

# LATEST DEVELOPMENTS IN RECYCLING PRODUCTION RESIDUES EMPLOYING CORELESS INDUCTION FURNACES

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# OTTO JUNKER

## Technical characteristics

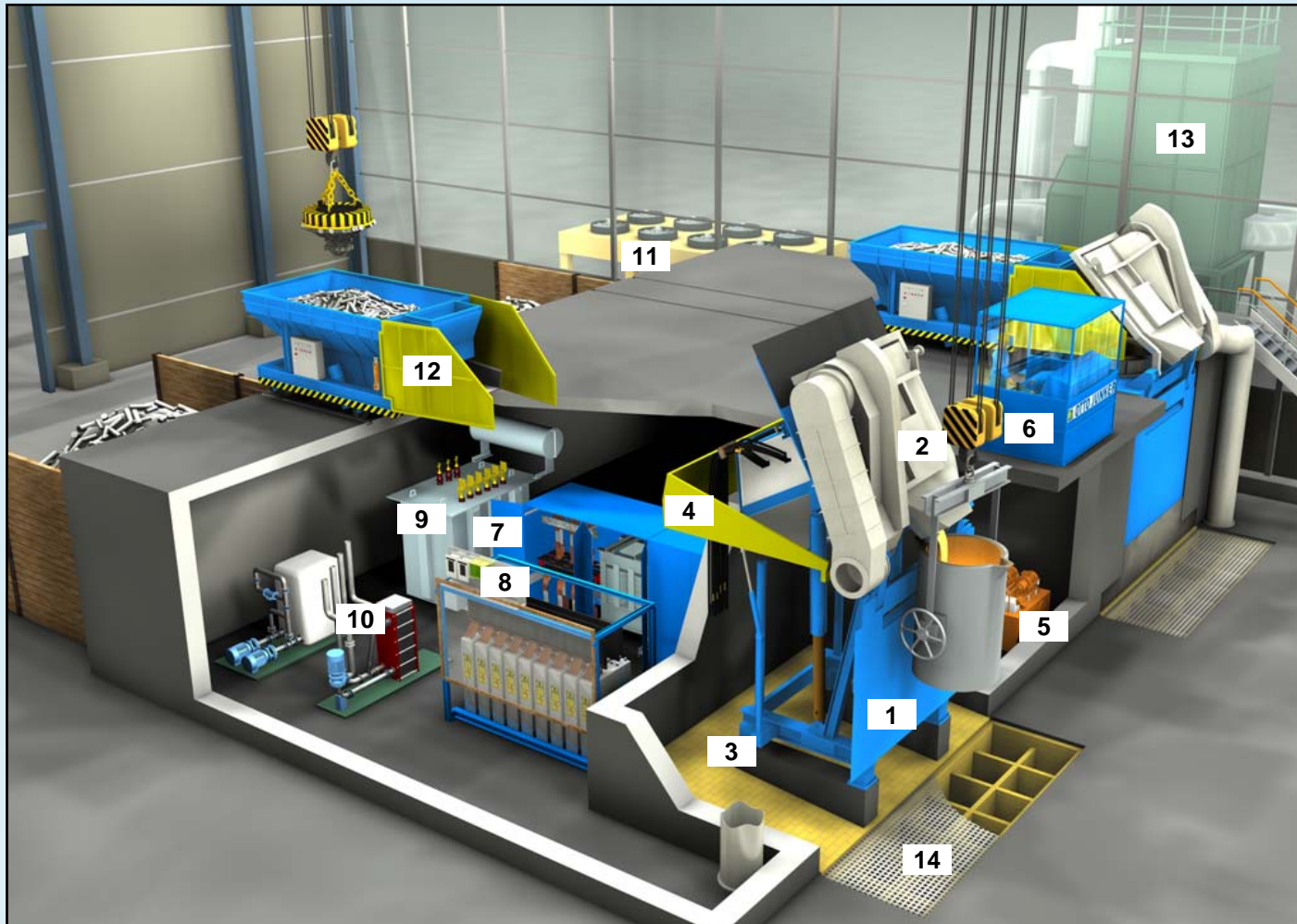
- ▶ High melting rate
- ▶ Flexible no-heel melting operation
- ▶ Easy change of alloy
- ▶ Short starting times, rapid heat sequence
- ▶ Precise temperature regime
- ▶ Low melting losses
- ▶ Adaptable to specific metallurgical requirements

## Economical characteristics

- ▶ High energy consumption efficiency
- ▶ Compact design reduces foundation costs
- ▶ Minimized erection times
- ▶ High power densities and automatic melting operation cut the labour cost



# MEDIUM-FREQUENCY INDUCTION FURNACE PLANT



- 1 Furnace
- 2 Exhaust Hood
- 3 Weighing system
- 4 Pit guard
- 5 Hydraulic power pack
- 6 Control stand with operator desk
- 7 Frequency converter (DUOMELT)
- 8 Capacitor rack
- 9 Transformer
- 10 Water recooling system
- 11 Air cooler
- 12 Charging machine
- 13 Dust collection system
- 14 Emergency collecting pit



## Converter uses advantages of the parallel oscillating circuit converter

- ▶ High efficiency
- ▶ Good reliability
- ▶ Easy maintenance
- ▶ Multi-frequency and Power Focus possible

## Inverter is equipped with IGBT modules

- ▶ Self-protection of modules
- ▶ Constant power factor of 1 at the converter entry
- ▶ Low requirement to cooling water quality

**Thyristor type available up to 15 MW**



## Data logging

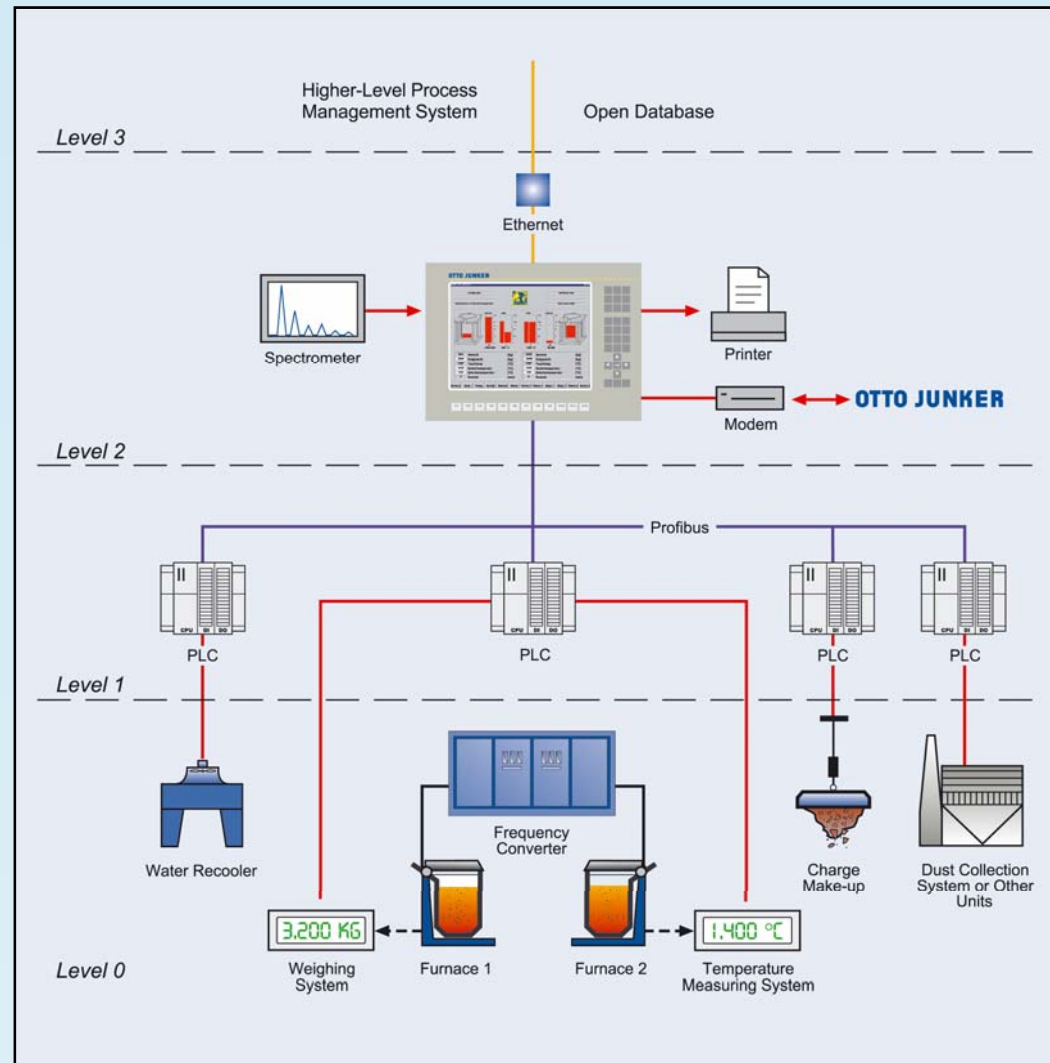
- ▶ Report generator (per load, shift, month, etc.)
- ▶ Charts (trends, refractory status, etc.)
- ▶ Alarms (errors, faults, statistics , etc.)

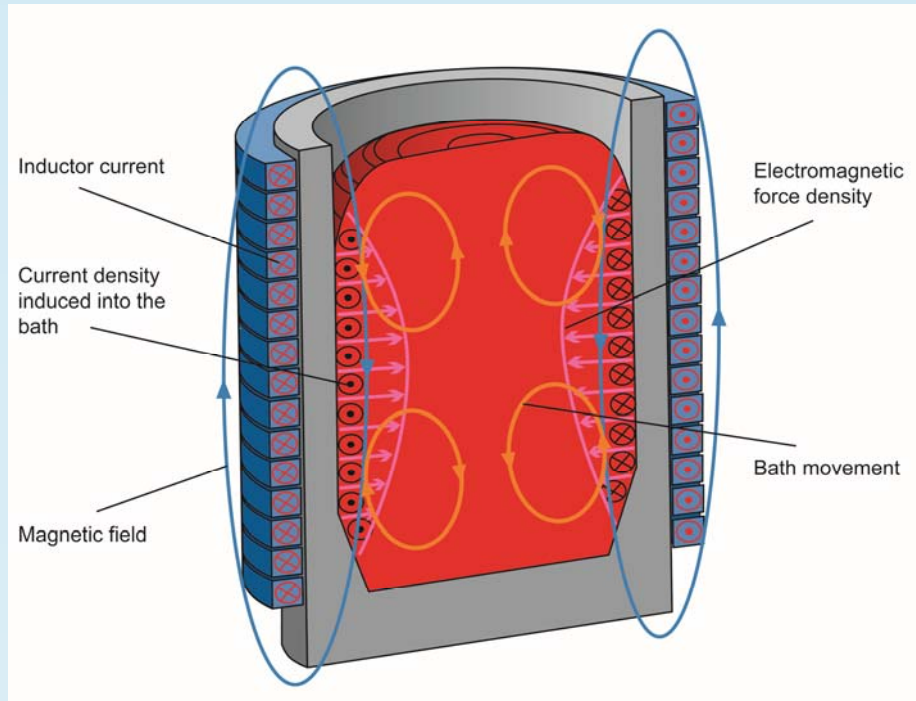
## Automation

- ▶ Modes of operation (melting, holding, etc.)
- ▶ Parallel furnace operation
- ▶ Power input

## Monitoring

- ▶ Process data
- ▶ Operating status
- ▶ Quality assurance



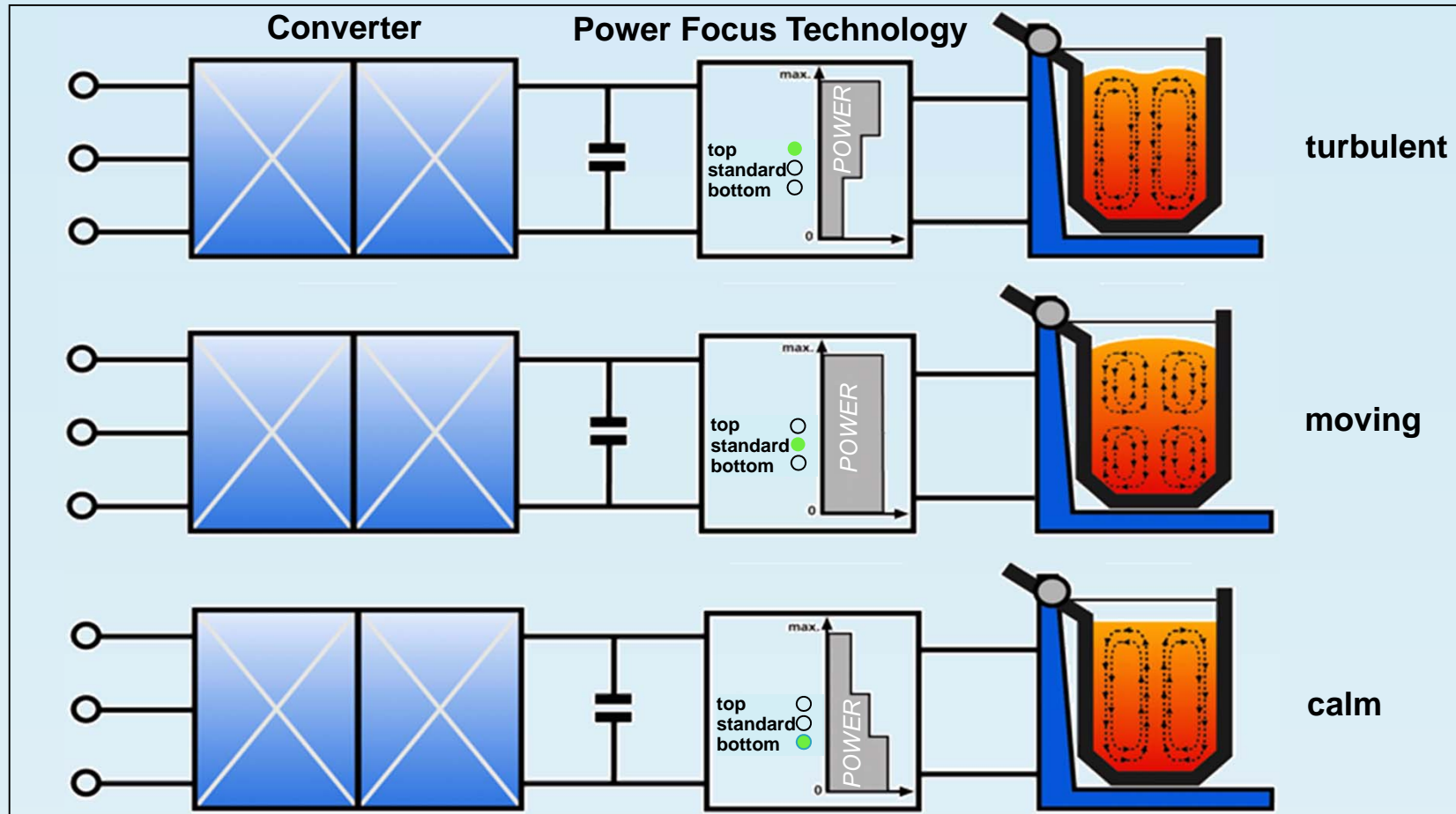


Origin: ETP Hannover

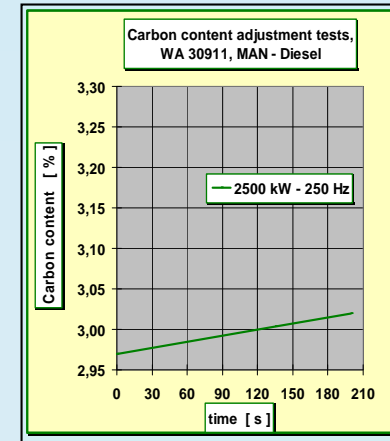
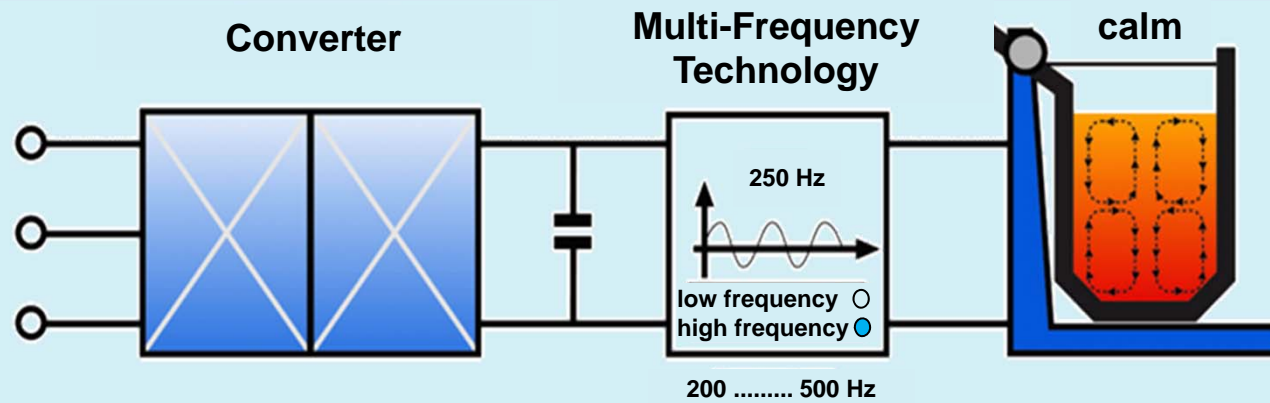
The bath movement is a characteristic feature of coreless induction furnaces and it is very important as it assists with optimum melt homogenisation and stir-down of additives.

The height of the bath dome and the intensity of the bath movement are basically a function of the a.c. operating frequency, the electrical power input, the bath level and the geometry of the furnace. They can thus be selectively controlled by design and electrically.

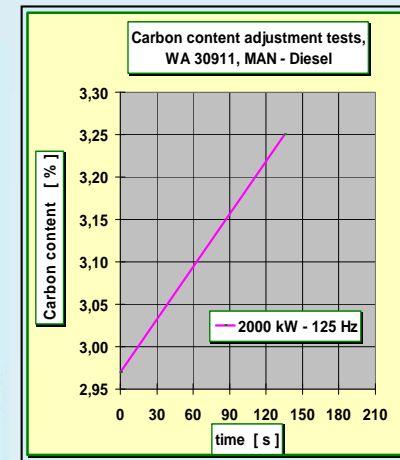
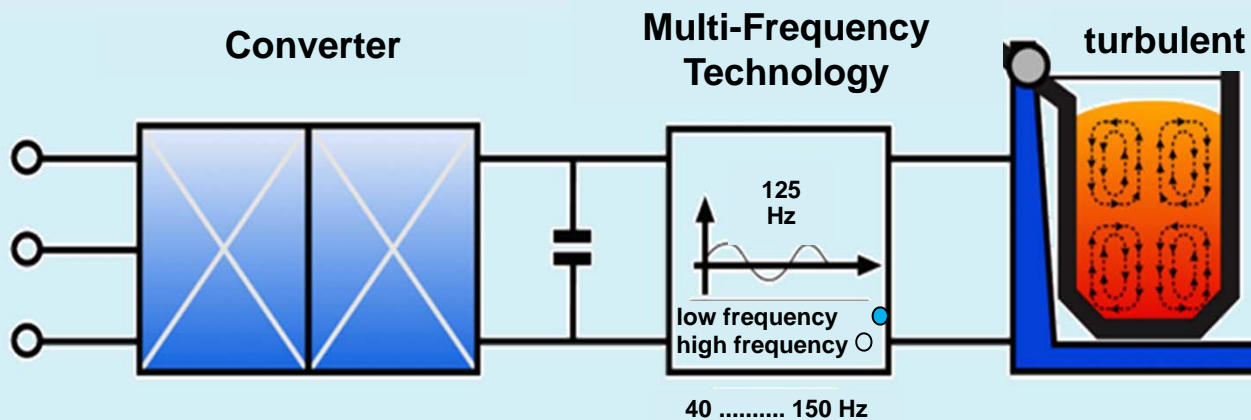
Shifting of the power concentration across the furnace coil by operator to suit process requirements processor controlled, depending on furnace filling level



### Melting e.g. at 250 Hz



### Alloying e. g. at 125 Hz





The focus is on minimum metal loss, high energy efficiency, low environmental pollution and optimum efficiency, no matter whether aluminium foil, punchings, slab milling chips or machining chips of castings need to be recycled.

For all these requirements the induction furnace, compared to other melting equipment, provides the ideal conditions:

- ▶ The bath surface area exposed to the atmosphere is very small, related to the furnace content. Together with precisely adjustable bath movement and temperature control this ensures minimum melting losses.
- ▶ The compact design combined with high power density makes the induction furnace the ideal solution where a chip melter is to be added to existing melting shops.

Melting applications in the own company, so-called in-house recycling, also gains increasing significance.

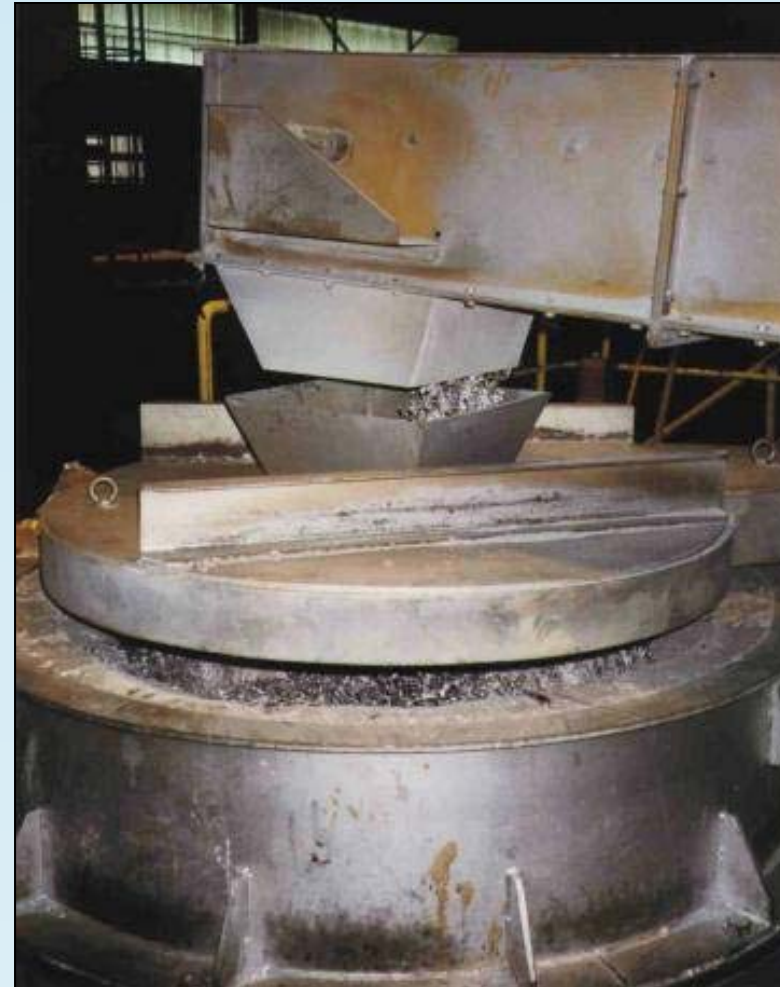


## Recycling of slab milling chips

- ▶ Capacity 7,500 kg, mode of operation with heel, power 2,600 kW
- ▶ Variable frequency 80 - 110 Hz
- ▶ Power concentration (***Power Focus technology***) controlled by the melting processor JOKS, depending on the filling level of the furnace
- ▶ Automatic, crucible saving mode of operation

## Results

- ▶ Practical melting rate 5 t/hr
- ▶ Service lives of refractory lining > 1 year
- ▶ Metal losses: less than 1 %
- ▶ Energy consumption: 520 kWh/t (750 °C)



## Recycling of machining chips

### Condition of chips:

- ▶ Fine chips from machining of aluminium wheels
- ▶ Alloy: AlSi9Mg
- ▶ Remaining emulsion in percent by weight after centrifuge: 1 – 2 %



### Technical data of the furnace:

- ▶ Capacity: 3,000 kg
- ▶ Power: 1,200 kW
- ▶ Frequency: 110 .... 150 Hz
- ▶ Controlled by the melting processor JOKS

### Results

- ▶ Practical melting rate: 1.75 t/hr
- ▶ Energy consumption: 540 kWh/t (750 °C)
- ▶ Metal losses: Approx. 1.5 % - depending on the degree of oxidation and contamination of the chips

## Recycling of aluminium foil packs

- ▶ Capacity 5,500 kg, power 1,500 kW
- ▶ Frequency 70 Hz
- ▶ Foil packs 300 x 300 x 400 mm (household foil), with rolling oil (kerosene up to 2 %)
- ▶ Mode of operation with heel



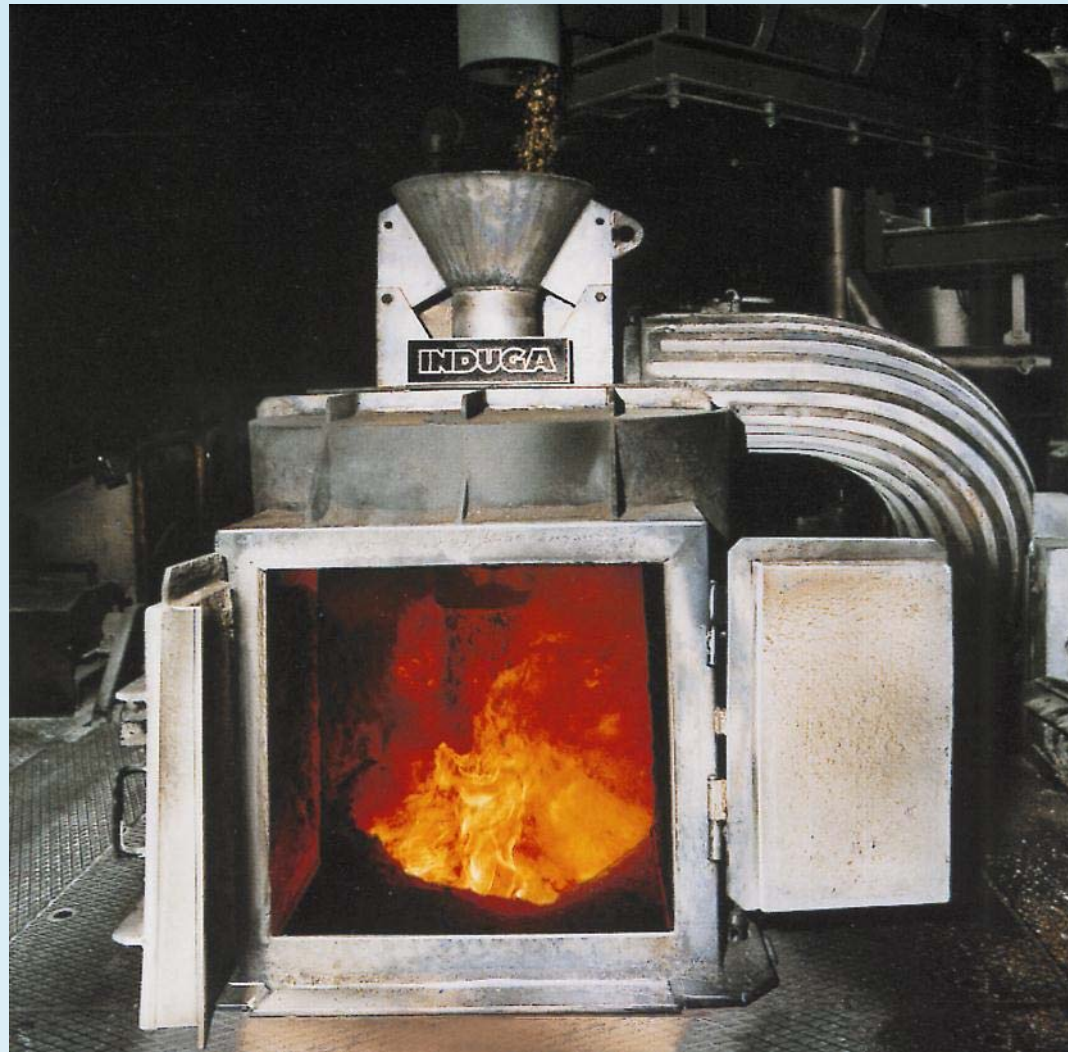
## Results

- ▶ Energy consumption: 520 kWh/t (750 °C)
- ▶ Metal losses: negligible
- ▶ Throughput 50 tonnes per day (in three shifts)

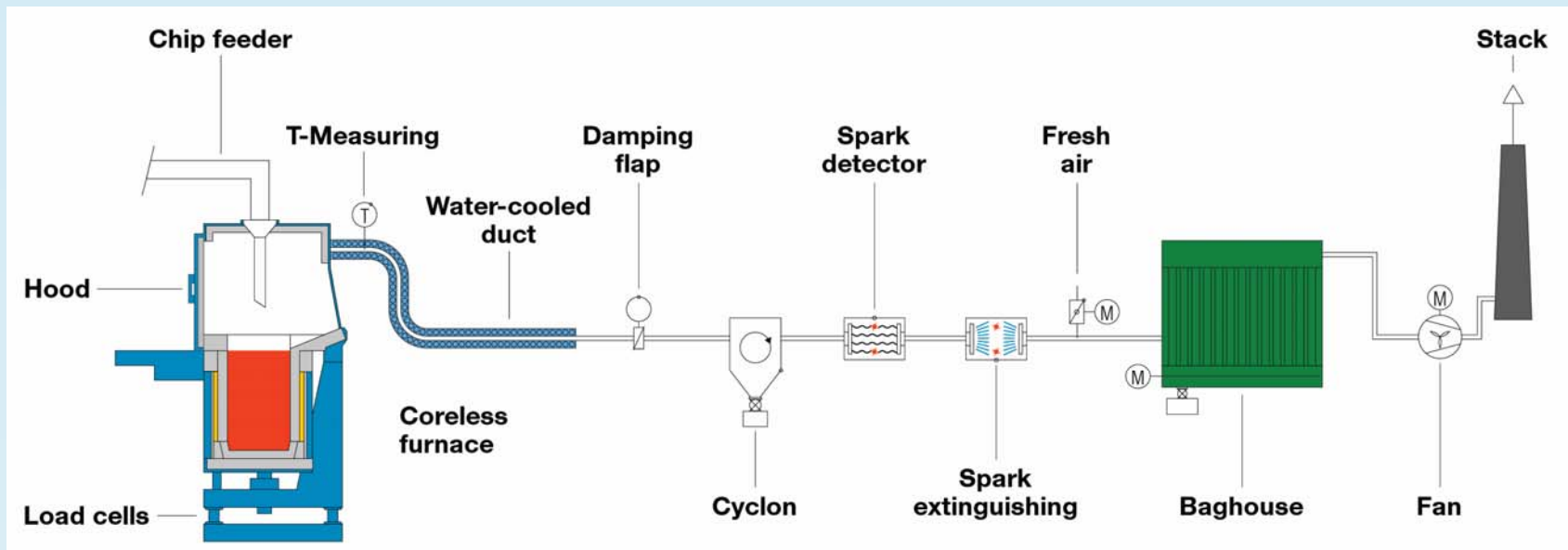


## Recycling of wet brass swarf

- ▶ Capacity: 12,000 kg
- ▶ Power: 2,400 kW
- ▶ Mains frequency
- ▶ Melting rate: 7,700 Kg/h
- ▶ Energy consumption: approx. 280 kWh/t
  
- ▶ Heel operation
- ▶ Moisture up to 6%
- ▶ Metal loss: 1-3%
  
- ▶ Collection and post-combustion of off-gases in watercooled refractory furnace hood
- ▶ Massive off-gas cooling system due to combustion temperature up to 1200°C



## Recycling of wet brass swarf



Schematic of a swarf melting plant including off-gas treatment equipment

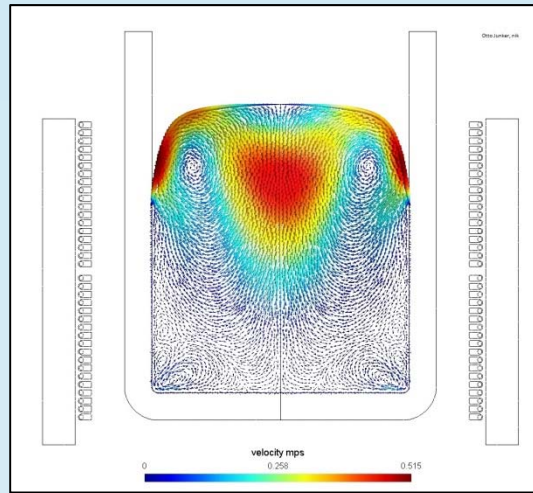
## Recycling of ferrosilicon fines

- ▶ Capacity: 3,300 kg
- ▶ Power: 3,300 kW
- ▶ Multifrequency: 125/250 Hz
- ▶ Melting rate: 3,300 Kg/h
- ▶ Energy consumption: approx. 1100 kWh/t
  
- ▶ Fines grain size: 0-3 mm
- ▶ Heel operation
- ▶ Furnace geometry optimized for strong stirring action
- ▶ Up to 15% of non-metallic components in charged material
- ▶ Treatment of slag recommended

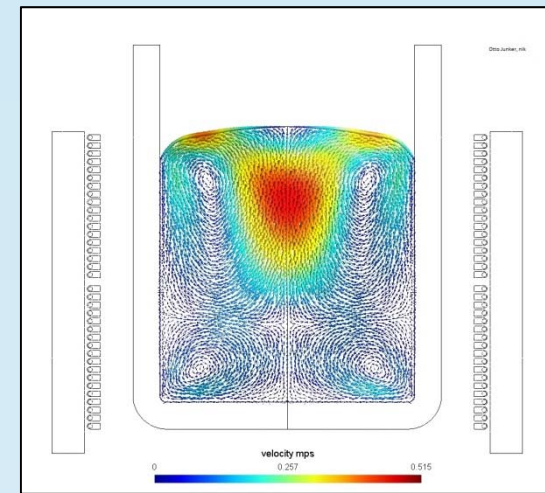


# Refining of a light metal melt by plasma surface treatment

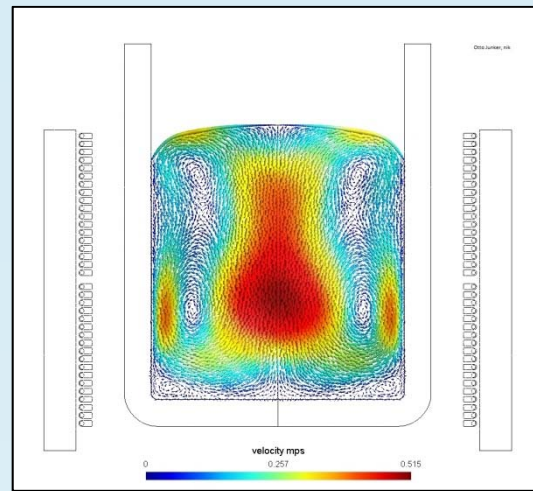
- ▶ Capacity: 100 litres
- ▶ Frequency and power for melting: 230 Hz/300 kW
- ▶ Frequency for stirring continuously adjustable from 34Hz to 100 Hz
- ▶ Power for stirring mode independently adjustable.
- ▶ Two coil sections can be operated at different phase angles
- ▶ Same technology in operation on 2,200 kg vacuum furnaces for preparing master alloys



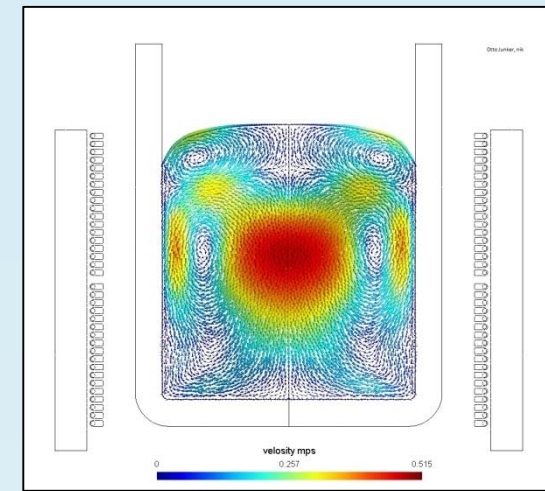
a) 120 kW, 230 Hz,  $\phi = 0$



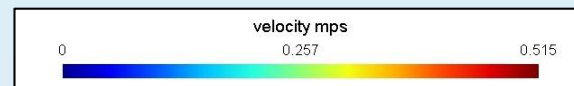
b) 28 kW, 34 Hz,  $\phi = 0$



c) 28 kW, 34 Hz,  $\phi = +90^\circ$



d) 28 kW, 34 Hz,  $\phi = -90^\circ$



Effect of Power, Frequency and Phase Shift on Bath Movement

Numerical flow calculation examples shown for aluminium melt





Custom-designed coreless medium-frequency induction furnaces with innovative circuit configurations and advanced process control system can recycle a vast variety of fine sized production residues successfully.

The unique combination of taylor-made stirring action, alloying flexibility, precise temperature regime, power density and melting loss makes the coreless induction furnace superior to any other type of melting equipment for the recycling of fine-sized metal scrap.

In the aluminium foundry they are an interesting alternative also for doing cost-effective in-house recycling instead of giving the scraps to remelting facilities.

**THANK YOU FOR YOUR ATTENTION**

