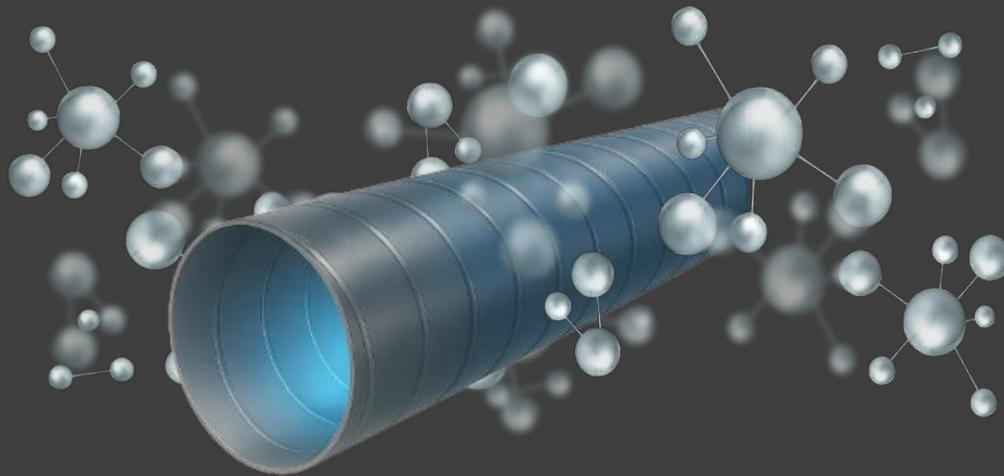


NAST[®] HVAC



Nanotechnology surface treatment for the buildings of the future

With groundbreaking Norwegian technology, we are setting a new standard for ventilation:
Lower friction, increased service life and sustainable solutions for tomorrow's environmental requirements

NAST® - Norwegian Innovation in partnership

Professional foundation and expertise

To ensure the product's integrity and technical foundation, the development work has been supported by a broad professional expertise
This groundbreaking development is the result of a targeted and close partnership between NAST-® Industrilakkering AS and Ventistål AS



The development work, which has been ongoing since mid-2021, has been driven forward with a common goal of creating cost-effective methods for large-scale production of nanotechnology for ventilation ducts and parts assortment.
The focus has been on delivering the next generation of raw material qualities with documented elevated corrosion standard and reduced surface friction to minimize energy loss

The development work has included:

Sintef Industri

KIWA

Fraunhofer IPN





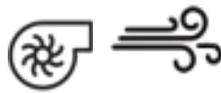
Ventilation Systems

Traditionally, ventilation system optimization has focused on isolated factors such as component design or certain surface characteristics.

However, nanotechnology from NAST® represents a paradigm shift. Our surface treatment is unique in that it delivers a rare synergy effect, combining improved corrosion resistance, significant pressure loss reduction, simplified cleaning and increased service life.

This provides outstanding operational and environmental benefits in one and the same system.

NAST® sets a new standard for ventilation with groundbreaking Norwegian nanotechnology and processing plants, which delivers semi-finished coils and dimensioned plates with documented lower friction, increased service life and sustainable solutions for tomorrow's environmental requirements.



PRESSURE LOSS IN VENTILATION SYSTEMS

Pressure loss in ventilation systems occurs as a result of energy loss when air flows through the ductwork. This wallpaper is divided into two main categories:

Local losses (system losses) – caused by components such as directional changes, branches, and dimensional changes.

The role of the surface in frictional loss – is due to the resistance between the airflow and the inner surfaces of the duct.

When the airflow touches the duct wall, its kinetic energy gradually decreases.

This leads to increased pressure loss and thus reduced energy efficiency in air distribution.

The microscopic roughness of the surface is crucial: a rough surface results in a higher coefficient of friction – and thus greater pressure loss.

REDUCED FRICTION – INCREASED SYSTEM EFFICIENCY

Through documented reduction of friction factor in nanotreated surfaces compared to untreated surfaces, a clear reduction in pressure loss along the longitudinal direction of the canal is achieved. The effect is due to reduced micro- and macroturbulence in the interface layer between the air flow and the duct wall.

Turbulence reduction and Friction factor shift:

At typical operating speeds of 4–5 m/sec, the Reynolds number (Re) is at a level deep in the turbulent regime. The nanotreatment does not shift the physical transition to laminar flow ($Re=2000$), but it does reduce the effective hydraulic roughness.

This causes the measured coefficient of friction to drop drastically, approaching values that are otherwise characteristic of laminar-like currents.

This is characterized by a more stable velocity profile and more even air distribution resulting in a significantly reduced pressure loss compared to untreated pipes.

System Benefit

The unique near-laminar performance provides two separate but related savings:

1. Friction Loss (Maximum Potential)

The nano-treatment provides a 20-40% reduction in friction loss in straight duct sections due to reduced friction coefficient.

This is the maximum potential for energy savings in the most efficient part of the system.

2. System Benefit (Conservative Guarantee)

We estimate that the average energy savings for the entire system fan work is 10-15% in typical installations, given that a complete ventilation system also includes specific pressure loss from components (bends, branches, dimensional changes, etc.).

MEASUREMENT RESULTS AND OBSERVATIONS

The effect of nanotechnology treatment is most pronounced in the system's critical components – such as bends, T-pieces and transition pieces.

Here, high turbulent resistance normally occurs, but the smoother surface provides a significant reduction in both frictional and local losses.

This improves the stability of the airflow and results in lower energy consumption throughout the plant.

THE RESULTS ARE CLEAR

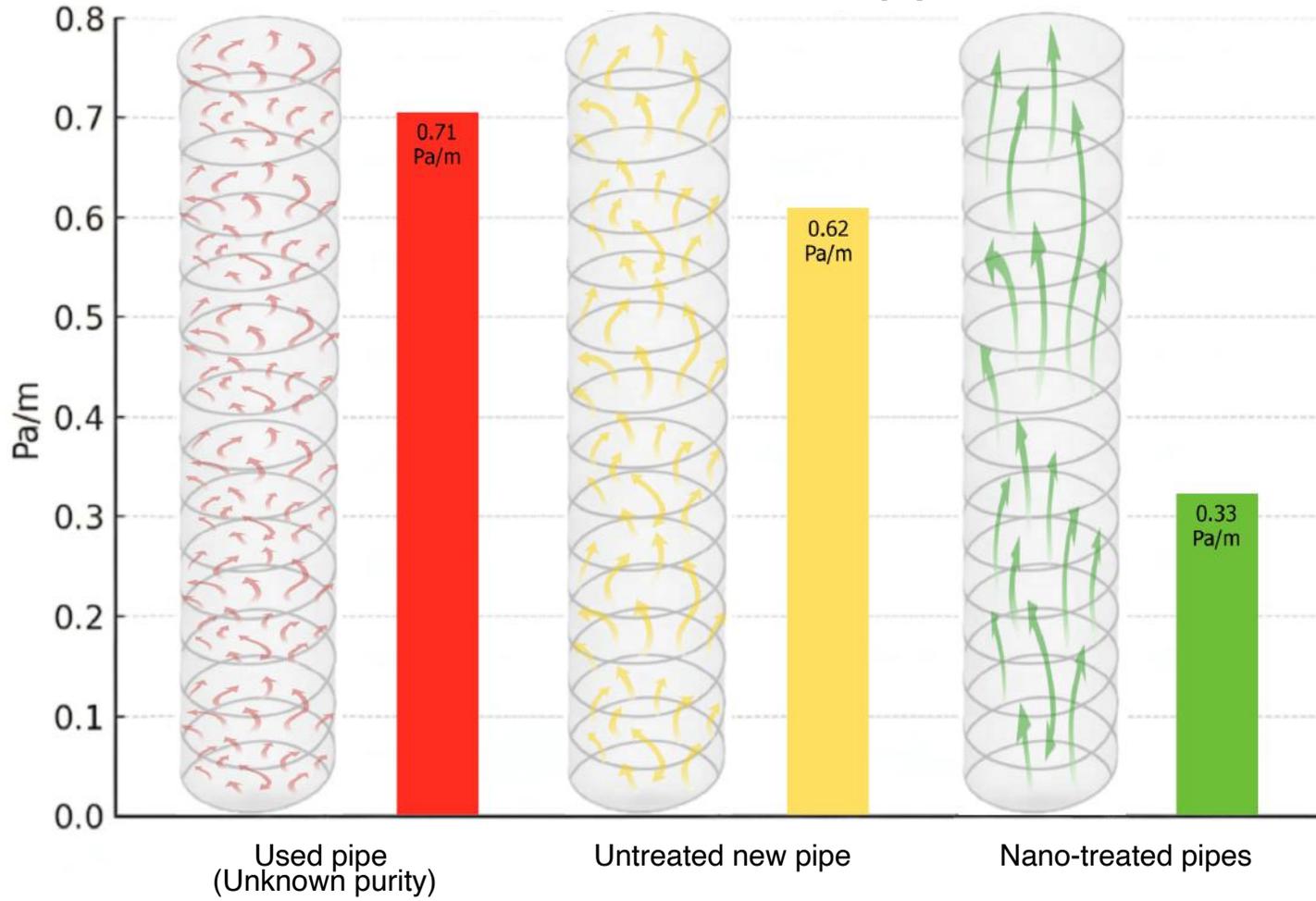
- Significantly lower pressure loss in the ductwork
- Reduced fan power and energy consumption
- Longer service life of both ducts and technical components
- Documented energy efficiency gains and lower operating costs

HOLISTIC EFFECT

The ventilation system achieves:

- Higher energy efficiency
- Improved sustainability
- A cleaner and more stable air environment – without reducing capacity or airflow

Pressure loss in ventilation pipes



Technical description of corrosion attacks in spiral folded ventilation pipes and other duct formats.

Incipient corrosion attack (starting point of degradation)

Internal corrosion in ventilation pipes occurs in materials coated with zinc (Zn), Alu-Zinc (Zn-Al), as well as Zn-Al-Mg alloys. These coatings, which consist of zinc oxide (ZnO), zinc hydroxide (Zn(OH)₂) and finally zinc carbonate (patina), can be identified or identified retrospectively as the exposure time under operating conditions has variable duration and lifetime.

The primary attacks are manifested as white corrosion deposits for Zn electroplating, and as darker deposits for Alu-zinc (Zn-Al) and Zn-Al-Mg alloys. The attack starts when the natural zinc carbonate patina is reduced or removed, exposing the underlying zinc layer to accelerated oxidation.

Types of corrosion in HVAC systems

- **General corrosion (Uniform attack):** Continuous corrosion of the zinc layer over the entire surface due to the influence of air quality and temperature differences.
- **Galvanic corrosion:** Accelerated corrosion of the zinc layer where it is in electrical contact with a more precious metal (e.g. by screws and clamps).
- **Local corrosion/Pitting:** Aggressive corrosion that leads to rusting in small, exposed areas, typically caused by chemicals or water condensation.

Localization and starting point:

The earliest corrosion attacks occur primarily in the surface texture pattern on the inner surface of the pipe. This pattern is an inevitable result of the mechanical manufacturing process. Such microscopic irregularities act as moisture and dirt traps, creating a local concentration of condensation. Our solution ensures a smooth surface, which will extend the life of the pipe and ensure optimal performance.

Mechanical causes of deformation of the microstructure of zinc coatings

Two primary factors contribute to the development of white corrosion:

- **Local corrosion of the surface's protective ability**
- **During cold forming and corrosion, a local plastic deformation of the electroplating occurs.**

This increased stress can reduce the protective effect at specific stress points. These weakened areas then act as an enlarged starting point where oxidation reactions can start.

Operational consequences and nanotechnology

Consequences for operation

The formation of zinc oxides and hydroxides results in an uneven surface texture that increases the hydraulic friction coefficient within the duct. The surface becomes more susceptible to the deposition of dirt and particles, which over time reduces the flow capacity and hygienic standard.

Without adequate protection, corrosion attacks will progress, particularly in climates characterized by fluctuating relative humidity.

Nanotechnological surface densification

By employing nanotechnological treatment, a densification of the zinc coating's microstructure is achieved through the integration of Zn /Ni nano-elements into the surface layer.

This treatment provides:

- **Reinforced and passivated surface:** The nanochemical treatment forms a homogeneous and passivated surface, effectively eliminating weak points in the surface profile and micropores. This protects the coating from micro-pitting and increased brittle fracture susceptibility.
- **Reduced corrosion tendency:** This leads to a significantly reduced propensity for corrosion degradation, even under prolonged exposure to humidity and condensation.
- **Substantially Increased surface strength:** Documented by improved resistance to micro-pitting and reduced brittle fracture susceptibility.

The result is a C5-based semi-finished product with markedly improved corrosion resistance, a lower friction coefficient, and a stable internal surface quality that ensures better operational economics and a longer service life for the ventilation system.

Nanotechnology surface reinforcement

Focus on modification and penetration

Nanotechnology processing modifies and reinforces the galvanized microstructure.

Zn/Ni nano elements integrate into the surface to create a deeper and more saturated protection

Integrity during mechanical machining

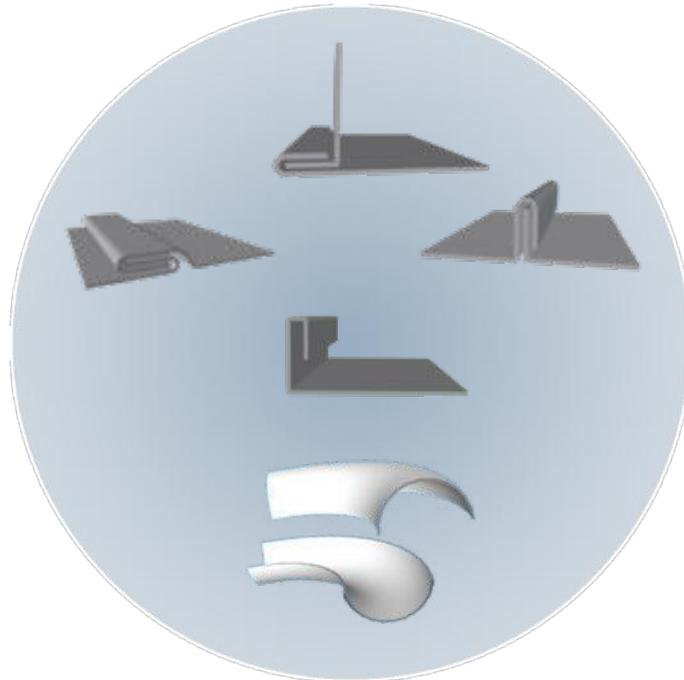
Unlike conventional coatings (such as powder coatings or wet coatings), where mechanical stress in the bending zone can lead to cracking or delamination, NAST® nanochemistry eliminates this risk.

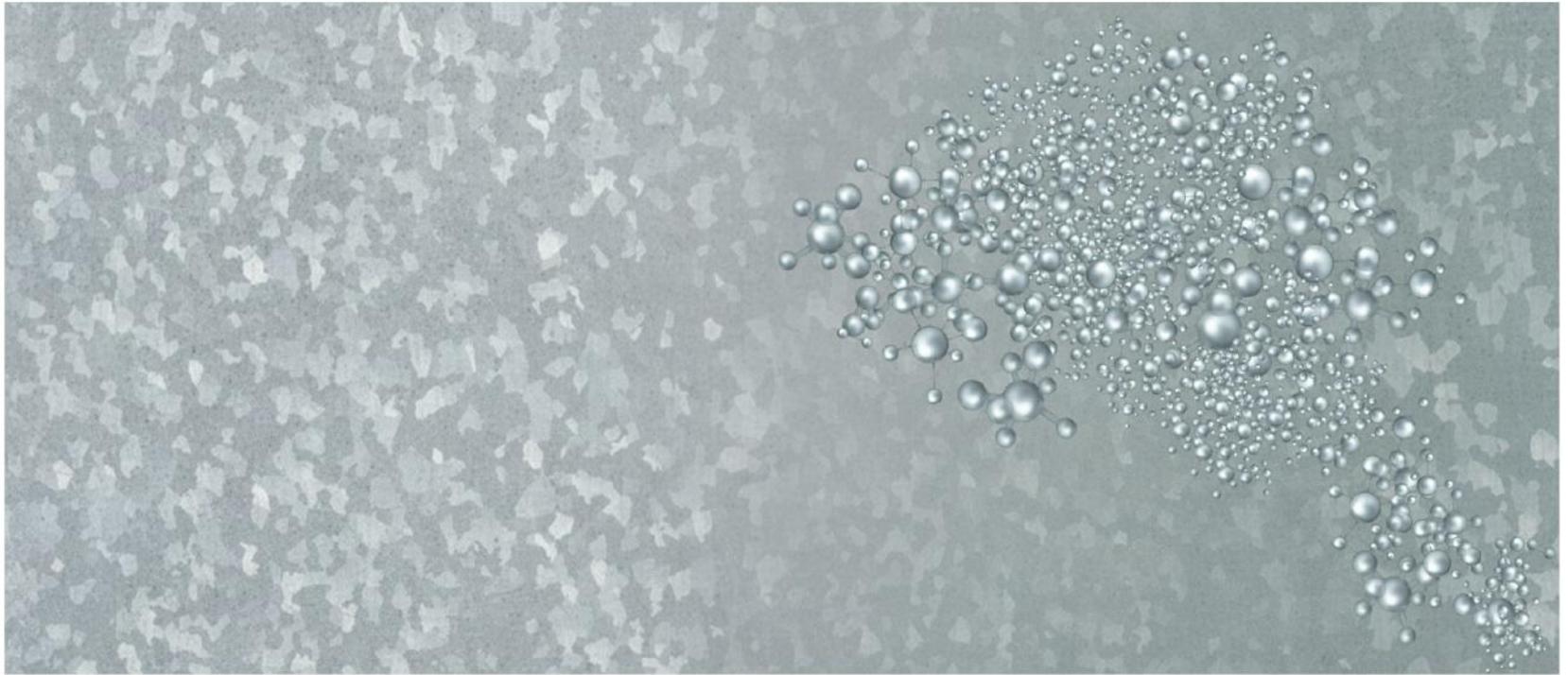
Because the nanochemistry saturates the microstructure of the galvanized surface, the material is not prone to defects in point loading.

Extensive testing of sheet metal machining techniques — including 90°/180° bending, Lockformer/Pittsburg seams, spiro tube seams and high-pressure forming — confirms this.

All machined zones have documented the same corrosion class C5 as unmachined plate.

This ensures full corrosion integrity of the entire duct network.





Product benefits and results

This treatment provides:

- Significantly increased surface strength through improved resistance to microdeformations and increased tensile strength.
- A more homogeneous and passivated surface, where anodic weakness points in the serration pits are eliminated.
- Significantly reduced tendency to white corrosion, even during prolonged exposure to moisture and condensation.

The result is a coil-based semi-finished product with significantly improved corrosion resistance, lower friction factor, and a stable inner surface quality that ensures better operating economy and longer service life for ventilation systems.

Resource management and Global sustainability

The efficiency of nanotechnology creates a decisive shift from quantitative to qualitative material consumption.

Strategic reduction of Zinc consumption

Through NAST® surface reinforcement, a markedly improved corrosion resistance and a more homogeneous surface are achieved, where anodic weakness points are eliminated. This functionalization is streamlined and shows that it enables the use of only 100 g of zinc/m², compared to the 275 g/m² normally required to achieve the equivalent lifetime in a C2-C3 environment.

The result: This means a massive 64% reduction in the consumption of zinc — an exhaustive and globally pressured resource.

Qualitative material consumption

Although the reduction in the CO₂ footprint (measured in EPDs) amounts to about 2% for material production, the real environmental benefits are related to strategic resource management.

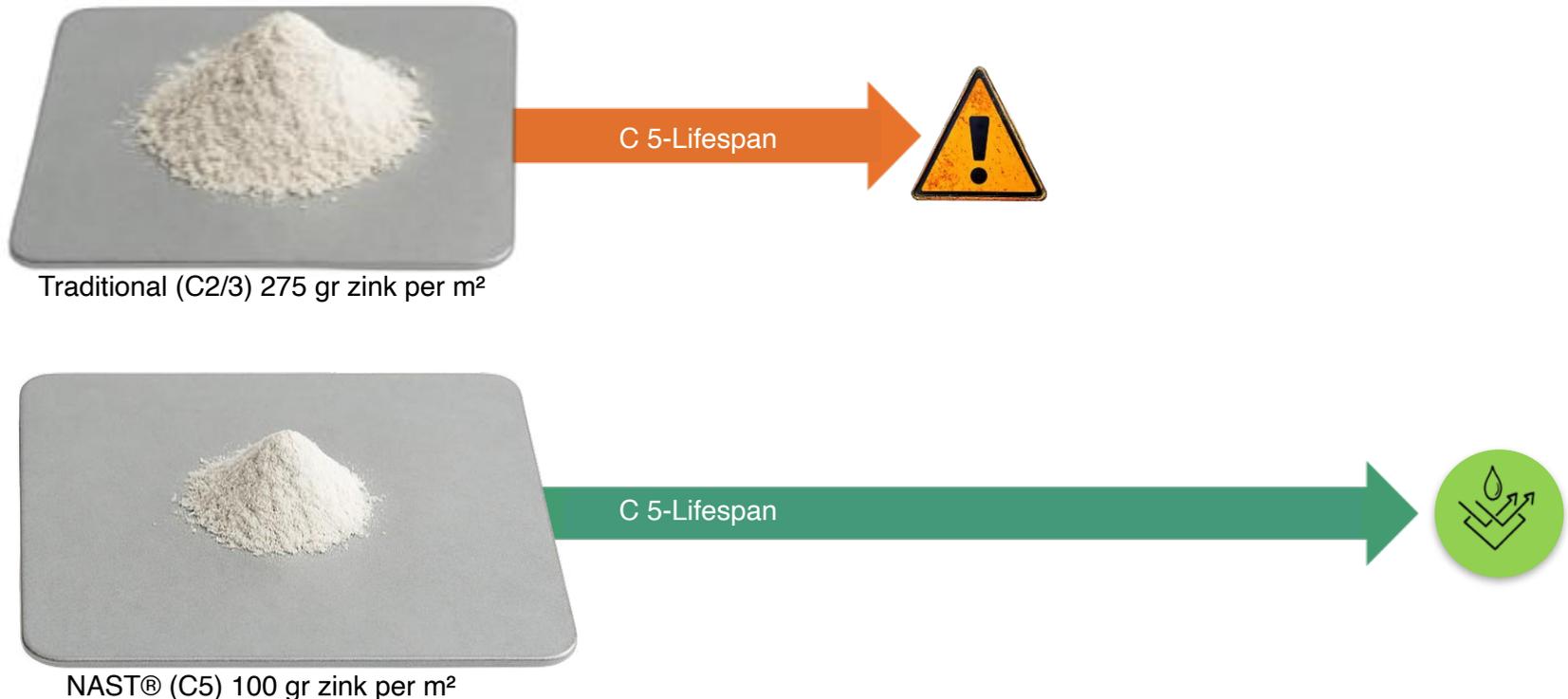
Superior functional performance: The nanotreatment acts as a passivating barrier that reduces the tendency for corrosion degradation (such as white corrosion).

This provides a corrosion resistance that functionally exceeds C3 requirements for duct life, even with a reduced zinc coating.

Circular economy: At a time of increasing scarcity of raw materials, our technology represents a significant contribution to the responsible use of nature's limited resources by maximizing performance from minimal material consumption.

Strategic asset management: 64% reduction in zinc consumption for superior performance and longevity.

Strategic resource management: 64% reduction in Zinc consumption for superior performance



Cleaning standards, material protection and operating economy (LCC)

The inner surface quality of the ducts has a direct impact on both hygiene and the costs associated with periodic cleaning.

Traditional galvanized material is sensitive; When cleaning, there is a real risk that heavy-handed brushing, aggressive use of chemicals or dry ice blasting will gradually deteriorate the surface, which accelerates degradation.

NAST® nanotechnology counteracts this degradation. The hydrophobic and oleophobic effect reduces dirt deposits and ensures that the cleaning procedure can be significantly simplified, with reduced need for harsh chemicals and harsh mechanical stress.

Material integrity is maintained and the life of the duct is extended.

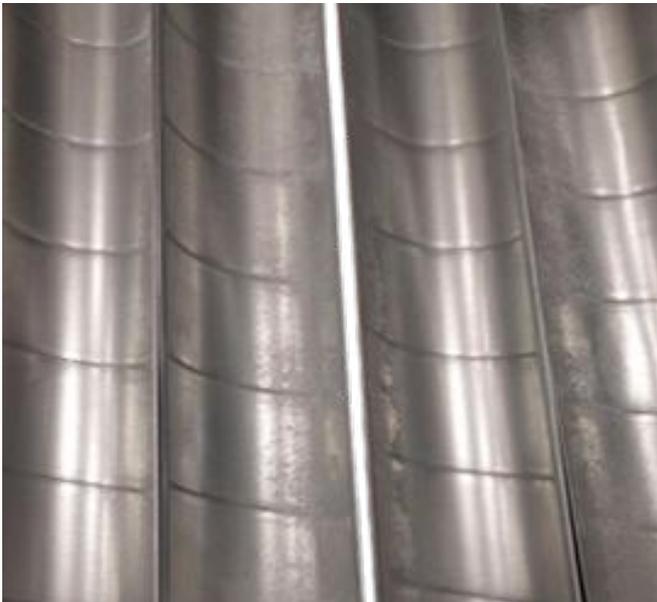
Reduced Downtime and Cost Savings: Through simplified and faster cleaning made possible by nanotechnology, the process time can be significantly reduced.

This minimizes downtime and allows for more flexible execution during regular working hours, resulting in significant savings in operating economy (LCC).

Untreated galvanised duct after 3 years operation

Traditional galvanised steel, exposed to normal moisture and operating conditions in ventilation systems, shows clear signs of corrosion deposits and stubborn dirt after only three years of use.

This degradation progressively degrades the surface, increases the risk of anodic points of weakness, and requires aggressive mechanical or chemical cleaning, further reducing duct life and increasing operating costs (LCC). This illustrates the real challenge of maintaining material Integrity over time.



NAST® Nano-treated duct after 3 years of operation

Corresponding channels treated with NAST's nanotechnology appear clean and intact after the same three-year period. The homogeneous and passivated surface and reduced tendency to white corrosion ensure that material integrity is maintained. The hydrophobic and oleophobic effect counteracts dirt deposits, significantly simplifies the cleaning procedure, and eliminates the need for harsh mechanical or chemical stress. The result is a stable inner surface quality that extends the life of the duct and provides significant savings in operating economy (LCC).



Reduced friction and electrostatic impact — a key factor for cleaner ventilation air

Background

Through nanotechnology surface treatment, we have achieved a strong reduction in the coefficient of friction, which in itself reduces energy loss and pressure loss in ventilation ducts.

However, this improvement also has a direct effect on the electrostatic properties of the duct and thus on the purity of the air in both supply air and exhaust systems.

1. Electrostatic mechanisms

When air flows through traditional galvanized ducts, small electrical charges occur as a result of friction between the airflow and the metal surface.

These charges can lead to:

- Build-up of static electricity on the duct wall
- Increased attraction of dust particles and aerosols
- Local accumulations that eventually bind as occupancy

The nano treatment from NAST® provides a surface with lower surface energy, reduced micro-roughness and homogeneous electrical conductivity, which prevents charge build-up and reduces the adhesion forces between particles and metal.

In addition, the intermolecular *Van der Waals* bonds, which are normally responsible for weak but sustained particle attraction at the micro level, are reduced.

The sum of this is a surface that is far less likely to allow dust and aerosols to adhere.

Electrostatic particle effect

Reduced by 87%



Untreated surface

Nanostructured

2. Cleaner supply air and better indoor climate

The reduced electrostatic effect means that airborne particles in the supply air system have a significantly lower tendency to stick to the duct wall.

This provides several documentable benefits:

- Increased degree of purity of the supply air and thus higher quality of the indoor environment
- Reduced need for filter change and duct cleaning
- Lower risk of secondary pollution, where particles are released again when air pressure changes

The result is a system that maintains stable air quality over time, with reduced microbial growth and better hygienic standards.

3. Reduced dust accumulation in exhaust systems

In exhaust ducts, the opposite effect occurs – the air flow transports particles that can be deposited on duct walls and components.

- The smoother, antistatic surface from the nanotreatment significantly reduces these deposits, providing:
- Less build-up of deposits in critical zones such as bends and transitions.
- Lower risk of flammable dust accumulation.
- Better air transport and stable system performance over time.

4. Health and environmental benefits

A ventilation system with reduced electrostatic and intermolecular adhesion forces contributes to:

- Lower particle concentration in indoor air.
- Reduced occurrence of allergens and microorganisms.
- Better working environment and documentable health benefits for users of the building.

Summarized:

Nanotechnology coating not only reduces friction and energy loss — it effectively eliminates both electrostatic and *Van der Waals*-based adhesion prerequisites for dust attraction.

This results in cleaner air, lower maintenance costs and real health benefits, while significantly extending the technical life of the system.

Total system integrity: Fastener Components and Suspension

A ventilation system's service life and corrosion resistance are measured based on each individual element of the system. Conventionally, fastener components — such as self-drilling screws, pipe clamps, threaded rods and rail systems are often the weakest points.

These are typically based on electro-galvanized (EG) design, which has a very low corrosion resistance.

NAST® — The goal is to ensure corrosion class C5 for any element of the overall plant, from duct to smallest screw.

Elimination of corrosive weaknesses

In parallel with the development of nanotechnology for duct substrates, the focus is on all necessary accessories in the context of assembly.

- **Enhanced protection:** Through our process, the corrosion resistance of electro-galvanized items is significantly upgraded. Each accessory component is now certified to achieve corrosion classes C5 and C5-High.
- **Total privacy:** This eliminates the risk of fastener components breaking down long before the actual ductwork, thus ensuring that the entire system meets the highest corrosion requirements over time.

Prevention of galvanic corrosion

By applying an elevated, uniform nanotechnology surface protection over all components, we have also eliminated the problem of galvanic corrosion.

Galvanic corrosion occurs when different metal grades (such as untreated zinc and steel) are put together, where the least precious metal is corroded more quickly.

NAST® nanoprocessing ensures a homogeneous standard of protection across all metal types in the fasteners, avoiding costly and destructive reactions between different metal qualities in the plant.

This approach positions you as a supplier that thinks about a complete system solution and removes one of the most common sources of error in installed ventilation systems.

High-Quality powder coating: Aesthetics and extreme durability

Powder coating is the preferred finishing for ventilation systems where aesthetics, corrosion protection and cleanliness are essential.

Reuse and C5-High Certification.

Reused ducts and components often have defects in the surface as a result of previous operation and disassembly.

Our process is unique in that it eliminates these defects and restores surface integrity.

Through a careful pre-treatment and application of a protective substrate (primer) — or in some cases metallization of the substrate — before the electrostatic powder coating layer is applied, we ensure complete restoration.

This guarantees corrosion class C5-High for the surface, regardless of whether it is new components or reused material

Powder coating is the preferred finishing for ventilation systems where aesthetics, corrosion protection and cleanliness are essential.

Primary benefits

- **Exceptional durability:** Resistant to peeling, scratching and fading
- **Environmental responsibility:** Powder coating contains no Volatile Organic Compounds (VOCs) or solvents

Customization with Nanochemistry

For use in areas exposed to heavy pollution (industry, car washes), a further final treatment is carried out with adapted nanochemistry. This establishes a hydrophobic and oleophobic effect, which ensures optimal cleanliness and durability even under the most aggressive operating conditions



 VENTISTÅL



NAST[®]

NORSE ADVANCED SURFACE TECHNOLOGY



NAST® Circular strategy: Recycling and reuse of duct systems

The construction industry has an increasing focus on circular economy

From the start, NAST® innovative development has been conscious of safeguarding this commitment, by facilitating nanotechnology for use on both new materials and reused components.

The challenge of reuse

Through extensive field trials, we have identified the two biggest challenges with the reuse of galvanized ventilation ducts:

1. Material destruction:

Internal ducts lack the natural, protective oxide layer (patina) that forms in outdoor environments.

This makes the surface more susceptible to corrosion from exhaust air.

2. Cleaning damage:

Necessary periodic cleaning procedures (with brushes, chemicals or dry ice blasting) expose the delicate zinc microstructure to mechanical wear. This gradually deteriorates the metallic structure each time cleaning is carried out, increasing the risk of corrosion attacks.

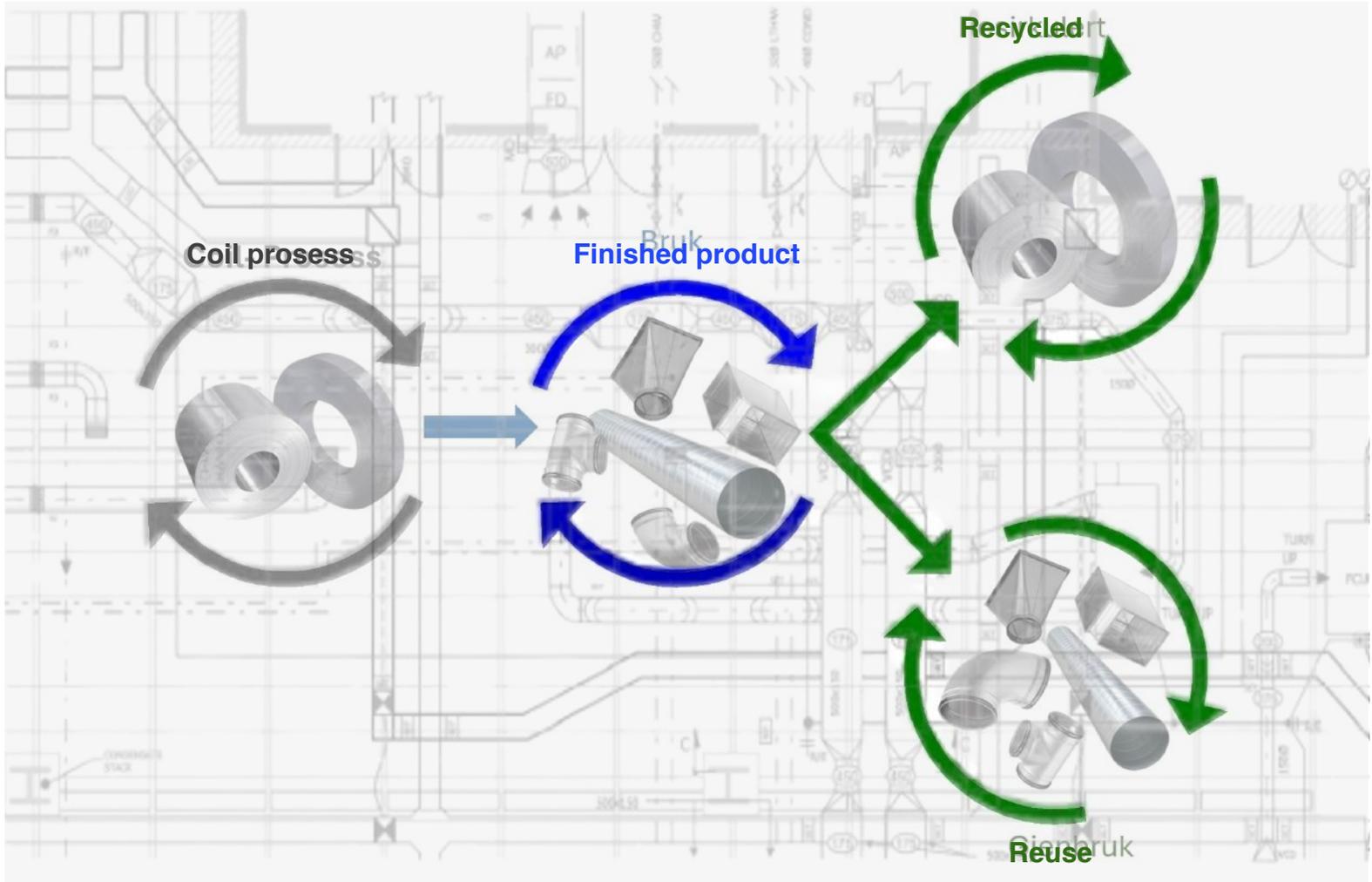
Optimization of reuse value

NAST® technology enables a preventive strategy by adding next-generation nanochemistry to used components.

The goal is to optimize the product's reuse value by ensuring that it achieves optimal values for corrosion resistance and maintenance procedures.

- **Re-establishment of corrosion class C5:** Through our process, reusable ducts regain the same high corrosion resistance as nano-treated new products.
- **Increased surface strength and longevity:** The nano treatment improves barrier strength, ensuring a stable inner surface quality that can withstand future cleaning without progressive deterioration.
- **Cost-effectiveness:** The process is facilitated for automation, which ensures a good economical process rate for surface treatment of reusable channels and parts.

Reuse factor and sustainability (Conclusion) The combined effects of increased corrosion resistance and improved surface strength result in a marked extension of the duct system's lifetime. This provides a unique reuse factor, reduces the need for replacement and is thus a highly sustainable topic that directly contributes to the circular economy and reduced environmental impact in construction projects.





SALT SPRAY CHAMBER TEST RESULTS

Testing in accordance with ISO 12944-6, corrosivity category C5-M

Focusing on improved material performance values, NAST® conducts accelerated corrosion testing in the form of both continuous and cyclic test procedures.

Such test procedures are carried out in a controlled salt spray / condensation environment and expose substrates under controlled and stressed conditions. In this manner, the material's performance value can be estimated, yet it does not confer an exact equivalence compared to the material's exposure under natural climatic conditions.

Natural environmental influences are diverse, and through our diligence and perseverance, we are making progress in understanding how environmental factors affect substrate values and how we can achieve optimal performance values by employing polymer tuning and advanced process treatments.

NAST[®]
HVAC

Tested in accordance to ISO 9227: 2017 - 810 hour test

Untreated substrate
Unwashed



Polymer treated from
semi-finished substrate
before press forming of
finished products

Unwashed



FOTO: LENE ØRNHOFT



Untreated substrate
Unwashed

Polymer treated from
semi-finished substrate
before press forming of
finished products

Unwashed

FOTO: LONE DRAGHOF T



Untreated substrate
Washed with
ionized water

Polymer treated from
semi-finished substrate
before press forming of
finished products

Washed with
ionized water

FOTO: LONE DRAGHOF T

Tested in accordance to ISO 9227: 2023 - 2130 hour test

Untreated
Electrogalvanized Carbonsteel substrate

Unwashed



Polymer treated
Electrogalvanized Carbonsteel substrate

Unwashed



Untreated
Electrogalvanized Carbonsteel substrate

Washed with DI - water



Polymer treated
Electrogalvanized Carbonsteel substrate

Washed with DI - water



Tested in accordance to ISO 9227: 2017 - 1440 hour test

Typical semi-finished substrates with a hot-dip galvanized layer in a thickness of 20 μ .
Mainly used in ventilation-oriented industry such as spiral folded pipes or other thin sheet processing.

Untreated substrate
257 hour test

Unwashed



Polymer treated substrate
1440 hour test

Unwashed



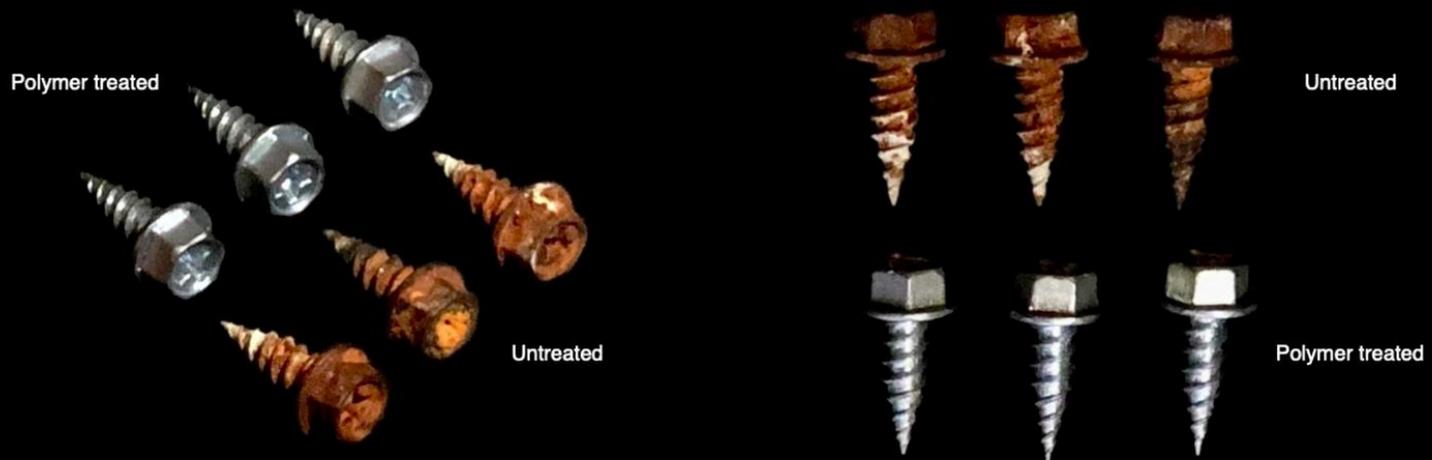
Self-drilling screw units are important detail units in the construction of the ventilation system.

In terms of process, such devices pose significant challenges during the electrogalvanization process, and this to a significant extent because the enlarged "batch amount" often drains the electrolyte and/or becomes contaminated.

This affects the quality of the galvanisation.

NAST nanochemical process technology requires greater than 99% purity of the zinc coating to achieve complete bonding and that a minimum layer thickness of 5 microns is required for the cohesive structure.

Our screw units meet the aforementioned requirement specifications and thus result in corrosion class C5-M





CHLORINE MIST CHAMBER TEST RESULTS

Testing in accordance with ISO 9227:2023, without NaCl.

Metal substrates in chlorinated environments

The chlorine-based chemicals used in water treatment facilities produce chloramines due to a reaction with nitrogenous compounds.

Chloramines are highly volatile and are released into the surrounding atmosphere in both indoor and outdoor climates, where they deposit onto metal surfaces. Once deposited, they degrade and form corrosive compounds. Repeated cycles of condensation followed by evaporation cause the accumulation of these aggressive chloride-containing compounds on metal-based substrate surfaces when exposed to oxygen.

These compounds pose significant metal corrosion problems in any chlorinated environment, whether for industrial purposes—such as in water treatment plants—or in public swimming pool facilities.

In public swimming halls, the presence of chlorinated water can lead to highly aggressive corrosion which is often not visible during routine inspection procedures. This is typically due to the large room volumes and considerable ceiling heights, which require extensive access equipment for inspection. NAST® conducts comprehensive laboratory tests in an artificial chlorine chamber, as well as parallel field tests in selected environments.

With a significant focus on increasing the barrier strength of electrogalvanized zinc using high-quality nanotechnology, tests performed on a selection of fasteners for HVAC systems (where galvanization constitutes a coating thickness of 10-12 μm), demonstrate a considerable increase in durability.

A corresponding increase in resistance is also observed for components made from Stainless Steel Grade 316L.

Chloride test 840 hours - Small pipe clamps VVS

The chloride test was performed in a salt spray test cabinet for 720 / 840 hours in accordance with ISO 9227: 2023, Without NaCl. 5% NaCl was replaced by chloride amount of 0,15g added into 100 ltr deionized water (DI)

Untreated
substrate



Polymer treated
substrate



Chloride test 840 hours - Toggle studs

The chloride test was performed in a salt spray test cabinet for 720 / 840 hours in accordance with ISO 9227: 2023, Without NaCl. 5% NaCl was replaced by chloride amount of 0,15g added into 100 ltr deionized water (DI)

Untreated
substrate



Polymer treated
substrate

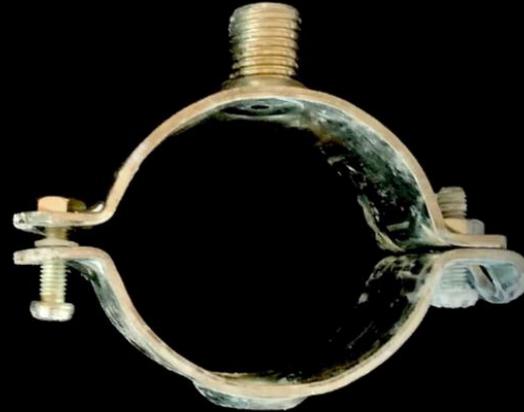


Chloride test 840 hours - Pipe clamps

The chloride test was performed in a salt spray test cabinet for 720 / 840 hours in accordance with ISO 9227: 2023, Without NaCl. 5% NaCl was replaced by chloride amount of 0,15g added into 100 ltr deionized water (DI)



Untreated
substrate



Polymer treated
substrate



Disclaimer and reservation of rights

All technical specifications, performance data, and capacity figures (including representative pressure reduction and CO₂ capture coefficients) are based on laboratory testing and theoretical calculations, which are performed under controlled conditions.

Actual performance and final results in any specific ventilation system will vary significantly and are dependent on individual factors such as installation quality, airflow volume, duct configuration, and operating patterns.

The information provided in this brochure is intended as guidance only and does not constitute a binding written warranty, prospectus, or project-specific agreement.



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