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DLyte The metal surface finishing revolution



SUCCESS CASE. PROPELLERS, IMPELLERS & HYDRO TURBINES

For Marine & Energy Industries

Powered by **DryLyte** TECHNOLOGY

PROPELLERS, IMPELLERS & HYDRO TURBINES.

For Marine & Energy Industries

THE COMPANY

GPAINNOVA's client is a company based in the USA, with many years of experience and vast expertise in the manufacture of marine propellers, impellers, and hydro turbines. This organization struggles to offer high-quality products on time, profitable, and with the lowest environmental impact.

THE PROBLEM

As it is well known, the design, manufacturing, and surface finishing of marine propellers and hydro turbines have a big impact in the energy efficiency and the speed of the boat. The standards of the marine industries require that the materials and surface quality of the components used fulfill in terms of geometry preservation, durability, homogeneity, corrosion resistance, and cleanability. Surface quality is a key factor so that the turbine or propeller can be cleaned easily and reliably to keep the surface free of marine organisms. Most of the propellers have a finishing between 2 microns and 6 microns laid down in ISO specifications.

Nevertheless, a super-smooth surface finishing (below 1 micron) improves the efficiency of the propeller and is inhospitable to marine organisms.



The grinding, sanding, and finishing of hydrodynamic parts must be free of lines, grooves, pits, or divots. Additionally, the surfaces must withstand corrosion from saltwater.

Achieving a perfect finish in turbines and propellers **involves repetitive and time-consuming manual tasks**, which means labor-abundant work or **complex multistep processes** in robotized cells and high-maintenance and operative costs. Secondly, traditional surface finishing is **inefficient, and it is linked to error-prone manual processes** which are not achieving the repetitiveness and consistency required by the sector, leading to **premature failure**. Finally, the current surface finishing processes suppose a **bottleneck** in the factory, because of the **lack of trained workers and space** in the factory for manual belting and buffing benches.



The current processes to achieve the required surface quality, manual belting, and buffing involve the exposure of workers to dust, noise and toxic compounds. Abrasive surface treatment generates dust and can be dangerous for the health, since the particles that cause damage are often invisible to the naked eye. This is why the eventual health effects of exposure can take many years to be visible. Abrasive surface equipment is usually very noisy and can lead to hearing loss in case of inadequate hearing protection or prolonged exposure to noise in the workplace. Additionally, operators of hand-held vibrating tools can suffer from pain in tendons, muscles, bones, and joints. At the same time, the nervous system can be affected.

In sum, the customer was looking for an efficient, cost-effective solution to polish **stainless-steel marine propellers** manufactured by casting, turning, and milling, which have been previously pre-processed by grinding. **The parts to be polished were expected to reach a mirror finish through a second grinding treatment and a high degree of roughness reduction to achieve a surface roughness below 0.3 microns Ra.** The big challenge is that the roughness before the final step in several areas of the piece is different, and the treatment should be able to improve the roughness in any area at least below the targeted roughness.

The current process of the customer is a multistep process including a final step of manual buffing.

The current process' drawbacks are:

- + **Lack of workers and space to produce the required volumes.**
- + **High costs of the process.**
- + **Inconsistency and uneven surface finishing, leading to the scratching of parts and premature failure.**
- + **Unaesthetic surface quality, especially low brightness.**
- + **Corrosion due to ceramic inclusions and no passivation process.**



THE GOAL

The most important challenge of GPAINNOVA's proposal of implementation was how to ensure a proper production performance at the client's site. The group defined the production performance with the aim to achieve the desired target cost,

processing time, and quality results. Once the equipment was installed at the customer's facilities, GPAINNOVA's Customer Care team smooth the machine implementation, running some different trainings and tests with the customer's staff.

THE SOLUTION

The customer prepared a batch of samples of marine propellers in different sizes and shapes, going from 200 mm to 400 mm diameter.

The parts were prepared with different grinding grades, with a roughness between 0.8- and 0.4-microns Ra. The targeted Ra was below 0.3 microns to fulfill the ISO standards and improve the energy efficiency and boat speed. The yearly production was 5,000 units of the biggest propeller which required to be polished one by one and 10,000 units of the smallest propeller which are polished in batches of 8 units.

The Process department defined the media electrolyte based on the material, initial and targeted roughness, and geometry of the pieces. Then, the Engineering department developed custom fixtures to

hold the pieces during the process without creating shadows and damaging them and maximizing the capacity per cycle of the selected equipment. The solution suggested by the process department was a **Dlyte PRO500**, a compact machine with high output, specially designed for mass production (it can treat up to **8 propellers of 220 mm diameter per cycle**). The movement and speed applied to pieces were defined to allow perfect media and electrical flow through the whole piece, without damaging it by the leverage applied.

The factors which determine the cost per piece are determined by the CAPEX, which depends on the equipment required, based on the yearly production, capacity per batch and process time per batch, and the OPEX, defined by the weight removal per piece, the media lifespan for the material and the maintenance costs.



The media lifespan is determined by the metal absorption capacity of the media, as the metal removed from the metal surfaces is captured by the media particles. The way we use to calculate the lifespan of the media is linked to the quantity (weight of metal that can be captured by the media). This way, we managed to calculate the number of pieces we will be able to treat with the media based on the average metal weight removal of a batch of sample parts. Metal absorption capacity of the media is different between materials, as the material density changes substantially depending on the metal. For heavy metals and alloys, the metal extraction will be higher than for light metals and alloys.

The aim of the test is to define the ideal combination of processes to reach the technical specifications of the surface with the lowest total process time and cost. The technical specifications include tight tolerances' preservation, non-stick capabilities, reduction of friction on contact surfaces and enhance of corrosion resistance. We did trials with different process time and parameters, including roughness measurements in different areas with a profilometer.

The best results were achieved with a dry suspension consumable which contains microporous particles and an electrically non-conductive liquid. The processing time was 60 minutes with a capacity of 1 piece per batch starting with an average roughness of 0.8 to 0.4 microns (31 to 15 microinches) and a final roughness below 0.2

microns (8 microinches) in 8 different measurement points through the surface. The mass removal was 7 grams per piece.

Taking into account the weight removal of 7 grams per piece and the weight removal capacity of a full media work bowl of 210 liters (in the case of the stainless steel with dry suspension media, it is 4.04 kg), we can treat 550 propellers per media charge. Based on a processing time of 60 minutes and an estimated total time for loading and unloading the holders of 4 minutes, the total process time is 64 minutes per batch of one piece. The daily output with 3 shifts is 22 propellers, so the yearly output with 250 working days is 5,500 units.

The customer also proved the use of Dlyte for polishing propellers of 220mm diameter in batches of 8 units with a weight removal of 2 grams in 60 minutes. The daily output with 3 shifts is 160 propellers and the yearly output with 250 working days is 40,000 units.



According GPAINNOVA's experience, the achievable roughness values, material removal and the time of process may change depending on the geometry and the previous state of the surface before being treated with the DryLyte Technology.

Those are the costs per piece based on material removal, process time, and capacity for propellers treated in batches of 8 units per cycle with a diameter of 220 mm, 1 kg, and a weight removal of approximately 2 grams:

***OPEX cost per part: €9** (including media, maintenance cost, electricity and air consumption)
CAPEX: : €3 per piece for 5 years with 26,000 pieces/year (including equipment and customized holder investment)

Those are the costs per piece based on the material removal, process time and capacity for big propellers treated one by one with a weight of 3.8 kg, 400 mm diameter and a weight removal of 7 grams:

***OPEX cost per part: €35** (including media, maintenance cost, electricity and air consumption)
CAPEX: : €24 per piece for 5 years with 5,000 pieces/year (including equipment and customized holder investment)

CURRENT STATE OF ART FINISHING


Milling
CNC manufacturing



Manual Belting
Abrasive grinding with belt



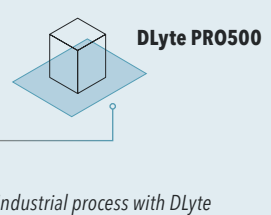
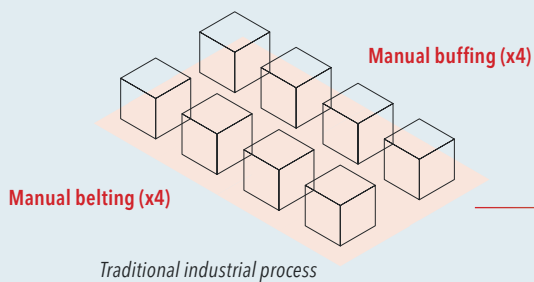
Manual Buffing
Mechanical manual final touch



DLYTE FINISHING SYSTEM

Milling
CNC manufacturing





BENEFITS

Among the new DLyte surface finishing process' main technical benefits, it is worth to highlight the following ones:

01. HOMOGENEOUS RESULTS ACROSS THE PIECE & GEOMETRY AND TOLERANCE PRESERVATION

DLyte is more precise and homogeneous than the current abrasive processes, since the material removal is performed by an electrochemical process which depends on the number of impacts of the media and the surface and the electrical field. The previous processes work manually or using a robotic arm to apply high-mechanical energy to scratch and remove material from the surface. The biggest drawback of those processes is that the application in some areas is uneven and generates substantial differences across the surface, as it is very difficult to reach some hidden areas mechanically.

02. BEST-IN-CLASS CONCERNING SURFACE ROUGHNESS (RA UNDER 0.2 MICROMETERS)

DLyte can reduce the roughness below the target and achieving a high gloss finishing. The surface finishing processes used before could not reduce the roughness to the target roughness without an extensive manual buffing.

03. STABLE RESULTS AMONG DIFFERENT BATCHES WITHIN THE ELECTROLYTE MEDIA LIFESPAN

The dry electrolyte does not require maintenance, as the equipment adjusts the conductivity of the media automatically. The media absorbs the metal ions during the process and the cathode remain clean. The previous manual process depends on the know-how of each worker, and therefore is inconsistent between pieces.

04. LONGER LIFESPAN FOR TREATED PARTS

Improved corrosion resistance

+ Samples processed with DLyte process corrodes between 4 and 15 times slower than liquid electropolishing. Electropolishing is 30 times more effective than passivation at eliminating corrosion and surface defects. The previous robotized grinding process used abrasives as diamond, with high risk of inclusions and directional and milling lines.



Corrosion Resistance Test Study.

The results of the study show that DLyte achieves better corrosion resistance than liquid electropolishing. The dry EP sample corrodes slower than the traditional EP sample.

QR - Download the Corrosion Resistance Study

Defect free and isotropic surfaces

+ DLyte process produces an isotropic non-directional finish which improves the surface finish and provides repeatable, non-directional, uniform finish as there is no abrasion of the surface, but instead the removal of material is produced by ion transport.



05. CLEANABILITY

DLyte achieves an ultra-smooth and polished surface which prevents marine organisms' adhesion. It makes cleaning more efficient.

06. BRIGHTNESS

DLyte Improves surface reflectivity and brightness of the surfaces better than other surface finishing methods.

Among **the new DLyte surface finishing process main operational, economic and environmental benefits**, it is worth to highlight the following ones:

07. NO NEED FOR MULTISTEP PROCESSES

DLyte replaces various finishing steps (manual belting and manual buffing), improving lead time, and ensuring quality consistence.

08. REDUCED FOOTPRINT

DLyte process has a high output in a very compact design. Manual belting and buffing required several stations which means 3 times more space for the same production.

09. COST REDUCTION

The new process supposes a production cost reduction over 50% including process, logistics, improved quality, etc.

10. WASTE MANAGEMENT

Dry electrolyte waste management can be easily handled by standard services. In its turn, all the metal removed from the workpieces remains in the media. As it is solid, there is no risk of discharge in waterways or drains.

11. EXPOSURE OF WORKERS DURING PROCESS AND MAINTENANCE

DLyte process does not generate dust, heavy noise or contact the workers with toxic compounds. Metals removed from the workpieces remain in the media, so workers are not exposed to the cathode.

12. HANDLING STORAGE OF MEDIA

DLyte only uses solid electrolyte media with a low acid concentration, which can be handled and stored without additional safety measures. It is not harmful for workers and, since it is solid waste, its handling reduces the probability of discharge in drains and waterways.

> *How to know when the electrolyte needs to be replaced?*

DLyte Technology incorporates a software that calculates the electrical charge accumulated during the polishing cycles, a parameter that is directly proportional to the mass extracted during the cycle. The system enables the operator to adapt the parameters during the lifespan of the media to compensate the age of the electrolyte and to guarantee repeatability and performance. Once the media arrives at the end of its lifespan, the machine indicates that the consumable needs to be replaced by a new one.

> *How does the DryLyte Technology work?*

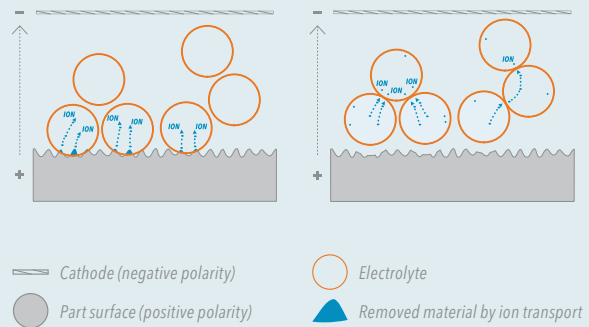
The technology combines the mechanical surface finishing and liquid electropolishing processes, being able to reduce the surface roughness without impacting on the original geometry as the removal is based on ion transport instead of abrasion of the surface.

The equipment uses electricity with specific electrical parameters and moves the parts fixed by fixtures inside a tank full of media. Every time an electrolyte particle impacts the metal surface, there is an ion transport that removes irregularities from the peaks of the surface.



DRYLYTE TECHNOLOGY PROCESS

DryLyte is a patented technology for grinding and polishing metals by ion transport using free solid bodies. DryLyte Technology works by combining the electrical flow created by the high-precision rectifier with the movement of the pieces through the electropolishing media. This results in an ion exchange, **removing material only from the peaks of roughness. The process does not round edges** and can access internal corners that are not easily accessed mechanically.



> *Why trust GPAINNOVA and DLyte?*

A personalized assistance for GPAINNOVA's clients is assured during all the DLyte journey, thanks to our experienced teams that:

- + Advise customers to find the most suitable polishing process
- + Design and customize the best solution for the customer
- + Ensure a proper production performance (achieving target cost, lead time and surface quality results)
- + Train customers to take the most of the DLyte Technology
- + Solve any doubt about the technology and the equipment
- + Promptly assess any maintenance service needed

Thanks to this, we count on:

- + More than 600 satisfied customers worldwide
- + More than 800 machines installed
- + 55 distributors in 5 continents
- + More than 10 years of expertise in surface finishing processes



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Powered by  **Technology**

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