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ABRASIVE PADS FOR SUSTAINABLE AND COST-EFFECTIVE INDUSTRIAL AND INSTITUTIONAL FLOOR CLEANING

Diamond, SiC and Al_2O_3 particle loaded pads for floor cleaning without chemical agents

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Abstract:-*Industrial and institutional floor cleaning today relies on mechanical action combined with chemicals, which is costly and a burden to the environment. There are floor cleaning pads on the market which claim increased service time due to diamond particles contained in the nonwoven materials. In this study, it was investigated whether cleaning results can also be obtained with hard-particle-coated pads using only water. SiC, diamond and Al_2O_3 were used with particle sizes between 5 and 125 µm. 5 g/m² of hard particles were applied to the pads in epoxy resin. Weight loss from abrasive cleaning in 500 cycles and gloss increase were measured. Diamond and silicon carbide particles were found to work with pure water, without the need for chemical cleaning agents.*

Introduction

Cleaning of industrial and institutional buildings is a constant need associated with high recurring costs for personnel and for chemicals. For floor cleaning, machines with rotating pads are commonly used [1], in different embodiments [2], [3]. Personnel costs are addressed by the development of cleaning robots [4]. In the chemical industry, chemical leasing is an innovative concept, and it has been applied successfully to solvents [5], [6]. For cleaning applications, there is still a very huge demand for chemicals, and it is rising at approx. 4% per year [7], and a solution is urgently needed to reduce their consumption.
Hard particles such as diamond were tested as coating on standard cleaning pads [8] and successfully commercialized, e.g. by HTC Cleaning Technology AB under the trade name "Twister™" [9]. In this work, different hard particles (diamond, SiC, Al_2O_3) in various particle size (5-125 µm) were tested with regard to their cleaning efficiency and effectiveness when attached to a cleaning pad, in order to further optimize floor cleaning to completely avoid the use of chemicals and to clean with pure water only. Water is necessary to avoid dust formation [10].

Hard particles to improve cleaning pad performance

It is known from the state-of-the art that hard particles on PET non-wovens can improve the service lifetime and reduce cleaning chemical consumption significantly [8], [9], [11]. There are different systems and approx. 10 manufacturers on the market [11], and the cleaning pads differ e.g. based on floor type (PVC, stone, laminate, etc.), job (cleaning, polishing) and level of contamination [1]. The standard ÖNORM D 2050:2017-01 gives a reference value of 5m² per hour with a 3 step diamond coated pad cleaning job [12].

Experimental

Diamond, SiC and Al_2O_3 powder in different sizes, from 5-125 µm, were ordered from multiple suppliers and applied to PET non-woven cleaning disks (46 cm in diameter) using epoxy resin as binder, with final concentrations of 5 g/m², and allowed to dry for 48h. As reference surface, Italian white marble was used in the experiments. The marble was etched using phosphoric acid (pH 1.5) for 10min, then rinsed and allowed to dry, to condition it for the experiments.
Two different tests were carried out:

1) Weight loss of the marble as a function of time and hard particle coating. A standard laboratory, calibrated scale (Mettler Toledo, +/-0.01 g) was used;
2) Increase in gloss value. An MG6-SS (mtv messtechnik OHG) was used to determine gloss. The key results are shown in Fig. 1 and 2. For the tests, a special testing apparatus was designed and built.

Results and Discussion

A marble plate (20 mm thickness) was prepared in that 5 cylindrical pieces with 35 mm in diameter were drilled using a core bit with 36 mm outer diameter and put back. The empty space between the 5 drill cores and the plate (approx. 1 mm) was stuffed with wood). 500 cycles were carried out with the coated pads, i.e. they were manually pulled over the cylindrical pieces sitting in the marble plate. The pads, which contained 5 g/m² of hard particles, were loaded with 0.5 kg/m² during the 500 cycles. Wetting with water was applied. Afterwards, the weight loss from the 5 inserted drill cores was determined, see Fig. 1.

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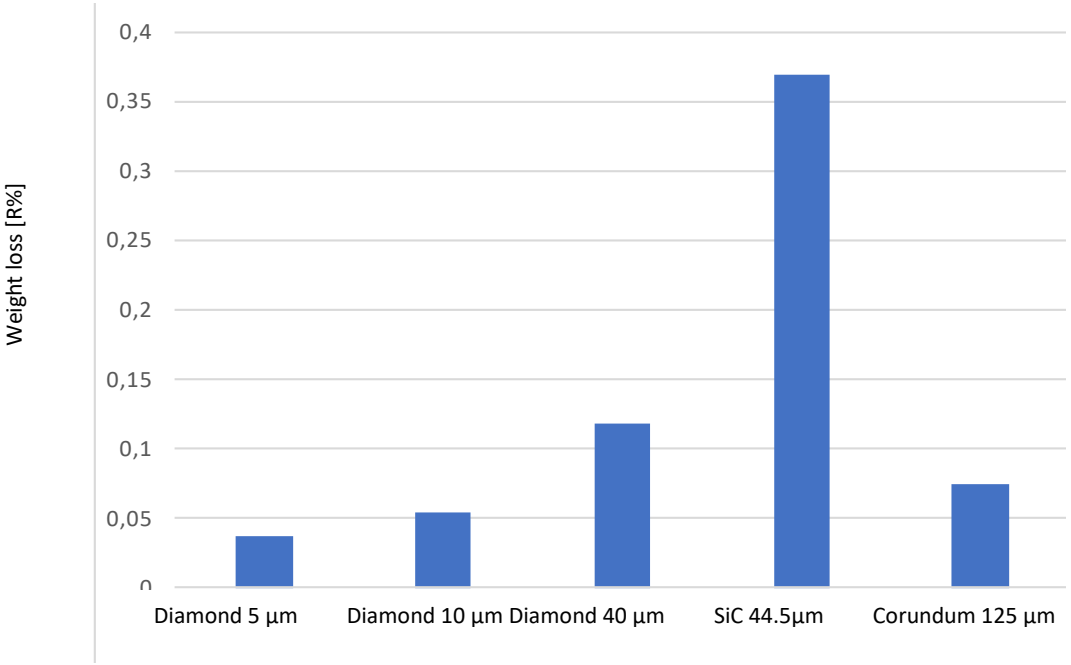

Figure 1: Weight loss for different hard particles coated onto the pads after 500 cycles over marble.

The weight loss is a measure of abrasion performance. As it can be seen from the above Figure 1, there are substantial differences in weight loss between SiC, diamond and corundum (Al_2O_3). Note that the tests used straight movements only, whereas commercial cleaning machines deploy rotary movements, which is not seen as major impact factor here. Interestingly, the coarse corundum gave rather low abrasion, and SiC had the best results.

Also, gloss measurements [13] were carried out. The marble plate was wetted with phosphoric acid and rinsed with clean water after 10 minutes. After drying, the gloss measurement gave a value of 0 GU [gloss units], which is the starting point for the trials.

They could confirm that small particle sizes have the best polishing effect (compare Fig 2). The pad with 5 µm diamond particles could significantly increase the gloss on marble after only 100 cycles.

Despite its very strong abrasive effect (compare Fig. 1), the SiC with 44.5 µm particle size gave a better polishing effect than the diamond pad with diamond particles of 40 µm.

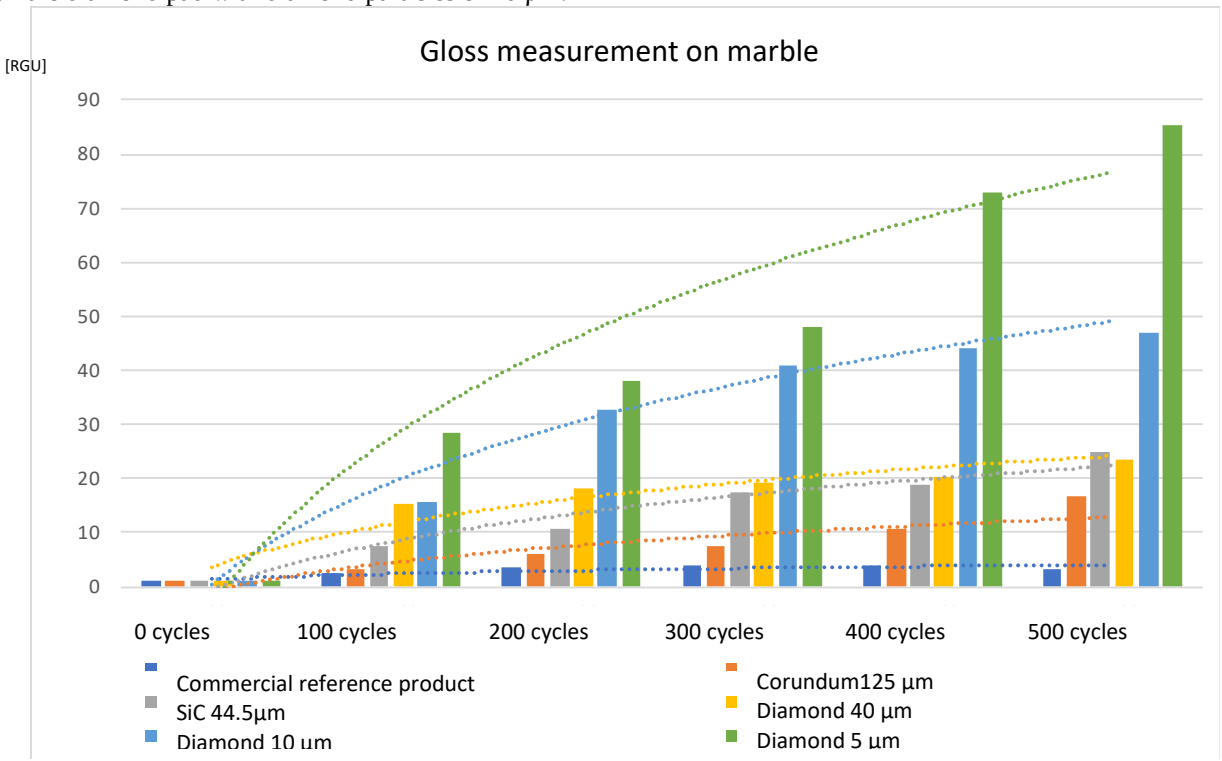

Fig. 2: Gloss measurements after up to 500 cycles on marble, using 6 pads with different hard particles coated onto them. See text for details.

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Again, a small amount of water was used in the trials (wetted marble surface). The gloss meter KSJ MG6-SS was used in the tests.
Apart from marble, preliminary tests with PVC and laminate floor were done, and similar results could be obtained. No differences between hard particles sourced from different vendors were found.

Conclusion

Based on the experiments, it was found out that diamond and SiC particles with 40-44.5 µm diameter, coated with epoxy resin on PET non-wovens with 5 g/m² loading, can be used for cleaning floors of marble, PVC and laminate. The rest results were obtained with diamond powder of 5-10 µm particle size. Polishing results were also very good with diamond particles and acceptable with SiC particles. As the authors could demonstrate, it was possible to achieve good industrial and institutional floor cleaning results without using chemicals, which translates into benefits for the environment and cost savings for cleaning operators and building owners.

References

[1] Preims, Hansjörg und Lembacher, Harald. Reinigung Aktuell. [ROnline] 28. 12 2017. [RZitat vom: 16. 02 2018.] http://www.reinigung-aktuell.at/diamantene-zukunft/.
[2] M. Ranjit Kumar and N. Kapilan, "Outline and Examination of physically worked floor cleaning machine," IJERT ISSN: 2278-0181 Vol. 4 Issue 04, April-2015.
[3] Chavan Abhishek, Datkhile Pratik, Khilari Suraj, More Pratik, Shinde Sachin, Manually operated powerless floor cleaning machine, International Journal of Advance Engineering and Research, Development, Technophilia-2018, Volume 5, Special Issue 04, Feb.-2018.
[4] Veerajagadheswar Prabakaran, Mohan Rajesh Elara, Thejus Pathmakumar, Shunsuke Nansai, Floor cleaning robot with reconfigurable mechanism, Automation in Construction, Volume 91, July 2018, Pages 155-165
[5] Petra Schwager, Branko Dunjic, Ingrid Kaltenegger, Success and failure of the Chemical Leasing model in addressing sustainability challenges: Evidence from practice, Current Opinion in Green and Sustainable Chemistry, Volume 8, December 2017, Pages 14-17
[6] Petra Schwager, Nils Decker, Ingrid Kaltenegger, Exploring Green Chemistry, Sustainable Chemistry and innovative business models such as Chemical Leasing in the context of international policy discussions, Current Opinion in Green and Sustainable Chemistry, Volume 1, August 2016, Pages 18-21
[7] Freedonia, Industrial & Institutional (I&I) Cleaning Chemicals, Study #2683, September 2010, https://www.freedoniagroup.com/brochure/26xx/2683smwe.pdf
[8] René Hein, Verfahrensvergleich zwischen chemischer, Reinigung und dem TwisterTM-Reinigungssystem im Krankenhaus, Bachelor-Thesis, Wintersemester 2014/15, Hochschule Albstadt-Sigmaringen
[9] HTC Cleaning Technology AB, https://twisterpad.com/wp-content/uploads/2016/12/CTGD038-Technical-Data-sheet-Twister-Extreme-Red.pdf
[11] Alexander Knapp, Master Thesis, University of Applied Sciences FH Technikum Wien, Austria, 2018.
[10] Thomas Schneider, Steinar K. Nilsen, Inger Dahl, Cleaning methods, their effectiveness and airborne dust generation, Building and Environment, Volume 29, Issue 3, July 1994, Pages 369-372
[12] ÖNORM D 2050:2017-01
[13] A. C. Chadwick, R. W. Kentridge, The perception of gloss: A review, Vision Research, Volume 109, Part B, April 2015, Pages 221-235

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