

# The coolest cleaning method you'll ever use.

Dry ice blasting with CRYOCLEAN® is convenient, eco-friendly and efficient.



# Contents.

- 4 Why dry ice blasting is an attractive alternative to conventional cleaning processes.
- 5 The special properties of CO<sub>2</sub>.
- 6 Cleaning with dry ice has many advantages.
- 7 How dry ice blasting works.
- 8 Dry ice blasting units: CRYOMAX®, CRYOMINI® and others.
- 10 Production of dry ice pellets.
- 11 The ICEMASTER system works with liquid CO<sub>2</sub>.
- 12 Dry ice blasting: some of the many applications.
- 14 Dry ice blasting: before and after cleaning.
- 16 Tried and tested: dry ice blasting works in most professional cleaning areas.
- 18 Dangers and precautions.
- 19 AGAs services and subsidiaries can be found worldwide.







# From now on, you can do without cleaning agent residues.

Why dry ice blasting is an attractive alternative to conventional cleaning processes.

During numerous natural, as well as industrial and other production processes, residues and other unwanted substances become attached to substructures, machine parts or storage tanks. Think for instance of oils, fats, waxes, resins, soot, inks, rubber, dyes, bitumen, paint, glue, moss, dirt etc. The soiling of surfaces, equipment, machines, tools or pieces of work has undesirable consequences:

- Poorer quality (necessitating either rejection or refinishing).
- Longer production cycles.
- Safety risks.
- Reduced efficiency of subsequent surface treatments.
- Unattractive appearance.

Then there are, of course, many intentionally applied coatings that have to be removed for a variety of reasons.

However, apart from the often difficult task of cleaning itself, most conventional cleaning processes cause additional problems:

- Wear as a result of using abrasive cleaning agents.
- Costs for disposal and processing of used cleaning agents (sand, glass beads, water etc.).
- Downtimes and/or costly cool-down and warm-up times because equipment has to be dismantled to remove soiled parts for cleaning.

Dry ice blasting with Linde Gas technology removes various kinds of contamination quite effortlessly, while being environmentally friendly. Unlike cleaning techniques that use substances such as sand or glass beads as blast-cleaning agents, it doesn't leave behind residues. Therefore, it is an attractive alternative to conventional cleaning processes. It lets you clean right at the production site, reduces downtimes, is gentle on substrates and doesn't require the disposal of cleaning agent residues.



# From dry ice to gas in no time flat.

The special properties of CO<sub>2</sub>.

Dry ice is the solid form of carbon dioxide, or CO<sub>2</sub> for short. Liquid CO<sub>2</sub> is stored either in cylinders at ambient temperature under about 60 bar or in vacuum-insulated tanks at about -20 °C under 20 bar pressure. When liquid CO<sub>2</sub> expands, finely powdered snow is formed.

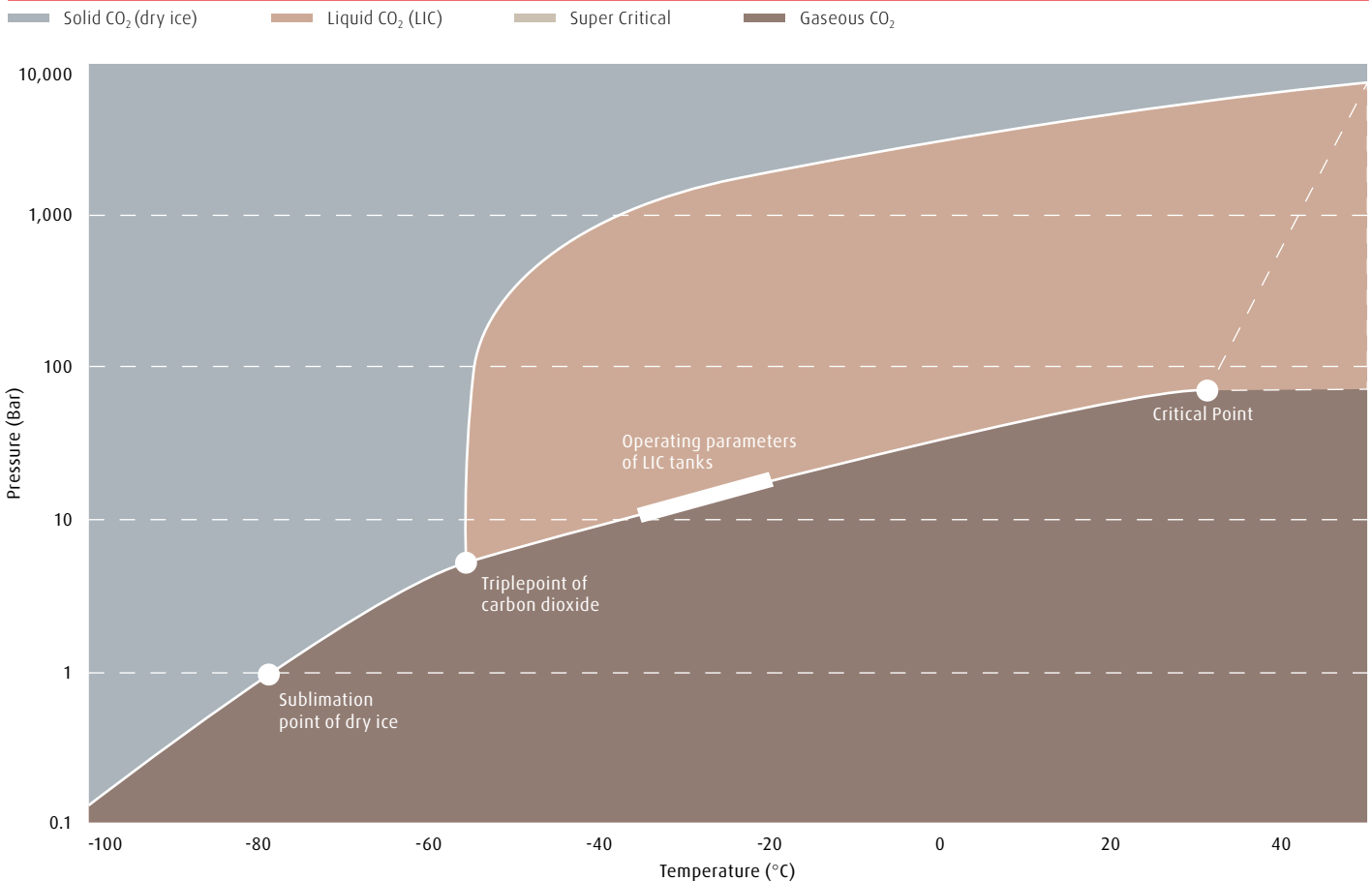
Dry ice closely resembles normal water ice, but has very different properties:

- Dry ice contains no water .
- Its temperature remains constant at -78 °C.
- When energy is applied (e.g. heat or energy released by impact), dry ice is directly converted into its gaseous state without liquefying first.

This eliminates the necessity of special disposal measures, thus saving you money.

- Carbon dioxide is considered non toxic.
- It is also non-flammable.
- The gas usually behaves as an inert substance, this means that there is no chemical reaction with its environment.
- There is no liquid phase at any step of the cleaning process.

## CO<sub>2</sub> state diagram



# It's a dirty job but now someone's going to love it.

Cleaning with dry ice has many advantages.

## Faster, and therefore cheaper

Machines no longer need to be disassembled for cleaning, as in-line cleaning is often possible. This cuts downtime to a minimum.

## Non-abrasive

Dry ice pellets are no harder than plaster and change into gas the moment they hit the surface. Contrary to conventional blasting media, the soft dry ice doesn't cause wear to the substrate. In dry ice cleaning, the blasting pressure can be adjusted between 2 and 16 bar, thus adapting the aggressiveness of the process to the individual demand of the special cleaning job.

## Eco-friendly

Dry ice can be an excellent replacement for corrosive and aggressive solvents – though without the harmful emissions. As this cleaning process doesn't use water, a lot of expensive waste water treatment measures are becoming obsolete. Sticky, elastic dirt is removed quickly and easily without leaving remnants of any blast-cleaning agent, thus eliminating additional cleanup and removal costs.

## Dry

Dry ice blasting is a dry method of cleaning. Because the cleaning agent evaporates, there is no mixing with the removed contaminant. No water is released during the process. This eliminates a lot of problems when cleaning processing units for water-sensitive products.



Cleaning a coffee production plant

# A convincing combination of amazing effects.

How dry ice blasting works.

Blast-cleaning with pellets of dry ice is based on a combination of four effects:

## 1 Embrittlement:

Organic materials harden and embrittle under cooling. This reduces their elasticity and adhesiveness, making removal easier.

## 2 Thermoshock:

Because of the sudden local cooling, differences in the rate of shrinkage create intense thermal tensions in the boundary area and loosen the compound between the contamination layer and the substrate.

## 3 Impact:

Upon impact – generated by the speed and mass of the dry ice pellets – kinetic energy is transformed into an abrasive cleaning force.

## 4 Explosive sublimation:

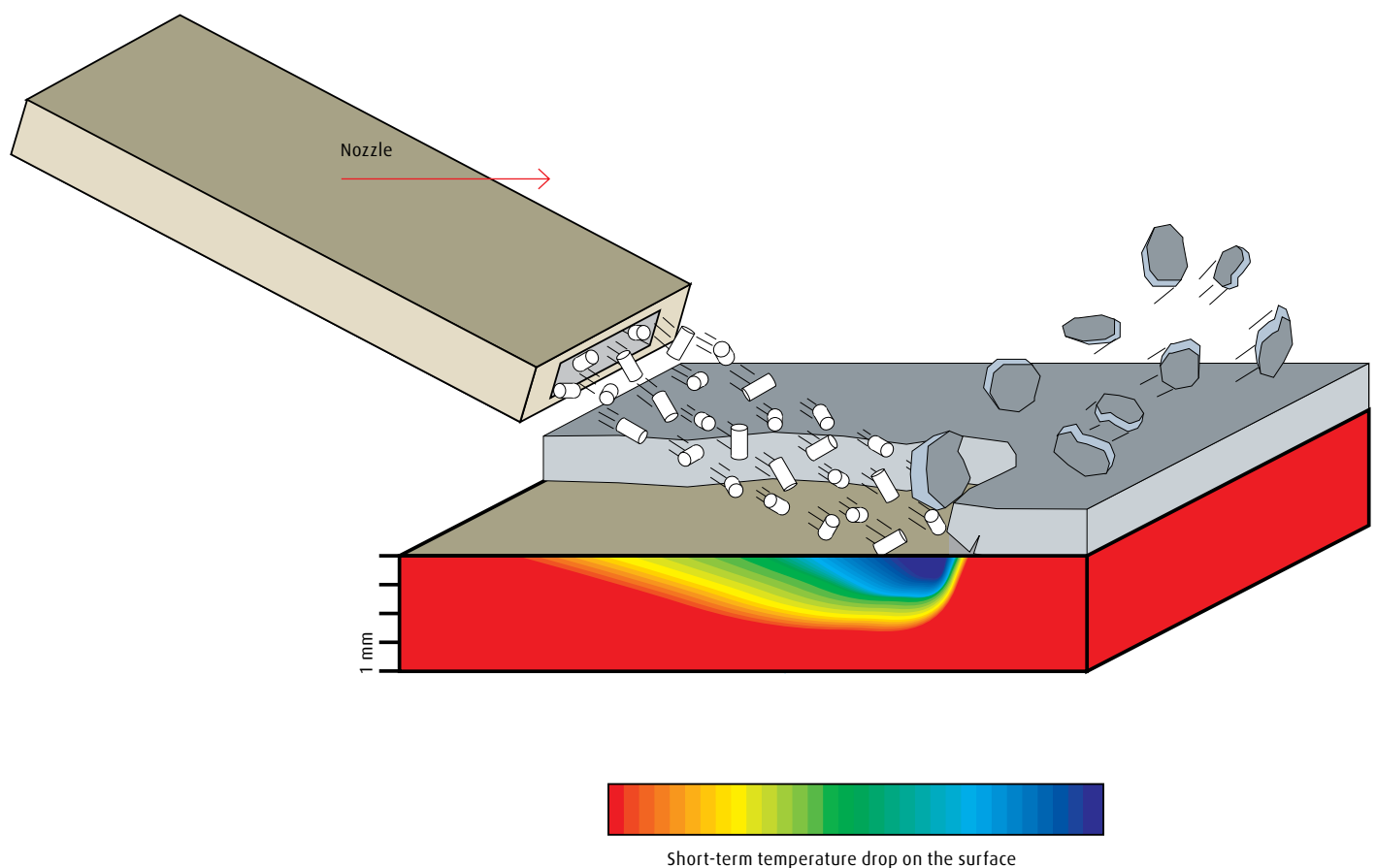
The transfer of heat from the very cold pellets to the relatively warm surface to be cleaned causes the solid-phase carbon dioxide to sublime almost instantly to the gas phase. This process is accompanied by a volume increase with a factor of approximately 500; this virtual micro-explosion of carbon dioxide blasts away the contamination, which has already been loosened, carrying it along on the flow of compressed air.

The result achieved with dry ice blasting depends on:

- the blasting pressure.
- the nozzle (available in a wide range of shapes).
- the properties of the contaminant to be removed.
- the material, temperature and surface roughness of the substrate.

The interrelation between the above factors determines the success.

## Removing resinated oil for renovation purposes





# Reliable, efficient, outstanding: a look at our hardware.

Dry ice blasting units: CRYOMAX®, CRYOMINI® and others.

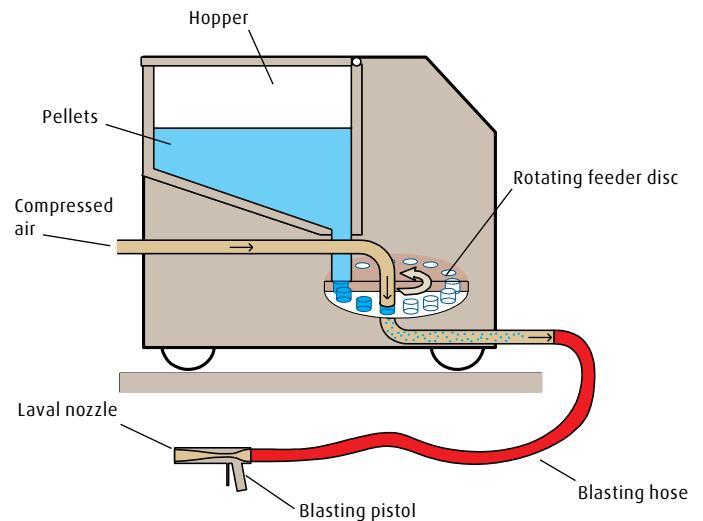
## 1-Hose blasting systems

By means of a (rotary) air lock, rice-grain sized pellets are fed from the machine's hopper into a stream of compressed air, carried towards the pistol and finally accelerated in a laval-type blasting nozzle to almost sonic speed. The pellets then blast against the surface being cleaned.

Many well-known enterprises use the easy-to-operate CRYOMAX®- and CRYOMINI®-systems. Hoek Loos, the Dutch subsidiary of the Linde Group, has been developing and building these blasting machines for over 15 years.

Linde Gas has been exporting the CRYOMINI® and CRYOMAX® to scores of countries all over the world for a number of years. Our references include many leading companies.

## CRYOMAX® and CRYOMINI®: Pressure-blasting unit (1-hose system)



The many advantages of the blasting units CRYOMAX® and CRYOMINI® include easy handling, high efficiency and low maintenance.



## 2-hose blasting systems

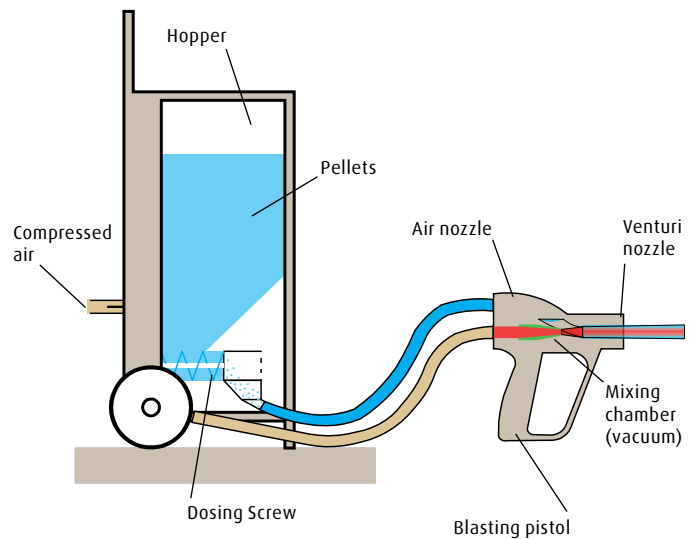
An alternative, slightly simpler design uses the suction principle to achieve the same result: The stream of compressed air produces a partial vacuum in the blasting gun. Dry ice pellets are fed from the unit's hopper into the sucked-in air by means of a simple dosing screw. These pellets are entrained by the air stream in the blasting hose and supplied to the Venturi blasting nozzle, where they are accelerated rapidly towards the cleaning target.

Some useful technical features are available for the CryoGen 2-hose units, for instance a built-in grinder for a soft cleaning effect on sensitive surfaces and a scraper-device which can be fed with bigger chunks of dry ice (e.g. finger-sized nuggets).

Every cleaning job has its own requirements. The best solution can be selected for every application from among several different models of 1- or 2-hose blasting units. The small and mobile blasting machines can be connected and disconnected in almost no time at all, which is why they are an attractive alternative to conventional cleaning methods.

If you want to use the dry ice blast-cleaning technique only from time to time, we can recommend experienced blast-cleaning service companies ready to serve you. Linde has highly reliable partners for professional industrial cleaning jobs in nearly every location.

## LT-100: Suction principle (2-hose system)



The number of professional blast-cleaning establishments using CRYOCLEAN® technology by Linde continues to increase day by day. A result of the efficiency and reliability of these machines.



Graffiti removal with LT-280



# The formula for the ideal cleaning agent.

Production of dry ice pellets.

## Pelletizer

Dry ice pellets consist of pure carbon dioxide (CO<sub>2</sub>) in the solid state. They are produced in a so-called pelletizer in our ICEBITZZZ® factories. Dry ice pellets (-78.5 °C) have approximately the same hardness as plaster.



## Pellets

For use as a cleaning agent, cryogenic carbon dioxide snow is compacted into dry ice pellets by pressing it through special dies. The bulk density of the pellets is about 1000 kg/m<sup>3</sup>. They have a characteristic rice-grain shape (approximately 5 to 10 mm long and 3 mm wide).



## ICEBITZZZ®

Because Linde Gas has its own production facilities in several dozen worldwide locations, we are able to supply dry ice according to the demand. Deliveries are made in insulated cryo-containers with capacities between 200 and 400 kg. The cryo-containers keep the dry ice usable for at least 5 to 7 days from the production date. Dry ice can also be produced on-site when higher demand arises.





# Slightly different method, great results: dry ice blasting without pre-produced pellets.

The ICEMASTER system works with liquid CO<sub>2</sub>.

For some automated cleaning applications a new, modified dry ice blasting system is available. The ICEMASTER produces the dry ice particles for the cleaning action directly on demand from a liquid-CO<sub>2</sub>-supply. Though less aggressive than the common dry ice blasting process (CRYOCLEAN®), the system is quite advantageous for many applications as it doesn't need pellet handling and requires only low-grade maintenance.

The special working principle of the ICEMASTER system has several advantages:

- Logjams in blasting units due to clogged pellets can no longer happen.
- No personnel is needed for refilling pellets or for other handling activities.
- No costs for storage of pellets or for moving pellet boxes between production and place of demand.
- As it is easily possible to store liquid CO<sub>2</sub> (LIC) on a long-term basis, cleaning power is always ready at hand, even for highly erratic cleaning demand.

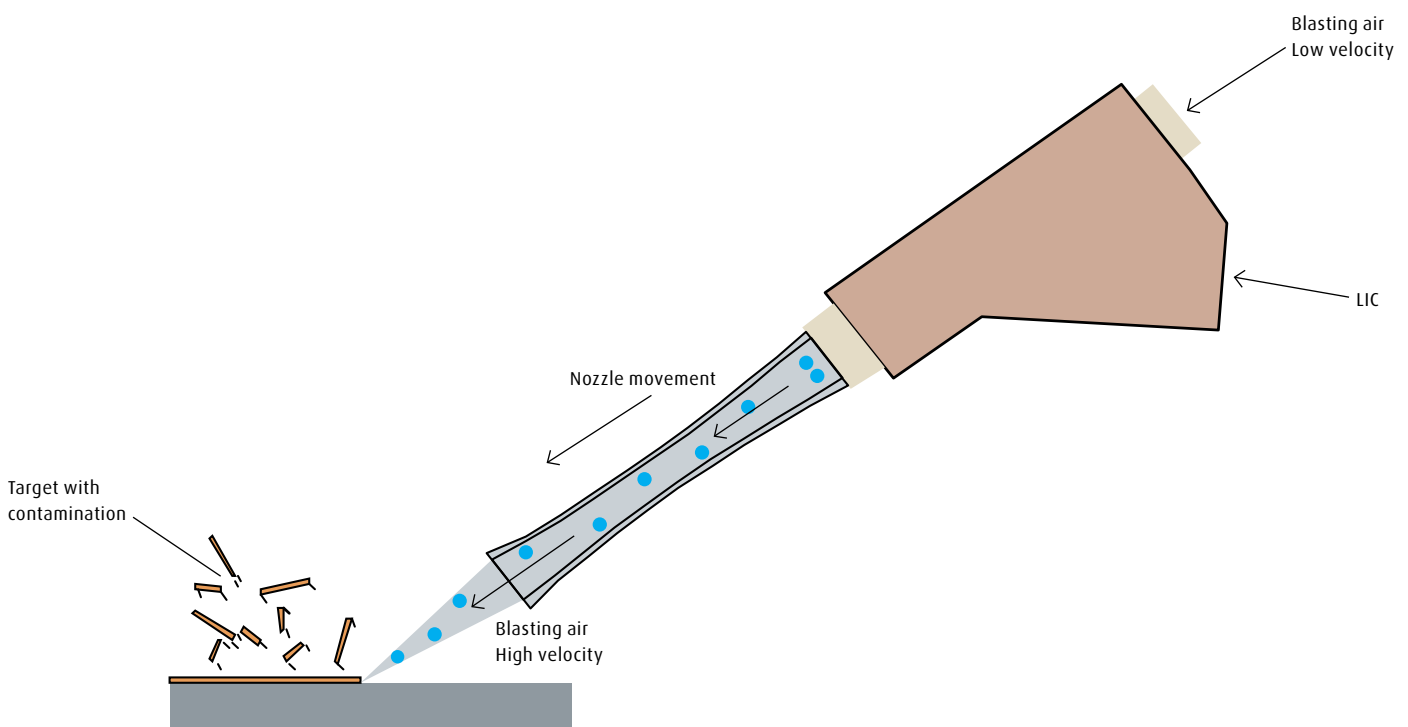
These are the benefits which make the ICEMASTER system a perfect solution for automation, where the cleaning process takes place in fixed locations such as:

- special cleaning cabins
- conveyor belts.
- process stations (e.g. drilling).
- etc.

However, the required aggressiveness of the cleaning process should be in the medium range and the layer thickness should not exceed 1 mm. Our specialists are available to adapt the ICEMASTER system to your requirements.

## Dry ice blasting without pre-produced pellets

- Dry ice particles



## And now it's time to see a piece of the action.

Dry ice blasting: some of the many applications.

The following applications are but a small selection of the numerous present-day uses. The successful application of dry ice blasting depends largely on your work process and your product (or that of your client) and the type of contamination that has to be removed. To establish the efficacy of dry ice blasting in your situation,

AGA can offer testing in its own Test and Demonstration Centers or at your site. Traversing systems are available for work of a repetitive nature, such as the cleaning of rollers and/or molds. It is also possible to use robots for cleaning molds. AGA has the right partners to arrange this.







Cleaning beaches after oil spill.



# Maximum effect with minimum downtime.

Dry ice blasting: before and after cleaning.

In recent years, Linde Gas has achieved excellent results in various branches of industry. Particularly in situations where conventional cleaning methods have detrimental side effects, the dry ice blast-cleaning

method can be the answer. The total absence of blast medium residues, the non-abrasive nature of the pellets and the intensive cleaning action have proved their value in industrial applications time and again.

## Cleaning the Spanish coast after the "Prestige" disaster



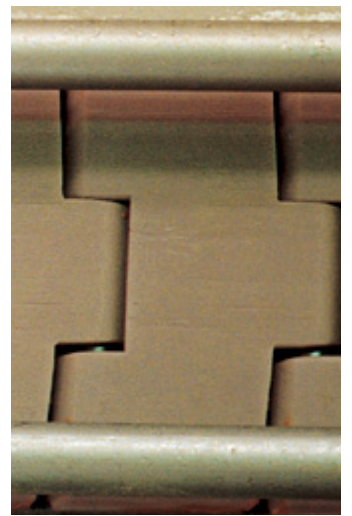
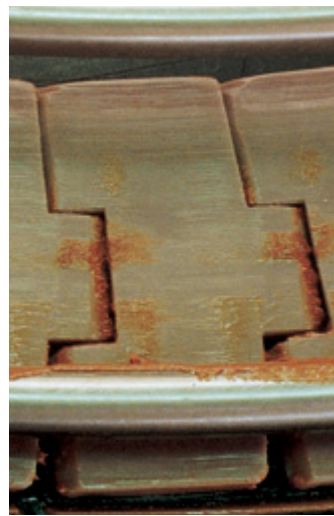
## Cleaning polyurethane molds



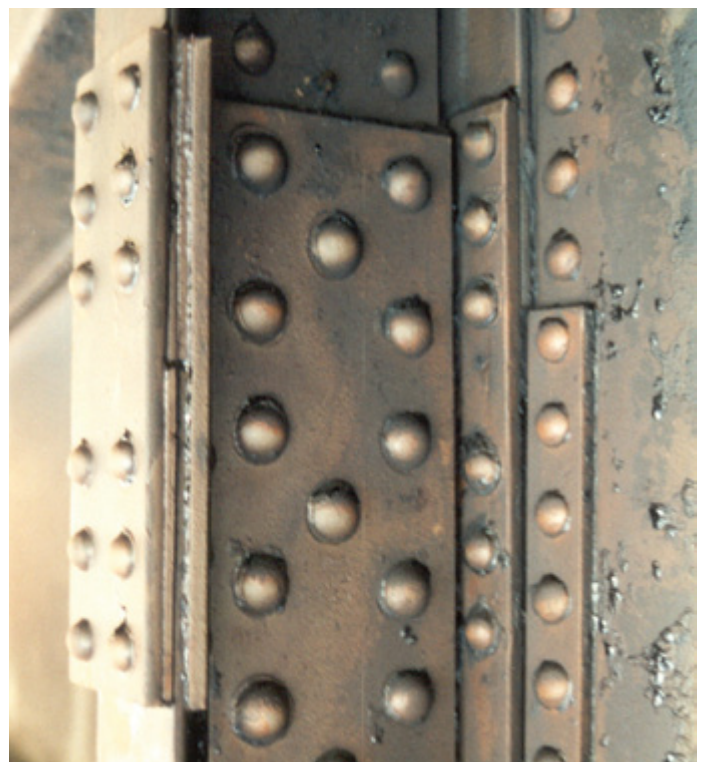


Before and after cleaning: streetcar platforms ...

... and conveyor belts.



Removing resinated oil for renovation purposes



# Tried and tested: dry ice blasting works in most professional cleaning areas.

Device or location	Type of contamination
<b>Printing and allied trades</b>	
offset printing presses, conveyor belts	printing inks, oil, grease
photocopier manufacture/parts	dyes, toners
toner extruder screws	hardened toner
crown-cork production machine parts/printing devices	printing inks, oil, grease
die plates, punching tools	product residues
finishing (and labeling) machines	remnants of glue, ink, stickers etc.
paper mills, filter screens	cellulose fibers
<b>Food industry</b>	
bread and pastry machines	(preliminary) product residues, fat, arabic gum
chocolate industry	caramel, (preliminary) product residues, fat, arabic gum
fat-processing industry	product residues (fat, additives)
ovens and conveyor belts	cooking residues, grease, arabic gum
deep cleaning in industrial kitchens (e.g. cooker hoods)	fat and oil remnants etc.
packaging (and labeling) machines	remnants of glue, ink, stickers etc.
machinery and halls	remnants of fats, cocoa, arabic gum etc.
fish and cheese processing (machinery, tiled walls)	product leftovers, deposits of protein material
<b>Metal-working industry/Foundries</b>	
core boxes	releasing agent, sand residues
casting molds/dies	releasing agent
rolling mill rollers	deposits of any kind
welding robots	welding vapor deposits, spatter
site decontamination	dust, smoke, deposits of any kind
steel machine parts	rust film
<b>Rubber/Plastic/Foam industry</b>	
presses and molds, e.g. in the automotive industry	fat, oil, dirt, product residues on peripheral parts
polyurethane molds (examples: dashboards, PU-foaming, seats, back shelves)	releasing agent residues
manufacture of packaging materials	glue, product residues
production of plastics (tunnel driers etc.)	vapor deposits
vulcanization molds, automobile tire molds	releasing agents, chemical evaporation
conveyor belts	rubber dust
splitter rollers, production machinery	plastic foils, various types of remnants



Matrixes and molds



Works of art



Device or location	Type of contamination
<b>Cleaning services</b>	
restoration of cars and other old machinery	paint, glue, oil, fat, wax, resin, dirt etc.
railway platforms, shopping malls, escalators, walls, decorative paving, public spaces and gardens	chewing gum, grease, dirt, paint weeds, green moss
parquet floor	varnishes and waxes, contaminated with dirt or hazardous substances
hardwood	soot left after a fire, paint or coatings
boats (yachts)	antifouling
building facades	paint, dirt, moss
acrylate billboards, trucks	stickers, glue remnants and lettering
aluminum window/door frames	anti-graffiti coatings
offshore accessory equipment, bridges and lock towers	rust, oil, grease, paint
public buildings, showrooms, production halls and equipment	soot left after a fire
building decontamination	PCB-contaminated expansion joints
<b>Industrial cleaning</b>	
turbine blades	combustion deposits, grease, dirt, anti-corrosion coatings
accessory equipment (e.g. stop valves and piping)	various types of deposits
flues and ventilation ducts	dust, fat
high-voltage installations	dirt, dust, moss
conveyor belts	various production residues
labeling machines	remnants of glue, ink etc.
road construction machinery, storage tanks, transport equipment (trucks), filling stations	fat, oil, bitumen, product residues
paint manufacture and processing, paint mixers, spraying cabins	dry paint remnants, overspray
storage tanks and production halls	
chemical substances of any kind etc.	paint, resin resp. preliminary products
welding robots	welding vapor deposits, spatter
switchboxes	dust
PVD machines	vapor deposits
asbestos removal	(sprayed) asbestos
steel machine parts	rust film
heat exchangers	various types of deposits
electric power plants/generators	dirt, attrition



Cleaning a caramel mixer



Deep cleaning in industrial kitchens

# What to keep in mind when dry ice blasting.

## Dangers and precautions.

### Ventilation

Gaseous carbon dioxide can displace the ambient air; always ensure that there is adequate ventilation in order to prevent the build-up of a dangerous concentration of carbon dioxide.

### MAC value

The MAC value (the Maximum Acceptable Concentration to which a worker may be exposed during eight hours a day) for carbon dioxide is 500 ppm (0.5 %) or 9 g per m<sup>3</sup>.

### Gas detection (CO<sub>2</sub>)

Carbon dioxide is 50 % heavier than air. It can accumulate in confined spaces or low-lying areas such as cellars and working pits. In such circumstances, use suitable gas detection equipment and ensure adequate ventilation.

Linde Gas would be glad to advise you on this.

### Explosive Atmospheres

Unfortunately, dry ice or CO<sub>2</sub> is prone to electrostatic charging. Even grounding all blasting equipment is no adequate precaution against electrical discharge. For cleaning jobs in those areas, the Ex-zone has to be suspended, e.g. by proper ventilation accompanied by diligent control measurements.



When dry ice blasting (e.g. when renovating an old half-timbered house, as shown here), always wear protective clothing.

### Gloves

In case of skin contact, the cold (-78.5 °C), solid-phase carbon dioxide can give rise to cold burn; always use gloves when handling dry ice.

### Ear protection

Dry ice blasting generates noise (from 70 up to 115 dBA), depending on the nozzle and the blasting pressure used; always use ear protection.

### Protective clothing

Always wear protective clothing while dry ice blasting, together with a face shield or safety goggles.

### Harmful material

The material blasted loose (the contaminant) is often harmful. Shield yourself and your surroundings from it by using a blasting cubicle, a gas mask or proper ventilation.



In some cases, gas masks are highly recommended – e.g. when cleaning heat exchangers and harmful materials are blasted loose.



# You can profit from our international contacts for dry ice blasting.

AGAs services and subsidiaries can be found worldwide.

For many of its customers, from industrial companies to privately-run enterprises, AGA has become much more than just a supplier of gases. With our in-depth knowledge and decades of experience, we are able to provide a wide range of services in all fields related to the use of gases. And with our worldwide network of international contacts, we can help you, our customers, to find just the kind of professional support you need.

Please note: Dry ice is available in many countries throughout the world, including the USA, most European as well as many South American and Asian countries. Where no pellets are available, liquid CO<sub>2</sub> or dry ice in other supply forms may be found.

**Just ask your local AGA partner for more information.**



# Getting ahead through innovation.

With its innovative concepts, AGA is playing a pioneering role in the global market. As a technology leader, our task is to constantly raise the bar. Traditionally driven by entrepreneurship, we are working steadily on new high-quality products and innovative processes.

AGA offers more. We create added value, clearly discernible competitive advantages and greater profitability. Each concept is tailored specifically to meet our customers' requirements – offering standardized as well as customised solutions. This applies to all industries and all companies regardless of their size.

## **AGA – ideas become solutions**

**Sweden**  
AGA Gas AB  
[www.aga.se](http://www.aga.se)

**Norway**  
AGA AS  
[www.aga.no](http://www.aga.no)

**Iceland**  
ISAGA ehf  
[www.aga.is](http://www.aga.is)

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