SUR/FIN® Where Finishing Connects

November 2-4, 2021
DETROIT, MICHIGAN

ATOTECH

Weld and Laser Scale Removal For Improved Coating Performance

Brandon Lloyd

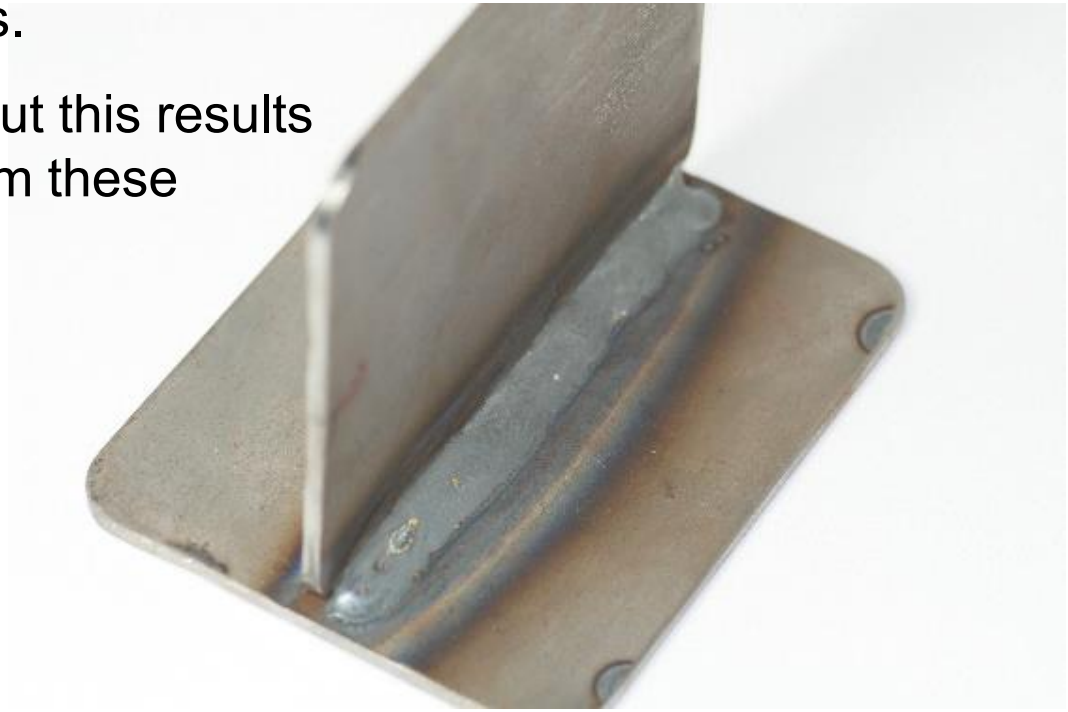
Global Product Manager – Paint Pretreatment

Atotech USA

Weld and laser descaling

Weld and laser scale removal is frequently ignored or considered too difficult/dangerous to solve in paint pretreatment systems.

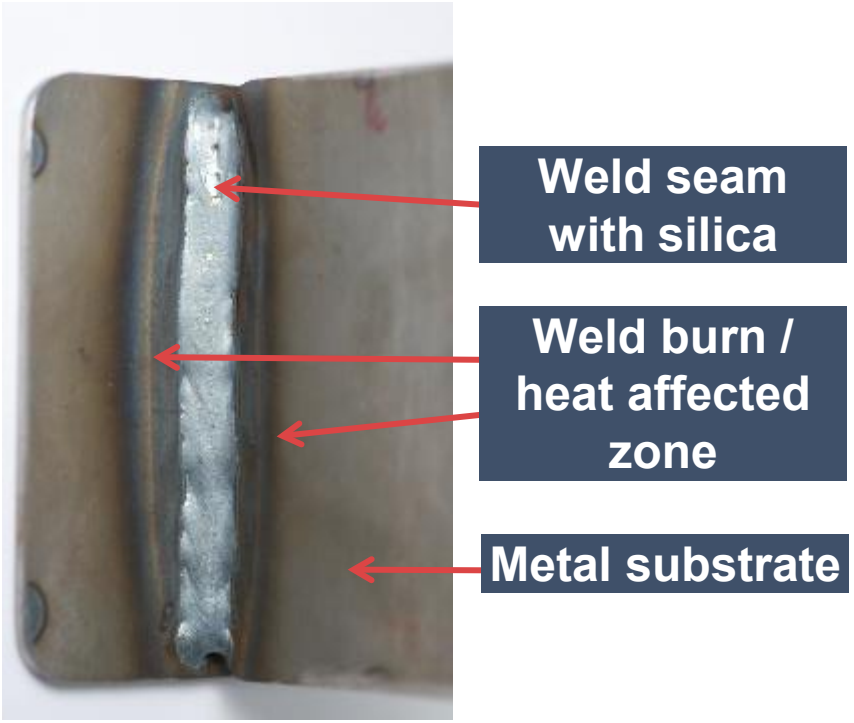
Applicators will bypass descaling welds and laser cuts, but this results in premature paint loss or corrosion, often emanating from these areas.



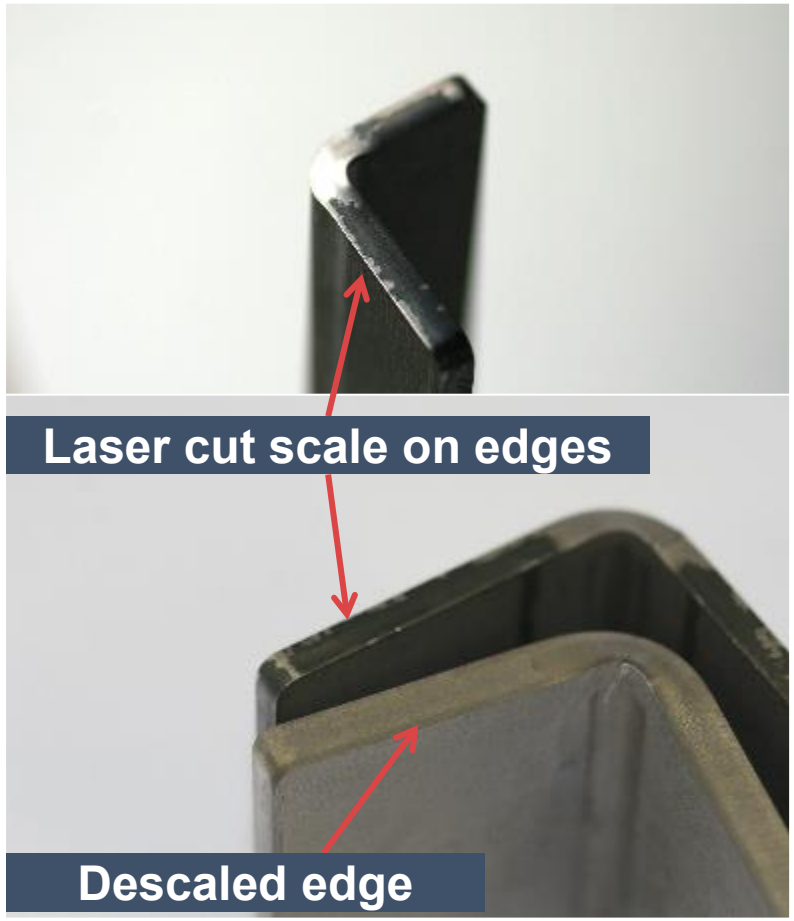
- The most common first point of failure of paint coatings is at welds and the associated heat affected zones, as well as areas of inorganic scale such as those created during laser cutting
- The scale formed during these processes prevent any organic coating (e-coat, wet paint, powder paint) from adhering to the substrate surface properly
- Traditional alkaline cleaners/degreasers are incapable of effectively removing weld or laser scale

Types of scale

Weld



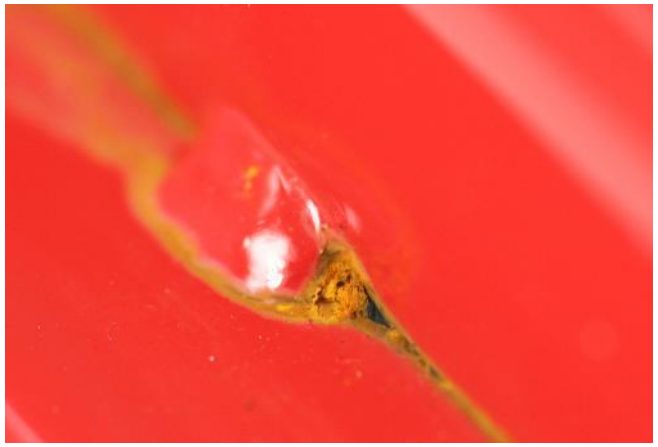
Laser



First point of failure

Often, applicators in the paint industry ignore this problem

- During paint performance evaluations, the adhesion and corrosion near welds, edges and laser cuts are not evaluated
- Electrophoretic paints (e-coat) will not completely cover or adhere to these scales. This will result in premature part failure, which is especially important in the automotive industry; some applications will manually touch-up the uncovered areas with further painting
  - Added cost of paint
  - Added cost of labor
  - Often still the first paint failure point due to thinner paint coating



Existing Scale Removal Methods

Mechanical descaling

Some applicators remove oxide scale using mechanical methods like media blasting or grinding. This can create several issues:

- Severe HES risk
  - Serious accidents (hand, eye, body)
  - Hearing loss
  - Repetitive strain injuries
  - Inhalation hazards from dust
- Costly
- Labor intensive
- Short equipment life
- Damage to substrate and surface profile
- Generate dust/debris, potential contamination source for paint application
- Line-of-sight issues for complex parts geometries or recessed areas

Strong acid/commodity descaling

Some applicators will remove oxide scale using strong acids:

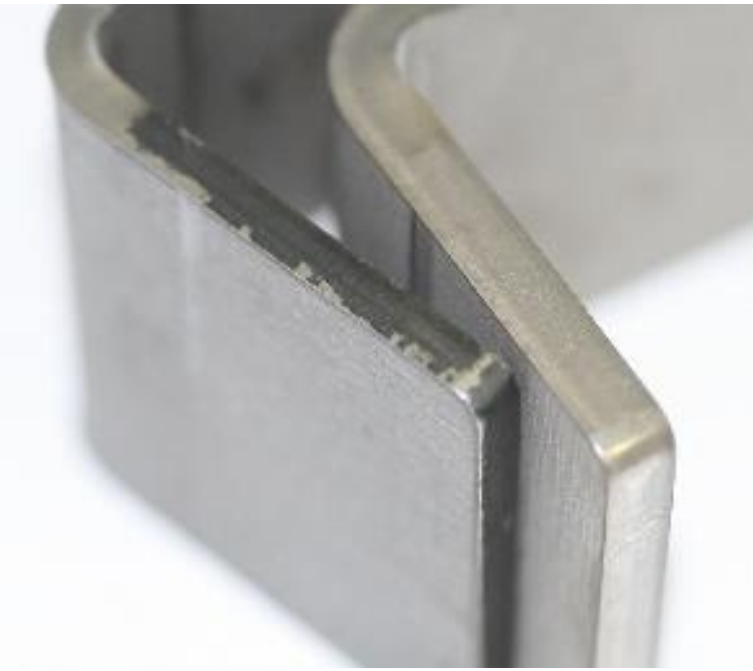
- Dangerous chemicals at elevated temperatures
  - Chemical burns to skin, eyes, respiratory system
  - Near misses and serious incidents
- Strong acids
  - Not safe to spray in conveyor systems and hand wands
  - Corrosion of equipment and factory
- Etching of substrates results in build-up of iron, resulting in short solution life
- Issues and costs associated with disposal of spent acids
- Issues with wastewater treatment regulations

Selecting the Right Process

Selecting the right descaling method

The most economical and convenient option for oxide/scale removal is in the pretreatment or plating sequence:

- Preserves substrate's surface integrity
- Avoids the labor and safety costs of mechanical descaling
  - Media blasting requires higher capital investment and short equipment life
  - Grinding requires labor and has a high associated injury risk
- Can minimize the necessity and cost of inert atmosphere laser cutting
  - Expensive capital investment, can still generate oxides if operated improperly
- Strong acid descalers are limited to immersion applications
  - Safety/HES concerns
  - Short equipment life
- Extra stages for either immersion and spray applications require a relatively small capital investment and low operating costs
  - Easily achieved for new line builds
  - Possible in existing lines if the factory has the floor space



Selecting the right descaling method

The most economical and convenient option for oxide/scale removal is in the paint pretreatment process:

- However, selecting this route means identifying the ideal proprietary chemical solution.
  - Contain hard chelating agents, a burden for WWT, especially for metal plating applications
  - Have very high etch rates
    - Short solution life
    - Feed-and-bleed
    - Both result in more expensive WWT operations
  - Risk of flash rusting
  - Incomplete oxide/scale removal
  - Poor paint adhesion
  - Less compatible in multi-metal applications

Innovations in Chemical Descaling

Selecting the right descaling method

Several key innovations in recent years have resulted in much more attractive chemical descaling solutions:

- Can operate at near neutral pH, resulting in less substrate etching which leads to process savings through longer solution life and lower WWT costs
- Contain surfactants to allow for organic and inorganic soil removal in one step when necessary
  - For best results, alkaline cleaning is recommended prior to descaling
  - On-going process innovations to achieve superior cleaning + descaling in one step, ideal for existing lines with limited chemical stage capacity

Selecting the right descaling method

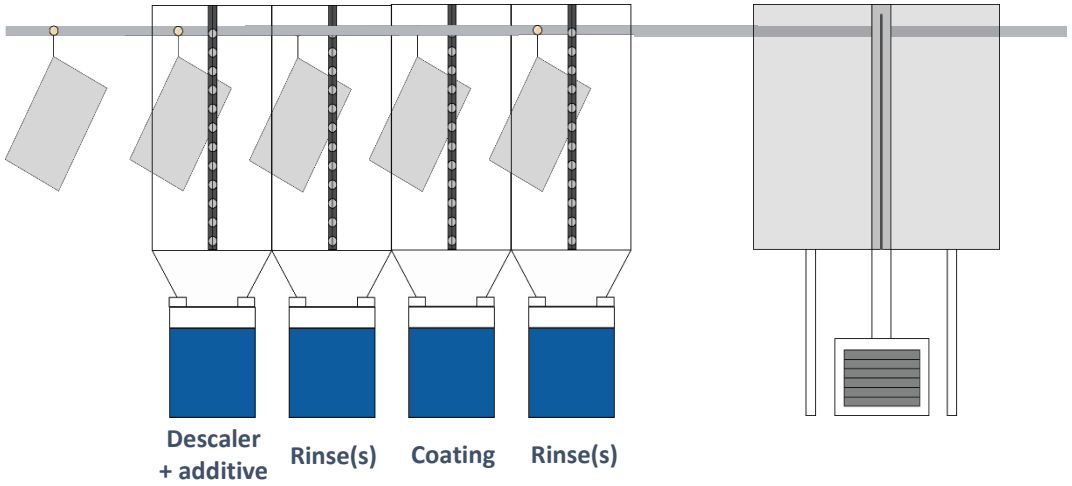
- Electrophoretic paints often have poor performance on weld and laser cut scales
  - Inert scales that lack electrical conductivity and therefore coverage
  - Poor adhesion and corrosion resistance around scales and burns
- Weld and laser descaling can greatly improve e-coat performance on scales
  - Decreased requirement for touch up paint and improved paint performance

Laser cutting scale before e-coat

Weld scale and burn before e-coat

Pretreatment line configurations

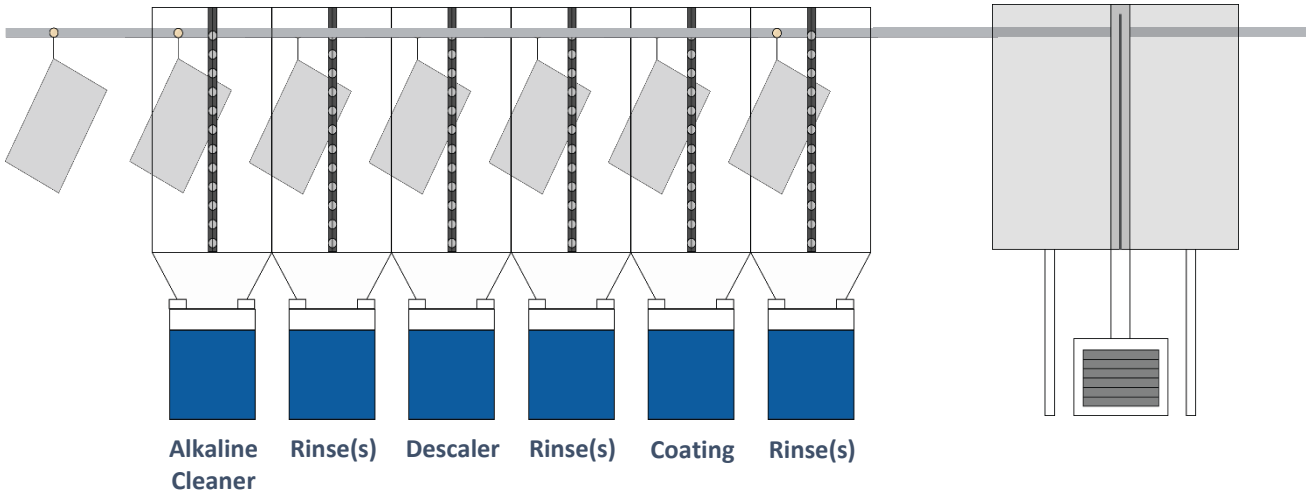
- Flexible descaling pretreatment line set up
  - 5-6 stage washers
  - Utilizes cleaning and descaling in one step
  - Ideal for line designs with limited stages or space for expansion



*May require neutralizing rinse after descaling, depending on production parameters

Pretreatment line configurations

- Ideal chemical descaling line set up
  - 7+ stages
  - Utilizes separate cleaning and descaling
  - Optimized for highest level of performance



*May require neutralizing rinse after descaling, depending on production parameters

Evaluating Scale Removal Effectiveness

Evaluating scale removal effectiveness

- One way to evaluate and compare the cleaning of scales is to immerse the part in an auto-deposition copper coating solution
  - A clean surface leaves a bright, consistent and adherent deposit

No descaling

Conventional chemical descaling

Next generation descaling

Evaluating scale removal effectiveness

- One way to evaluate and compare the cleaning of scales is to immerse the part in an auto-deposition copper coating solution
  - A clean surface leaves a bright, consistent and adherent deposit

As received | Clean only | Clean + descaling

Notable elimination of “burn areas,” which typically require manual grinding

Evaluating scale removal effectiveness

Benchmarking against competing processes, laser cut 4340 steel

Panel	Treatment	Time	Temperature	Concentration
1	Ground (Mechanical)	NA	NA	NA
2	Clean → **Next Gen chemical descaling** → coating	2 min	55 °C	4%
3	Clean → coating	NA	NA	NA

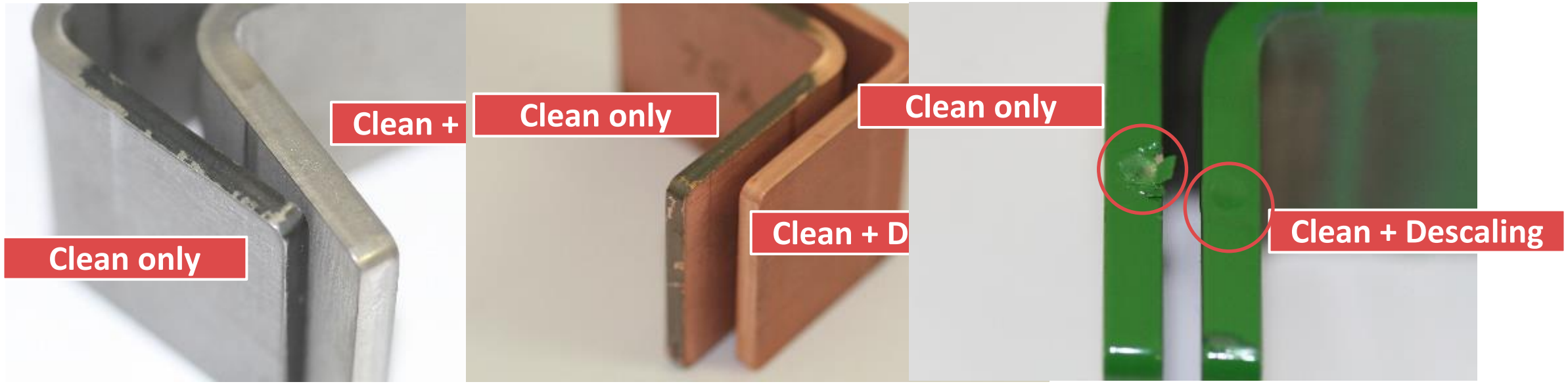
Panel 1

Panel 2

Panel 3

Degree of paint loss after 35 cm-kg, or 30 in-lb, impact test

Evaluating scale removal effectiveness

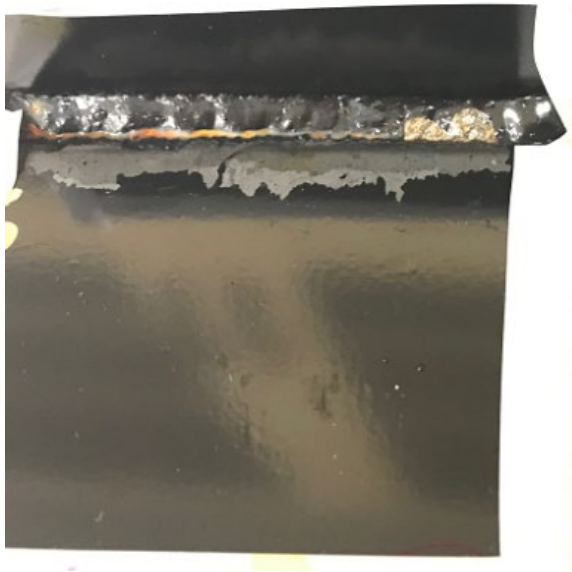


Evaluating scale removal effectiveness

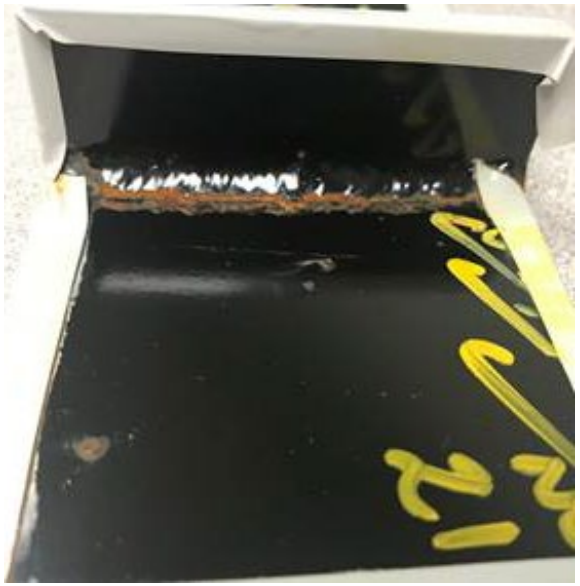
Part before and after near neutral descaling – e-coat and NSST

- E-coat paint thickness averaged 15 – 20 µm for all parts

Clean only (336 hours)



Clean + descaling (840 hours)

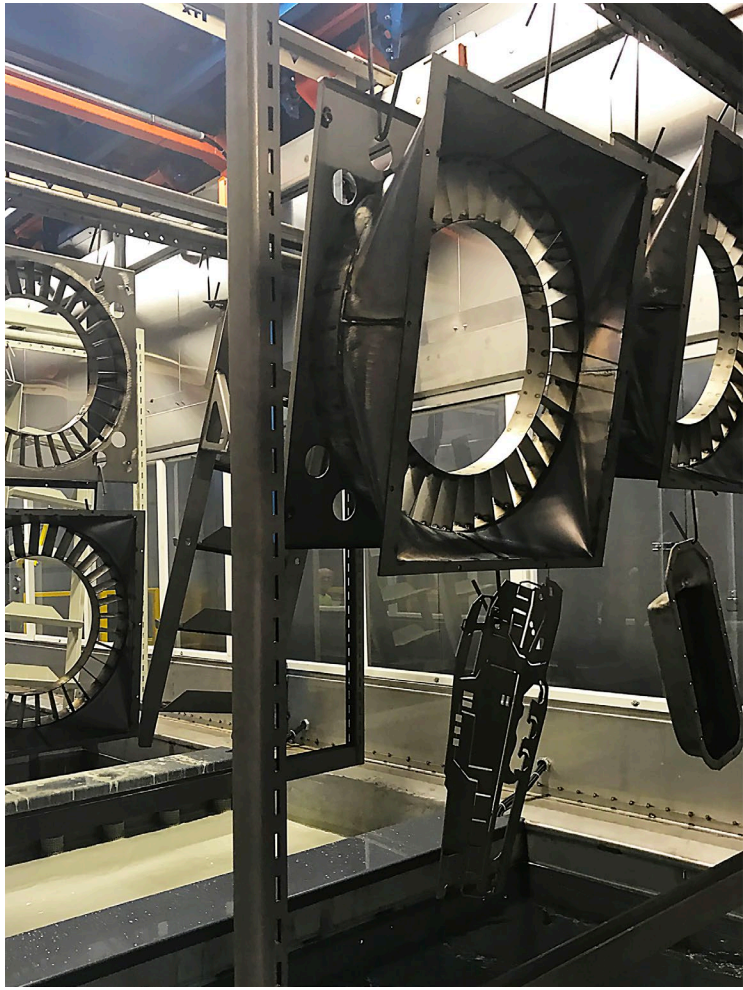


Descaled samples consistently show much less rust and paint loss at the weld areas than parts that were only cleaned

Case Studies

Case study 1

- Applicator planned to build a new pretreatment line
- Required a chemical process that could be implemented in pretreatment line to replace existing mechanical grinding method
- Needed e-coat with good paint performance on welds; dedicated 6+ people to grinding all welds, heat affected areas and laser cuts that resulted in an average of 4 safety incidents annually
- Strong acids were regulated for this site and could not be used
- In-line chemical descaling solution offered the following benefits:
  - Improved e-coat coverage and paint performance
  - P-free, APE-free, minimal etching of steel, safe and easy to use and waste treat
  - >$400k/a in savings attributed to implementation of near neutral descaling



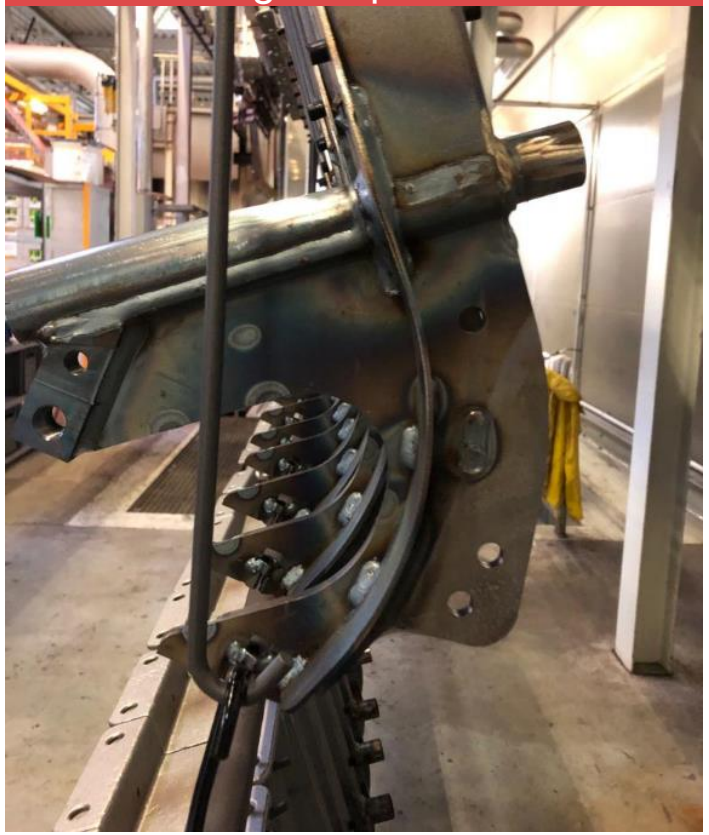
Case study 2

- Prior proprietary descaling process had several associated disadvantages:
  - Very high cost due to high etch rate, requiring 25% tank volume feed-and-bleed daily
  - Poor paint coverage and corrosion resistance for welds, laser cuts and plasma cuts
- With implementation of an improved chemical descaling process, the following improvements were realized:
  - Reduced etch rate by 40 - 50%
  - Less burden for WWT
  - Reduced reject rate by 80%
  - Improved part quality and flash rusting
  - Allowed for capability of producing cast iron parts, increasing plant efficiency

Plasma cut edge with no paint loss

Case study 2

Welded component prior to descaling and pretreatment

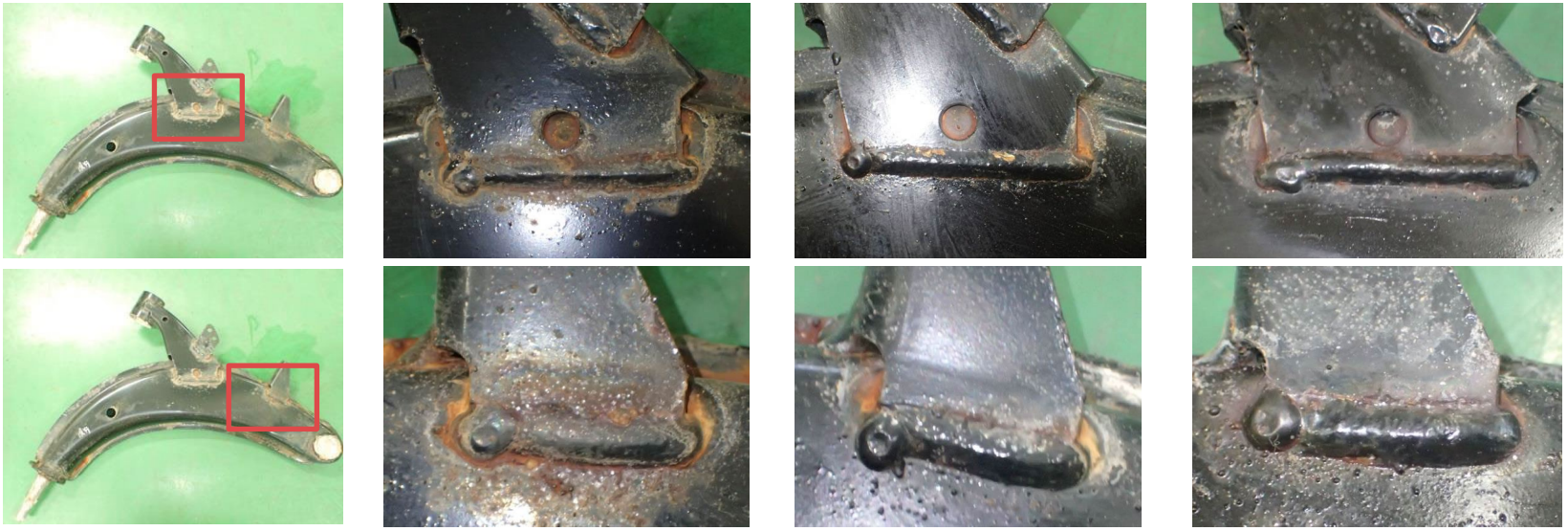


Welded component after descaling and pretreatment

Case study 3

Cyclic corrosion
50 cycles (1 year)

No descaling | 2 min descaling | 5 min descaling

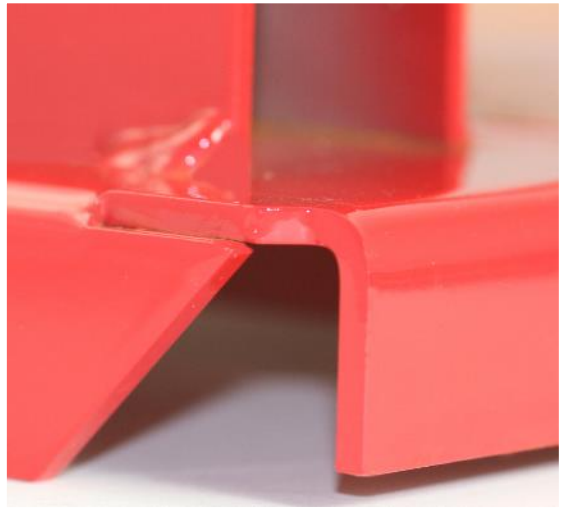


- No descaling exhibits red rust after 1 year simulated CCT; implementation of chemical descaling extended first presence of red rust to 3 years simulated CCT
- Chemical descaling resulted in 44% less corrosion depth at welds

Summary

Summary

- Improve the paint performance on the first point of failure
- Near neutral pH
- Multi-metal
- Reduced wastewater treatment issues
- Overall cost savings for process



Thank you for your attention!

To learn more about Atotech's innovative paint pretreatment and paint removal processes, visit us at Booth 401

ATOTECH