CONCEP NOTE:

TECHNOLOGIES AND PROCESSES FOR RECYCLING ALUMINUM SCRAP

Melting aluminum scrap, a fundamental stage in recycling of aluminum scrap, demands efficient furnaces capable of withstanding high temperatures and managing contaminants in recycled metal. Five primary furnace types are available, each with distinct advantages and limitations:

1. Reverberatory Furnace

A large, rectangular furnace where burners heat the roof, reflecting (reverberating) heat onto the metal bath. Scrap is loaded directly into the chamber.

Advantages:

- Batch or continuous operation – Ideal for high-volume scrap processing.
- High flexibility – Accommodates mixed or contaminated scrap.
- Low maintenance – Simple operation with robust construction.

Disadvantages:

- Low thermal efficiency (25–35%) – High power consumption.
- Slow melting process – Longer processing times.
- High emissions & fuel use – Significant environmental footprint.
- Excessive dross formation – Increased oxidized aluminum waste.

2. Rotary Furnace (Tilting Rotary Furnace, TRF)

A rotating cylindrical furnace that mixes molten aluminum with flux, often using salt (salt slag) to minimize oxidation, resulting in environmentally challenging salt sludge byproducts.

Advantages:

- High metal recovery – Efficient for dross reprocessing.
- Versatile scrap handling – Processes fines, coated materials, and high-impurity inputs.
- Compact & tiltable design – Facilitates easy pouring.

Disadvantages:

- Salt flux generates hazardous waste – Salt slag disposal is costly and regulated.
- Environmental impact – High disposal and compliance expenses.
- Complex operation – Requires skilled management.

3. Induction Furnace

An advanced, non-combustion system using electromagnetic induction for heating, offering superior energy efficiency and minimal emissions.

Advantages:

- High efficiency (~50–60%) – Optimized energy use.
- Precise temperature control – Ensures consistent melt quality.
- Clean operation – No direct emissions; low oxidation and dross.
- Industry-leading performance – Considered the "gold standard" for scrap recovery.

Disadvantages:

- Requires clean, sorted scrap – Unsuitable for heavily contaminated inputs.
- Limited batch sizes – Smaller capacity than reverberatory furnaces.
- Higher initial investment – Significant capital cost.
- Material sensitivity – Performance depends on scrap's magnetic properties.

4. Crucible Furnace

A compact, pot-style furnace where aluminum is melted in a crucible, heated by gas or electricity.

Advantages:

- Low upfront cost – Affordable for small-scale operations.
- Easy operation & maintenance – Minimal technical requirements.
- Specialty use – Ideal for small batches or niche applications.

Disadvantages:

- Low efficiency (especially gas-fired) – Energy-intensive.
- Limited scrap compatibility – Only clean, sorted materials.
- Small capacity – Batch-only; unsuitable for industrial-scale production.
- Labor-intensive – Higher manual handling costs.

5. Shaft Furnace

A vertical furnace where scrap is preheated as it descends by gravity, melting in a lower hearth zone.

Advantages:

- High thermal efficiency – Preheating reduces energy waste.
- Continuous operation – Steady production flow.
- Low dross formation – Minimizes metal loss.

Disadvantages:

- Limited scrap versatility – Unsuitable for fine or lightweight materials.
- Consistent input quality required – Demands uniform scrap size and composition.
- Mechanical complexity – Higher maintenance needs.

Comparison Summary

System Type	Efficiency	Scrap Flexibility	Scale	Environmental Impact	Cost
Reverberatory	Low	High	Large	Moderate–High	Medium
Rotary	Medium	Very High	Medium	Very High (salt slag)	High
Induction	**High**	**Low–Medium**	**Small–Medium**	**Low**	**High**
Crucible	Low	Low	Small	Low–Moderate	Low
Shaft	High	Medium	Medium–Large	Low	High

Conclusion

Selecting the right furnace depends on scrap type, production scale, and environmental considerations. While reverberatory and rotary furnaces handle contaminated scrap, induction furnaces offer cleaner, high-efficiency melting. Crucible furnaces suit small operations, while shaft furnaces excel in continuous, high-efficiency processing.

The proposed system: Induction Furnace for Aluminum Scrap

TECHNICAL OVERVIEW: INDUCTION FURNACE

1. Basic Principle

An induction furnace melts aluminum by generating eddy currents within the metal using a high-frequency alternating electromagnetic field. This process relies on resistive heating (Joule effect), ensuring efficient, uniform melting without direct external heat sources.

2. Furnace Types – Coreless Induction Furnace

- Description: A crucible surrounded by a water-cooled copper coil, where magnetic fields induce currents in the metal charge.
- Ideal for: Clean, sorted aluminum scrap and alloying operations.
- Capacity: 100 kg to over 10 tons.
- Frequency: Medium frequency (500 Hz – 10 kHz) for optimal aluminum melting.

3. Key Technical Parameters

Parameter	Specification
Power Input	50 kW – 5 MW
Thermal Efficiency	~55–70%
Temperature Range	700–800°C (aluminum-specific)
Heating Rate	~3–10°C/min (varies with power and scrap)
Recovery Rate	>95% (clean scrap)
Emissions	Negligible (non-combustion process)
Dross Formation	Low (controlled heating, minimal air exposure)
Noise Levels	Low (compared to combustion furnaces)
Cooling System	Soft water-cooled coil & capacitor bank

4. Advantages

- High energy efficiency: Minimal heat loss vs. gas furnaces.
- Precision melting: Ideal for applications requiring strict temperature control and low contamination.
- Low oxidation: Reduces dross formation, improving metal yield.
- Modular & scalable: Easily automated for industrial use.
- Environmentally friendly: No NOx, SOx, or direct CO_2 emissions.

5. Disadvantages

- Scrap requirements: Pre-sorted, non-ferromagnetic materials only.
- High capital cost (CAPEX): More expensive than crucible/reverberatory furnaces.
- Conductivity sensitivity: Charge material must be electrically conductive.
- Maintenance needs: Regular coil and cooling system checks required.

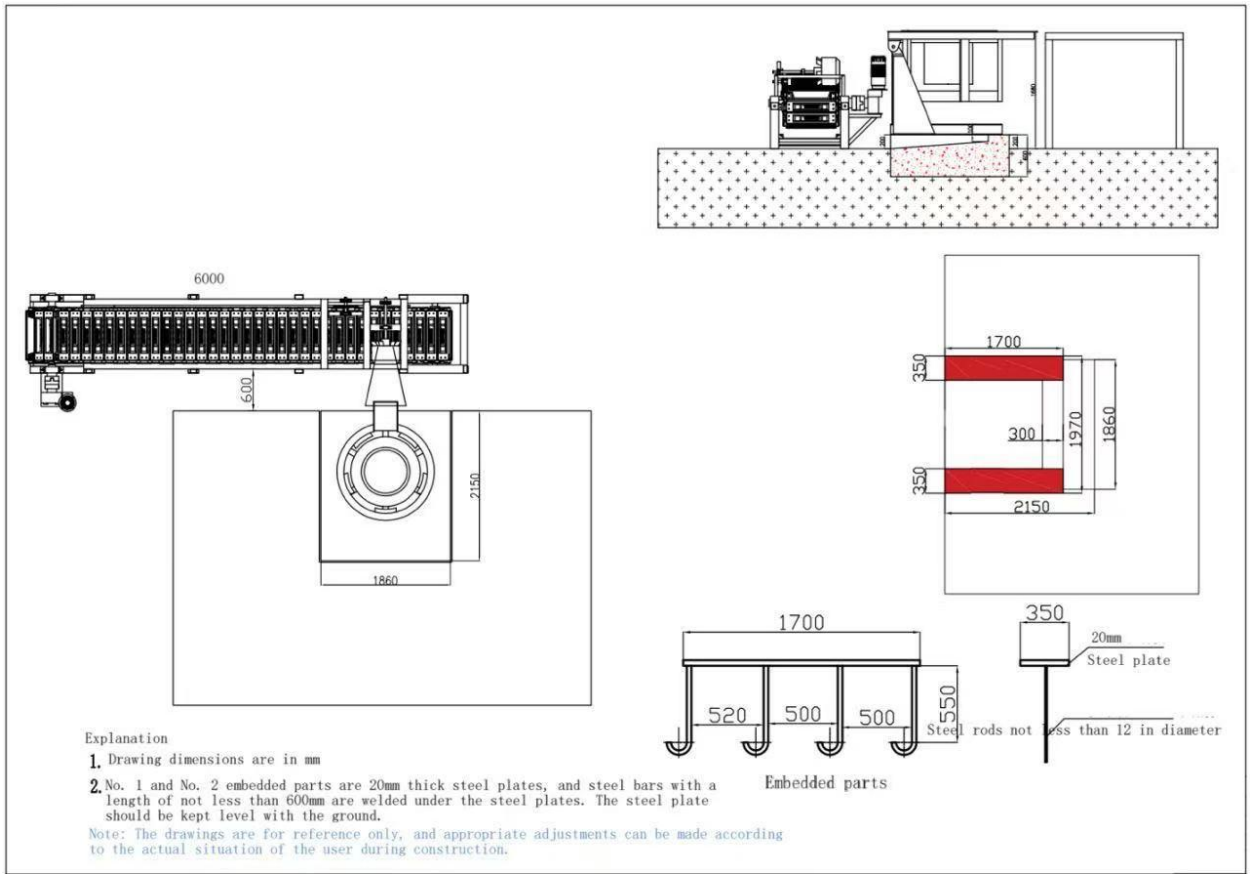
6. Typical Process Flow

- Scrap Preparation: Clean, dry, and sorted scrap (no contaminants).
- Charging: Manual or automated loading into the crucible.
- Melting: Induction heating initiates (current/frequency adjusted).
- Alloying (Optional): Additives (Si, Mg, Cu) introduced for desired specs.
- Temperature Hold: Maintained at 700–750°C for casting/transfer.
- Tapping/Pouring: Molten aluminum transferred to molds/holding furnaces.

7. Example: 500 kg Melting Furnace Specifications

Model	500 kg Melting Furnace
Power	160 kW
Voltage Input	3×380 V, 50 Hz
Frequency	1500 Hz
Control Cabinet Size	850 × 350 × 1800 mm
Crucible Size	Inner diameter: 780 mm, Height: 780 mm

Specific technical information (Example for 500kg/h)



Induction Melting Reactor Specifications – Example 500 kg/h

Melting Furnace - Technical Parameters

Parameter	Specification
Model	500 kg Melting Furnace
Power	160 kW
Voltage Input	3×380 V, 50 Hz
Frequency	1500 Hz
Control Cabinet Size	850 × 350 × 1800 mm
Crucible Size	Inner Diameter: 780 mm, Height: 780 mm
Melting Time	70 min (second furnace)
Power Consumption	350 kWh/T
Insulation Consumption	3.5 kWh/T
Cooling Method	Water cooling + air cooling

2. Closed Soft Water Cooling Tower Specifications

Model	HTGP-15T
Main Circulation Pump	3 kW, 380 V, 50 Hz (2 sets, 1 spare)
Cooling Water Volume	23.5 m³/h
Cooling Tower Type	Closed circuit
Cooling Capacity	75,000 kcal/h
Fan	0.55 kW × 2
Spray Pump	0.75 kW × 1
Inlet/Outlet Pipe	DN 65 mm
Water Filling Port	DN 25 mm
Soft Water Requirement	0.3 m³
Water Tank Capacity	0.25 T
Net Weight	0.64 T
Operating Weight	1.2 T
Dimensions	3320 × 1050 × 2770 mm

3. Aluminum Ingot Caster - Technical Parameters

Item	Specification
Power	2.2 kW
Length	4 m
Speed	Adjustable
Ingot Mold Material	QT-500 (cast iron)
Ingot Weight	10 kg/ingot
Mold Quantity	50 pcs
Cooling Method	Air cooling

4. Briquetting Machine Specifications

Parameter	Specification
Input Voltage	380 V, 50 Hz
Press Block Size	300 × 300 × 300 mm
Material Chamber Size	1200 × 800 × 450 mm
Power	18.5 kW
Hydraulic System Pressure	Max 25 MPa
Motor Speed	960 rpm/min

Frequently Asked Questions (FAQ)

Q: Is your system an induction furnace or gas-heated?
A: It is an **induction furnace**, offering energy efficiency, precise temperature control, and lower emissions compared to gas-fired systems.

Q: What form of aluminum scrap is required for feeding?
A: Shredded scrap can be directly fed, but **briquetted scrap** significantly improves melting efficiency and furnace productivity.

Q: What are the dimensions of the briquettes produced?
A: Standard briquette size: **150 × 150 × 300 mm** (optimized for uniform melting).

Q: How much soft water is required? Does the system require a water softener, or is it supplied with the system?
A: The system requires 0.3m³ of soft water for each filling, with an hourly consumption of approximately 0.08m³. The water softener is an integral part of the system.

Q: What is the waste produced by the process, and how is it removed?
A: The Induction Furnace and other machines do not produce waste.

Q: Is there any gas emission?
A: The process is based on electromagnetic heating, which does not involve emissions. However, we provide a gas capture and treatment unit as an integral component of the system.

Q: What makes your system different from others?
A: Our technology offers a competitive advantage by providing lower prices than alternative systems, including other low-cost systems.

Q: Is your system certified according to international quality standards?
A: Yes, our system complies with EU standards and holds two CE certificates.

Q: What is the cost (CapEx), expected income, and ROI timeline?
A: The cost depends on the system's capacity. For example, for a system with a 500kg/h capacity:

🔧 **Scenario Assumptions:**

- Daily aluminum throughput (10 working hours): 5,000 kg
- Operating days/year: 300
- Scrap: Clean
- Melting temperature: 700-750°C
- Aluminum market price: $2,500/T
- Electricity cost (EU): $0.15/kWh
- Electricity consumption: 180 kWh
- Metal yield (recovery): 97%
- CapEx: $300k (induction)
- Lifespan: 10 years
- Maintenance/year: $5k
- Labor: 2 employees, $15/hour

Profit & Loss Analysis

Operation: 500 kg/h Aluminum Can Recycling | **Shift:** 9 hours/day | **Annual Days:** 300

Category	Unit Value	Price ($/Unit)	Annual Total ($)
Revenue			
Processed Aluminum	1,310 T*	2,500/T	**3,275,000**
Expenses			
Capital Expenditure	-	-	(300,000)

Category	Unit Value	Price ($/Unit)	Annual Total ($)
Electricity	180 kWh/h	0.15/kWh	(72,900)
Labor (2 workers)	2 workers	15/hour	(81,000)
Maintenance	-	-	(5,000)
Total Expenses			**(258,900)**
Annual Profit			**3,016,100**

Notes:

- **Metal Yield:** 97% (1,310 T/year from 1,350 T raw input).
- **Electricity:** Based on 180 kWh/hour × 9h/day × 300 days/year.
- **Labor:** 2 workers × $15/h × 9h/day × 300 days/year.

Have more questions? You're welcome to apply to us:

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