"VACUUM BLASTING". AN INNOVATIVE NEW PROCESS FOR METALLIC COATING OF SURFACES WITH A SHOT/POWDER MIXTURE

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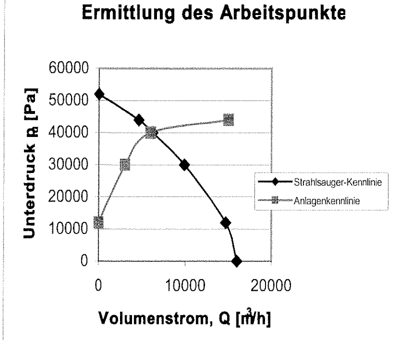
1. Abstract

In the course of further technological development, a new field of application has opened up for the vacuum blasting technique developed for the cleaning of surfaces by GP *innovation* GmbH: the production of metallic coatings. In this process, the most diverse types of metallic powders, mixed with impact shot (balls) are blasted on to the surfaces in question instead of cleaning or abrasive blasting agents. This innovative technology has up to now achieved coating of steel surfaces with zinc, tin, copper, aluminium, and other metals, with absolutely no emissions. These coatings are built up by means of mechanical embedding, adhesion forces and micro-welding between the particles applied and with the surface to be coated. The unconsumed mixture of powder is vacuumed off immediately, separated from the air flow by means of a separator, and returned to the process. This is, therefore, a largely closed-circuit system. Such vacuum blast coating systems can be used in automated form in manufacturing and production facilities. Utilizations found for this new process include up to now the application of functional layers, separating and connecting layers, decorative coatings, anti-corrosion layers, etc..

2. Working Principle
"Vacuum blasting" : Zero-emissions sand-blasting

A vacuum generator (side-channel compressor, industrial vacuum cleaner, reciprocating pump, etc.) generates within the system, by means of a compressor, a partial vacuum vis-à-vis the atmosphere. The air flowing into the system generates a suction flow which, on the one hand, conveys the blasting agent within the system and, on the other hand, accelerates it, within a steel hood fitting tightly on the material's surface, via a suitable nozzle on to the surfaces requiring treatment.



Each system is adapted for its particular task. The characteristics curve for the suction side of the flow generator and of the system is optimized for this purpose. The working point determined for the vacuum blasting system should preferably be in the p_u ~ 35,000 to 40,000 Pa (350 to 400 mbar) partial-vacuum range. The working point determines volumetric flow. Flow velocities of v_{St} ~ 150 to 280 m/s are possible, depending on blasting-nozzle diameter (Figure 1).

The emission of particles can be excluded, since the working zone is sealed off from the environment by a blasting hood and a partial vacuum vis-à-vis the atmosphere exists in all elements conducting blasting agent. The vacuum blast system is designed in such way that it is even possible to perform sand-blasting work in vessels without the need for any special individual protective equipment. No particulates can be emitted, and noise is generated only by the vacuum unit (flow generator) located outside the vessel. Blasting can be conducted without a face-mask, since the suction effect causes continuous influx of fresh air. Thanks to the system design, blasting dust cannot escape even in case of leaks or other defects.

The blasting system is of an extremely simple technical conception and is extremely user-friendly, with the result that no special qualifications are required for its operation. Servicing and maintenance are generally restricted to filter-changing and replacement of wear parts.

Blasting-agent consumption is highly economical. The unconsumed blasting agent is recovered in a cyclone before the air passes through the filter, and is then returned to the process. Only then is the air cleaned, on a filter tailored to this particular application. The blasting agent can be recycled a number of times, depending on specific operating conditions.

The most diverse applications in a range of different industries have opened up since vacuum blasting was introduced. This is illustrated by the following examples:

Paint removal:	from automotive components and copper conductors
Coating removal:	from sheet zinc
Cleaning:	of railway-vehicle axles, casting moulds and isolating elements
Delustration:	of glass and stainless steel
Engraving:	of logos and serial numbers
Roughening:	as a preparation for painting
Derusting:	of structural elements
Deburring:	of aluminium castings and punched/cut parts
Smoothing:	of welds and cut components
Strengthening:	of metal surfaces

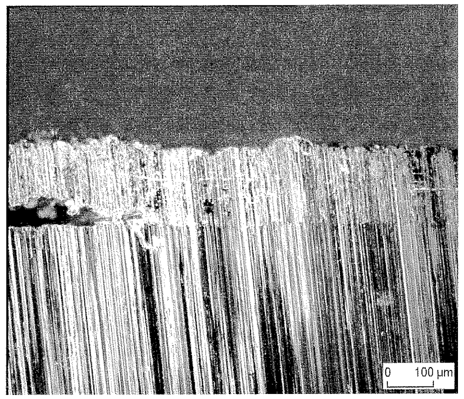
These many and diverse potential uses derive from the fact that practically all blasting agents available on the market, with their extremely diverse properties, can be used and from the fact that blasting intensities can be defined and set with extreme precision. A further advantage is the fact that vacuum blasting can be implemented not only in stationary plants but also in mobile systems. These can be deployed both in a workshop and in paint-shops and other facilities where freedom from dust in the atmosphere is vital.

In summary, the benefits of the vacuum blasting technique can be found in the fact that:

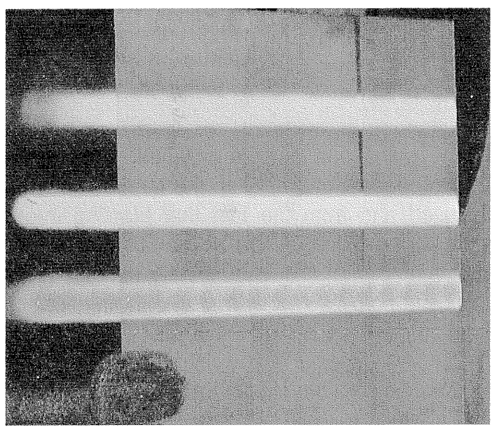
- A broad range of blasting agents can be selected to match the most varied and diverse task requirements
- There is no need for expensive special health and safety precautions
- The process meet high health, safety and environmental standards
- The systems simple structure permits easy handling, use, servicing and maintenance
- The process can be readily adapted for the diverse possible areas and fields of use
- The process can be applied in manual and in fully automated form

3. Description of process: "Coating", Experimental procedure

Vacuum blasting technology modified for application of metallic layers has been tested with a metallic shot/powder mixture. The mobile vacuum blast system was set up with a corresponding blasting hood for the purpose of performance of these tests. An industrial vacuum cleaner rated at 5.5 kW and with a maximum volumetric flow of 810 m^3/h and a maximum achievable "underpressure" (partial vacuum) of 42,000 Pa (420 mbar) was used in this context. The vacuum blast system generates a sound level of approx. 76 dB(A) during operation.

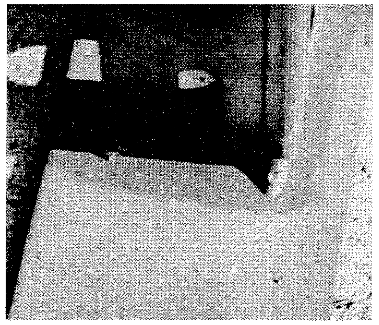


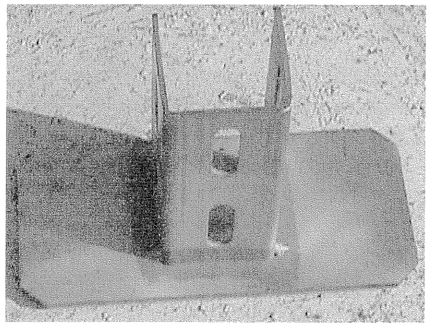
As in suction blasting, placing of the blasting hood in position closes the circuit and the shot/powder mixture fed via a high-precision screw-metering system is drawn in automatically. The pre-accelerated shot/powder mixture is raised to a velocity of approx. v_{Sm}~ 20 to 80 m/s in the injector blasting lance.
Upon impact with the surface to be coated, the highly accelerated metallic constituents are "welded" on to and into the surface by the shot (see Figure 2). The surplus, non-fused mixture is vacuumed away immediately and routed via a cyclone-separator in the media tower. Here, the reusable shot/powder mixture is separated, after which it can be re-used several times. Fines, such as particulates and disintegrated shot material, are vacuumed off into the vacuum unit and captured there on an ultra-fine filter (filter surface area: 19,500 cm²), which can then be fed to a preparation system or appropriately disposed of. Only filtered air leaves the vacuum unit. Wider or narrower strips can be applied, depending on the design of the blasting nozzle (see Figure 3), and layer thickness can be varied by means of multiple passes. Average layer thicknesses of 8 to 12 µm, and maxima of as much as 40 µm, have been

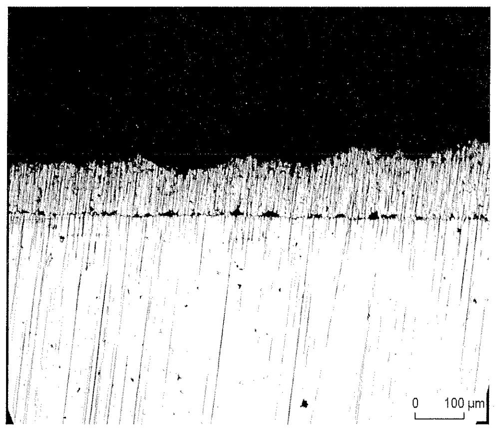


achieved in coating with zinc, while the corresponding figures for copper are 10-20 µm on average and a maximum of up to 100 µm.

A shot mixture with the following composition was prepared for application of a layer of zinc (see Figure 4, 5 and 6):
- 50 % pulverized zinc (particle size: ~ 8 µm)
- 50 % ceramic shot (particle diameter: ~ 400 µm)







The use of more powerful industrial vacuum cleaners than that used in the test system makes it possible to achieve higher surface-coverage rates during the coating process. We envisage, on the basis of the test results achieved, a large number of diverse applications for vacuum blast coating. The arguments in favour are, above all, the advantages of freedom from emissions, and also benefits in industrial health and safety, cleanness (freedom from dust), mobile availability, recycling of the shot/powder mixture and low noise emissions.

4. Summary

Vacuum blast systems are eminently suitable for the most diverse range of applications in the field of surface treatment and refinement:

- Coating of diverse surfaces
- Preparation for test and inspection procedures (e.g. ultrasonics, magnetic-powder, etc.)
- Preparation and finishing of joining processes (such as welding, soldering, brazing, bonding, etc.)

- Cleaning and removal of coatings from surfaces
- Adjustment of defined surface qualities (for the purpose of painting, coating, etc.)
- Corrosion elimination
- Marking and signing of components
- Blasting off of pollutants and other harmful substances

The patented vacuum blast system which we have developed, along with its dust-free manner of function, permits the use of sand-blasting methods even in ultra-sensitive areas.

In addition:
- Process-costs are reduced
- The quality of the treated surfaces is optimized
- Working conditions for staff (emissions, health and safety, etc.) are significantly improved

5. Acknowledgements

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6. References

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