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CII NATIONAL AWARD FOR ENVIRONMENTAL BEST PRACTICES – 2026

Team

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Sustainable Casting Cleaning through Laser Technology

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Project Title –

ECO-FRIENDLY LASER CLEANING OF CASTINGS

Replacing Chemical Cleaning & Shot Blasting with Cleaner, Safer & Resource-Efficient Technology

Trigger points –

- High thinner consumption and **hazardous waste** from conventional cleaning
- Dust generation and **operator exposure** during shot blasting
- High dependency on consumables such as chemicals and blasting media
- Person dependant process affecting cleaning quality
- Time consuming process causing assembly delays & waiting time
- Unsafe process

Objective –

The project aims to eliminate thinner and blasting media usage, It's hazardous waste / dust generation & improve safety at workspace

Project Uniqueness -

One laser technology replacing **two conventional processes** – thinner cleaning & shot blasting

Chemical- and abrasive-free, non-contact cleaning with reduced consumable dependency

Cleaner & safer workplace through reduced hazardous waste, dust and operator exposure

Precision and consistency with improved surface-cleaning quality and process control

Portable unit which can be taken to workplace

Roadmap & Milestones

Sustainable Casting Cleaning through Laser Technology

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1. Process Assessment

- Existing-process study; chemical/shot-blasting consumption, manpower, cycle time, quality, safety & environmental concerns documented

Completion Criteria

Baseline established and key improvement opportunities identified

1

Jun 2023

2. Techno-Commercial Evaluation

- Evaluation of available cleaning technologies; supplier discussions; trials; cost-benefit comparison

Completion Criteria

Technical feasibility and commercial viability established

2

Jul 2023

3. Technology Selection

- Laser-cleaning trial results; technical specifications; comparative evaluation; recommendation

Completion Criteria

Laser cleaning selected based on cleaning quality, productivity, safety, sustainability & economics

3

Jul 2023

4. Management Approval

- Business case; CAPEX proposal; ROI/payback calculation; implementation plan

Completion Criteria

Management approval and financial sanction obtained

4

Mar 2024

5. Procurement & Installation

- Purchase order; machine & accessories; site readiness; installation and commissioning

Completion Criteria

Machine commissioned and acceptance criteria successfully demonstrated

5

Jun 2024

6. Training & Handover

- Operator/maintenance training; SOPs; safety instructions; parameter settings; trial production; handover documentation

Completion Criteria

Central technical team + local implementation team

6

Aug 2024

The project transformed implementation challenges into standardized practices, creating a repeatable model for reliable operation, sustained benefits and future replication.

Brainstorming session

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CFT brainstorming discussion and POAs

Idea generations :Q.C.D.S.M framework, Current process mapping and feasibility study of alternate process

Prerequisite and product process attributes :

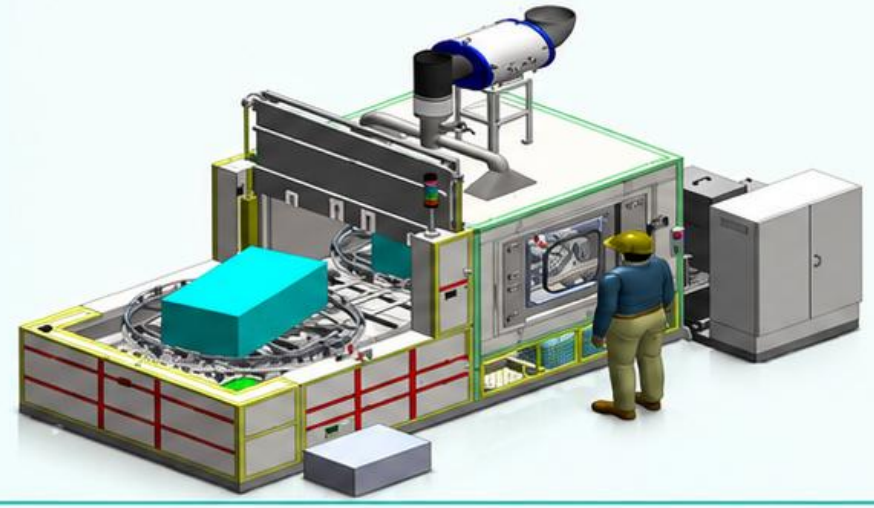
1. Product performance characteristics
2. Suitability for refrigerant of various type various (R134 a, R513 a, R404 ,R410, R1234ze ,R1234yf)
3. Impact on Product performance, piping systems and compressor efficiency
4. Suitability with compressor lubrication oils
5. MOC ,Grade, Hardness, Coolant used during machining
6. Study of MSDS of various chemicals& solvents and its effect
7. Effect on filters, cartridge and internal product part hygiene
8. Impact and results Product and compressor Performance Process validations and field feedbacks



Technology comparison – Trial

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High jet pressure casting cleaning trials with chemicals and solvents



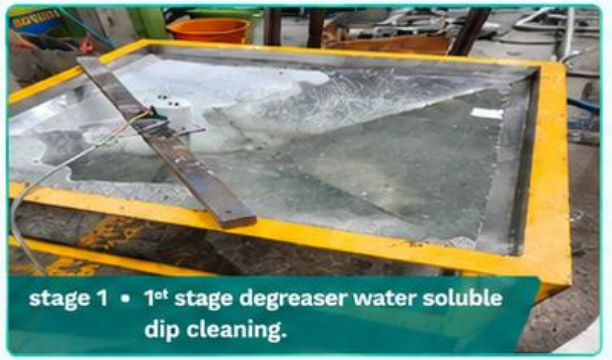
(Casting parts Cleaning Trials : Oct 2021 to Feb 2023)

- SUPERSTRIP CR Alkaline stripping chemicals for rusty surfaces
- Opteon SF80 specialty fluid is designed to meet the high solvency needs in the industrial cleaning
- ARTCLEAN 8313 benzyl-dimethyl-tridecyl- azanium chloride 8001-54-5, Boric Acid H3BO3'Superstrip CR
- Lumipro carbon cleaning chemicals









stage 1 ▪ 1st stage degreaser water soluble dip cleaning.



stage 2 ▪ High pressure jet cleaning



Results :

Casting cleaning Trial parts not satisfactory

Technology Comparison Trials

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Ultrasonic cleaning trials





Results:
Casting cleaning trails not satisfactory due to
Potential damages to machined delicate surfaces
and limitation to intricate shapes

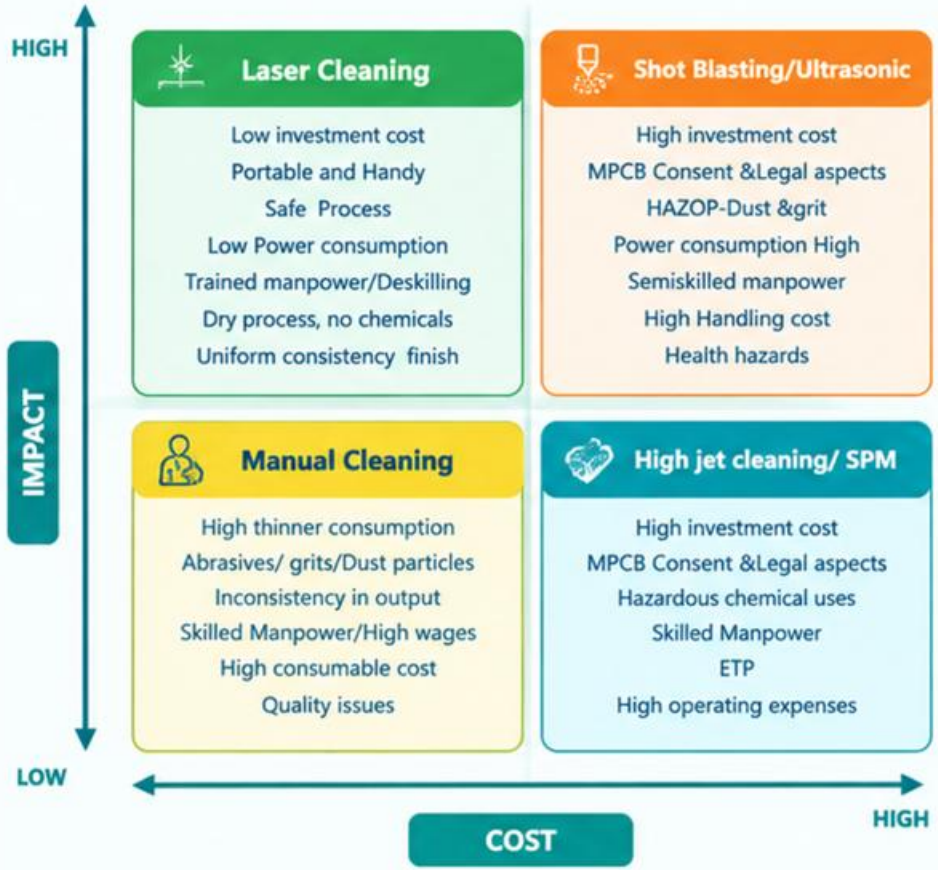
Laser cleaning trials



Results:
Satisfactory. No any residue after
cleaning process.
Process time drastically reduced

Technology Comparison and Process Finalization

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Comparison of various technologies

Description	Ultrasonic Cleaning	Shot Blasting	Laser Cleaning
Description	Uses high-frequency sound waves in a liquid bath to create cavitation (the formation and collapse of microscopic bubbles). These bubbles generate intense local agitation that dislodges contaminants from surfaces immersed in the liquid	This method uses a high-pressure stream of abrasive material (like metallic shots) to impact the surface and remove contaminants through mechanical abrasion	A high-power laser emits a beam of light at a specific wavelength to remove / evaporate contaminants from surfaces to be cleaned
Costing	3 stage - 6535000, Single stage - 1373000	3781000	1130000
Space requirement	1.8 x 1.9 x1.5 mtr tank size - single stage	7.5 x 3.5 x 4.0 mtr - Chamber size	1.0 x 1.0 x 1.2 mtr
Power consumption	9.0 KW per hour	17.9 KW per hour	1.5 KW per hour
MPCB consent	Consent might change to RED	Consent shall change to RED	No change in current ORANGE consent
Advantages	Internal cavities of the casting components shall get clean properly	Fabricated components can be cleaned properly	Movable, can be taken at any location
	By using Eco friendly chemicals, we can avoid hazard due to chemicals		Apart from casting can be used for flanges, fittings, fabricated components
			No any additional consumable required
			Easy operation
Disadvantages	Fabricated components cannot be cleaned	Machined castings cannot be cleaned	Un-accessible areas can not be cleaned
	Dedicated space required, all the components shall be required to move to cleaning area	Dedicated space required, all the components shall be required to move to cleaning area	Hazard due to laser beam - Need to take proper care. Skilled operator required
	If we go with single stage system; need additional pre cleaning system	Additional equipment's such as duct collector required	
	Handling of chemicals	Handling of shots	

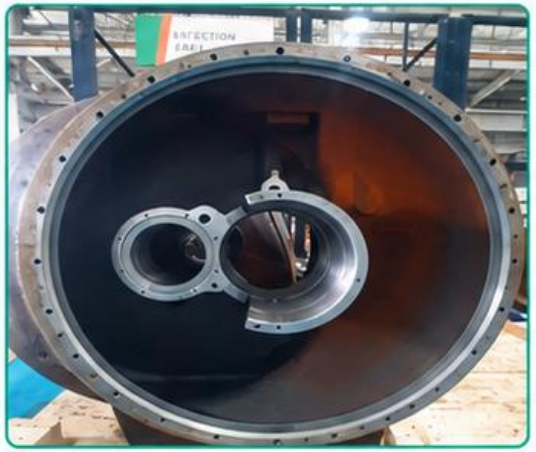
Process Implementation

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Operator Training



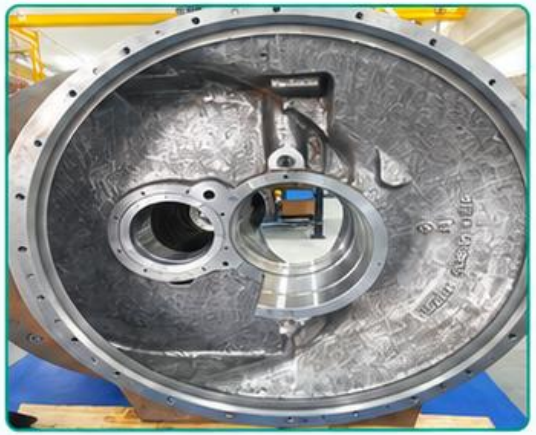
Component before cleaning

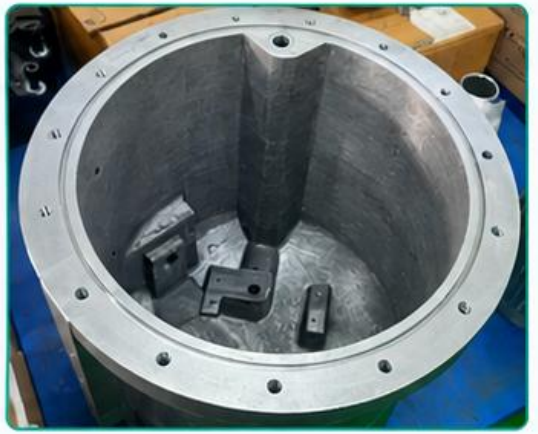


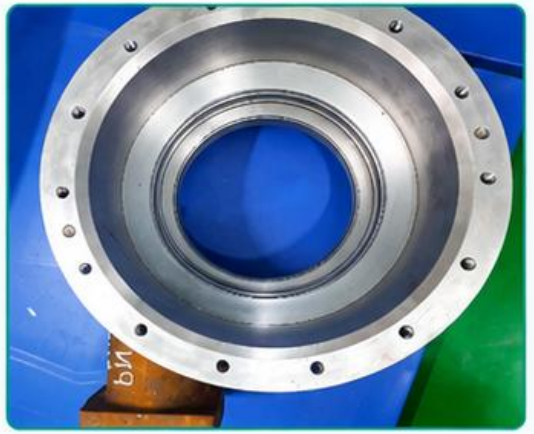




Component after Laser cleaning







Visual Displays

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LASER MACHINE DO's AND DON'Ts

DO's	DON'Ts
Use safety goggles and mask while operating laser machine.	Do not expose skin towards laser beam.
Keep gas cylinder away from machines to avoid hazards.	Do not keep gas cylinders nearby laser machine.
Keep flammable, combustible & reflective materials away from laser machine.	Do not keep flammable, combustible & reflective material nearby laser machine as this may cause explosion.
Please keep the safety lock on while laser machine is in operational during process.	Do not keep the safety lock off while machine is in transportation during process.
Regularly check for any leakages in laser machine.	Do not operate lase machine if any damages are found and immediately report to maintenance.
Make sure the operating temperature (10° to 40°) meets the specifications.	Do not operate the machine if the temperature is not met.
Laser gun should be pointed at an inclined angle of 45° towards the job.	Laser gun should not be operated at 90° inclination towards the job.





TRAINED OPERATORS:

1) SWAPNIL TAMBE
2) SAGAR CHAWAN
3) PRATHAMESH RAUT
4) SAMEER CHAWAN
5) RAMANAND KUMAR
6) SANKET DAL

Preconstruction Lean Office Activities

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Purpose By: वेअरहाउस ऑपरेटर्स	Operational Control Procedure	Prepared By: Ramnath Deshmukh

1 Purpose:
उद्देश:
Establish procedure for handling & Usage of Laser Machine inside the premises.
आमटया प्रकिरेसाठी लेझर मशीनचा वापर व हाताकणी करण्यासाठी प्रक्रिया स्थापित करणे.

2 Scope: Applicable to all the areas where Laser Machine is operated.
व्याप्ती: सर्व विभागात लेझर मशीन चालवल्ती जाणाऱ्या सर्व क्षेत्राना लागू.

3 Responsibility:
Shift-in-charge / Site engineer / Safety officer / Vendor Supervisor / Warchman
जबाबदारी: शिफ्ट इन्चार्ज / साईट इंजिनियर / सुरक्षा अधिकारी / विक्रेता पर्यवेक्षक / वॉचमन

4 Instructions:
- Switch On the MCB at the rear side of the machine.
  मशीनच्या मागील बाजुस MCB चालू करा.
- Insert key and turn to switch ON the front HMI screen.
  की टाकुन आणि समोरील HMI स्क्रीन चालू करा.
- Set the parameters as per requirement of the cleaning operation
  स्वच्छता ऑपरेशनसाठी आवश्यकतेनुसार सेट करा.
- Set the alarm setting as per requirement.
  आवश्यकतेनुसार अलार्मना सेट करा.
- Put the laser/cleaning head (black and angle of 45 degrees towards the job to be cleaned.
- Start the [illegible] लेझर क्लिनर साफसफाई झोनचा 45 डिग्रीचा अँगलमध्ये ठेवावा.
  Start the cleaning with a constant light (inner and to and fro motion).
- After cleaning is done switch off the laser machine.
  सफाईनंतर लेझर क्लिनरचा वापर थांबवावा the laser mochine.
- Load the screen to avoid unwanted touch. If strict cleaning is to be concerned, I'll for cleaning process is completed then after turning on the laser safety button, switch off the HMI screen with light key. [illegible]
- [illegible] HMI screen चालू ठेवावा जेणेकरून अनावश्यक स्पर्श टाळता येईल. काटेकोर सफाईच्या दृष्टीने, साफसफाई प्रक्रिया पूर्ण झाल्यानंतर लेझर सेफ्टी बटण चालू केल्यानंतर, HMI स्क्रीन लाईट की वापरून बंद करावी.
- Turn off the MCB.
  MCB बंद करा.
- Close the cap on the laser gun and place properly on the side of the machine.
  लेझर क्लिनरचे कॅप बंद करून ते मशीनच्या बाजूला व्यवस्थित ठेवावे.

kirloskar Chillers	Laser Machine Operation लेझर मशीन ऑपरेशन	Document No. : P-109 Revision No: : 01 Date: : 18.08.2024 Page No: 1 of 1
Purpose By: वेअरहाउस ऑपरेटर्स	Operational Control Procedure	Prepared By: Ramnath Deshmukh

5 Personal Protective Equipment:
वैयक्तिक सुरक्षा उपकरण:
- Safety shoes, Hand Mask, Ear plug, Helmet, Handgloves,
  सुरक्षा बूट, हँड मास्क, इअर प्लग, हेल्मेट, हातमोजे, इत्यादि.

6 Impact in case of deviation:
विचलन झाल्यास होणारे परिणाम:
- Material damage, M/C, Pollution.
  साहित्य हानी, मशीन, प्रदूषण.
- Minor / Major accident.
  लहान / मोठा अपघात.
- Personal risk of accident.
  व्यक्तिगत अपघाताचा धोका.

7 Corrective Action:
सुधारात्मक कृती:
- Training & Re-training to be provided for Forklift Safety to the operators.
  फोर्कलिफ्ट सुरक्षा साठी ऑपरेटरसाठी प्रशिक्षण आणि पुनर्प्रशिक्षण पुरवले.
- Daily Shift Inspection Checklists for Mobile Equipment.
  मोबाईल उपकरणांसाठी दैनंदिन तपासणी यादी.
- Preventive maintenance Schedule for mobile equipment
  मोबाईल उपकरणांसाठी प्रतिबंधात्मक देखभाल वेळापत्रक.

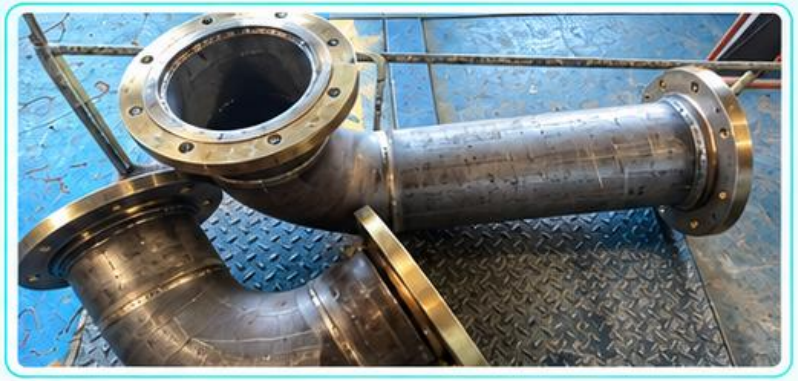
8 Cross Reference:
संदर्भ क्रॉस-रेफरेन्स:
- Preventive Maintenance Record.
  सोबत शिप लेबलांत तर वरोवरदर वाचावे.
- Emission check certificates & Noise monitoring records.
  सबार्डिन तपासणी संबंधानसरे अवलंबन रशिनिंग रिसीव्हण यादी.
- Driver License copy.
  मशीन सोबत संतरे बासते.
- Statutory compliance reports.
  होयोसम्स अपलोड्स न अनुपलब्धी.

Implementation – Scaling Up

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Laser cleaning used for fittings, flanges, system piping





Laser cleaning used in place of shot blasting
Critical requirements - Holiday & Pull-off test complied after painting
Eliminated transportation of chiller (Weight – 30 Ton) for blasting

Process

Tangible benefits

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KEY IMPACT	MEASURED / CALCULATED BENEFIT
Annual Cost Saving	₹11.05 Lakh / Year
Payback	15 Months
Process Simplification	2 Processes replaced with 1 Technology
Chemical Dependency	Nil
Shot-Blasting Dependency	Nil
Manpower	3-person cleaning activity optimized to 1 person
Waste & Environment	Zero chemical waste & blasting dust
Safety	Eliminated exposure to chemical, dust & abrasive

Back Up calculations

Conventional Process – ₹13.05 L/year

Laser Operating Cost
₹4.14 L/year

NET ANNUAL SAVING
₹13.05 L – ₹4.14 L = ₹8.91 L/year

Laser CAPEX: ₹11.30 L

Payback: ₹11.30 L ÷ ₹8.91 L = **1.27 years ≈ 15 months**

To Summarise -

- **₹8.91 Lakh/Year Savings –** Delivers a measurable and sustainable reduction in cleaning costs.
- **~15-Month Payback –** Rapid recovery of the ₹11.30 Lakh laser investment, creating a strong business case.
- **2 Processes → 1 Technology –** Replaces chemical cleaning and shot blasting with a cleaner, safer and resource-efficient laser process.

Intangible benefits

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PEOPLE

- **Improved Safety –** Reduced chemical, dust & abrasive exposure
- **Higher Morale –** Safer, modern work environment
- **Skill Development –** Builds laser technology expertise

ENVIRONMENT

- **Cleaner Workplace –** Less dust and hazardous waste
- **Reduced Chemical Use –** Lower environmentat impact
- **Sustainable Manufacturing –** Cleaner production practices
- **GHG Emission Reduction –** Reduced carbon footprint through lower chemical consumption

PROCESS

- **Process Consistency –** Controlled & repeatable cleaning
- **Lower Consumable Dependency –** Reduced reliance on chemicals & media
- **Automation Readiness –** Platform for future automation

STRATEGIC VALUE

- **Technology Leadership –** Adoption of advanced laser technology
- **ESG Contribution –** Supports sustainable manufacturing
- **Customer Confidenes –** Demonstrates controlled, cleaner processes
- **Replication Potential –** Scalable across processes & plants
- **Innovation & Reputation –** Demonstrates technology-led improvement

Replication Potential

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- **Standardized Solution:** Replicable laser-cleaning solution adaptable to different manufacturing applications.
- **Component Flexibility:** Suitable for components of varying size, material, geometry and surface condition.
- **Scalable Implementation:** Can be implemented as a standalone, semi-automated or fully automated system.
- **Minimal Process Changes:** Can be integrated into existing manufacturing processes with minimal modification.
- **Parameter Standardization:** Cleaning parameters and process settings can be documented and standardized for repeat applications.
- **Cross-Plant Replication:** Proven parameters and practices can be transferred to similar processes across plants and companies.
- **Wide Application Scope:** Potential for replication across castings, MS flanges & fittings, heat exchangers and other suitable components.
- **Scalable Business Model:** Once validated, the solution can be rapidly replicated across multiple manufacturing locations



Laser cleaning demonstrated to Kirloskar group company employees as well as supplier representatives



Alignment with National & International Standards

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Laser Cleaning: From Conventional Cleaning → Cleaner, Safer & Resource-Efficient Manufacturing

4M BENCHMARK	PROJECT IMPROVEMENT	RESULTING BENCHMARK	STANDARDS / PRINCIPLES SUPPORTED
MAN	Training, safer handling & reduced exposure	**Safer workplace & improved capability**	**ISO 45001 • ESG – Social**
METHOD	Chemical/shot blasting → standardized laser cleaning	**Cleaner & repeatable process**	**ISO 14001 • Sustainable Manufacturing**
TECHNOLOGY	Conventional → **1500 W laser cleaning**	**Cleaner, resource-efficient & automation-ready technology**	**ESG – Environment • Sustainable Manufacturing**
MEASUREMENT	Monitor cost, quality, cycle time, consumables & safety	**Data-driven process control & continual improvement**	**ISO 14001 / ISO 45001 principles**

"The project demonstrates how technology-led process innovation can simultaneously advance environmental performance, occupational safety, resource efficiency and sustainable manufacturing."

Post implementation Plan

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Priority	Timeline	Key Action	Resource Management	Success Measure & status
1 **Stabilize & Standardize**	0–3 months	Freeze laser parameters, SOPs, quality criteria and safety standards	1 Production + 1 Quality + 1 Maintenance owner; operator training	Stable quality
2 **Maximize Utilization**	3–6 months	Increase machine utilization and optimize cleaning sequence/parameters	Dedicated trained operator; Maintenance PM support	**>90% availability,** No breakdown
3 **Lock-in Financial & Sustainability Gains**	3–6 months	Track chemical, abrasive, manpower, energy, waste and dust reduction	Production + Finance/IE + EHS	**@ 8.9 lakh/year saving validated**
4 **Fast-Track Application Expansion**	6–12 months	Identify and trial additional castings, flanges, fittings and heat-exchanger components	Cross-functional trial team; use existing machine before new CAPEX	Utilised for system piping, forged components, heat exchanger shall cleaning
5 **Automation & Manpower Optimization**	12–18 months	Evaluate fixtures, semi-automation and robotic integration for repetitive jobs	Engineering + Automation + Production	Automation not yet implemented
6 **Replication & Scale-up**	18–24 months	Replicate proven applications across lines/plants and develop standard implementation package	Central technical team + local implementation team	Checking feasibility for further scaling up

Challenges during implementation & counter measures

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Challenge	Countermeasure	Measurable Outcome / Benefit
Input power fluctuations	UPS installed for the laser system	Improved equipment **reliability & uptime protection**
Fumes during operation	3M respiratory mask for operator introduced. Fume extractor with filtration installed	Improved operator safety & workplace air quality
Torch damage due to improper handling	Spare torch head procured and kept with Maintenance	Reduced downtime & faster recovery response
Torch design change affecting consumables	Protective & focus window glasses stocked for **both torch designs**	Improved consumable availability & reduced waiting time

Reliability → Reduced disruption risk & improved uptime **Safety** → Controlled fumes & safer operating environment
Response → Spare torch enables faster restoration after failure **Availability** → Critical consumables available for both torch designs

Implementation challenges were converted into preventive controls, improving equipment reliability, operator safety, maintenance response and operational continuity.

Key learnings from project implementation

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Area	Key Learning
Application Feasibility	Laser cleaning deployed for various other areas & components
Process Standardization	Defined **laser parameters**, SOPs and handling practices are essential for **consistent cleaning quality. HIRA** updated
People & Safety	Operator training, correct handling and safety controls are critical for **safe and reliable operation.**
Equipment Reliability	Power quality, preventive maintenance and **critical spares availability** directly influence machine uptime.
Consumable Management	Changes in equipment design can affect consumables; maintaining **compatible critical spares** avoids operational interruption.
Data-Driven Improvement	Tracking cost, cycle time, quality, utilization, consumables and downtime is essential to **validate benefits and identify further improvements.**

The project transformed implementation challenges into standardized practices, creating a repeatable model for reliable operation, sustained benefits and future replication.

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THANK YOU!

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