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WATER VS ABRASIVE

What is surface preparation?

Surface preparation is done to increase adhesion to coatings. Without good quality surface preparation, meaning ultra-clean and a proper profile, all coating systems will fail. It can be done mechanically or chemically, with different techniques, reaching different cleaning grades. Surface preparation processes are used for clearing surfaces of coatings, imperfections, residue, organic matters, oxidation and other contaminants like salts.

Comparison **grades for surface preparation** between different organizations

Cleaning grade NACE, SSPC abrasive	Cleaning grade ISO, NACE water only	NACE abrasive	NACE SSPC	SSPC abrasive	ISO & SIS abrasive	water	tool
White metal	Bare metal	1	WJ-1	SP-5	Sa 3		
Near-white	Very thorough	2	WJ-2	SP-10	Sa 2 ½	Wa 2 ½	
Commercial	Thorough	3	WJ-3	SP-6	Sa 2	Wa 2	
Industrial	Thorough	8	WJ-3	SP-14			
Brush off	Light	4	WJ-4	SP-7	Sa 1	Wa 1	
Power tool	Light			SP-3			St 3
Hand tool	Lightest			SP-2			St 2

What is water blasting and what is abrasive blasting?

Water blasting is being used since the early 1800s. Coal miners used water pressure to remove loose debris and coal. Of course water jetting has evolved and nowadays we use Ultra-High-Pressure (UHP) water. UHP is a technique used for surface preparation. It removes various coatings, contamination, chlorides (salts) and corrosion. Water blasting or hydro blasting has to be done with chloride-free water to remove unwanted materials and leave the surface ultra-clean.

UHP water blasting removes paint and various contaminants from the bottom up. This means it cuts through paint and shears it of the surface when water bursts onto the underlying material. It doesn't affect the original profile but leaves it intact. It's best used for removing heavy rust, various hard to remove paint systems and salts.

Abrasive blasting is being used since the late 1800s. It's propelling a stream of abrasive material against a surface under high pressure, mostly used to roughen surfaces and remove surface contaminants. A pressurized fluid, typically compressed air, is used to propel the blasting material, often called media or abrasive.

Abrasive blasting removes paint and various contaminants from the top down. It can be done with various media, some highly abrasive, others barely abrasive. Most abrasive are metallic, sand, grit and garnet blasting. Moderately abrasive are glass beads and plastic (PMB) with ground-up plastic stock or walnut shells and corncobs. A mild version is soda blasting and there are also barely abrasive and non-abrasive alternatives such as (dry) ice blasting. Abrasive is best used to create a surface profile needed for proper adhesion of

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coating systems. A problem is when abrasive leaves the surface contaminated. This means the less contamination an abrasive leaves at the surface, the better.

Abrasive and hydro blasting can be done at different pressures, but to both applies that using a higher pressure increases productivity.

Configurations for water blasting;

- Low-pressure water cleaning, <5.000 psi, 340 bar
  Economical
- High-pressure water cleaning, 5 – 10.000 psi, 340-680 bar
  Used with and without abrasive, fairly economical.
- High-Pressure water jetting, >10.000 psi, 700 bar – 30.000 psi, 2.000 bar
  At this point water becomes supersonic, coatings come off, productivity increases.
- Ultra-High Pressure (UHP) water jetting, > 30.000 psi, 2.000 bar
  Productivity is up. Almost every type of coating is sheared off to bare metal.

Configurations for abrasive blasting;

- Dry abrasive blasting
  Pressurized air is used to transport abrasive to the nozzle.
- Wet abrasive blasting
  Water is added to the stream of air at the nozzle, or sooner.
  Amount of water used may vary.
  Adding abrasive to a stream of water is also considered wet abrasive blasting.

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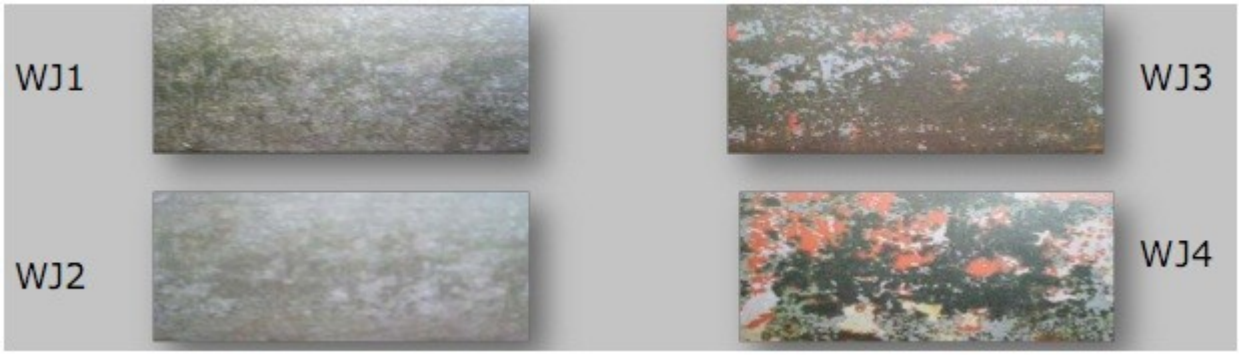
Concerns about water and abrasive.

Water blasting has a concern surrounding the look of the surface, it doesn't make the surface shine like traditional methods often do. The shiny "White Metal" finish, as you see after abrasive blasting, is because abrasives also remove a portion of the original profile and surface. UHP water blasting doesn't remove the original profile, which is why it's a "near white metal" finish. The surface is dull grey or brown rather than white metal because all imperfections are now visible.

Water blasting needs to be done using clean water without any contaminants. The thing with this "near white metal" finish is that it has absolutely no salts or chlorides meaning the surface is perfectly clean. As we all know, **water blasting does not create any profile but it doesn't damage the surface either**. This means we go back to the original profile that was created when the surface got painted before. If everything has been done properly before, it means we go back to the SSPC/ NACE WJ1 standard or ISO & SIS SA3 standard.

A second concern about water blasting is so-called "flash rust", giving the surface a light to dark brown colour. Of course that's true, I'll never argue it's not, and if there are still salts left behind you will get rust. However, if you've done a proper job there will be no contamination and the surface won't rust for thousands of hours. The light brown coloured "flash rust" is what we call "good rust". This type of "rust" is accepted for coatings by all good paint manufacturers worldwide. "Bad rust", to be identified by a blackish, spotty liquid, will not be accepted.
Keep in mind contaminants can be deposited on the metal after blasting by rain (acid rain), airborne contaminants etc.



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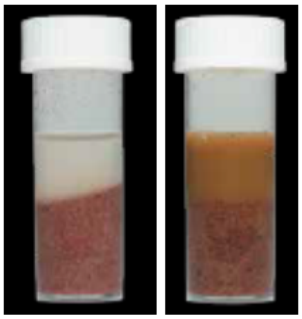
Abrasive blasting has the concern of dust. It can cause lots of (sometimes toxic) dust entering the environment, but also leaves dust behind on the surface. Most abrasives fracture on impact and leave dust

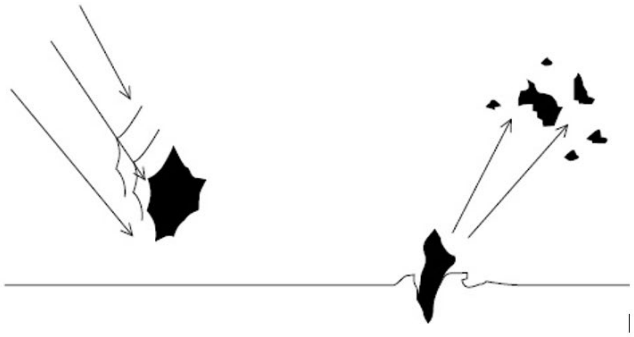
which reflects light, some form a shiny 'plateau of metal'. This might look nice 'White Metal", but causes a contaminated surface. This means high quality, contamination-free and low dust (non-fracturing) abrasive is a must-have and will increase productivity and quality. Choosing a wet or mist abrasive blasting alternative will reduce dust to almost zero. Also, a washdown after dry blasting is recommended to remove any dust left behind on the surface, but you have to take in mind this may cause "bad rust" to form when the surface is still contaminated by invisible salts or chlorides.

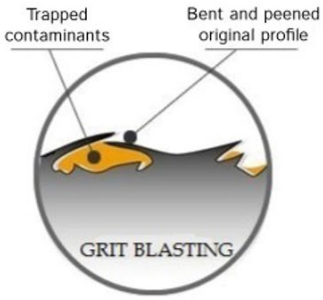


Low dust High dust

Another concern is that abrasive blasting removes some of the steel and makes it thinner which can harm the strength of constructions. This is true, but remember rust isn't good for the strength of steel constructions either. When in doubt about the steel thickness and strength of constructions it's important to always do Non-Destructive Testing to make sure the situation will not get dangerous.

A concern not many people think about is that media, rust, salts and chlorides can get embedded. This can happen when you use low quality abrasive which fractures on impact causing the media to get partly embedded in the steel, closing the pit it just made and leaving contamination. The second situation where this can happen is while blasting a rusted or contaminated surface. If the original profile is 'bent' before rust or contamination is properly removed it'll embed this contamination. Most dangerous is the second situation because when you test the surface for cleanliness and profile it seems to be fine, but coating systems will fail faster because the embedded contamination will cause your surface to corrode faster.





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Pros and cons of water and abrasive

Water blasting has several pros compared to abrasive blasting. Most common argument to choose water blasting is because of the lower costs of operation. Water blasting equipment, in general, is more expensive as abrasive blasting equipment, but all other operational costs are a lot less. Maintenance, labour, media, waste, utility and health & safety costs are only a fraction of the costs compared to abrasive blasting. It can be 80% less!
Knowing surface preparation is about 50% of the costs for a coating job this is a significant benefit.

The **environment** is getting more important every day, as is should be of course. Water blasting is more environmental friendly in several ways, it doesn't create any dust or air pollution during operation. Also, closed blasting is a lot easier using water, making sure you collect all contaminated water at once. Another benefit from not having any dust, trades can work side by side. This reduces downtime and leads to faster turnaround times.

Using water gives you a **more healthy work environment** as well. Because there is no dust, inhalation of air contaminants and the risk for respiratory problems is reduced to a minimum.

Surface cleanliness will not get any better as when using water.

Substrate	Contaminant	Salt level (µg/cm2)		
		Uncleaned	Grit-Blasted	Hydroblasted
	Sulphates	40	3	0
A-36 steel with	Phosphates	0	0	0
mill scale	Chlorides	2	2	1
	Nitrates	0	6	0
A-285 Grade 3 steel with mill scale	Sulphates	5	5	0
	Phosphates	0	1	0
	Chlorides	4	3	1
	Nitrates	0	11	1
	Sulphates	5	2	1
Rusted water	Phosphates	1	2	0
Service piper	Chlorides	28	32	1
	Nitrates	6	1	1
Intact Coating on water service pipe	Sulphates	8	4	0
	Phosphates	0	2	0
	Chlorides	6	1	1
	Nitrates	4	2	1
	Sulphates	7	4	0
Heat exchanger	Phosphates	0	0	0
shell	Chlorides	17	31	0
	Nitrates	0	3	0

Element	Soluble substance in µg/cm2	
	waterjetting	Abrasive blasting
Nickel	0.006	0.057
Zinc	0.063	1.512
Manganese	0.003	0.031
Magnesium	0.021	0.672
Calcium	0.121	1.989
Copper	0.033	0.25
Aluminum	0.003	0.352
Lead	0.015	0.045
Iron	0.018	9.45
Potassium	0.414	0.513
Sodium	0.855	42.03
Chloride	0.846	62.55
Sulphate	0.211	1.26

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Cons of water blasting are scarce but most important about water blasting is that it is not able to create a surface profile. When this is necessary you will have to use abrasive of some sort to create a profile.

The higher purchase cost of water blasting equipment can also be a con for some, and in rare cases in some very dry countries water can be more costly as abrasive.

The biggest **pro of abrasive blasting** is, of course, that it can create a profile that guarantees the physical bond between a coating and surface, which increases the life and performance of a coating system.
What is also interesting is that you can choose from dozens of different types of media, all with their specific characteristics and benefits.

Another benefit from abrasive blasting is that this way of preparing a surface is known and accepted by all paint manufacturers around the world and does not require 'special' paint like some grades of water blasting do.
Less but not least, purchase prizes of abrasive blasting equipment are less expensive.

Most **cons in abrasive blasting** have to do with the environment and health of workers. Abrasive blasting removes a small portion of the blasted material creating dust and air pollution, the biggest concerns from abrasive blasting. Both can have a huge impact on the environment and workers. Inhaling dust, silica or metals will eventually cause respiratory diseases and these substances pollute the environment. Of course, there are ways to minimize this by, for example, using wet abrasive blasting and proper PPE's but these cost extra which increases the operational costs.

Operational costs are high due to the environmental and health & safety measures, but you also have to take more expensive maintenance, labour, material, utility and waste/ cleanup costs into account.

Contaminant	Potential Health Hazards
Aluminum	Respiratory irritation.
Arsenic (metal)	Occupational overexposure to arsenic can increase the risk of skin, lung and possibly lymphatic cancers and lead to peripheral neuropathy and vascular disease.
Cadmium	Occupational overexposure to cadmium can lead to degeneration of the renal tubules [kidney damage] manifested by increased protein in the urine [proteinuria]; increased blood pressure contributing to hypertension; obstructive lung diseases like chronic bronchitis, pulmonary fibrosis and emphysema; and increase the risk of lung and prostate cancer.
Chromium (metal)	Skin irritation and increase the risk of lung fibrosis.
Chromium (III)	Respiratory irritation and allergic dermatitis upon skin contact.
Chromium (VI)	Risk of lung cancer and occupational asthma, damage nasal tissue and cause allergic dermatitis with skin contact.
Cobaltt	Chronic lung inflammation and pulmonary fibrosis, increase the risk of lung cancer, and cause allergic contact dermatitis with skin contact.
Copper	Respiratory irritation.
Lead	Occupational overexposure to lead can cause subclinical and clinical peripheral neuropathy [muscle weakness, pain, and paralysis of extremities], disruption of hemesynthesis and anemia, loss of kidney function, increased blood pressure, nephropathy, reduced sperm

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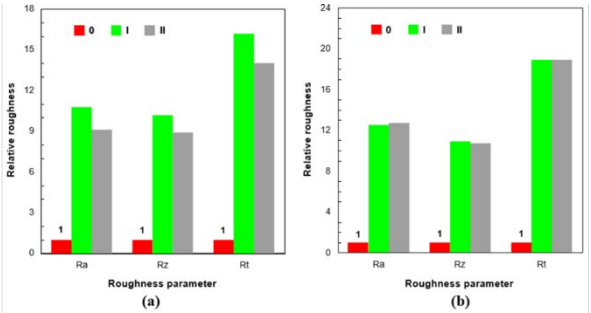
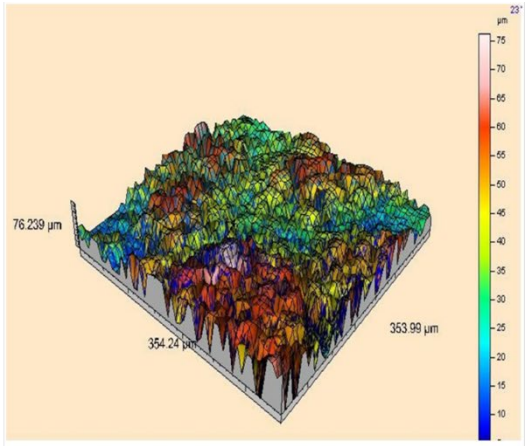
Conclusion

Both water- and abrasive blasting have up- and downsides. Which way is most efficient for your surface preparation project depends on many parameters. Many studies show that water blasting is more technically capable to clean surfaces, and does this without damaging the substrates original profile. It's a cost-effective and environmentally friendly method compared to conventional abrasive blasting methods. That's why during maintenance, and recoating a surface that has a proper profile, water will be your best choice.

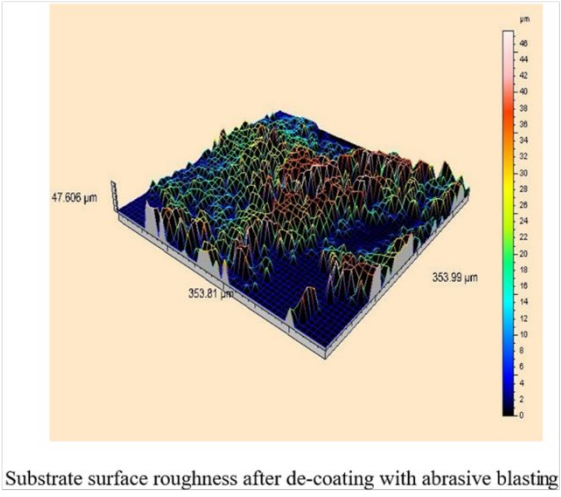
Water alone does not create any profile and when this is required you will have to use abrasive media of some sort, preferably high quality abrasive without contaminants of course, to (re)create a surface that will properly adhere to a coating.



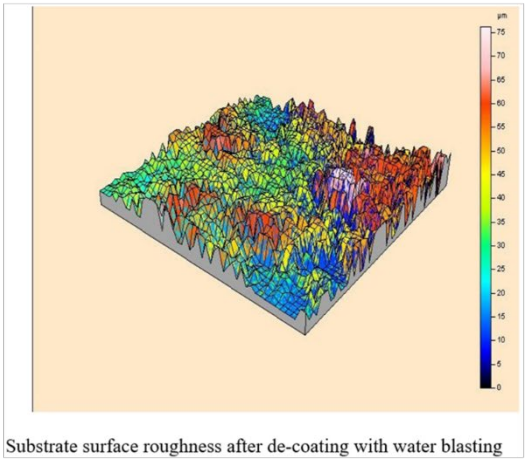
Substrate surface roughness measurements.
a – Untreated (0); primary abrasive blast (I); De-coating with the abrasive blast (II)
b – Untreated (0); primary abrasive blast (I); De-coating with the water jetting (II)



Substrate surface roughness after primary abrasive blasting



Substrate surface roughness after de-coating with abrasive blasting



Substrate surface roughness after de-coating with water blasting

Not always you have to choose between water- or abrasive blasting, you can also use it both. I know a lot of cases where contractors first used water blasting to remove all surface contamination and afterwards used abrasive blasting to 'refresh' the surface profile. When using high quality abrasive without any contaminants this combination will give you the perfect base for a new coating!

Sources;

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UHP WATERJETTING – THE OLDEST - NEW METHOD FOR SURFACE PREPARATION, Brady DeRoche, Innovative Surface Prep

Water is the True Grit of the 21st Century by Dr. Lydia M. Frenzel

TECHNICAL AND ECONOMICAL COMPARISON OF WATERJET AND ABRASIVE BLAST METHODS TO BE USED IN DE-COATING AND CLEANING PROCESSES by Hamid Teimourian

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