Großflächige Oberflächenreinigung: Schleuderstrahlen mit Trockeneis
Neueste Entwicklungen der Anlagentechnik

Energy-Efficient Cleaning and Pre-Treatment
Centrifugal Wheel Blasting with Sensitive Blasting Media

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Outline

Introduction
challenge, approach, objective

Dry-Ice Blasting
environmental aspect, process, active mechanisms

Experimental Set-Up
test stand, test material, measuring systems

Results
pellets velocities

Conclusions and Outlook
Introduction

Challenge

- new environmental laws
- importance of cleaning within manufacture, repair, maintenance and recycling processes – dry ice blasting already introduced as an alternative to conventional processes based on water or chemical substances
- development of an acceleration method with higher energy efficiency compared to conventional dry ice blasting

Approach

- development of a rotational wheel blasting technology for sensitive blasting media

Objective

- qualification of rotational wheel blasting with dry ice for de-coating, cleaning and pre-treatment with:
  - higher energy efficiency, higher maximum mass flow,
  - less dry ice consumption, noise emission and area needed
Dry Ice Blasting

**environmental aspect**
- CO₂ (dry ice) used for blasting is a by-product of the chemical industry
- dry ice blasting does not contribute to the global warming additionally

**process characteristics**
- compressed air blasting process
- solid single-way blasting medium CO₂
- no residues due to this sublimation
- non-corrosive, non-toxic and non-abrasive
- reduction of process time and costs
- Suitable for different substrate materials, coatings and sensitive surfaces

**process model**
- Compressed air
- CO₂-Particles
- CO₂-Gas
- Contamination
- Substrat
Dry Ice Blasting

active mechanisms

• local cooling and embrittlement of the coating, stripping from base material by the use of tensions caused by different thermal expansion coefficients
• stripping due to the impulse transfer
• abrupt volume increase of the CO2 due to the phase change from solid to liquid, stripping caused by a pressure surge

\[ T_p = -78.3 \, ^\circ C \quad l_p = 5 - 15 \, mm \]
\[ \rho_p = 1100 \, kg/m^3 \quad d_p = 3.0 \, mm \]
Experimental Set-Up

conventional equipment

Integration example: Suitability for wood working machine tools

energy consumption of 134 kW for the generation of compressed air
Experimental Set-Up

conventional equipment
Experimental Set-Up

classical centrifugal wheel blasting device and first prototype for sensitive blasting media
Experimental Set-Up

measuring systems

high speed camera system with up to 8000 frames per second

proof of concept: first prototype for centrifugal wheel blasting with sensitive media
Results

pellet velocity

measured velocity of up to 64 m/s by high speed camera, correlation of calculated and measured pellet velocities

![Graph showing particle velocity vs. revolutions per minute for different wheel diameters. The graph includes measured data points and calculated linear trends.]
Results

construction improvements

- reducing mechanical loads, higher accuracy of parts with high relative velocities
Experimental Set-Up

Second prototype
Conclusions and Outlook

Advantages of rotational wheel blasting for sensitive blasting media:

- Saving energy due to higher efficiency (≈ 10 kW : 130 kW)
- Saving time due to higher maximum mass flow rate
- Less investment costs (no compressor, filters, ... needed)
- Less sound pressure level: up to 130 dB (A) of compressed air blasting
- Large area related processing rate, not restricted to blasting nozzle’s footprint

Disadvantages:

- Low blasting speed of dry ice pellets, less kinetic energy, less abrasive
- Higher number of revolutions per minute, larger diameter (longer blades) for speed comparable to conventional dry ice blasting with compressed air

Dry ice consumption, running costs (losses due to early sublimation)?