The Definitive Guide

Dry Ice Blasting

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Topics

Introduction

Dry ice blasting is used across the globe as a solution for surface cleaning, surface preparation and parts finishing in a wide range of industries. It is a preferred method because it is non-abrasive, non-conductive, non-toxic and does not create secondary waste.

This guide is designed to answer all of your questions about dry ice blasting. It will review everything from what dry ice blasting is to what you need to start cleaning.

You will learn that dry ice blasting is an environmentally responsible cleaning and surface preparation technique that will help you cut costs, decrease cleaning time and reduce labor allocated to cleaning projects.

You will also learn if dry ice blasting is right for you.

What is dry ice blasting?

Dry ice blasting, or dry ice cleaning, is similar to sand, bead and soda blasting in that it prepares and cleans surfaces using a medium accelerated in a pressurized air stream. It differs in that dry ice cleaning uses solid carbon dioxide (CO_2) pellets or MicroParticles, accelerated at high velocities to impinge on the surface and clean it. The particles sublimate upon impact, lifting dirt and contaminants off the underlying substrate without damage.

The dry ice blasting process has unique characteristics that differentiate it from other cleaning methods and other media blasting methods.

The dry ice cleaning method is:

- Non-abrasive
- Non-conductive
- Non-flammable
- Non-toxic
- Environmentally responsible

The dry ice blasting process ***does not create secondary waste.*** The dry ice sublimates, or phase transitions from solid CO_2 to gaseous CO_2, when it impacts the surface being cleaned. This eliminates the secondary waste stream that is created with other media blasting techniques. The only remaining waste products are the dislodged contaminants, which can be vacuumed or swept away.

Dry ice blasting was originally developed to remove paint and coating from airplanes in the 1970's. The technology has been developed commercially by Cold Jet since 1986.

Dry ice blasting is also known as CO_2 blasting or cryogenic cleaning.

What are the applications & uses?

Surface cleaning

Dry ice blasting is a *non-abrasive*, *non-conductive*, *non-toxic* cleaning method that *does not create secondary waste*. It is used to clean many types of surfaces in a multitude of commercial and manufacturing settings. Surfaces of tooling, machinery and finished parts can all be cleaned with dry ice.

Dry ice cleaning has a wide range on the aggression spectrum (from very aggressive to delicate cleaning). The compressed air pressure, dry ice particle size and dry ice feed rate can be adjusted and dialed down to clean very delicate and sensitive surfaces, such as soft alloys, electrical wires and sensors. It can also be dialed up to clean heavy and stubborn contaminants, such as asphalt, corrosion and weld slag.

What are the applications & uses?

Surface preparation

Dry ice cleaning can safely remove a variety of contaminants from parts, including oil, dust, release agents, fingerprints and more without causing part surface damage. Dry ice cleaning is a *dry process* and eliminates the need for aqueous or chemical solutions when preparing a surface for painting. Coatings and paint can be applied immediately after cleaning because the surface is left completely dry.

Parts finishing

Dry ice cleaning can safely remove flash and burrs from a variety of materials: PEEK, PBT, Acetal, Nylon, LCP, ABS, UHMWPE, Nitinol and more. Due to its non-abrasive nature, dry ice leaves the surface undamaged and free of residual media. Dry ice blasting also provides a faster and more uniform flash and burr removal process than manual methods.

What are the properties of dry ice blasting?

Properties of dry ice blasting:

1. **Non-abrasive**
2. **No secondary waste**
3. **Environmentally responsible**
4. **Non-toxic**
5. **Non-conductive and non-flammable**

1) Non-abrasive

Dry ice is a very soft media and can clean most surfaces without damage. It can clean sensitive surfaces, such as electronic equipment, printed circuit boards and plastic molds, without etching, profiling or changing surface dimensions.

2) No secondary waste

Dry ice sublimates upon impact with the surface being cleaned, which results in no secondary waste, *no residue* and *no moisture* introduced. This eliminates extra cleanup, disposal of secondary waste streams and additional cleaning preparation, such as masking delicate sensors or wrapping electronic components before cleaning. Elimination of secondary waste allows equipment to be cleaned *while online and still operating*.

What are the properties of dry ice blasting?

3) Environmentally responsible

The dry ice used in the dry ice cleaning process is made of *reclaimed* CO_2 that is collected and recycled from other industrial processes. It *does not produce more* CO_2 or add additional greenhouse gases to the atmosphere.

It also allows for the elimination of environmentally harmful cleaning chemicals and eliminates worker exposure to hazardous cleaning agents. It also does not produce any toxic waste that must be disposed of.

4) Non-toxic

Dry ice is a food grade media and is approved for use in FDA and USDA inspected facilities. It is colorless, tasteless, odorless and non-toxic.

5) Non-conductive and non-flammable

Dry ice is non-conductive and will not cause corrosion or rusting of surfaces. It also allows for electrical equipment to be safely cleaned. CO_2 is also a non-flammable gas and there is no risk of combustion.

What are the benefits of dry ice blasting?

Dry ice cleaning enables:

1. **Reduced costs**
2. **Improved productivity**
3. **Prolonged equipment life**
4. **Improved worker safety**
5. **Enhanced sustainability efforts**

Alternative cleaning methods are time consuming, labor intensive and costly. Manual scraping or scrubbing with wire brushes and water or chemicals can consume many hours and result in extended downtime. It can also cause damage to equipment and shorten asset life or make it less productive.

The unique characteristics of dry ice make it the perfect cleaning media.

Dry ice is *non-abrasive* and *non-conductive* and *will not damage surfaces* or equipment. It sublimates on impact, leaving behind *no secondary waste*. It is also *non-toxic* and *safe for employees*.

These attributes make dry ice cleaning an efficient, cost effective and *environmentally responsible* cleaning solution.

What are the benefits of dry ice blasting?

1) Reduced costs

Dry ice cleaning reduces labor costs because it can be done quickly by one person and in significantly less time than conventional manual labor. This enables a cleaner clean, even in situations that are difficult or unpopular to clean by hand or with other conventional methods. In some instances, cleaning time will be measured in **minutes instead of hours**.

2) Improved productivity

Dry ice blasting **does not require water or create secondary waste**, which allows equipment to be cleaned while **hot and online**. This eliminates the need to perform timely equipment disassembly and helps to reduce shut down times.

By cleaning equipment in less time, facilities are able to get **more production cycles** from existing equipment. Preventive maintenance or spot cleaning can also be done more frequently without impacting production. This increases tool uptime, which extends production runs and **reduces downtime** associated with cleaning.

3) Prolonged equipment life

Dry ice cleaning is a dry process that is non-abrasive and non-conductive; meaning it won't damage equipment and is safe for most surfaces, including electrical components. Other cleaning methods, such as manual scraping or scrubbing with chemical solvents, are abrasive and corrosive and can damage the equipment or wear it down. By **extending the life of key assets**, dry ice blasting can save significant amounts of money.

4) Improved worker safety

Dry ice cleaning **eliminates exposure to toxic cleaning materials**. The process also eliminates repetitive motions of hand cleaning, scrubbing, chiseling or activities that require pounding, sanding or scraping.

5) Enhanced sustainability efforts

When using solid grit media or water for cleaning hazardous materials, the cleaning media also becomes hazardous, requiring special handling, disposal and regulatory reporting. The resulting waste can also create downstream contamination that affects surrounding installations. **Dry ice does not create waste stream additions.**

How does it compare to other cleaning methods?

When comparing dry ice blasting to other cleaning methods, such as abrasive blasting (sand, bead, etc), soda blasting, pressure washing, chemical solvent washing and manual hand tools, it is important to ask the following questions of each:

- Is it abrasive?
- Does it create secondary waste?
- Is it environmentally responsible?
- Is it toxic?
- Is it electrically conductive?

The attributes of each cleaning method not only affect the cleaning result, but also dramatically affect the surface area being cleaned, the surrounding area and the safety of the person performing the cleaning.

Below is an overview of dry ice blasting vs. alternative cleaning methods.

Cleaning Method	Abrasive	Secondary Waste	Environmentally Responsible	Toxic	Electrically Conductive
Dry Ice Blasting	**No**	**No**	**Yes**	**No**	**No**
Abrasive Blasting	Yes	Yes	No	*	No
Soda Blasting	Yes	Yes	No	*	No
Pressure Washing	No	Yes	No	*	Yes
Solvents/Chemicals	No	Yes	No	Yes	N/A
Hand Tools	Yes	No	N/A	N/A	N/A

** Upon contact, the media becomes contaminated when used to clean hazardous substances and objects. These blasting materials are also then classified as toxic waste and require appropriate safe disposal.*

Who uses dry ice blasting?

Dry ice blasting is used for a wide variety of cleaning, surface preparation and parts finishing applications in a diverse range of industries.

Dry ice cleaning is successfully used in the following industries:

- Aerospace
- Automotive
- Contract Cleaning
- Composite Tool Cleaning
- Electric Motor
- Engineered Wood
- Fire Restoration
- Food and Beverage
- Foundry
- General Maintenance & Facilities
- Historical Restoration
- Medical Device Manufacturing
- Mold Remediation
- Oil and Gas
- Packaging
- Plastics
- Power Generation
- Printing
- Rubber
- Textile

What do I need to begin dry ice blasting?

Dry ice blasting requires a simple setup

Along with your dry ice blasting machine, the systems will come complete with a blast and air hose, an applicator and a nozzle that is best suited for your application.

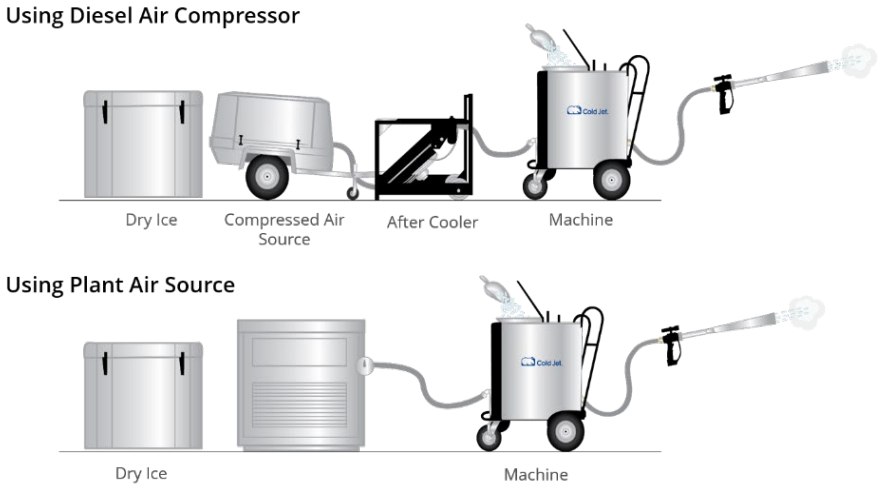
The only other items needed to operate the system are:

- Compressed air source (either plant air or an air compressor)
- Electric power source
- Dry ice supply

An after cooler may be useful if you are using a portable diesel compressor as your air source. An after cooler removes most of the moisture from the system and can cool the air within 15° F (-9.4 ° C) of the surrounding air. This is primarily dependent on humidity levels.

Air pressure requirements

Dry ice blasting systems using pellets typically consume **100 cfm (2.8 m3/min)** at **80 psi (5.5 bar)**, while MicroParticle systems typically consume **30 cfm (0.9 m3/min)** at **80 psi (5.5 bar)**. Low flow nozzles for the MicroParticle systems can consume as little as **12 cfm (0.3 m³/min)** at **80 psi (5.5 bar).** However, your needs will depend on your application.



The most common dry ice questions

Where do I get dry ice?

Dry ice pellets or blocks can be ordered from industrial gas suppliers, welding supply companies and other regional suppliers. Dry ice can be picked up directly from suppliers, or most major metropolitan areas have regular delivery trucks that cover 100 mile radiuses. Dry ice can also be shipped using a common carrier and it is delivered in insulated containers.

How do I store dry ice and how long does it last?

Dry ice should be stored in an insulated container, which is provided by the supplier and picked up by them when needed. The thicker the insulation, the slower the dry ice will sublimate. Depending on the climate and thickness of your container, dry ice sublimation is approximately 2% to 10% per day.

How much dry ice do I need?

The amount of dry ice needed to clean effectively varies from application to application and also can vary dramatically with each dry ice blasting system.

The average dry ice consumption for dry ice blasting equipment will range from approximately 0.7 lbs (0.32 kg) per minute for a MicroParticle system to 2 1/2 lbs (1.1 kg) per minute for a pellet system.

How much does dry ice cost?

Dry ice is a commodity and prices vary geographically.

Can I make my own dry ice?

Dry ice can be produced on demand using a dry ice production machine, also known as a pelletizer. Producing your own dry ice must be economically viable and the amount of dry ice used on a daily and weekly basis must be considered.

Pelletizers can be equipped with multiple dies to produce a range of extrusion sizes (3mm to 19mm). From nuggets to pellets, pelletizers can produce multiple sizes of dry ice for a broad range of solutions.

What are the types of dry ice media?

The size and density of the dry ice particle greatly affects the resulting clean. Different sized particles are used for different cleaning applications.

There are two types of dry ice media used in dry ice blasting:

1. **Pellets**
2. **MicroParticles**

Dry ice pellets

- 3mm in size (roughly rice sized)
- High density
- Used for a more aggressive clean, getting rid of the most stubborn contaminants

Dry ice MicroParticles

- Sugar-sized particles (~0.3mm)
- Used to clean delicate and sensitive surfaces
- Less aggressive than pellets
- More media strikes the surface per second and per square inch
- Increased coverage area
- Less air power is needed to accelerate dry ice (less noise)

MicroParticles are the result of **shaving dry ice (pellets, block, etc)*

Can I automate the dry ice blasting process?

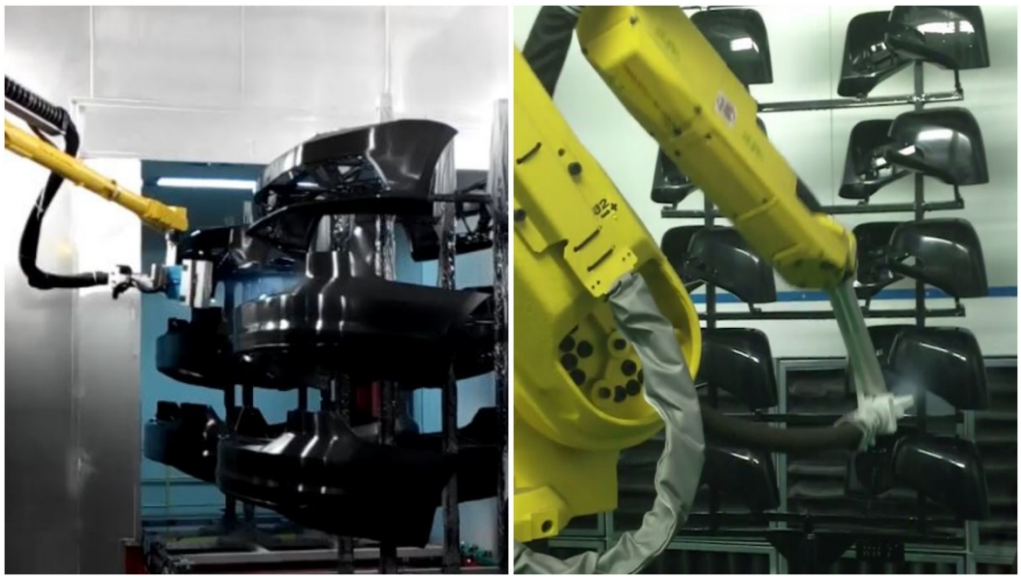
Integrated dry ice blasting systems combine dry ice production and one or more blasting system into one unit; allowing for continuous, completely automated blasting.

From simple customization to full automation, each integrated system can be engineered to meet specific customer requirements.

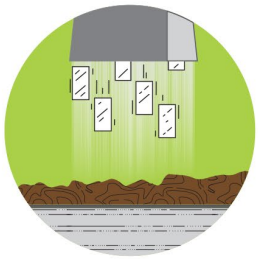
These systems are commonly used to provide cost effective cleaning and surface preparation solutions and are used extensively in the automotive OEM, tire, aerospace, semiconductor and many other industries.

The systems can perform a number of different cleaning applications:

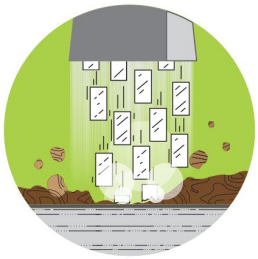
- Surface preparation - Plastic, metal and composite parts
- Plastic injection molds and permanent aluminum molds
- Deflashing and deburring
- Tire molds (complete systems)
- Paint fixtures / paint booths / paint lines
- Welding robots and fixtures
- Semiconductor component cleaning



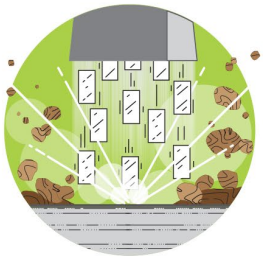
How does dry ice blasting work?



I *mpact of pellets creates a Kinetic Energy Effect. The soft dry ice is accelerated by compressed air through specially designed nozzles at supersonic speeds.*



C *old temperature of dry ice pellets creates a Thermal Effect. The temperature of dry ice (-109°F/-78.5°C) causes the contaminant to embrittle. This helps break the bond between the substrate and the contaminant.*



E *xpansion of the dry ice pellets. Dry ice pellets sublimate upon impact, volumetrically expanding in size, removing the contaminant.*

Because dry ice is non-abrasive and turns back into gas, you are left with a clean surface, no secondary waste and no damage to your equipment.

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How does dry ice blasting work?

Dry ice blasting combines three primary factors to remove contaminants:

- Pellet Kinetic Energy
- Thermal Shock Effect
- Thermal Kinetic Effect

Pellet Kinetic Energy

Dry ice is accelerated by compressed air through a nozzle at supersonic speeds. When the dry ice collides with the substrate being cleaned it creates a kinetic effect. This effect has the largest contribution to the cleaning process when substrates are at ambient temperatures or below.

Even at high impact velocities and direct head-on impact angles, the kinetic effect of solid CO_2 pellets is minimal when compared to other media (grit, sand, PMB). This is due to the relative softness of a solid CO_2 particle (1.5 – 2 on the Mohs Scale of Hardness), which is not as dense and hard as other blasting media.

Also, the pellet changes phase from a solid to a gas, almost instantaneously, upon impact. Very little impact energy is transferred into the coating or substrate, so the dry ice cleaning process is considered to be non-abrasive.

How does dry ice blasting work?

Thermal Shock Effect

The temperature (-109˚ F / -78.9˚ C) of the dry ice causes thermodynamic shock, which causes the contaminant to embrittle and shrink. The resulting micro-cracking helps break the bond between the surface and the contaminant.

The instantaneous sublimation (phase change from solid to gas) of dry ice upon impact absorbs maximum heat from the very thin top layer of the surface contaminant. Maximum heat is absorbed due to latent heat of sublimation.

The very rapid transfer of heat into the dry ice from the coating top layer creates an extremely large temperature differential between successive micro-layers within the contaminant. This sharp thermal gradient produces localized high shear stresses between the micro-layers. The shear stresses produced are also dependent upon the contaminant's thermal conductivity and thermal coefficient of expansion / contraction, as well as the thermal mass of the underlying substrate. The high shear produced over a very brief period of time causes rapid micro-cracking between the layers leading to the failure of the bond between the contaminant and surface of the substrate.

How does dry ice blasting work?

Thermal Kinetic Effect

Upon impact, the combined impact energy dissipation and extremely rapid heat transfer between the pellet and the surface causes the dry ice particles to sublimate, or expand instantly, and return to the natural gas state. During this phase transition from solid to gas, the volume of dry ice expands up to 800 times in a few milliseconds and lifts the contaminant off of the substrate. This is effectively a “micro-explosion” at the point of contact.

The "micro-explosion" aids in the lifting of thermally-fractured coating particles from the substrate. This is because of the dry ice particle’s lack of rebound energy, which tends to distribute its mass along the surface during the impact. The CO_2 gas expands outward along the surface and its resulting "explosion shock front" effectively provides an area of high pressure focused between the surface and the thermally fractured contaminant particles. This results in a very efficient lifting force to carry the particles away from the surface.

Have more questions?

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