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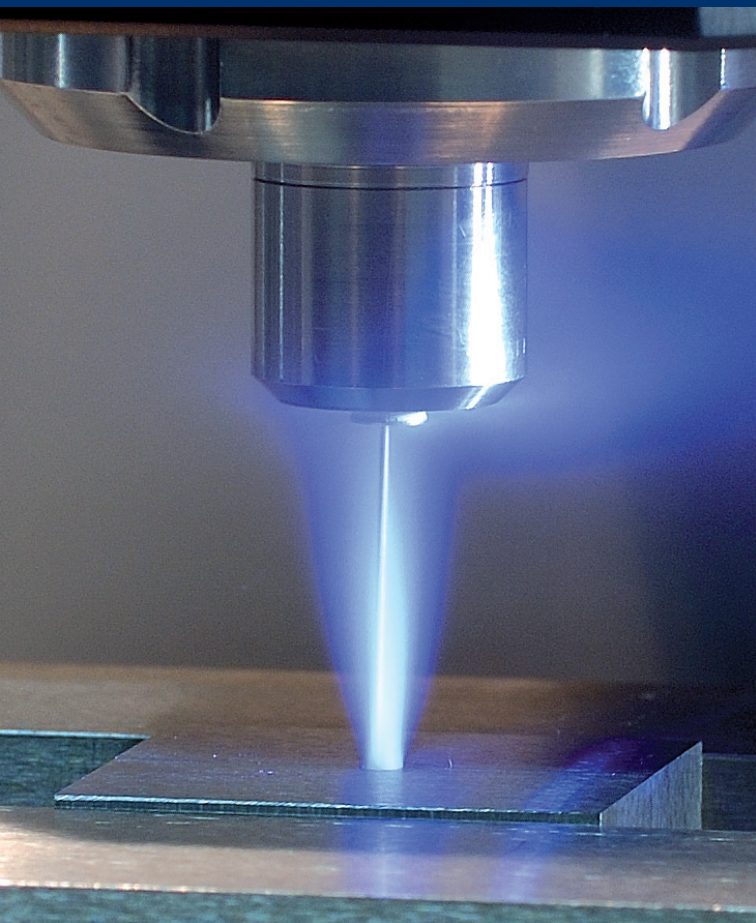
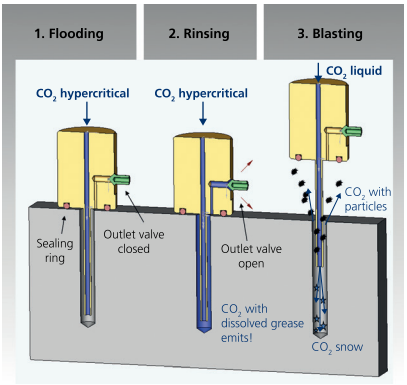
FRAUNHOFER INSTITUTE FOR
MANUFACTURING ENGINEERING AND AUTOMATION IPA

THE CO_2 INJECTOR – CLEANING SOLUTIONS FOR BOREHOLES AND BLIND HOLES





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Introduction

The trend towards higher standards of product cleanliness has remained unbroken for many years. In a number of sectors, cleaning has become a key technology which needs to be mastered in order to achieve high product quality. Many established cleaning techniques have reached their limits as far as cleaning accuracy, process stability and manufacturing integration are concerned. This is especially the case for components with complex geometries which are difficult to access, such as boreholes and blind holes with high aspect ratios. Here, chips, particles and residues from machining oils often need to be removed in very short cycles.

Solution approach

Highly-accelerated CO_2 snow is ideally suited for removing particulate contamination from surfaces. However, with boreholes, grease also needs to be efficiently removed and this is achieved by using hypercritical CO_2 as a solvent. The new patented cleaning technique of the CO_2 injector cleaning tool combines both these effective methods, thus enabling boreholes and blind holes to be rapidly dry-cleaned.


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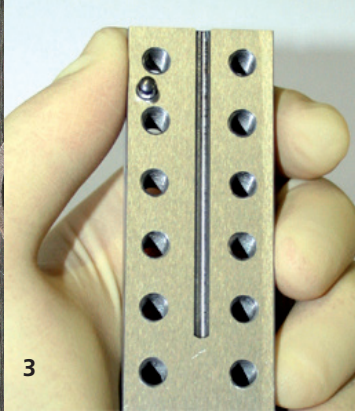
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Cleaning takes place in the following steps:

1. The injection needle is inserted into the borehole
2. The borehole is sealed
3. Flooding with hypercritical CO_2 (> 31 °C, > 78 bar)
4. Rinsing with hypercritical CO_2 (to remove oil)
5. Blasting with CO_2 snow (to remove particles and chips)

The solvent effect of the hypercritical CO_2 is adapted to the type and quantity of oil to be removed by altering temperature, pressure and the number of rinsing cycles.

Depending on the degree of contamination of the borehole, the cleaning procedure takes only a few seconds. For this reason and also due to the fact that refinishing work such as drying is no longer required, the process can be easily integrated into a mass production.

Procedure

For the first time, new developments made by the Fraunhofer IPA now permit the huge advantages of CO_2 cleaning to be utilized for boreholes and blind holes:

- Efficient cleaning action (particles and oils)
- Localized cleaning

- Gentle, dry workpiece handling
- High degree of automation
- Good levels of system integration
- Environmentally friendly circulation of cleaning medium possible

The technique can be adapted to different manufacturing tasks by:

1. Assessing the ability of the technique to remove the contamination in question by carrying out a test borehole
2. Adapting the CO_2 injector to the borehole to be cleaned
3. Determining specific process parameters

1 *Borehole cleaning sequence.*

2 *Machining residues in borehole (chip, oil).*

3 *Separable test borehole for assessing cleaning efficiency.*

Our range of services

- Analyzing user-specific cleaning tasks
- Designing, realizing and testing customized CO_2 cleaning tools and processes
- Cleaning series
- Drawing up cleanliness concepts regarding transport, storage and further processing

TITLE *Blasting with CO_2 snow.*

4 *Test set-up for borehole cleaner.*

5 *CO_2 injector.*

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