seconds, and with negligible power consumption (about 1 kW).

In particular these results are obtained by means of two constructive features: on one hand the nozzles are aligned in line to one another underneath the motorized roller rack, so that their jets are aimed from below upwards at a predetermined vertical distance from the motorized roller rack, leaving an empty space, possibly adjustable, between the rack and the nozzles; and on the other hand the extraction hood is defined by a tubular element provided with a straight collection slit facing the nozzles in the same direction of alignment as the nozzles themselves. As a matter of fact, it has been found that when these two constructive features are present at the same time, they have a synergistic effect that permits regulation of the amount of poorly mineralized water deposited on the brake pad and that wets the compound to be treated with an extremely high degree of precision. This is of the essence in order to achieve the desired electrical conductivity without soaking too much the brake pads.
An additional advantage of the system according to the invention is that it is capable of coating both, NAO asbestos-free organic brake pads and low steel metallic brake pads by simply turning off the pre-treatment station. It is therefore possible to alternate from one type of compound to the other on the same production line without performing any modifications.

Finally, the plant and method of the invention are completely environmentally friendly.

**Brief description of the drawings**

Additional features and advantages of the present invention will be apparent from the following description of the two non limiting embodiments thereof given exclusively for exemplification purposes with respect to the enclosed drawings, where:

- Figure 1 depicts a schematic lateral elevation view, partially in a longitudinal cross-section, of a powder coating plant implemented according to the invention;

- Figure 2 depicts an enlarged scale schematic view in cross-section of a component in the plant in figure 1;

- Figure 3 depicts an enlarged scale perspective view of a second component of the plant in figure 1;

- Figure 4 depicts a schematic lateral elevation view,
partially in a longitudinal cross-section, of a second embodiment of the powder coating plant implemented according to the invention; and

- Figures 5 and 6 depict two charts displaying the weight and electrical conductivity variation of asbestos-free organic friction compound brake pads treated according to the method of the invention.

**Detailed description**

With reference to figure 1, is depicted a powder coating plant, overall indicated with reference number 1, for painting non electrically conductive elements 2, in particular brake pads manufactured with asbestos-free organic friction compounds, known in the art and therefore not shown in detail but only illustrated as blocks.

Said type of brake pads are initially manufactured by molding the compound at a temperature of between 130 and 200°C in order to create a plaque or pad, which are subsequently cured by thermal treatment, assembled onto an iron metal support, and finally painted together with the support.

NAO brake pad compounds obtained in this manner however, using previously existing technologies, cannot be powder coated but only spray painted, with all the associated issues, including protection of the environment, that this implies.

According to the invention, on the contrary, the powder
coating plant 1 is utilized, which in general comprises a pre-treatment station 3, where non electrically conductive elements 2 are made to be temporarily electrically conductive in the manner that will be described hereinafter and are therefore "transformed" into electrically conductive elements 2b, a station 4, of a type known in the art and therefore illustrated only schematically, where coating powders 5 are applied electrostatically onto elements 2b, a melting and polymerization station 6 for the coating powders 5, preferably defined by a baking oven of the tunnel type known in the art and therefore illustrated only schematically for simplicity, and at least one transport mechanism 7 suitable for tidily transporting non electrically conductive elements 2 to be coated in series along stations 3, 4, and 6, in order to traverse the same and finally produce non electrically conductive elements 2 provided with at least one surface 8 to be coated (which may extend to the entire external surface of elements 2 or to part only thereof as the case may be), a coating layer 9 made of the coating powders 5 melted and polymerized in oven 6 at the temperature common for powder coating processes (in general around 200-220°C).

In the depicted non limiting example, plant 1 comprises a transport device 7 traversing stations 4 and 6, and which places the coated elements 2 onto a table 10, and a second
device 7 supplying elements 2 to station 3, located upstream of stations 4 and 6.

Hereinafter the terms "upstream" and "downstream" are understood as referring to the direction of advancement D of non electrically conductive elements 2 along plant 1, and more specifically stations 3, 4, and 6, indicated by the arrows in figure 1.

According to the invention, pre-treatment station 3 comprises a means 11 for depositing and/or adsorbing poorly mineralized water onto at least the surface 8 to be coated of the non electrically conductive elements 2, and preferably on each entire non electrically conductive element 2, in order to cause a measurable weight increase in the non electrically conductive elements 2, corresponding to an amount of low mineral content water retained on the same (at least in correspondence with the surface 8) thus causing said elements 2 to temporarily electrically conduct, "transforming them" into elements 2b.

As previously stated, "poorly mineralized water" is to be understood as water having a composition devoid of ions that would be potentially chemically reactive with iron compounds (which constitute the support for the asbestos-free organic friction compound of brake pads 2), and hence devoid of ions such as Cl⁻, and having an amount of dry residue and an electric conductivity quantitatively
comparable to those of the bottled water. The poorly-mineralized water that may be used in plant 1 according to the invention must nonetheless possess a chemical composition such that it has a specific conductivity measured at 20°C comprised between 1 and 5,000 μS/cm and preferably between 10 and 700μS/cm.

Furthermore, still according to the invention, melting and polymerization station 6 for coating powders 5 must be suitable not only for melting and polymerizing powders 5, but also for eliminating at least part (in fact substantially all) of the water previously adsorbed and or deposited onto non electrically conductive elements 2. Taking into account that station 6 comprises a tunnel oven known within the art where temperatures in the range of 200°C are reached, this last characteristic is built-in. Nonetheless, said characteristic is necessary within the scope of the invention, and hence precludes the use of melting and polymerization stations where there is no certainty of eliminating the water retained upon/within the elements 2.

According to the embodiment illustrated in figure 1, pre-treatment station 3 of plant 1 comprises in combination: a rack 12 comprising a plurality of, for example four, motorized rollers 13 displaced each from the other in direction D along which the non electrically conductive elements 2 are transported tidily in line during processing; a plurality of
nozzles 14 supplying high pressure jets 15 of poorly mineralized water (as previously defined, for example well water) towards the non electrically conductive elements 2 found on the rack 12; at least one pump 16 supplying (at a pressure greater than 60 bar and preferably equal to 70 bar) the low mineral content water (contained in a tank not illustrated for simplicity or obtained directly from a well or other natural sources) to nozzles 14; and an extraction hood 17 facing the supply nozzles 14 and provided with a suction fan 18 that collect the environment air together with most of the water supplied by the nozzles 14, so as to prevent water dripping onto the elements 2 after the jets 15 have passed through the rack 12 (through the spacing between the rollers 13) and "wetting" the elements 2 found on the rollers 13.

In particular, the nozzles 14 supply jets 15 that expand in a cone pattern dispersing the water in the air thanks to the drop in pressure at the nozzle, creating in the process a mist (a very fine uniform dispersion of water micro droplets in air) all around the non electrically conductive elements 2 traversing on rollers 13, around the rollers 13 themselves, and in general around the entire volume between the nozzles 14 and hood 17, which wets and deposits a conductive film onto the insulating surface of the elements 2, and where excess water is subsequently aspirated by the hood 17 by means of the suction fan 18,
which forces the water into a discharge pipe 19. Being a simple mixture of water and air, the mist aspirated by the hood 17 may be discharged directly into the environment, or treated in order to at least partially recycle the water.

According to the illustrated preferred embodiment, the supply nozzles 14 (see figure 3) are aligned and spaced along the direction L (figure 3), perpendicular to the transport direction D of the non electrically conductive elements 2 along the plant 1 in general, and on the motorized rollers 13 rack 12 in particular. Direction L is specifically perpendicular to direction D.

In the illustrated example, nozzles 14 are placed under the motorized rollers 13 of rack 12, in order to aim the jets 15 from below upwards; moreover, according to an important aspect of the invention, the nozzles 14 are spaced apart vertically from the motorized rollers 13 of rack 12 by a fixed amount i.e. a predetermined distance T, so that between the rack 12 of motorized rollers 13 and the nozzles 14 there is an empty space, indicated by the letter S in figure 3.

Preferably, station 3 in plant 1 also comprises a means for varying in an adjustable manner the predetermined distance T, which is illustrated schematically only in figure 3 as holes 20b and as a hydraulic or pneumatic piston 20c (any other type of actuator is suitable). According to the non limiting illustration in figure 3, the rollers 13 are each
attached to a gear 21, which is rotated by means of a gear transmission 23 driven by a motor 24 common to all four rollers 13, which therefore rotate synchronously. Rollers 13, transmission 23, and motor 24, together with all the remaining rack 12 parts are supported by a frame 25 which is part of the support structure of the plant 1, not illustrated for sake of simplicity.

Frame 25 also comprises upright supports 26 eventually provided with holes 20b spaced apart to one another in the vertical direction; for example, on the upright supports 26 (only one of which is shown for simplicity in figure 3, however it is clear that at least two are necessary, one on each side of rack 12) slides a C section beam 27. The beam 27 provides support for a pipe 28 laid out along direction L, which further bears upwards the nozzles 14. The nozzles 14 are arranged in a line within a pair of bulkheads 29 also connected to beam 27, the top border of which defines the distance T of the nozzles 14 from the rollers 13. Beam 27 may be activated automatically by actuation means 20c, or displaced manually while system 1 is not operating, and fixed in a new position by inserting specially devised fixing pins or cleats (known in the art and not illustrated for simplicity) into holes 20b.

While possessing the above described characteristics, extraction hood 17 is not only constructed as illustrated
schematically in figure 1, but is instead implemented as an extraction hood 17b depicted in figure 2.

Extraction hood 17b is defined by a tubular element 30 facing nozzles 14 below, provided with a straight longitudinal aspiration slit 31 running along the direction L of nozzles 14. Said straight slit 31 is defined along its length by two V bent edges/rims 32 bending back into tubular element 30 so as to define inside and at the bottom of said tubular element a water collection suction trap, from which suction trap 33 the collected water (which is thus prevented from falling back towards elements 2) is then removed by the suction fan 18 by means of suction. For this purpose, suction fan 18 is arranged to face directly opposite slit 31.

In this manner, the mist created by nozzles 14, thanks to the empty space S between them and rollers 13, in which jets 15 can be dispersed precisely forming the cited mist, is extracted by hood 17b through slit 31, causing it to travel around elements 2 and rack 12. Subsequently, the water droplets suspended in the air in order to form said mist, are extracted by hood 17b together with the air where they are suspended; a large portion of the water finds its way directly into drain 19; the water droplets that are not directed to drain 19 lose velocity within pipe 30, which operates as a form of cyclone, and are collected into suction trap 33, without falling onto elements 2, also
thanks to the presence of the bent edges 32.

Therefore, elements 2 being transported upon rack 12 receive a controlled amount of water, which they are able to covalently retain, consequently slightly increasing their weight. System 1, and in particular the elements comprising station 3, is/are sized to cause an increase in weight of elements 2 traversing station 3 of between 0.15% and 0.30%.

With respect to figure 4, where similar or identical details to those described previously are indicated with the same reference numbers for simplicity, a plant 1b is depicted corresponding to a possible variation of plant 1 according to the invention, previously described.

Plant 1b differs from plant 1 in that pre-treatment station 3 is replaced by a pre-treatment station 3b again for the purpose of uniformly wetting in a controlled manner at least the surface 8 to be coated, and preferably each entire non electrically conductive element 2 by adsorption and/or deposition of poorly mineralized water which is covalently retained on elements 2, but in a different manner.

Pre-treatment station 3b comprises: a superheated steam generator 35 that receives a flow of low mineral content water F, as defined previously, and heats it in order to create a flow of steam V at approximately 200°C; a plurality
of nozzles 38 supplying such steam to non electrically conductive elements 2; and steam/air mixing means 37 suitable for creating a flow of air/steam with a steam ratio of between 15 and 30 m³/kg directed towards non electrically conductive elements 2, when these are located on transport device 7.

According to the non limiting example shown, plant 1b comprises three separate transport devices 7, a first device to load elements 2 into station 3b, a second device 7 included as an integral component of station 3b, on which elements 2 are found when struck by the air/steam flow, and a third device 7 traversing stations 4 and 6 to deposit the coated elements 2 onto table 10. Nozzles 38 (as is the case for all of station 3b) are obviously located upstream of electrostatic application station 4 of coating powders 5, and are arranged in an analogous scheme to that of nozzles 14, but positioned so as to operate above elements 2 and above transport mechanism 7 on which elements 2 are placed tidily e.g. in series while traversing station 3b.

Station 3b further comprises a cooling means 40 for elements 2b located immediately upstream of powder coating station 4. Elements 2b are simply the non conductive elements 2 that retain the poorly mineralized water supplied by said controlled air/steam flow and which therefore form a covalent bond (also for system 1 described previously) directly above elements 2, which
thus became electrically conductive elements 2b.

In the depicted non limiting embodiment, air/steam mixing means 37 and cooling means 40 are defined by two adjacent sections 390 and 391 of a tunnel hood 39 arranged above transport mechanism 7 comprised in station 3b at a predetermined distance T2 from transport mechanism 7 and from a suction fan/aspirator 392 assembled on tunnel hood 39 which aspirates air from the environment into tunnel hood 39 through a slit or gap 393 defined by the distance or empty space T2 between the top surface of transport mechanism 7 on which elements 2/2b are placed and the bottom border of tunnel hood 39; said air, together with a large portion of the steam supplied by nozzles 38, which are arranged inside tunnel hood 39 within section 390 distal from coating station 4, is eliminated by means of a drain 394. Section 391 of tunnel hood 39 is instead next to station 4 and is found immediately downstream of nozzles 38 and immediately upstream of electrostatic powder coating 5 application station 4.

Within section 390 the steam V supplied by nozzles 38 is mixed with part of the environmental air aspirated through gap 393 within hood 39, where the flow of air/steam formed in this manner is directed towards fan 392 and hits elements 2, depositing an amount of poorly mineralized water onto the same, which adheres to surface 8 by means of covalent bonds,
"transforming" non conductive elements 2 into conductive elements 2b. In section 391, the remaining environmental air aspirated into tunnel hood 39 by fan 392 hits electrically conductive elements 2b, thus eliminating potential excess water and cooling them (elements 2/2b are in fact heated in section 390 as a result of the heat content of steam V to a temperature not suitable for carrying out the electrostatic powder coating 5 deposition).

On the basis of the above description, it is clear that both plants 1 and 1b are suitable for implementing a method for powder coating of electrically non conductive elements 2, in particular brake pads, comprising: a pre-treatment phase, where non electrically conductive elements 2 are made to electrically conduct on at least one of a surface 8 thereof to be coated, giving rise to temporarily conductive elements 2b; a deposition phase where coating/painting powder 5 is applied by means of an electrostatic field to surface 8 to be coated; and a baking phase, where coating powder 5 previously applied on elements 2b is melted and polymerized in order to create a coating layer 9 on surface 8 to be coated.

According to the invention, instead of performing the deposition by spraying using solvents and a conductive primer as in the prior art, the pre-treatment phase consists in uniformly wetting at least surface 8 to be coated, and preferably each entire non electrically conductive element 2,
by adsorption and/or deposition of water, preferably poorly mineralized water, as defined previously, in order to produce a measurable weight increase in the non electrically conductive elements 2, which causes said elements 2 to temporarily conduct electrically, giving rise to elements 2b.

The water retained by the non electrically conductive elements 2 in order to create elements 2b, which differ from elements 2 precisely because of the presence of water, preferably low mineral content water, adhered by means of covalent bonds to at least surface 8, is subsequently at least partially eliminated (preferably substantially completely removed) during the baking phase.

The poorly mineralized water retained by elements 2 by means of covalent bonds during the pre-treatment phase must possess a chemical composition such that the specific conductivity of such water measured at 20°C is to be comprised between 1 and 5,000 μS/CM and preferably between 10 and 700 μS/cm. Furthermore, the pre-treatment phase is carried out so that each non electrically conductive element 2 retains such an amount of water (adsorbed and/or deposited) as to cause an increase in weight in each non electrically conductive element 2 of between 0.15% and 0.30%.

By means of plant 1b, the pre-treatment phase is performed producing, starting from said poorly mineralized
water, superheated steam at least 200°C, mixing a flow $V$ of said superheated steam with at least a proportion of an air flow $A$ aspirated inside tunnel hood 39 from the exterior in order to generate at nozzles 38 housed in section 390 of tunnel hood 39 a flow of air/steam in a ratio of between 15 and 30 m$^3$/kg, and directing said steam/air flow by means of suction fan 392 located in section 391 of tunnel hood 39, and therefore placed next to coating station 4 downstream of nozzles 38, onto the non electrically conductive elements 2, arranged tidily, e.g. in line on a conveyor belt (mechanism 7). Said pre-treatment phase is immediately followed by a cooling phase of non electrically conductive elements 2 and made electrically conductive (elements 2b) because of the poorly mineralized water retained with covalent bonds. Said cooling phase is carried out before depositing the painting powder 5, in section 391 of the tunnel hood 39, arranged downstream of section 390 where the nozzles 38 are located.

On the other hand, by means of plant 1 the pre-treatment phase is carried out by spraying high pressure poorly mineralized water jets 15 onto the non electrically conductive elements 2 in order to create a mist around said elements, while extracting the mist through extraction hood 17/17b.

In this case, jets 15 of said poorly mineralized water are aimed at non electrically conductive elements 2 from
below, while the elements 2 are moving on the motorized roller
rack 12, above which the extraction hood 17 is located.

The effects of the pre-treatment method according to the
invention were tested experimentally on a set of samples. A
plurality of brake pads of a type known in the art were
produced, utilizing however asbestos-free organic friction
compound.

Some of the brake pads were treated by means of the
above described station 3b with the steam/air mixture and
subsequent cooling, measuring their weight before the
treatment, after coming into contact with the air/steam
mixture (wet pads) in section 390 of tunnel hood 39, after
cooling in section 391 of tunnel hood 39, and after baking in
tunnel oven 6, at the same temperature utilized for
traditionally painted pads. The results obtained with the
samples are displayed in figure 5. As it can be immediately
seen, the charts depicting the change in weight of the various
samples are completely consistent as a trend, and display an
increase in weight for wet pads, which diminishes after the
cooling phase, and which substantially disappears at the end
of the baking phase, proving that the water retained by the
brake pads after supplying the steam/air mixture is eliminated
in the powder coated (painted) pads. Similarly, the continuous
line chart displays the weight variation trend for a coated
pad: as it can be seen, the weigh of the pad after cooling
remains constant, since the weight of the water lost is equivalent to the weight of the coating (coating powder 5) deposited and baked in stations 4 and 6.

Further brake pads were treated in station 3 described previously, displaying the same weight variation trend.

Finally the mean of the weight increase/decrease measurements and electrical resistance for the "blank" (not coated) brake pads before water treatment, after treatment, at the exit of tunnel hood 39, and at the exit of oven 6 are shown. The results obtained are shown in the charts in figure 6. As it can be seen, in the "wet" state the non conductive brake pads become conductive, showing mean electrical resistance values between 0.01 and 0.02 Mega Ohm, against a mean electrical resistance values of non treated pads (not wet) and after baking in oven 6 of approximately 1,000,000 Mega Ohm.

Since stations 4 and 6 are identical to those of traditional powder coating plants devised for treating brake pads obtained with conductive compounds (containing metal), it is clear that plants 1 and 1b can be derived from already existing plants, by simply adding station 3/3b in series. Furthermore, by simply activating/deactivating stations 3 and 3b, plants 1 and 1b are suitable for treating brake pads obtained from both conductive compounds, and non conductive compounds.
Therefore the aims of the invention are fully met.
CLAIMS

1. - A method for powder coating of electrically non-conductive elements (2), in particular brake pads, comprising a step of pre-treating, in which the electrically non-conductive elements (2) are made conductive on at least one surface thereof to be painted (8), a step of electrostatically depositing a painting powder (5) on the surface to be painted, and a step of baking, in which the painting powder (5) is melted and polymerized to form a coating layer (9) on the surface to be painted; characterized in that the step of pre-treating consists in uniformly dampening at least the surface to be painted (8) and, preferably, each entire electrically non-conductive element (2), by covalent retention of water, preferably low mineral content water, to such an extent to produce a measurable increase of weight of the electrically non-conductive elements (2), such as to make such elements electrically conductive (2b); the water retained on the electrically non-conductive elements being subsequently eliminated at least in part during the step of baking.

2. - A method according to claim 1, characterized in that the water which is made to be retained during the step of pre-treating must have a chemical composition such as to have a specific conductivity comprised between 1 and
5,000 µS/cm and preferably between 10 and 700 µS/cm measured at 20°C.

3. - A method according to claim 1 or 2, characterized in that during the step of pre-treating an amount of water is made to be retained on each electrically non-conductive element (2) such as to produce an increase of weight of each electrically non-conductive element comprised between 0.15% and 0.30%.

4. - A method according to one of the preceding claims, characterized in that the step of pre-treating is carried out by producing, starting from low mineral content water, over-heated steam to at least 200°C, mixing a flow (V) of said over-heated steam with an air flow (A) to generate an air/steam flow with an air/steam ratio from 15 to 30 m³/kg, and addressing said steam/air flow onto the electrically non-conductive elements tidily arranged in series on a conveyor device (7); said pre-treating step being followed by a cooling step of the electrically non-conductive elements which have been made conductive (2b) by covalent retention of low mineral content water.

5. - A method according to claim 4, characterized in that said step of pre-treating is carried out by delivering the steam flow (V) by means of a plurality of nozzles (38) housed within a first portion (390) of a tunnel-shaped hood.
(39) arranged immediately above said conveyor device (7) and by simultaneously sucking environment air inside the tunnel-shaped hood (39) by means of a fan (392) arranged at a second portion (391) of the tunnel-shaped hood (39) located downstream of the first portion (390); the step of cooling of the electrically non conductive elements being carried out in the second portion (391) of the tunnel hood (39) by means of the sucking of environment air within the tunnel-shaped hood (39).

6.- A method according to any one of the claims from 1 to 3, characterized in that the step of pre-treating is carried out by spraying high pressure jets (15) of said water onto the electrically conductive elements (2) so as to create a mist all around them and at the same time aspirating said mist by means of a suction hood (17;17b).

7.- A method according to claim 6, characterized in that the jets (15) of said water are addressed onto the electrically non conductive elements (2) from the bottom upwards while the elements (2) move on a rack (12) with powered rolls (13), over which said suction hood (17;17b) is arranged.

8.- A plant (l;lb) for powder coating of electrically non conductive elements (2), in particular brake pads, comprising a pre-treating station (3,3b), in which the
electrically non conductive elements are made temporarily electrically conductive (2b), a coating station (4) for electrostatic applying painting powders (5), a station (6) for melting and polymerizing the painting powders (5), preferably defined by a tunnel-shaped baking oven, and at least one conveyor device (7) adapted to make the electrically non conductive elements (2) to be painted move along said stations (3;3b,4,6); characterized in that the pre-treating station (3;3b) comprises means (11) for making water, preferably a low mineral content water, to be covalently retained on at least one surface (8) to be painted of said electrically non conductive elements and, preferably, on each said entire electrically non conductive element, to such an extent to produce a measurable increase of weight in the electrically non conductive elements, which makes such elements electrically conductive (2b); said painting powder melting and polymerizing station (6) being further adapted to eliminate by evaporation at least part of the water previously retained on the electrically non conductive elements (2).

9.- A plant (1b) according to claim 8, characterized in that the pre-treating station (3b) comprises in combination: an over-heated steam generator (35) starting from said low mineral content water; a plurality of
delivery nozzles (38) for said flow of over-heated steam (V) toward said electrically non conductive elements; air/steam mixing means (37) adapted to produce towards said electrically non conductive elements (2), when they are placed upon said at least one conveyor device (7), an air/steam flow with an air/steam ratio comprised from 15 to 30 m3/kg; and cooling means (391;392) through which said electrically non conductive elements are guided by said at least one conveyor device (7), downstream of said air/steam mixing means (37) and immediately upstream of the painting powder coating station (4).

10. - A plant (1) according to claim 8, characterized in that the pre-treating station comprises in combination: a rack (12) with powered rollers (13) on which the electrically non conductive elements (2) transit tidily; a plurality of nozzles (14) for supplying high pressure jets (15) of said water towards the electrically non conductive elements (2), said nozzles (14) being adapted to create a mist all around said electrically non conductive elements; at least one feeding pump (16) for said nozzles; and a suction hood (17;17b) arranged facing said nozzles (14).

11. - A plant according to claim 10, characterized in that, in combination:
1.) - said nozzles (14) are arranged aligned side by side with an aligning direction (L) transversal to a forward direction (D) of the electrically non-conductive elements on said powered roll rack (12); ii) - the supply nozzles (14) and at least one feeding pump (16) are adapted to generate said pressurized water jets (15) at pressure of at least 60 bar; iii) - the nozzles (14) are arranged under the powered roll rack (12), so a suction hood (17b) is defined by a tubular element (30) provided towards the nozzles with a rectilinear through suction slot (31) provided towards the nozzles with a predetermined vertical gap (1) that it comprises means (20) for adaptability varying said gap (1) and in that said gap (1) of the nozzles, the suction through suction slot (31) is determined by a tubular element so that an empty space (S) is delimited between the rack and said nozzles; iv) - the suction hood (17b) is adapted to address said jets (15) at a pressure of at least 60 bar, to bottom upwards, at a predetermined vertical gap from the roll rack (12), so as to address said jets (15) from the roll rack (12) towards the nozzles (14) are arranged under the powered roll rack (12), so as to determine said suction hood (17b) as a suction trap (33) as to delimit within and under the same a water collecting suction trap (33).
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

INV. B05D1/04 F16D65/02

According to International Patent Classification (IPC) and to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B05D F16D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of database and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Relevant to claim No.</th>
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*A* document defining the general state of the art which is not considered to be of particular relevance

*E* document, earlier application or patent but published on or after the international filing date

*L* document, which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

*O* document referring to an oral disclosure, use, exhibition or other means

*P* document published prior to the international filing date but later than the priority date claimed

*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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*Z* document, member of the same patent family

Date of the actual completion of the international search Date of mailing of the international search report

27 January 2014 03/02/2014

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
N.L.-2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Brothier, J

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