Booklet

WASTE MINIMIZATION GUIDANCE MANUAL FOR BRASSWARE CLUSTER

A MANUAL DEVELOPED BY

THE ENERGY AND RESOURCES INSTITUTE

EARTH SCIENCE AND CLIMATE CHANGE DIVISION

The Energy and Resources Institute

...towards global sustainable development

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1 Waste Minimization

Waste Minimization, as currently defined by USEPA, is the reduction in the amount of toxicity or waste produced by a facility. There are several reasons why Waste Minimization is becoming a focus of environmental managers:

- Businesses are facing stricter regulatory requirements in the management, transportation, and disposal of hazardous waste
- Small generators generally do not have technology or finances to deal with their own waste generation
- The number of hazardous waste disposal facilities has decreased
- There are greater restrictions in the use of landfills
- Transportation and disposal costs are rising
- The long-term liability associated with handling and disposal of hazardous waste is substantial

2 About the Manual

This manual, focusing on waste minimization strategies, is aimed primarily at process engineers, shop floor workers, and managers of small businesses in the brassware cluster sector in India. Although the focus of the manual may be on the process and related activities, the methodology is applicable right across the industry. The need of the manual is critical at a time when the creation of waste is coming under close scrutiny not only by regulatory agencies but also by other affected stakeholders. The contents includes various processes involved in the brassware industry, the background for waste minimization, its benefits, the methodology of waste minimization and practical technical techniques to minimize waste. This guidance manual has been developed and designed to help your facility prepare a waste reduction/ waste minimization plan.

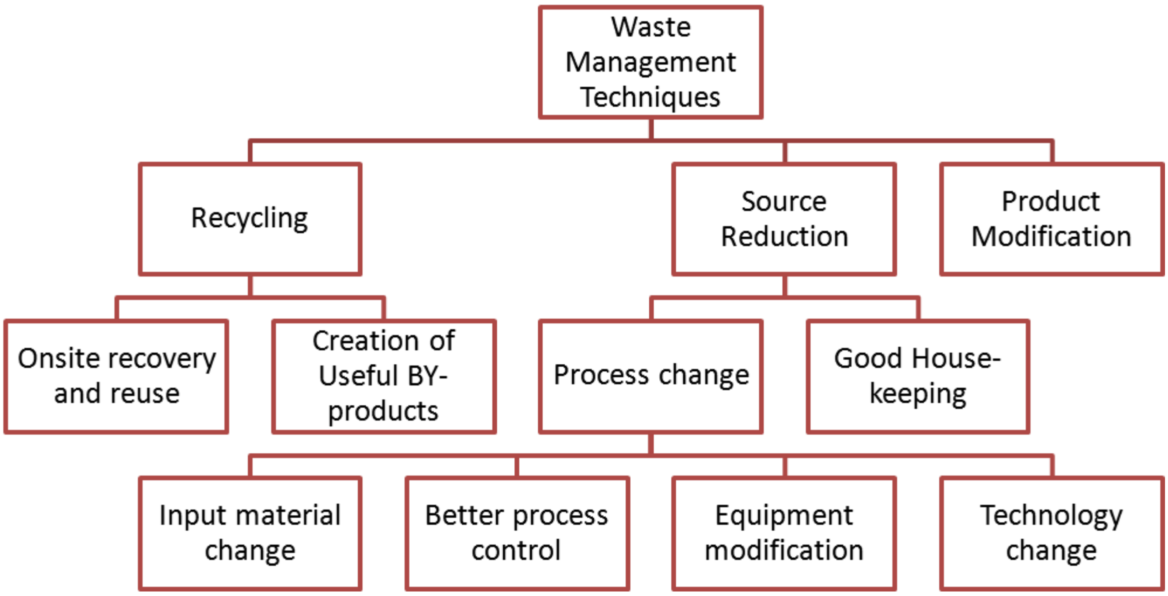
Since individual facility circumstances and needs vary widely, users of this manual are encouraged to modify the procedures to meet their unique requirements. The manual is intended to serve as a point of reference, not as a set of rigid requirements.

3 Background

Brassware manufacturing is a material intensive process that also generates a lot of waste in its various stages – casting, welding, grinding and emery, scraping, polishing and electroplating. These waste streams arise as solid (in the form of metal dusts) as well as liquid electroplating spent bath effluents, washes etc. Apart from these, there are emissions arising from various stages such as VOCs (use of resins, molasses and oils at various stages), metal dust and pollutant gases (use of coal in casting).

To control and mitigate the waste that is generated by the industry, waste minimization strategies can be implemented. These strategies are three fold in nature – recycle (onsite recovery and re-use and creating useful by products), reduce at source (changing the process and having good housekeeping practices), and modify the product to eliminate the responsible constituents.

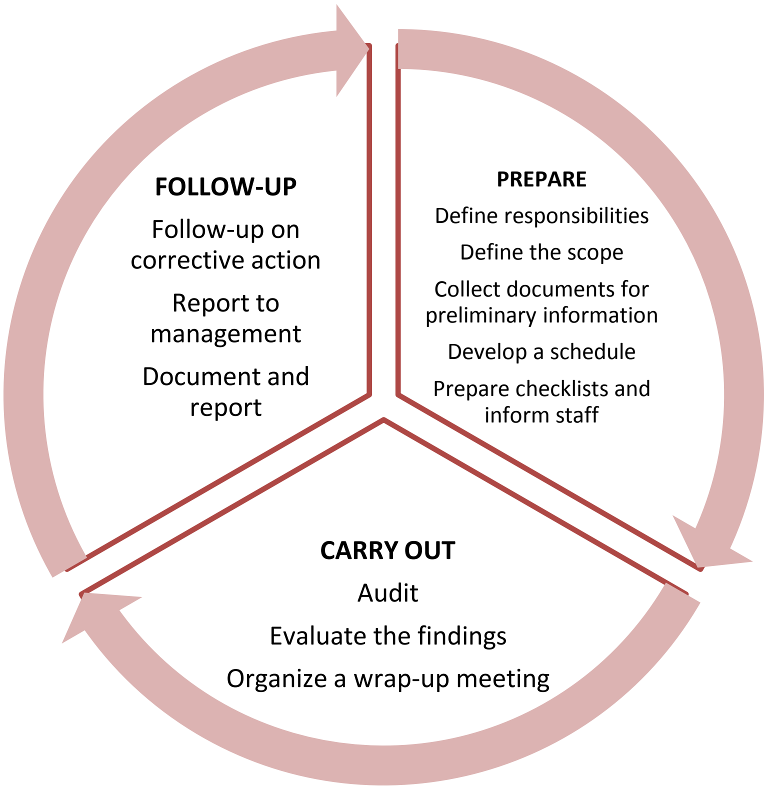
4 Waste management techniques



5 Steps for waste minimization

- Conduct process audit
- Identify opportunities for waste reduction, recycling

Cleaner Production Audit



6 Waste minimization in different operations involved in brassware manufacture at Moradabad

6.1` Waste minimization in casting

Reduce at Source

Alter Raw Materials- Charge material, containing lower concentrations of lead, zinc and cadmium should be acquired.

Install Induction Furnaces as they offer advantages over electric arc and cupola furnaces. They emit 75% less dust and fumes and with relatively clean scrap material, the need for emission control equipment may be minimized

Recycle

If the **zinc and lead levels** of metal dust are relatively low (most economical recovery options require the zinc content of the dust to be at least 15-20 %) consider **returning the dust to the furnace for recovery of base metals** (iron, chromium or nickel).

Waste can be **reused outside the original process** by reclaiming the zinc, lead and cadmium, concentrated in emission control residuals.

Silica-based **bag-house dust** from sand systems and cupola furnaces **may be used as raw material by cement** manufacturing industries.

6.2 Waste Minimization in Spent Casting Sand

Segregate

Re-plumb dust collector ducting on the casting metal gate cut-off saws to collect metal chips that can be recycled.

Install bag-house on sand system to separate the sand system dust from the furnace dust.

Install new screening system on main moulding sand system surge hopper to continuously clean metal from sand system.

Install magnetic separation system on the shot-blast system to allow the metal dust to be recycled.

Detoxify sand that remains unusable

Recycle

Screen and Separate Metal from sand

Reclaim Metal and Sand with the help of the chemical process

Reclaim Sand with the help of thermal recovery systems.

- Thermal Calcining/Thermal Dry Scrubbing
- Rotary Drum
- Multiple-Hearth Vertical Shaft Furnace

Use selected foundry wastes for both final cover and as a topsoil substitute for foundry landfills. Also, foundry sands and other wastes can be used for construction fill.

Apply

Bituminous concrete, commonly called asphalt, is a potential reuse market for foundry wastes.

Most portions of foundry sands can be used as substitute to raw materials used in the manufacture of Portland Cements.

Spent sand can provide silica, green sand fines would provide alumina, and slag would provide quicklime and silica.

6.3 Waste Minimization in Electroplating

WASTEWATER

- Introducte rinse water recirculation with automatic benefit of chemical recovery and reuse
- Recover static rinse water
- Avoid and control spillage
- Use troughs between tanks and use well defined linear configuration in place of barrels and avoid haphazard rinsing and washing
- Introduce cascade and/or counter-current rinsing
- Use fogging and spraying on objects (rack plating)
- Introduce metal recovery by electrolytic method (ion exchange and its advanced application

GASEOUS EMISSIONS

- USe collecting hoods and scrubbers
- Completely cover baths. Also, use top suction hoods with properly designed scrubber system
- For VOCs, avoid those compounds associated with high environmental concerns. If the re areno options, keep the tanks fully covered at all times and use vapor arresting devices

SOLID WASTE

- Use non-hazardous chemicals to minimize hazard in solid waste from process chemicals.
- Use Cyanide free process (e.g. Alkaline Cyanide Free Zinc plating)
- Use trivalent Chromium in place of hexavalent Chromium

7 Best Available Technology (BAT) Options

Best Available Technique (BAT) means the most effective and advanced stage in the development of activities and their methods of operation, which indicate the practical suitability of particular techniques for providing in principle the basis for minimum emission values designed to prevent and, where it is not practicable, generally to reduce emissions and the impact on the environment as a whole.

Table 1: Specific CP (Cleaner Production) approach in Pre-Treatment:

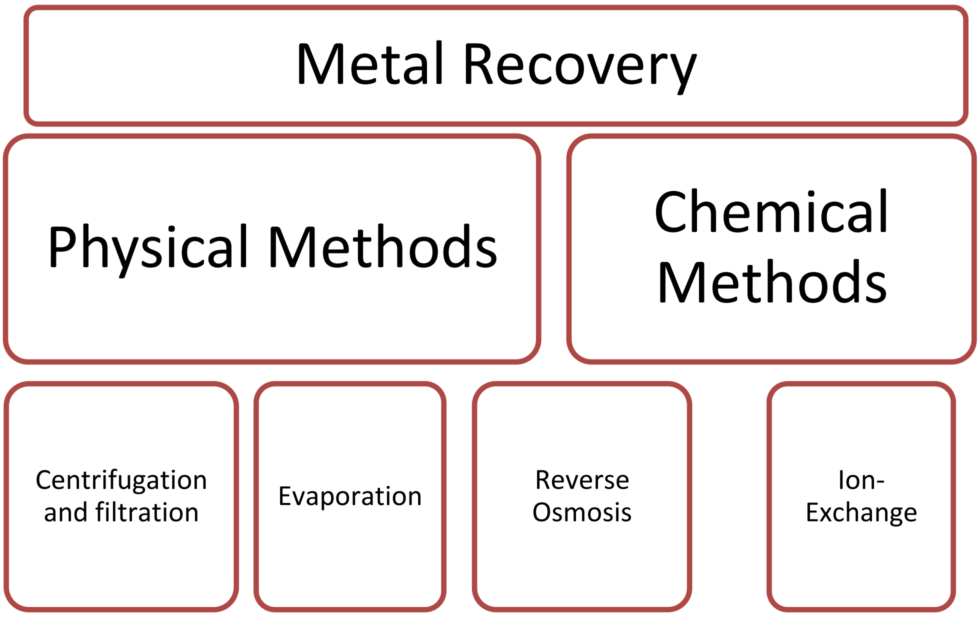
Application of Pre-treatment	Method	Benefit
Pre-cleaning of small size work-pieces	Use centrifuge to remove all dirt prior to de-greasing or Impose cleanliness requirement onto the customer (medium tech)	• Reduces lengthy pre-treatment • Reduces electricity consumption in surface preparation
Removal of accumulated oil and grease	Use centrifuge (medium tech)	• Reduces infiltration of impurities (undesirable salts and organics including oil and grease) in degreaser tank • Prolongs life span of degreaser bath
Ultra-filtration of alkaline degreaser bath for inlet water	Self-explanatory (high tech)	As above
Ultrasonic degreasing	Self-explanatory (high tech)	As above

Table 2: Specific CP approach in Plating

Application in Plating	Method	Benefit
Water flow and conductivity meter	• Introduce on-line flow meter in intake water pipe • Introduce on-line conductivity meter in process tank	Water saving from correct adjustment of • Water flow into last rinse tank • Plating chemical replenishment
Reverse osmosis (RO) on last Rinse water for inlet water	RO is not recommended for use in systems where • pH is 12-14 or pH is 0-2 • Organics in influent water > 5 g/ l	Reduces infiltration of impurities (undesirable salts and organics) into rinsing tanks
Zinc plating	Place evaporator next to the plating bath. The inlet pipe and back-filling pipe is installed in the process tank	Reduces consumption of zinc
Nickel, chrome, copper and tin plating	Recover heavy metals from used rinsing water for reuse in plating baths by means of electrolysis cell or ion exchanger (and evaporation unit if required)	Savings of raw materials Reduces amount of sludge Reduces concentrations of heavy metals in wastewater Recovers heavy metals for re-use or secondary raw materials to be sold off

8 Clean Production Audit

Recovery of metals



9 Energy saving and use of energy efficient techniques in casting and electroplating

9.1 Energy saving in metal casting/ reheating

Table 3: Energy and Material Losses in Different Kinds of Furnaces

Melting Furnace	Common use	Melt Loss (%)	Thermal Efficiency (%)
Cupola	Iron	2-12	40-50
Electric Arc	Steel	5-8	35-45
Electric Reverberatory	Aluminum	1-2	59-76
	Zinc	2-3	59-76
Gas Crucible	Aluminum	4-6	7-19
	Magnesium	4-6	7-19
Gas Reverberatory	Aluminum	3-5	30-45
	Zinc	4-7	32-40
Gas stack Melter	Aluminum	1-2	40-45
Induction	Aluminum	0.75-1.25	59-76
	Copper Base	2-3	50-70
	Magnesium	2-3	59-76
	Iron	1-2	50-70
	Steel	2-3	50-70

Metal casting and reheating processes can be made more efficient by:

- Minimizing the temperature of exhaust gases from the furnace by increasing the length of the preheating zone of the furnace.
- Reducing the charging time to ensure maximum capacity utilization and faster mass flow rate.
- Reducing the holding time to ensure minimum fuel/ electricity consumption while holding (non-productive operation). This will also improve the life of the refractory lining in induction furnaces.
- Planning and scheduling the furnace operation, specially for batch melting furnaces, such that the number of cold starts is minimized. Each cold start consumes 10 – 20% more energy than regular furnace running and also reduces the life of the refractory.
- Optimizing excess air in the furnace.

Table 4: Recommended Excess Air for Different Fuels

Fuel	Type of Furnace/Burners	Excess air (% by weight)
Pulverized coal	Completely water-cooled furnace for slag tap or dry ash removal	15-20
	Partially water-cooled for dry ash removal	15-40
Coal	Spreader stoker	30-60
	Water-cooler vibrating-grate stokers	30-60
	Chain-grate and travelling grate stokers	15-50
Fuel oil	Oil burners	15-20
	Multi-fuel burners and flat flame	20-30
Natural gas	High pressure burner	5-7
Wood	Dutch over (10-23% through grates) and Hofft type	20-25%

- Fuel should be stored according to the guidelines or that particular fuel. For liquid and gaseous fuels, leakages in storage and supply lines are wasteful and can be dangerous. The supply lines and the storage should be checked for leakages/ blockages once in a week.
- Never allow the burner flame to directly touch the material or the refractory. Direct touching will increase scale losses, reduce the refractory lining's life and cause inefficient heating. Also, flames from different burners should not touch each other inside the heating chamber of the furnace.
- Use digital temperature indicators and automatic controllers in place of human monitoring. This will reduce the chances of the material overheating and also prevent energy/ material loss.
- Heat loss occurs through furnace openings in the following ways:
    - Direct radiation loss
    - Leakage of hot combustion gases
    - Infiltration of cold air
- Seal any furnace openings caused by normal wear and cover material flow gates with proper curtains.

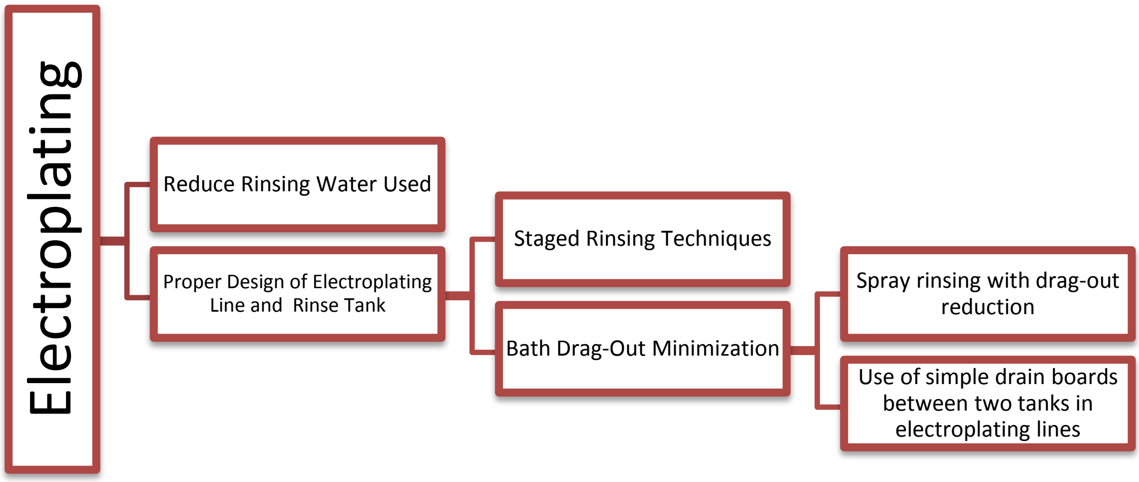
- In heat treatment furnaces, use proper digital temperature indicators so that the furnace gates do not need opening to check the temperature.
- Follow the specified heating treatment cycle for material while using bogey type heat treatment furnaces. Use thermostat based controls to maintain the required temperature.
- Load the material in optimum sizes in batch type furnaces. This will ensure that there is no obstruction to the flow of hot gases, flame path and the exhaust port.
- In crucible furnaces, place the stock near the furnace opening for preheating.

Table 5: Efficient Operation of Furnaces and Combustion Systems

Do's	**Don'ts**
Always maintain proper air-fuel ratio. Use combustion analysers to find air-fuel ratio	Don't estimate furnace temperature
Clean burner nozzles to remove deposits once a month	Don't leave air supply open while fuel supply is closed
Plan production to avoid furnace cold starts	Don't open furnace gates unnecessarily
Use correct/ recommended frequency in induction furnaces for the alloys being melted. This will ensure faster mixing of additives and reduce cycle time	Don't use liquid fuel without proper heating and pumping
Always use calibrated digital meters for reading temperature and pressure. Manual estimation may be incorrect	Don't use adulterated fuel
Seal unnecessary furnace openings and leakages	

9.2 Energy saving in electroplating

In the electroplating process, metallic baths are placed in series and are separated by one or more rinse water tanks between every two metallic bath tanks. Rinse water tanks are to remove the chemicals from the previous metallic bath and prevent mixing of chemicals into the next metallic bath. Therefore, a considerable amount of water is required to be pumped into these rinse tanks to keep the process chemically stable.



10 Socio Economic Benefits of Clean Production Technologies

Cleaner production techniques are considered as an expensive proposition. While initial investment costs may sometimes be a little steep, the payback period on the incorporation of these techniques is extremely attractive. A number of options are worthy of consideration:

1. Pre-treatment options are available that can help reduce both material and energy consumption to a significant degree.
2. Waste minimization practices can help reduce material losses, an important factor of consideration since brass alloys are expensive.
3. Optimized furnace and burner operations for air flow and temperature translate into greater savings on fuel expenditure.
4. Metal recovery processes from the electroplating bath rinses can significantly reduce costs of raw material. Optimizing the operations for bath flows can help reduce energy costs significantly.

Cleaner production techniques also offer several non-economic advantages. Reduced fossil fuel consumption can help to reduce the overall impact of the industry, particularly from the casting operations. Similarly, improved electroplating techniques can reduce the amount of heavy metals discharged in the wastewater streams, thus reducing the load on nearby water bodies.

Occupational health is directly linked to the process activities. Cleaner production techniques are a crucial element in improving the working conditions. Control on exposures to acid fumes in electroplating can be easily achieved by covering the electroplating baths suitably. Similarly, the casting and forging operations can be improved upon to prevent exposures to high temperatures and noxious gases that are continuously released due to improper coverings.

Table 6: Benefit Analysis of Clean Production Techniques

Clean Production Option	Nature of Benefit Offered (Monetary or Non-monetary)	Benefit Offered
Pre-treatment of metal surfaces	Monetary	Reduced material costs Reduced electricity consumption Time optimization of process
Optimized casting operation Reclamation of casting sands Optimization of air flow Hot starts for process	Monetary	Reduced fuel costs Reduced energy consumption
	Non-monetary	Reduced air pollution release Lower occupational exposure to noxious gases
Switching over to induction furnaces Sealing off furnaces	Monetary	Reduced fuel costs Reduced energy consumption
	Non-monetary	Reduced air pollution release Lower occupational exposure to noxious gases
Hooding electroplating baths Electrolytic solution recovery	Monetary	Material cost reduction
	Non-monetary	Reduced occupational acid and heavy metal exposures Reduced waste streams for handling and disposal

11 Acknowledgement

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Moradabad's brassware manufacturing industry has gained international name and recognition for the quality of work and intricacy of pieces produced from it. It is a major industrial cluster in India that contributes about INR 2500 crores annually to India's Gross Domestic Product (GDP) and accounts for about 40% of the total handicraft exports (Sekar, 2007). Typical of the industrial development scenario in India, the brass industry of Moradabad primarily consists of small and medium enterprises (SMEs), all the way down to individual artisans working out of their homes, which is also contrasted by large export oriented units catering to international demand from such big retailers as Walmart.

Pollution from industrial clusters is a major problem in India. Central Pollution Control Board (CPCB) has identified several industrial clusters in its assessment exercise in 2009, and expressed concern for the high levels of untreated waste and wastewater as well as the exposure of toxic waste to the local populace, in particular the factory workers and artisans (CPCB, 2009). However, waste minimization strategies that could be applicable to the local industry received little attention previously. Keeping these things in mind, The Energy and Resources Institute (TERI) proposed to MoEF for examining the waste generated by the brassware industry of Moradabad and

- Identifying areas to minimize waste generation in the brassware industry
- Identifying areas of recovery and recycling
- Broad identification of areas where energy can be saved.

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