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# RecoDust

**New pyrometallurgical recycling technology**

alfred.edlinger@tribovent.at

# Fields of application (some examples) 1/2

- Steel mill dusts, slags, sludge and scales
- ASR (Automotive Shredder Residue)
- Galvanic residues
- Electronic scrap
- Used catalysers
- Used batteries
- Al-recovery of used packaging material
- Sewage sludge ashes
- Artificial blast furnace slag (cement)
- Waste glas
- Grinding dusts
- Incineration wastes

# Fields of application (some examples) 2/2

- Ferro Alloy (Carbure) – Production
- Slag for Electro Slag Remelting
- Micro Silica production
- Raw Silicium
- Hazardous waste
- Raffinery waste, ashes
- Steam cracking of pyrolysis gases
- used tyres gasification
- Production of SIC and $CaC_2$

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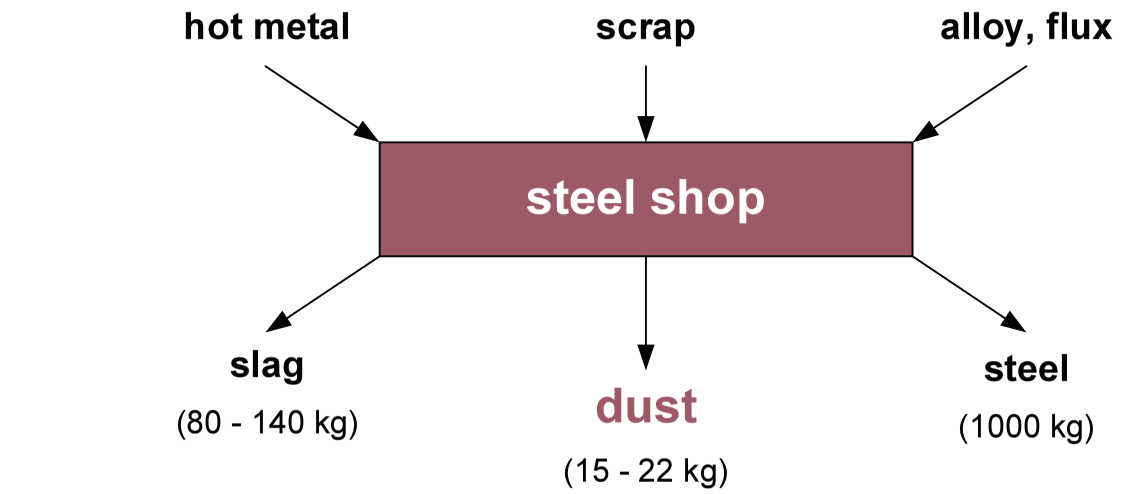
# RecoDust Technology

- Example: Steel mill dust Pyroprocessing
  - Steel mill dust – generation and characterisation
  - State of the art / statistics
  - Demands for new process approach
  - RecoDust-Process, 2 options
  - Utilisation of RecoDust - products
  - Evaluation Waelz vs. RecoDust
  - Operation Units of RecoDust
  - InduCarb (Inox)
  - RD1 - Testing Plant in Bludenz (AT)

# Steel mill dust – generation and characterization




**BOF plant**

- Zn (4 - 14 %)
- high Fe-content
- low halogen-content

**EAF plant**

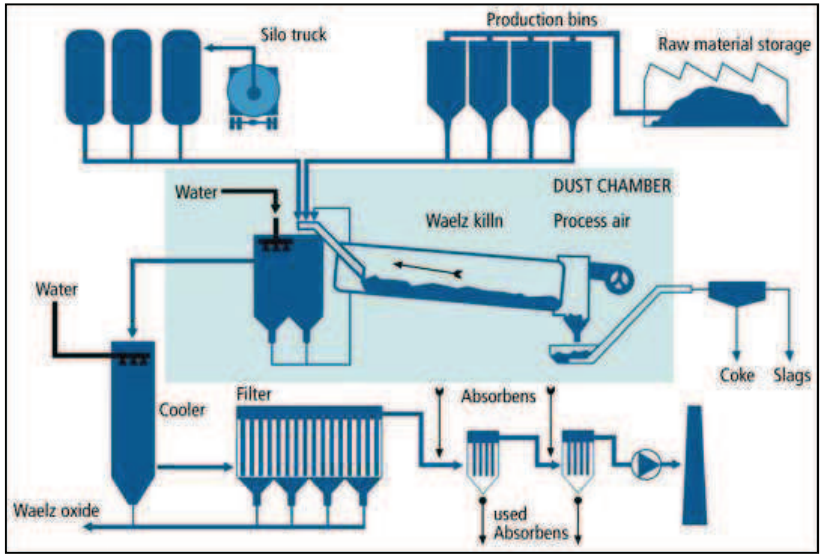
- Zn (20 - 40 %)
- Pb, Na, K
- high halogen-content

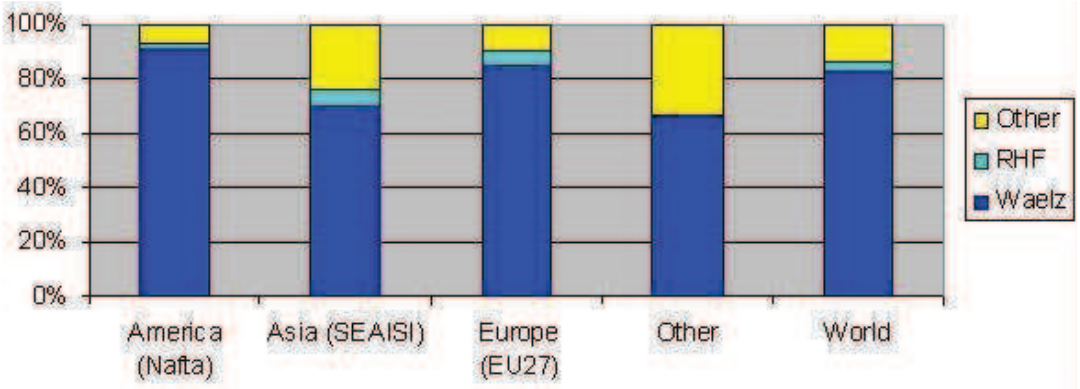
**EAF special steel plant**

- Zn (0 - 15 %)
- in part: high Cr-content
- high fluctuation

# State of the art / statistics

- Waelz-Process
- other processes
  - **OxyCup**
  - **Plasma-Dust (ScanDust)**
  - **multiple hearth/iron bath (Primus)**
  - **rotating hearth furnace proc. (Redsmelt, Inmetco)**
  - **submerged Arc Furnace**




**annual world-production**

**steel dusts: ~ 20 Mio.t**

**steel slags: ~ 150 Mio.t**

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# Demands for new process-approaches

- Recovery of Fe, Cr, Ni, Mo, W, …

- increase of Zn-yield

- zero waste (no landfilling): premelt, cementitious slag

- mini mill solution (close to customer)

- intensivation (space/time yield)

- low specific emissions

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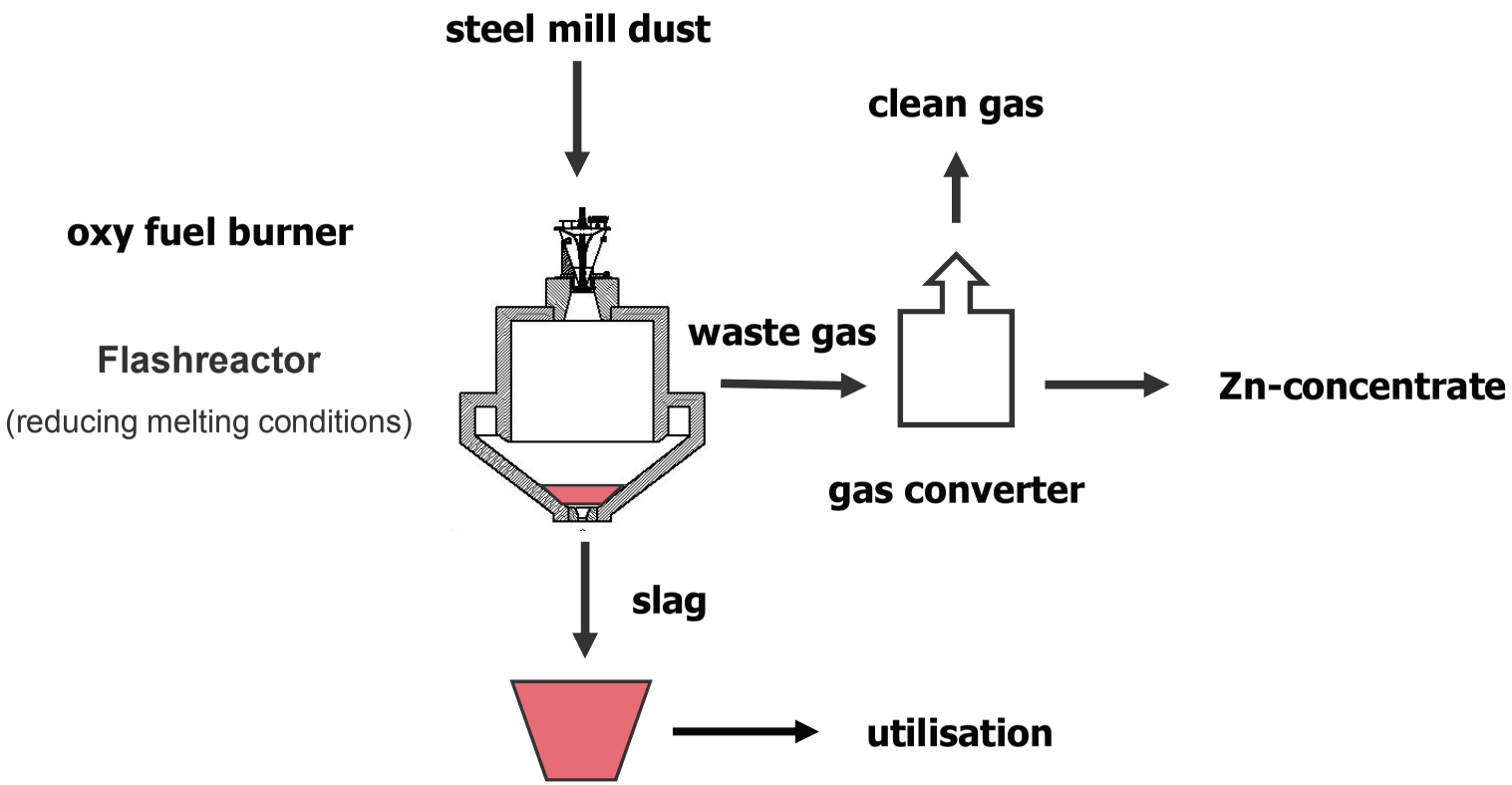
# RecoDust – Process (RD)

## Process-Options

| | |
|---|---|
| **RD 1** | Flashmelting-Reduction (1 step process) |
| **RD 2** | Flashmelting-Oxidation with subsequent melt reduction (2 step process) |
| **InduCarb (Inox)** | stand alone solution, cold feeding |

# RD 1: reducing smelting conditions

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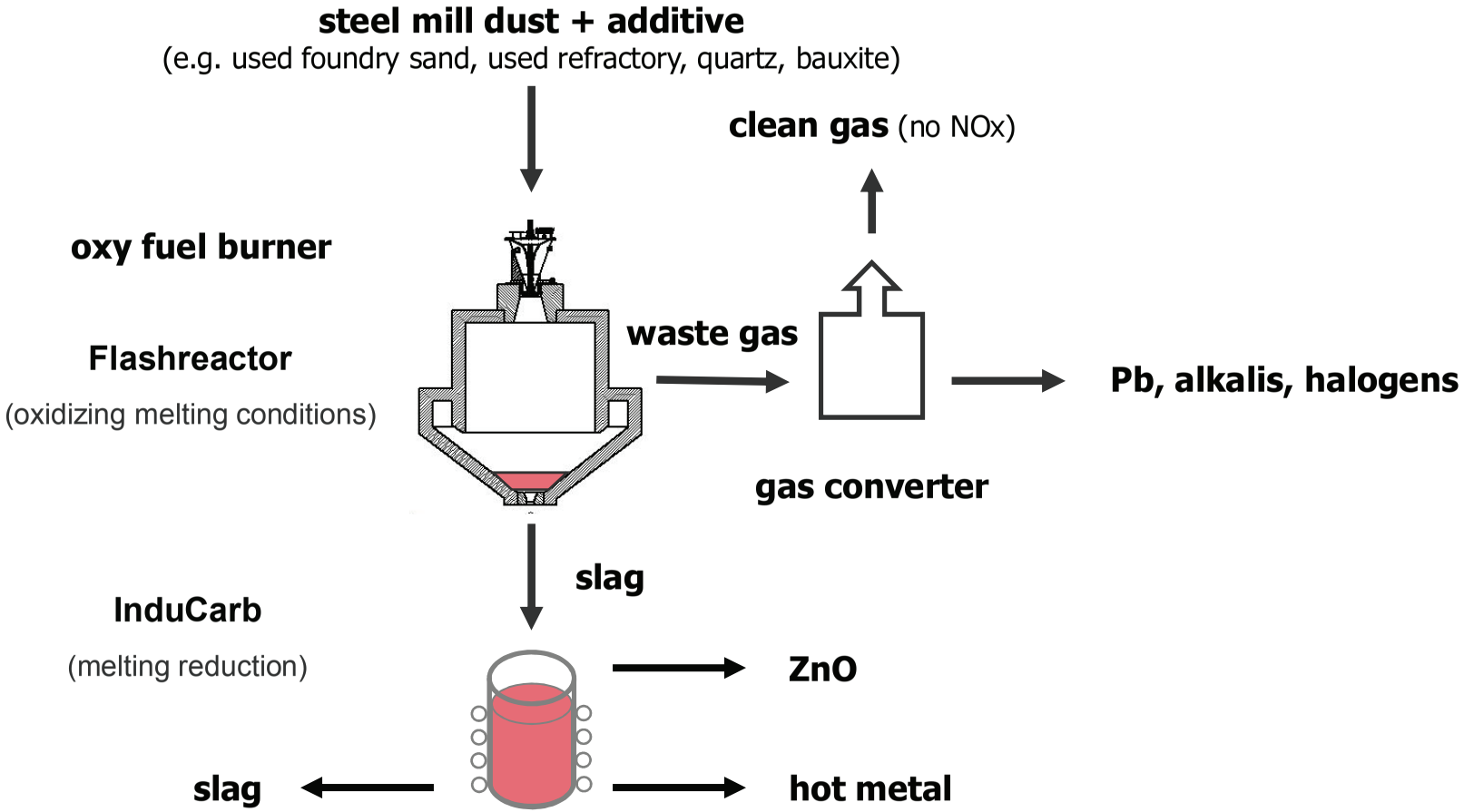
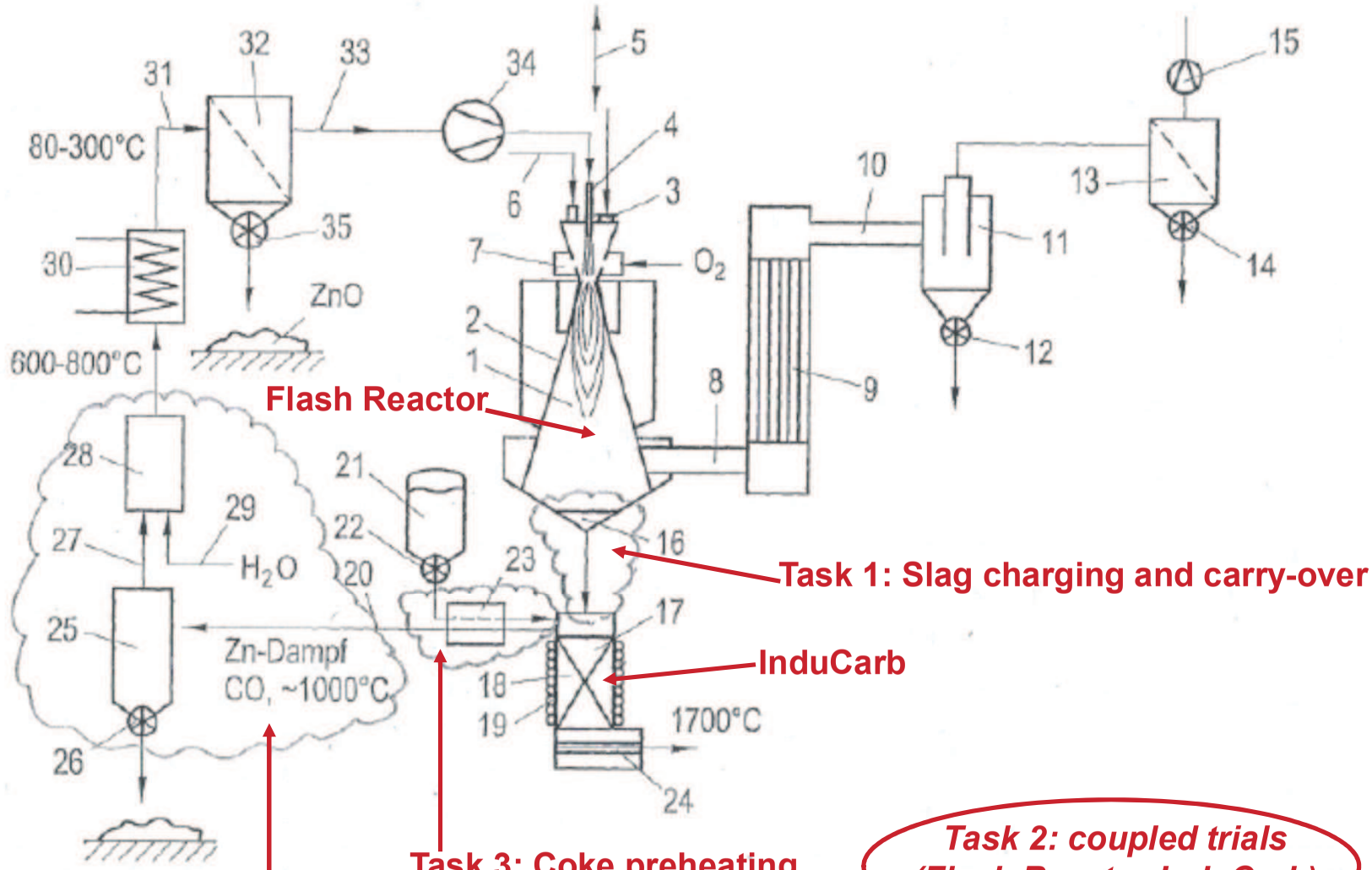
# RD 2: Oxidising smelting conditions, melting reduction



# Detailed overview of the fully integrated RecoDust-concept: WP3, Tasks 1 - 4

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# Utilisation-potential of RD 1 - products

## ZnO-dust

- Zinc-Hydrometallurgy

  **heavy demand on concentrate !**

  - Xstrata-Nordenham
  - Hydrometal

- Zinc-Pyrometallurgy

  **very few in Europe**

  - 1 ISF in Poland

## Slag

- cement clinker formation
- concrete additive (strength enhancer)
- lime/iron carrier (blast furnace)
- slag formation (steel mill)
- blasting material
- construction material
  - road construction
  - freeze protection layer
  - brick filler
  - asphalt filler
  - concrete aggregate

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# Utilisation-potential of RD 2 - products

## ZnO - directly marketable!

- pigment
- vulcanization catalyst
- galvanization
- chemical industry
- also production of metallic Zn (high purity) possible

## amorphous slag

- after milling as cement/concrete binding component (high hydraulic activity)

## hot metal

- premelt
- internal recycling in the steel shop (liquid or solid)

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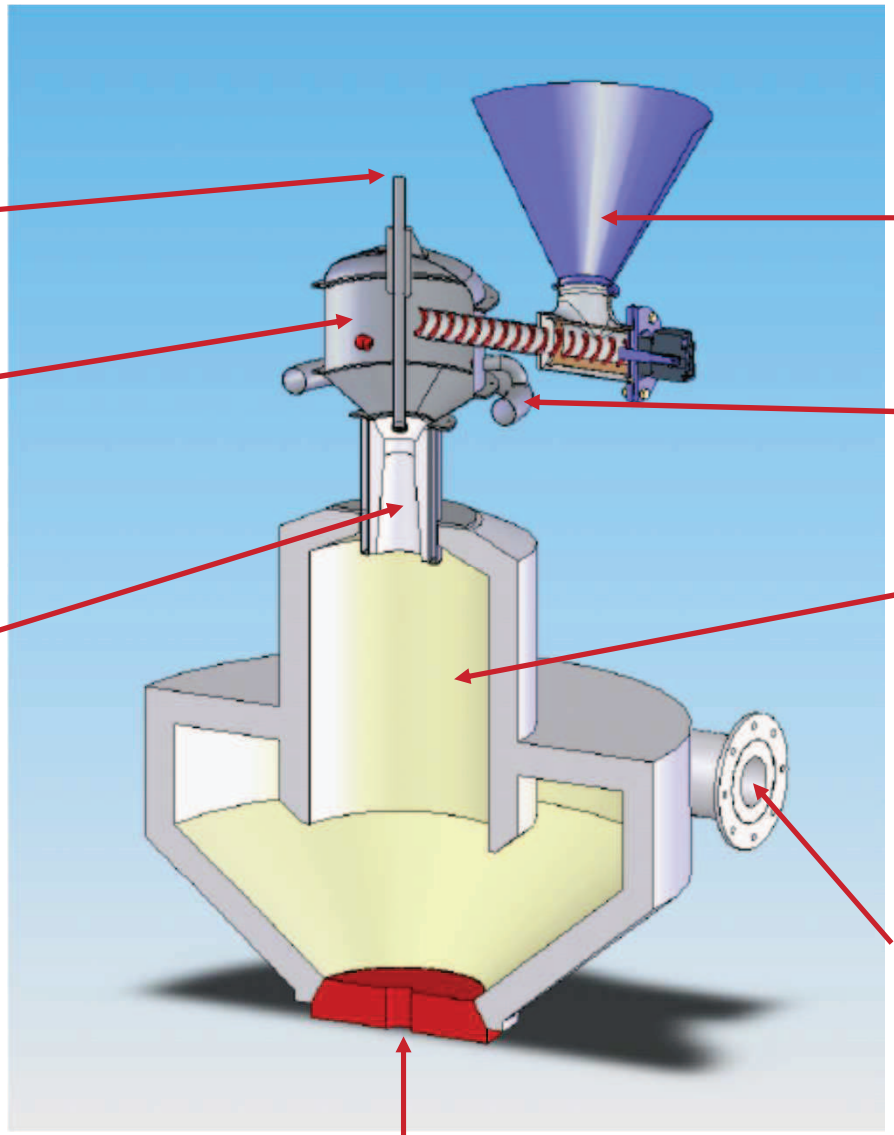
# Evaluation Waelz-process vs. RecoDust (RD 1)

| ITEM | Waelz | RD 1 |
|---|---|---|
| **operation unit** | rotary kiln | Flash-Reactor |
| **working temperature** | 1.250 °C | 1.500 – 1.900 ℃ |
| **retention time** | 5 – 6 h | some seconds |
| **additives** | CaO, $SiO_2$, gypsum | no additives |
| **residue** (Zn – content) | sinter (4 – 8 %) | homogenous slag (0.2 %) |
| **residue properties** | landfilling | Industrial utilization |
| **thermal energy demand** | 6,0 GJ/t | 5,5 GJ/t |
| **fuel** | coke, petcoke | gas, heavy oil, waste (alternative fuel) |
| **waste gas emissions** | 7.500 $Nm^3/t$ | 2600 $Nm^3/t$ |
| **break even production** | 60.000 t/a | 10.000 t/a |

# Flash-Reactor

- dust melting under oxidizing or reducing conditions directly in an oxyfuel-flame
- used for RD 1 & RD 2

# Flash-Reactor

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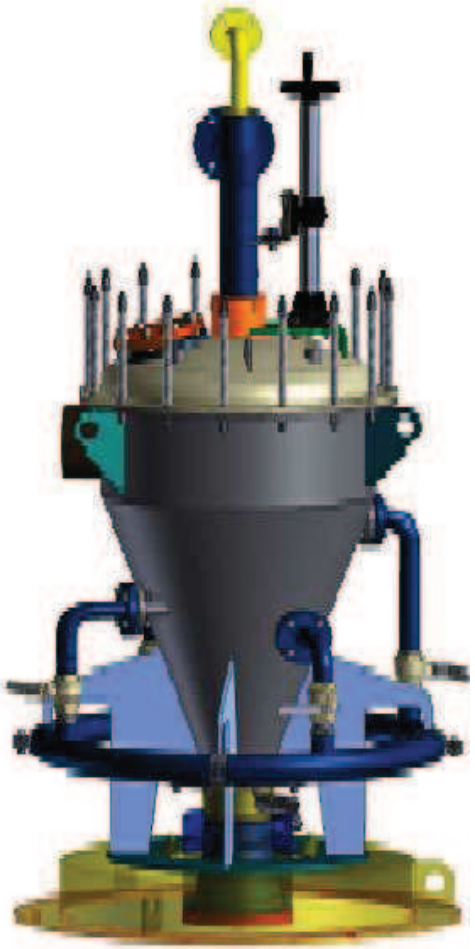
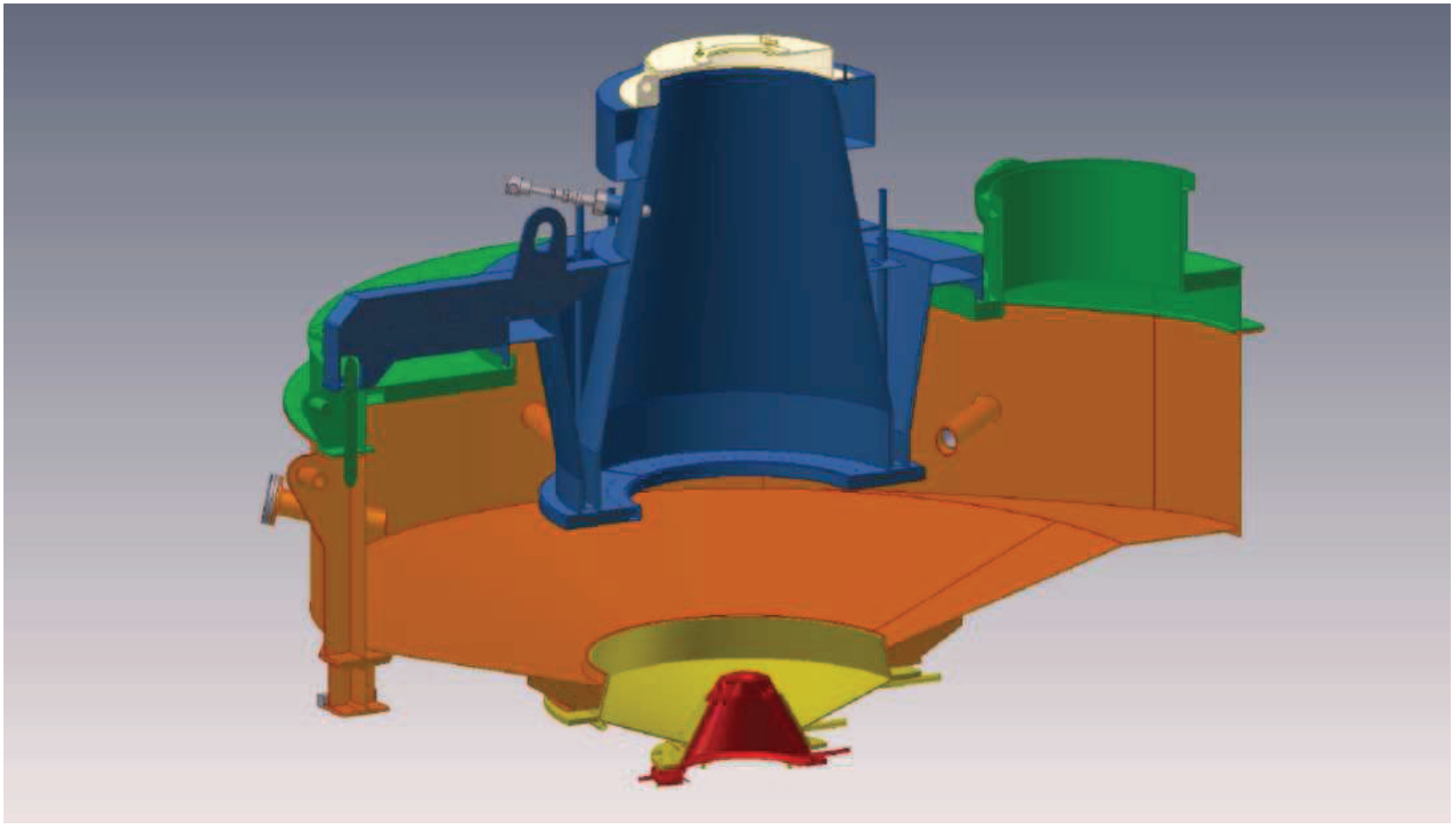
# Characteristics of the Flash-Reactor

- intensive heat- and material-exchange in an oxyfuel flame
  (also waste fuel, spent solvents, pyrophoric dusts, coal-, coke-tailings, etc.)
- fast reaction due to high intensive energy-exchange
- even dust distribution in the flame and deslagging
- high flexibility regarding dust-granulometry and chemistry (also pyrophoric dusts)
- highly abrasive dusts
- minimised contact melt/refractory material
- high burning chamber temperature (1500 – 1900 ℃)
- burning chamber length depending on grain size
- low specific investment costs



# Characteristics of the Flash-Reactor



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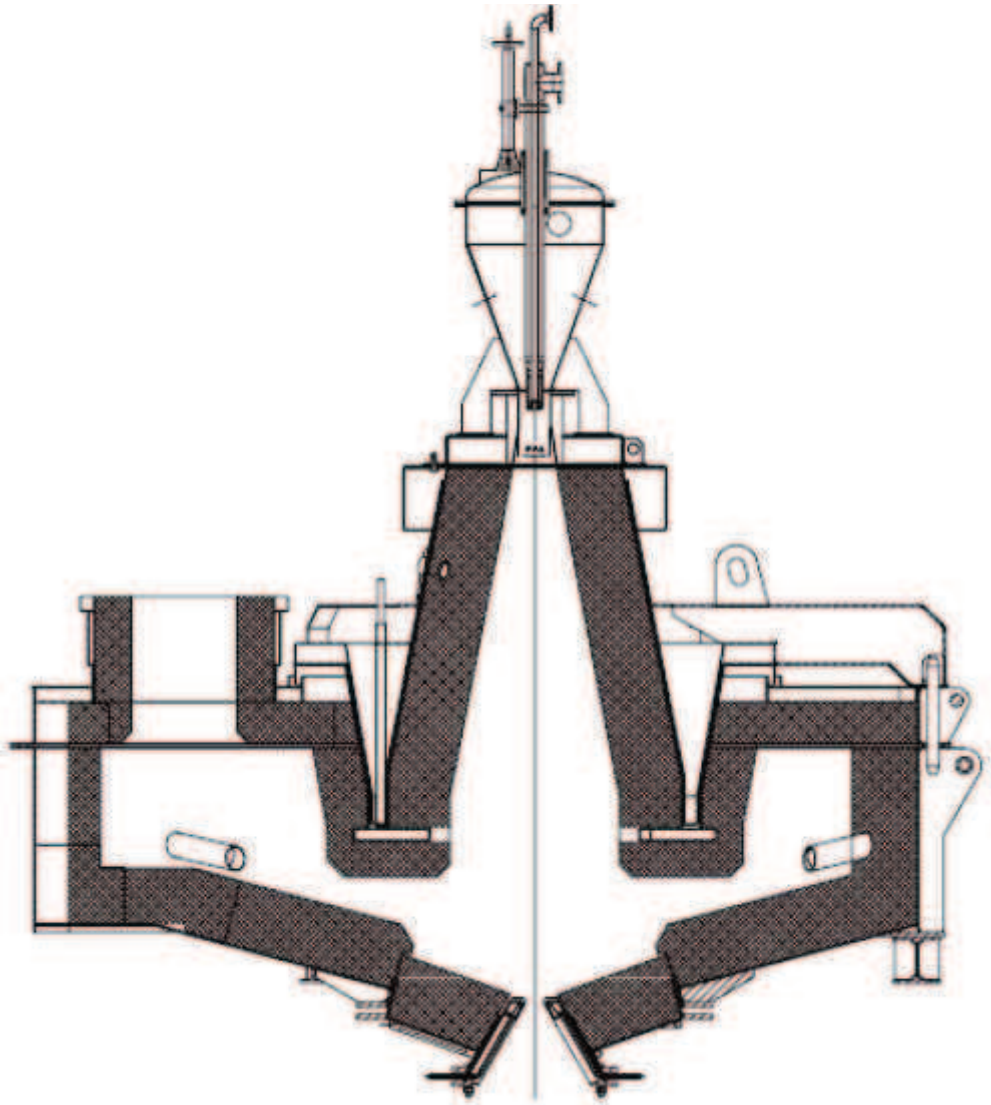

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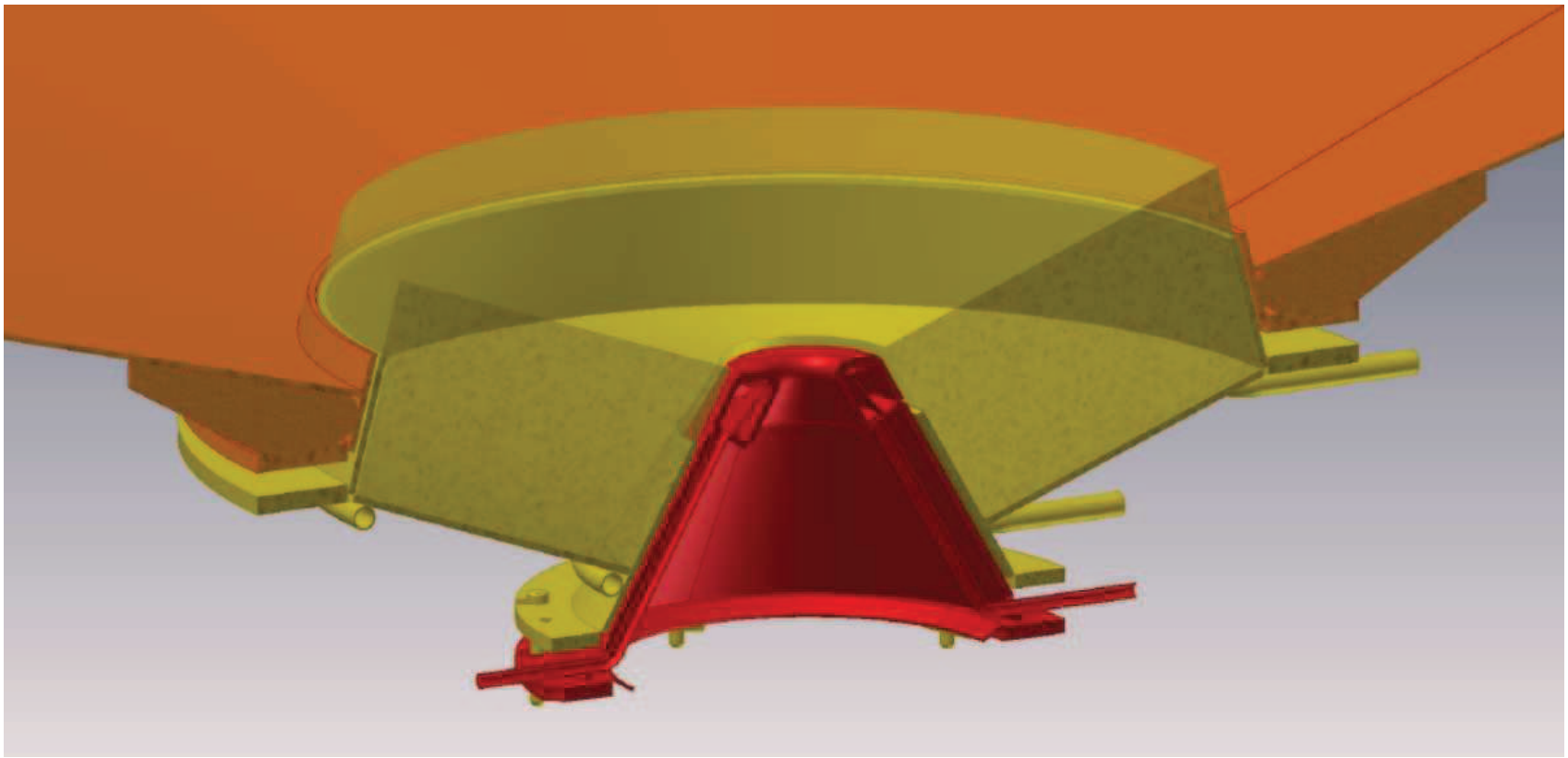
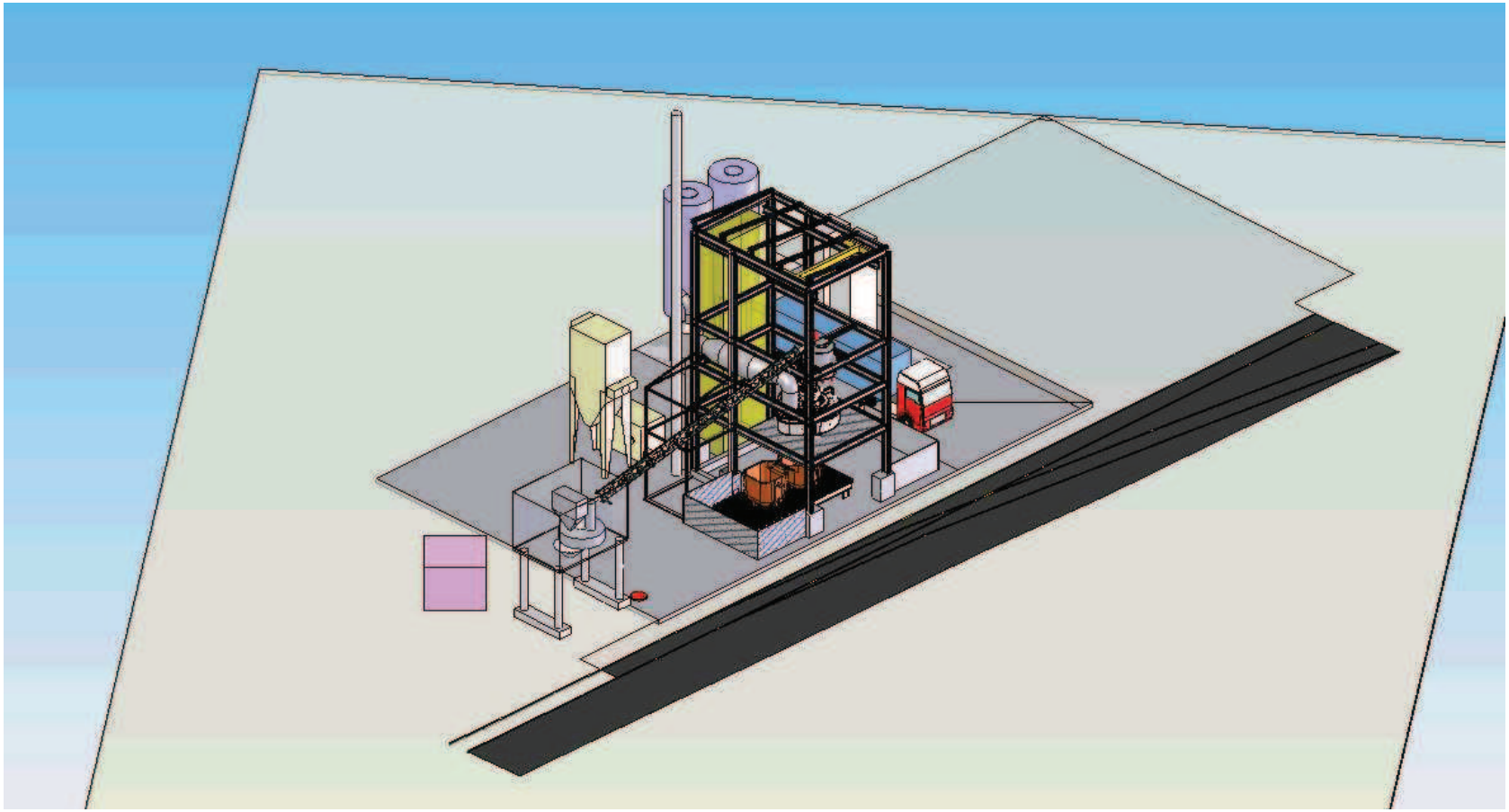


# RD 1 – plant (example): 15.000 t pa EAF-D



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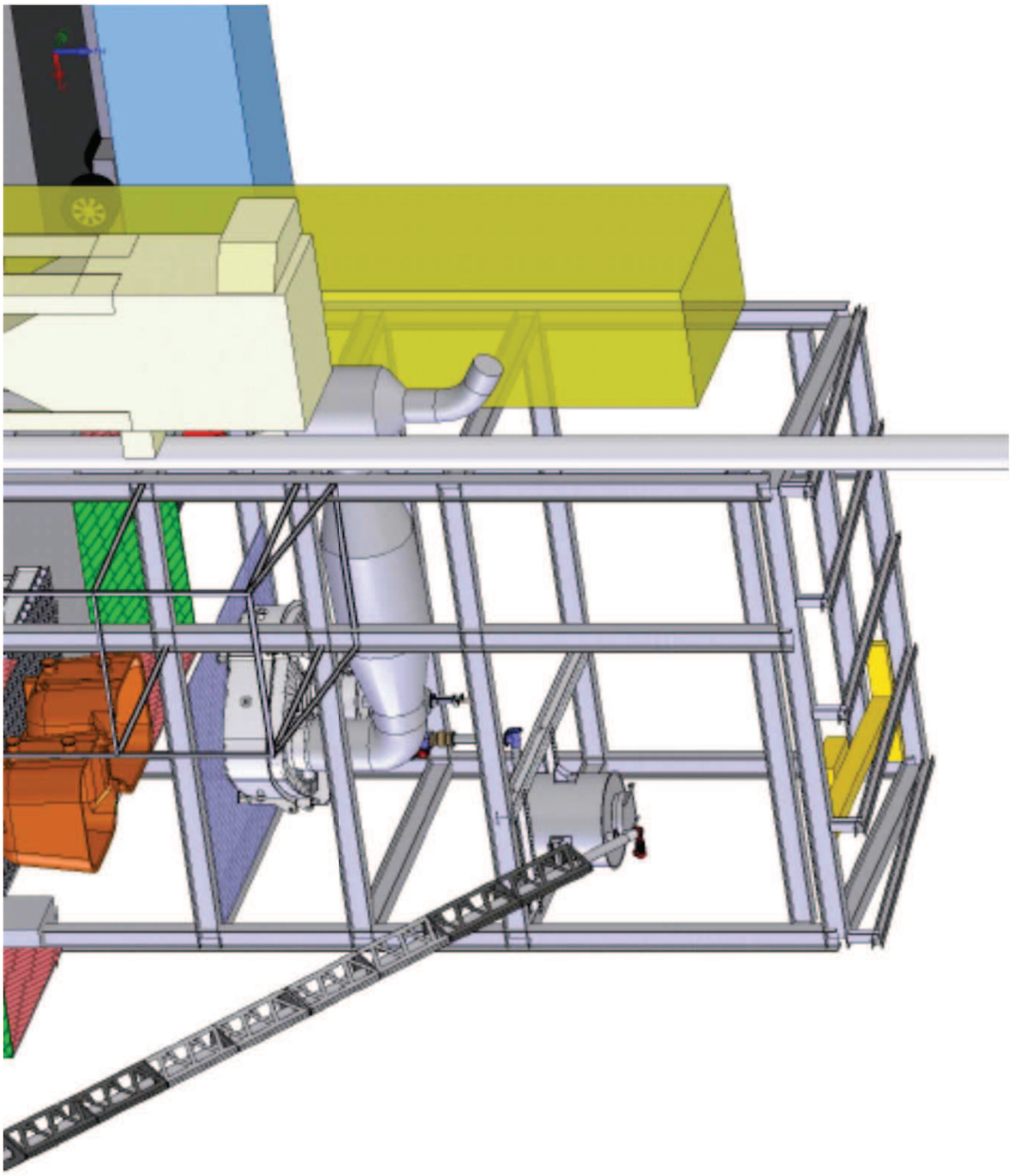

RD 1 – Modell

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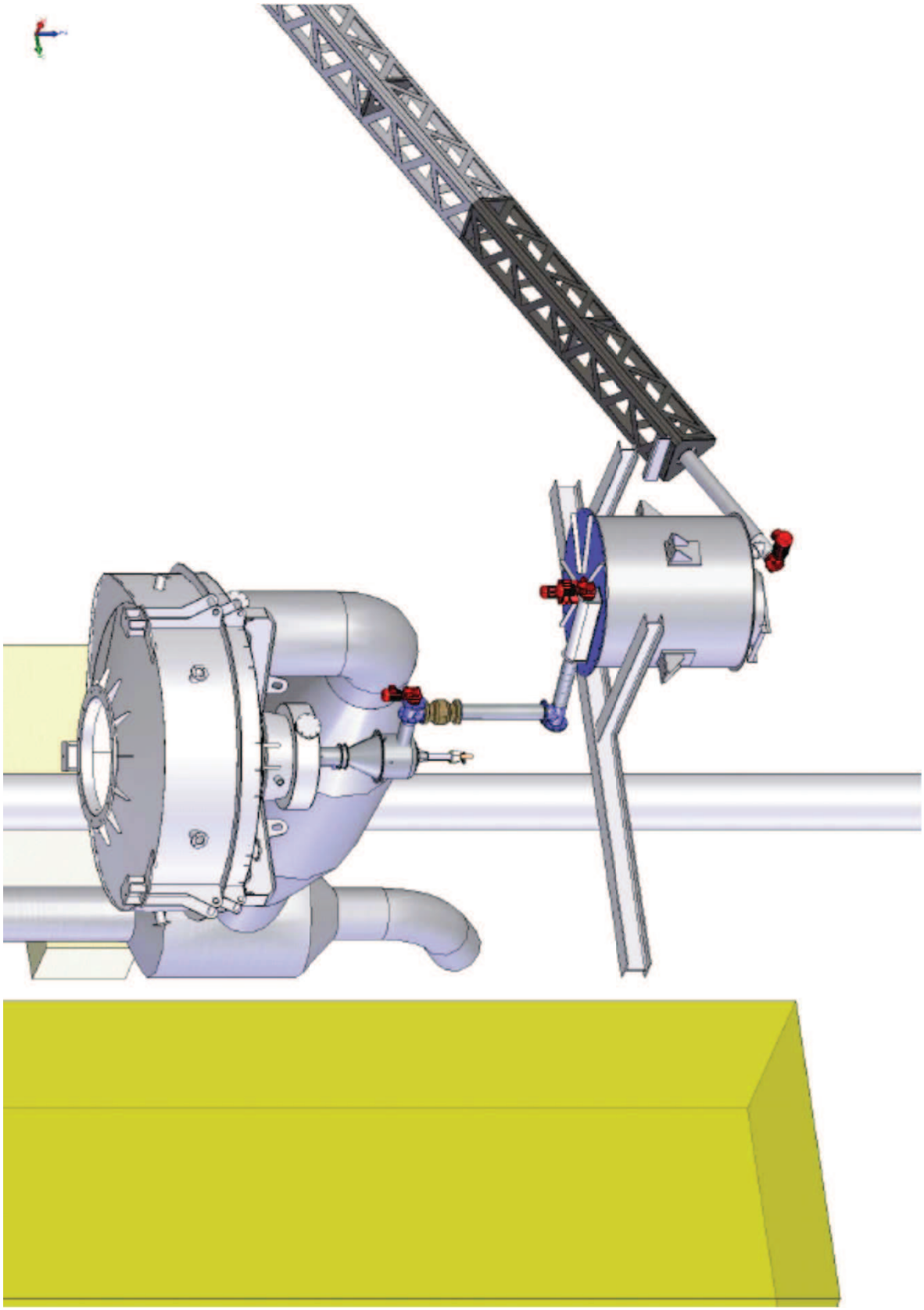

RD 1 – Modell

# RD 1 – impressions of the industrial prototype

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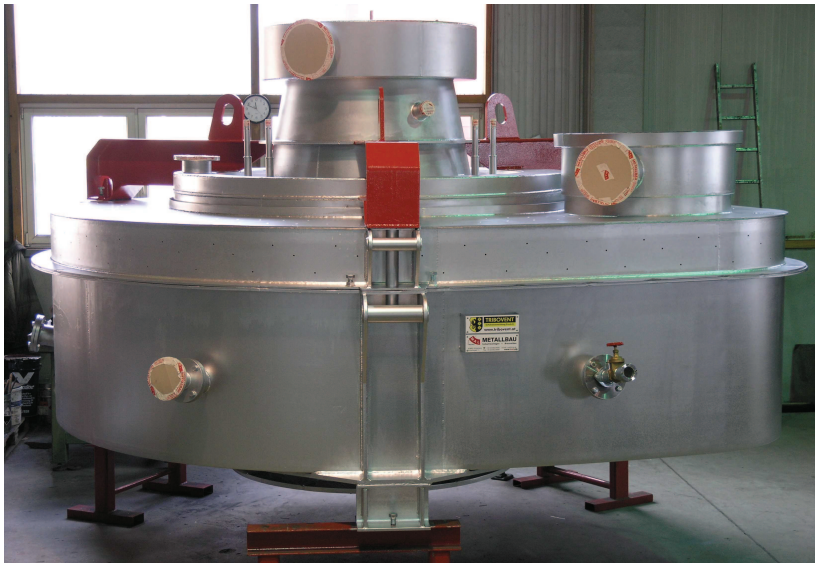
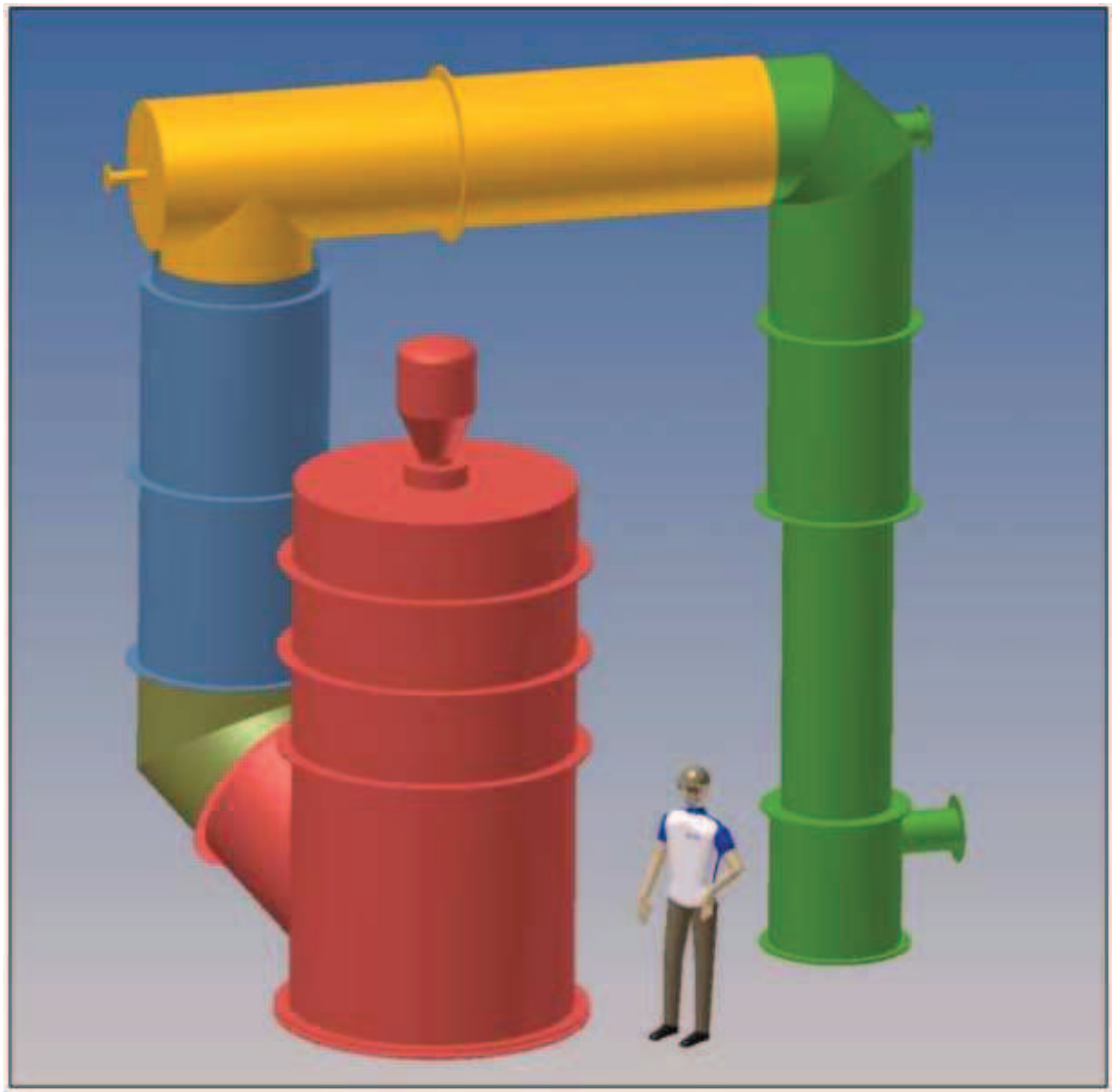
# RD 1 – impressions of the industrial prototype

# RD 1 – impressions of the industrial prototype


# Test Flashreactor – Leoben (under construction)



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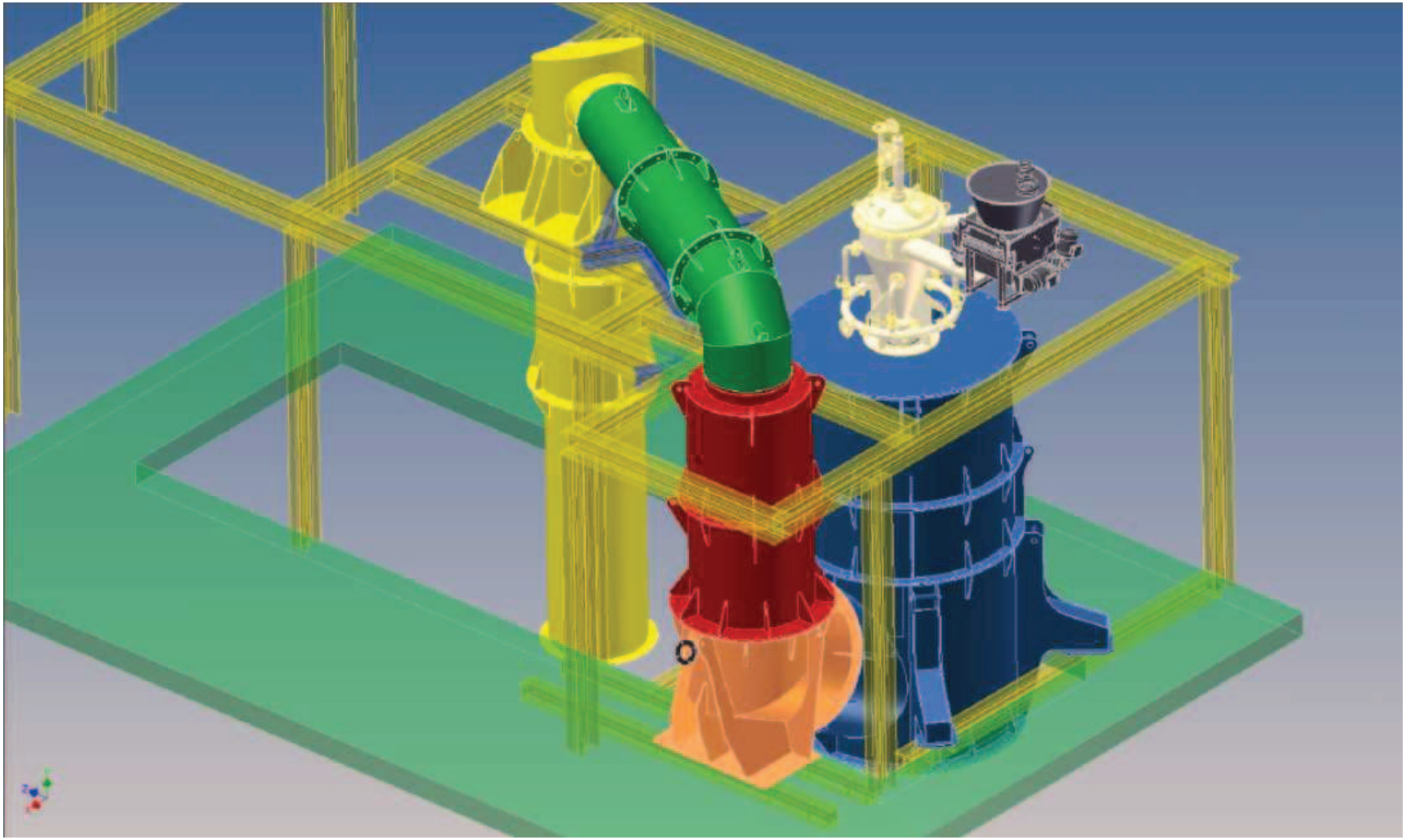

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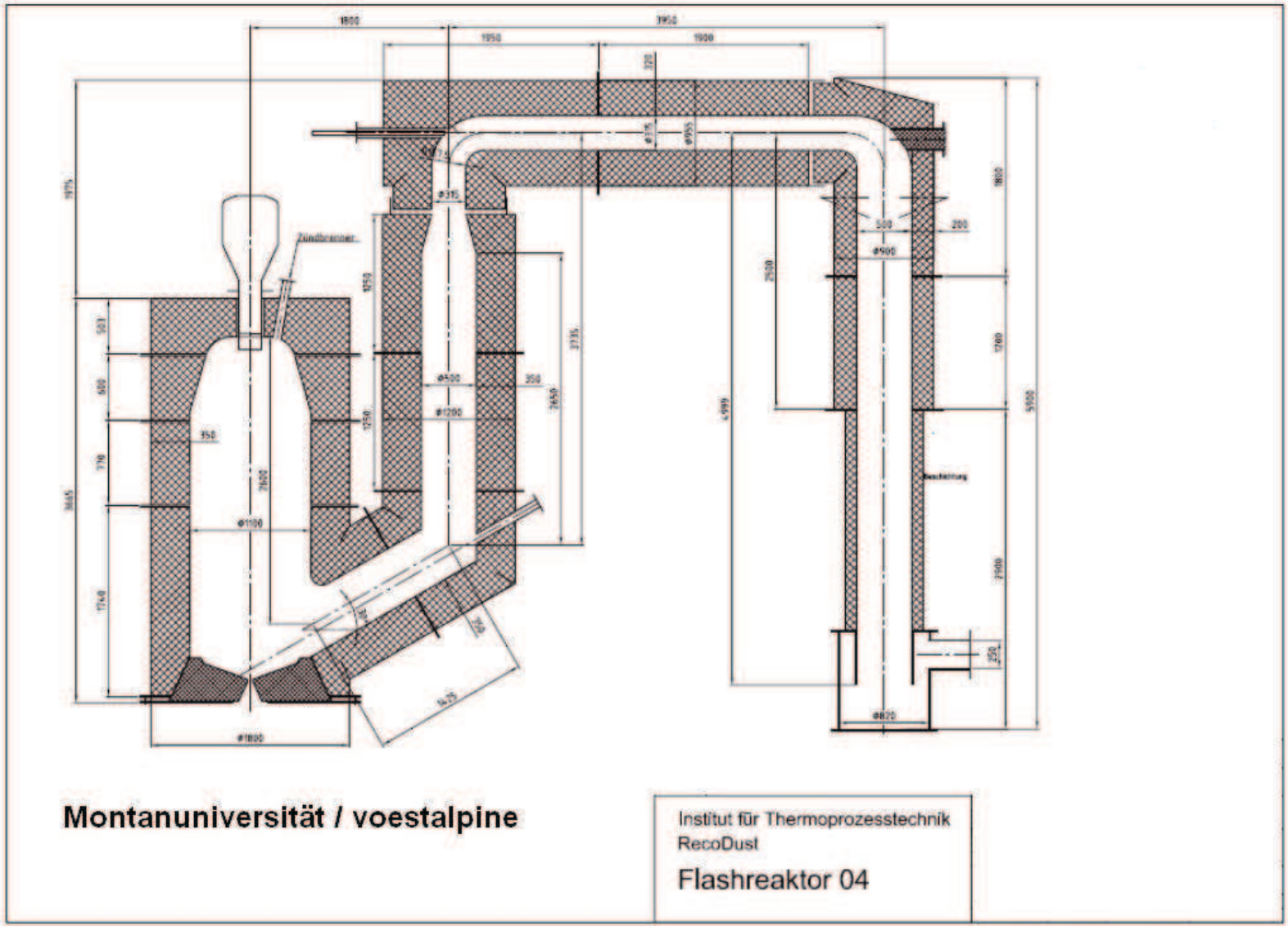

# Test Flashreactor – Leoben (under construction)

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# InduCarb – melting reduction

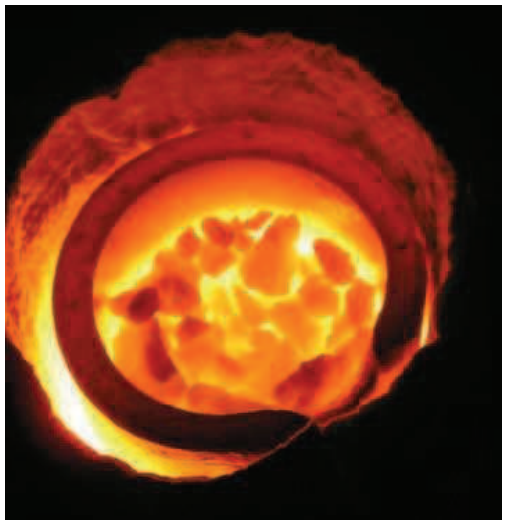
- slag reduction
- inductively heated coke-bed
- very high reduction potential
- application fo RD2, but also stand alone = InduCarb (Inox)

# InduCarb – Features (1)

- good electrical and thermal conductivity of coke due to a certain crystalline C-fraction (graphite) enables inductive heating
- resonance frequency (10 – 100 kHz) depending on:
  - coke quality (type C-carrier)
  - grain size
  - temperature
  - feeding material
- fast heating
- very high temperatures possible
  - high space-time-yield
  - uniform temperature distribution
  - no internal circuits

# InduCarb – Features (2)

- **high reduction potential**
  - high coke temperature
  - very low oxygen-partial-pressure
- **feeding of solids (cold top – coarse and fine dust) & melts (hot top) possible**
- **feeding of oxidized calcinate or sinter**
- **feeding of organic contamidated wastes**
- **“stand alone” process-option**
- **compact design (small reduction unit)**
- **possibility for additional application of oxygen, steam, natural gas, hot blast and “reactive” gases**
- **internal circuit problem (volatiles) solved**



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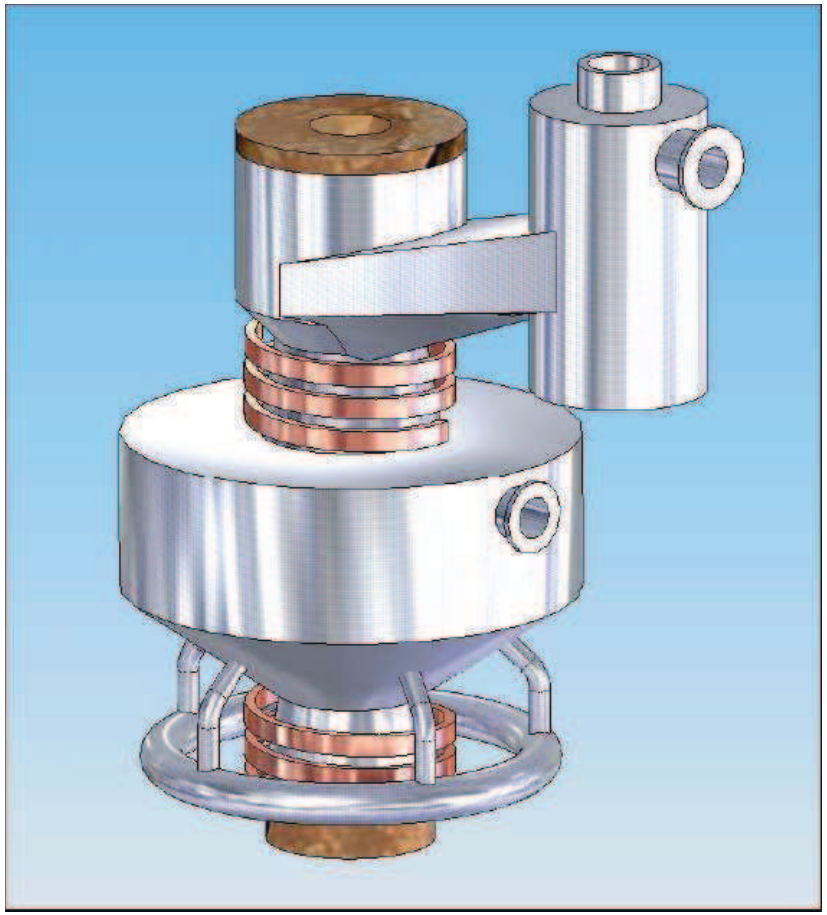
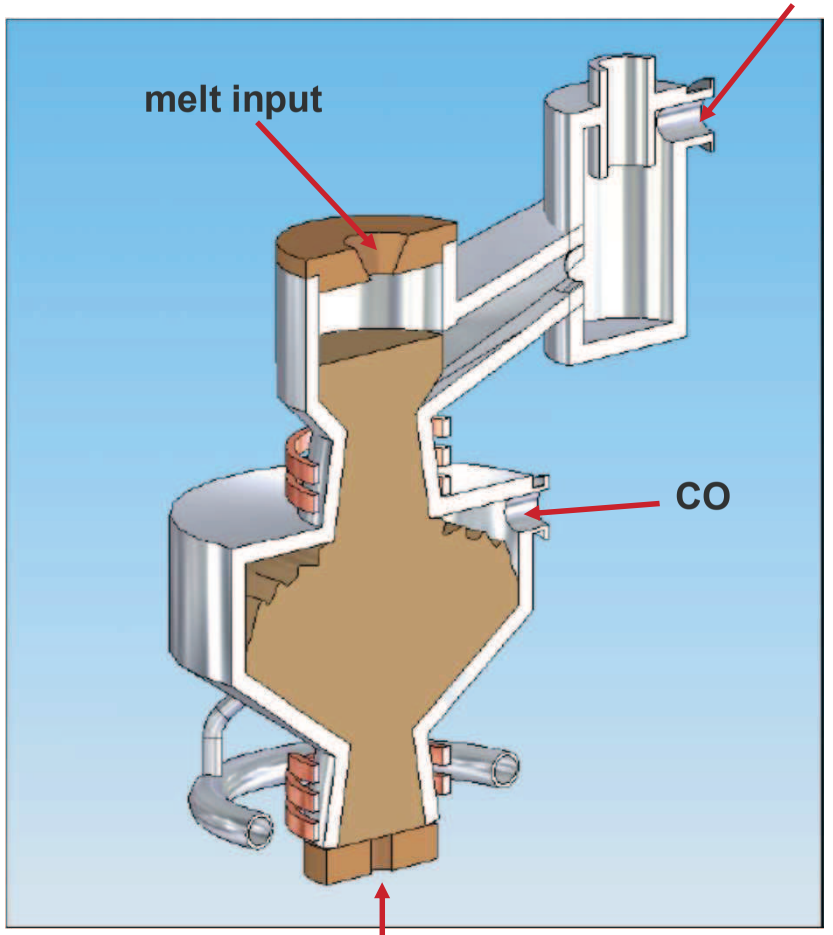
# concept: hot (melt)-charged InduCarb



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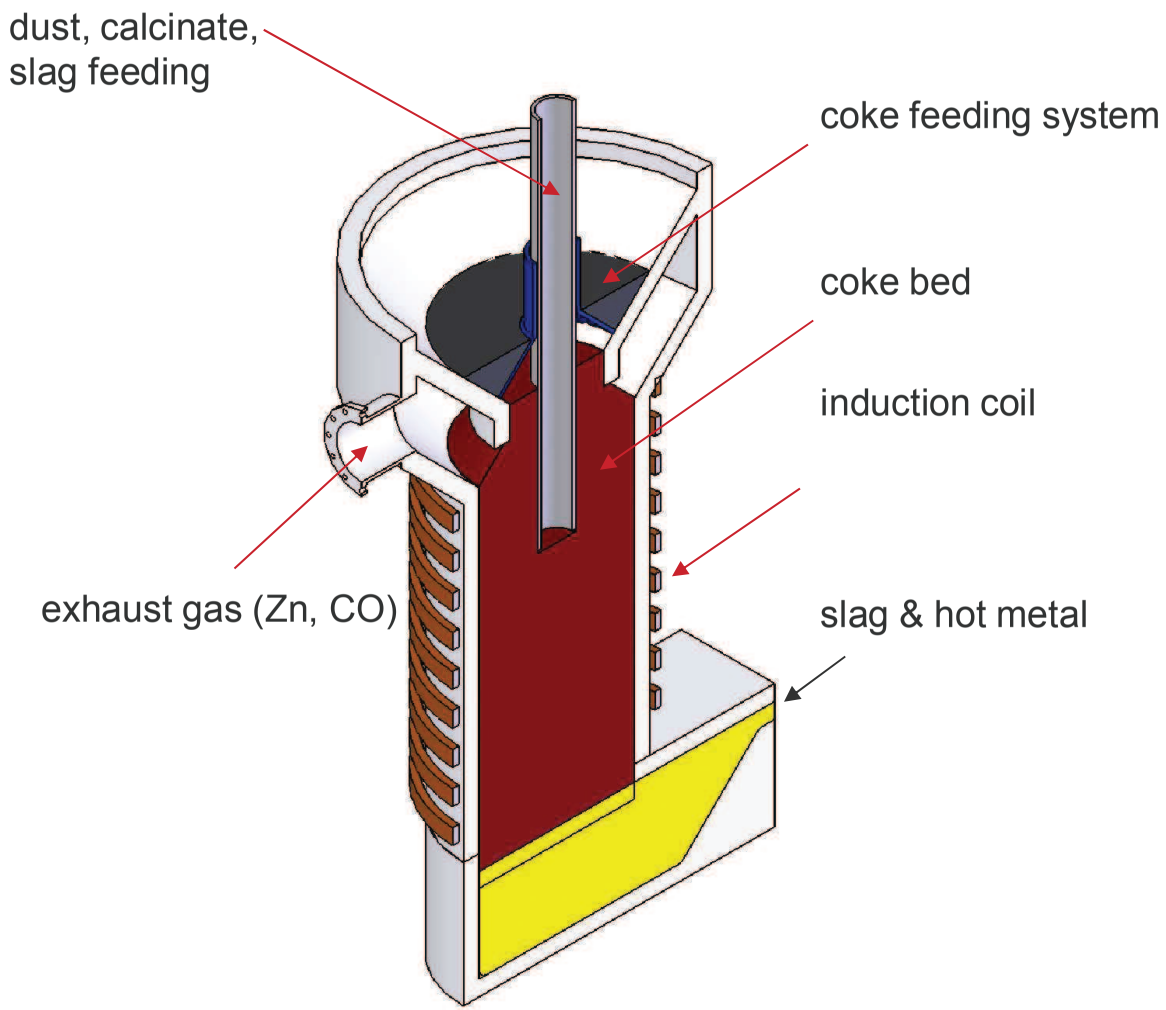
# cold charged InduCarb

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# InduCarb (Inox)

- Coke option
- Graphite option

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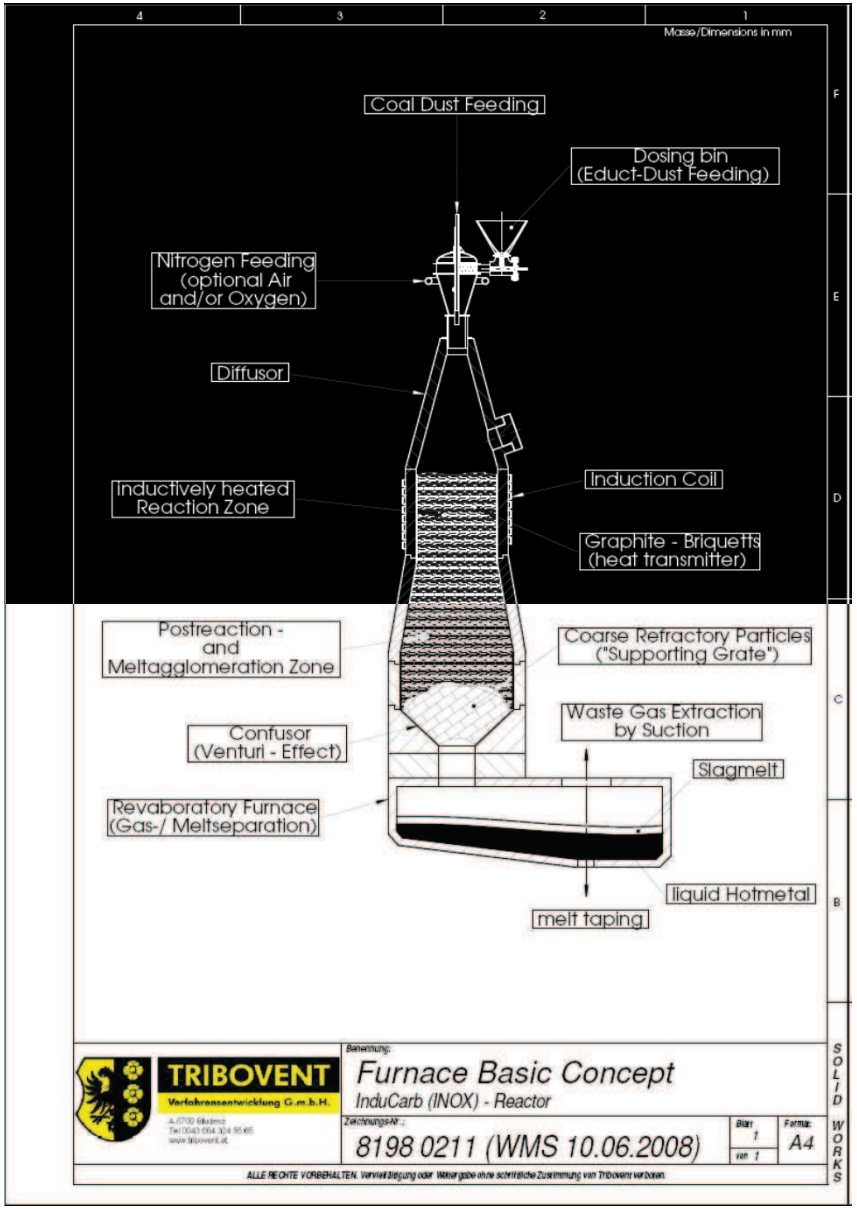
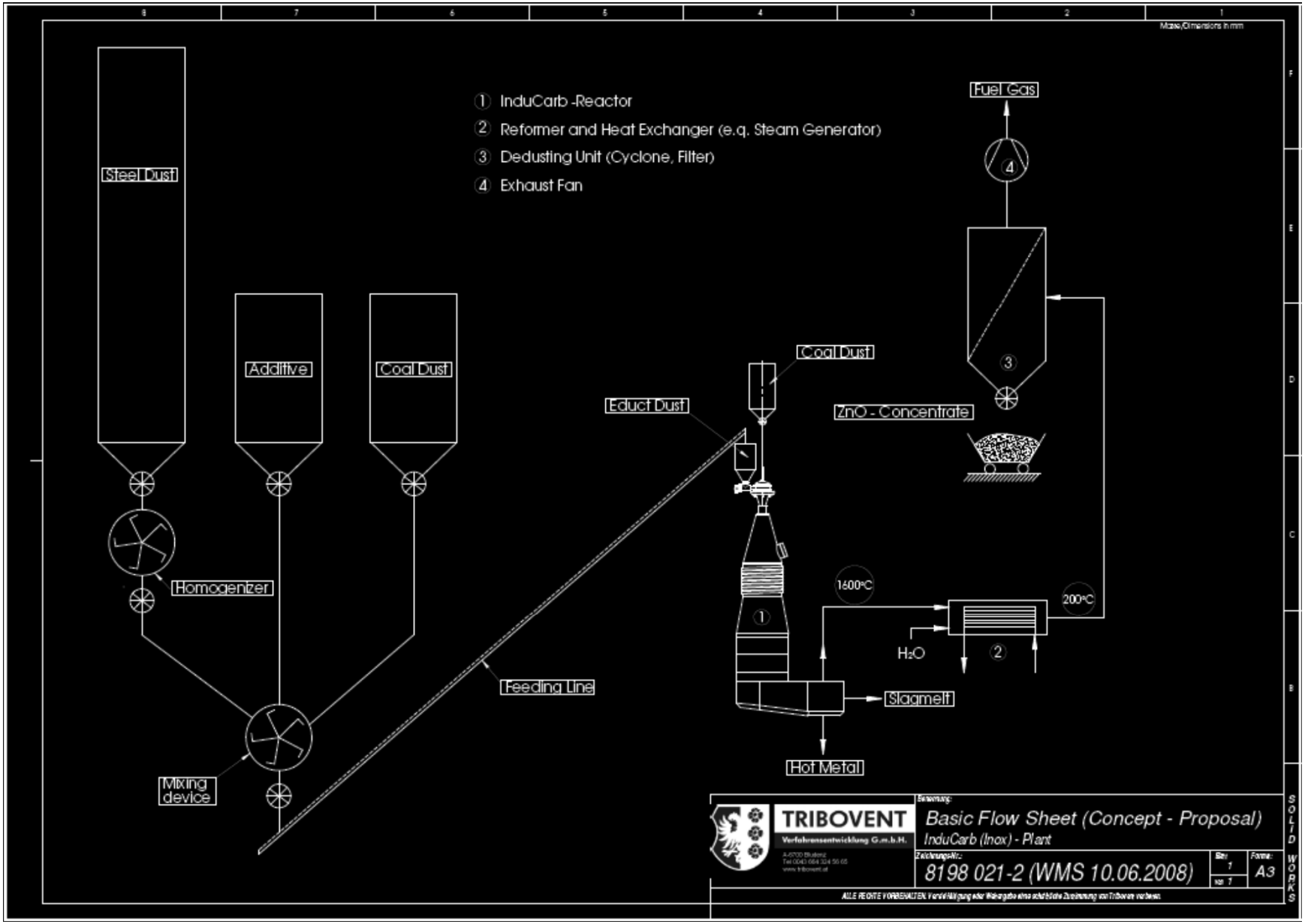
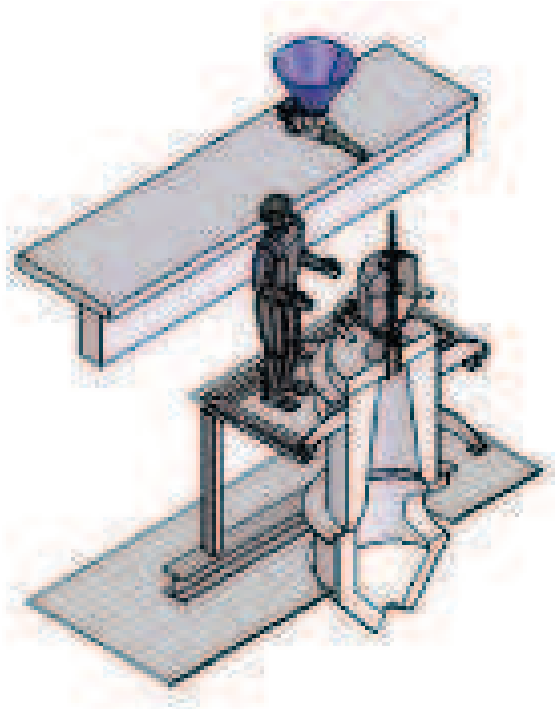
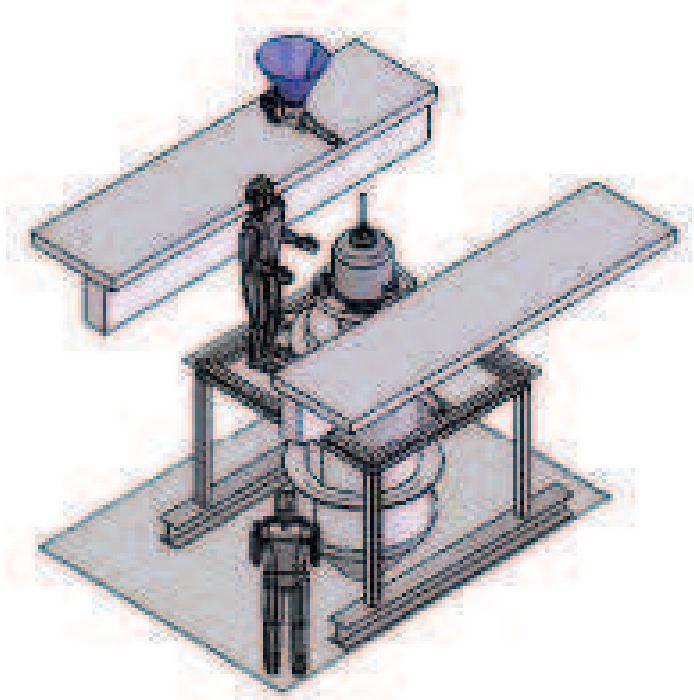



## InduCarb (Inox)

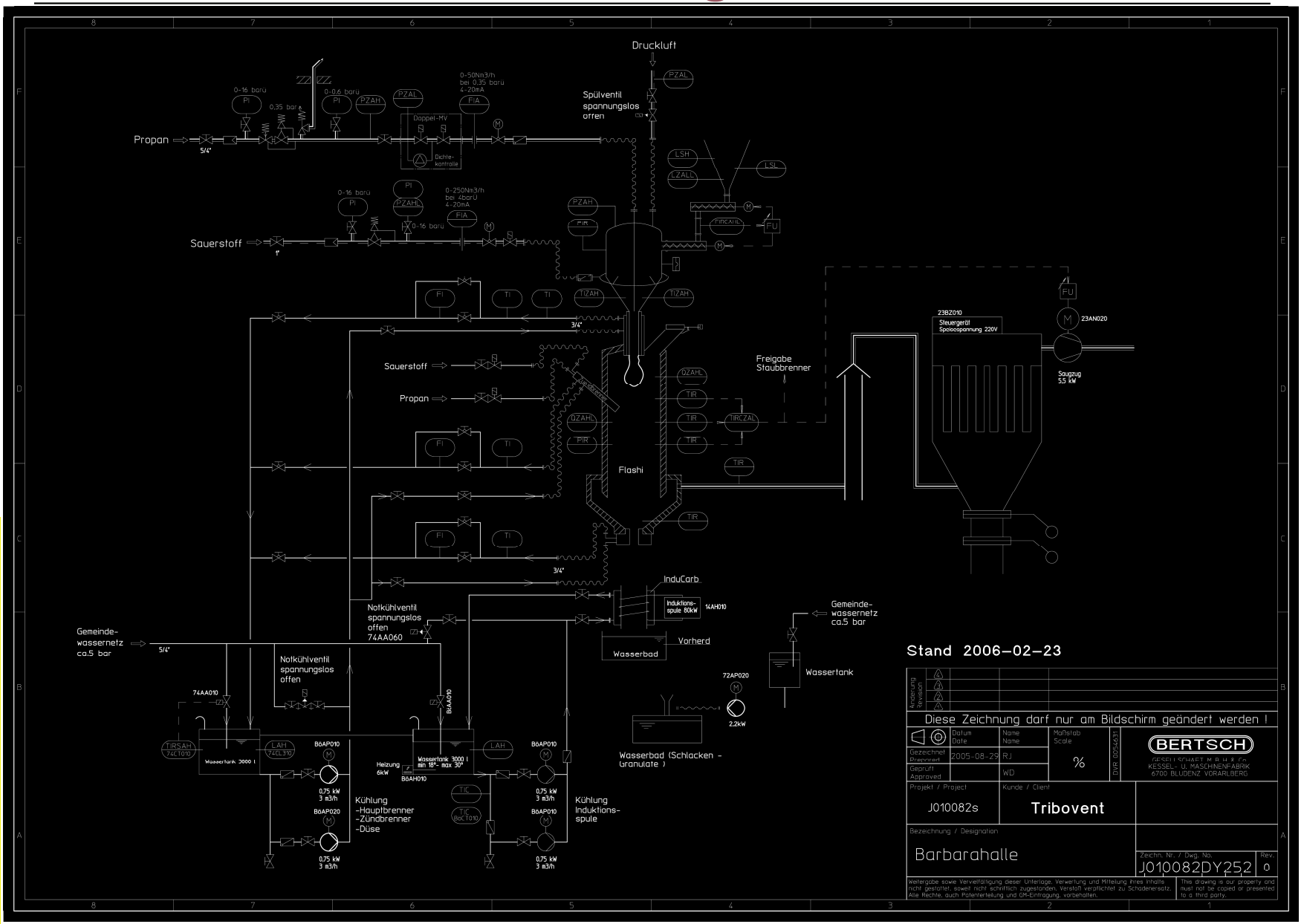

① InduCarb -Reactor
② Reformer and Heat Exchanger (e.q. Steam Generator)
③ Dedusting Unit (Cyclone, Filter)
④ Exhaust Fan
Steel Dust
Additive
Coal Dust
Homogenizer
Mixing device
Feeding Line
Educt Dust
Coal Dust
Fuel Gas
ZnO - Concentrate
1600°C
200°C
H₂O
Slagmelt
Hot Metal
TRIBOVENT
Verfahrensentwicklung G.m.b.H.
Basic Flow Sheet (Concept - Proposal)
InduCarb (Inox) - Plant
8198 021-2 (WMS 10.06.2008)
A3
ALLE RECHTE VORBEHALTEN

# Testing Plant in Bludenz - Austria (Flash Reactor)





# R&I Schema Versuchsanlage Bludenz

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# Testing Plant: Flash Reactor in operation

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# RD1 – Testing Plant: Flash Reactor in operation

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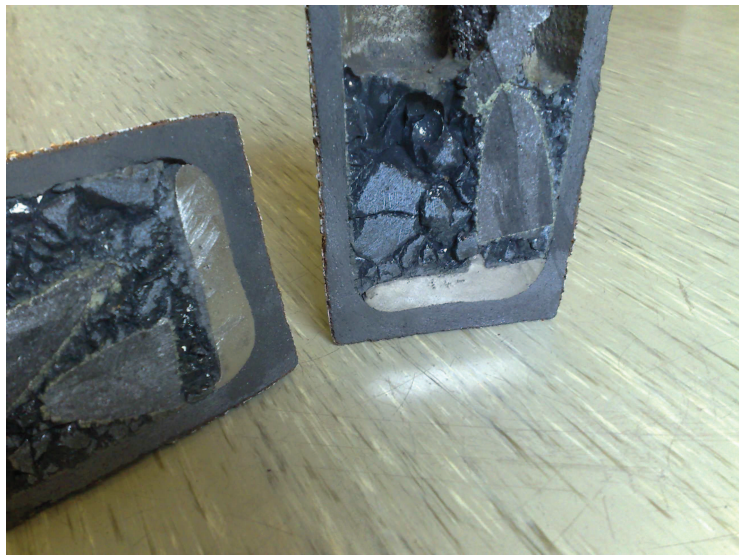
# InduCarb lab melting test, steel mill dust



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# InduCarb lab melting test, steel mill dust

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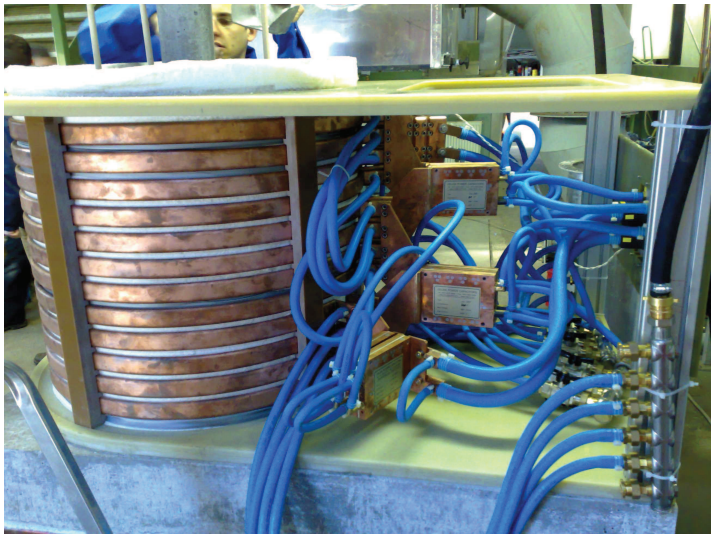
# InduCarb, 600mm



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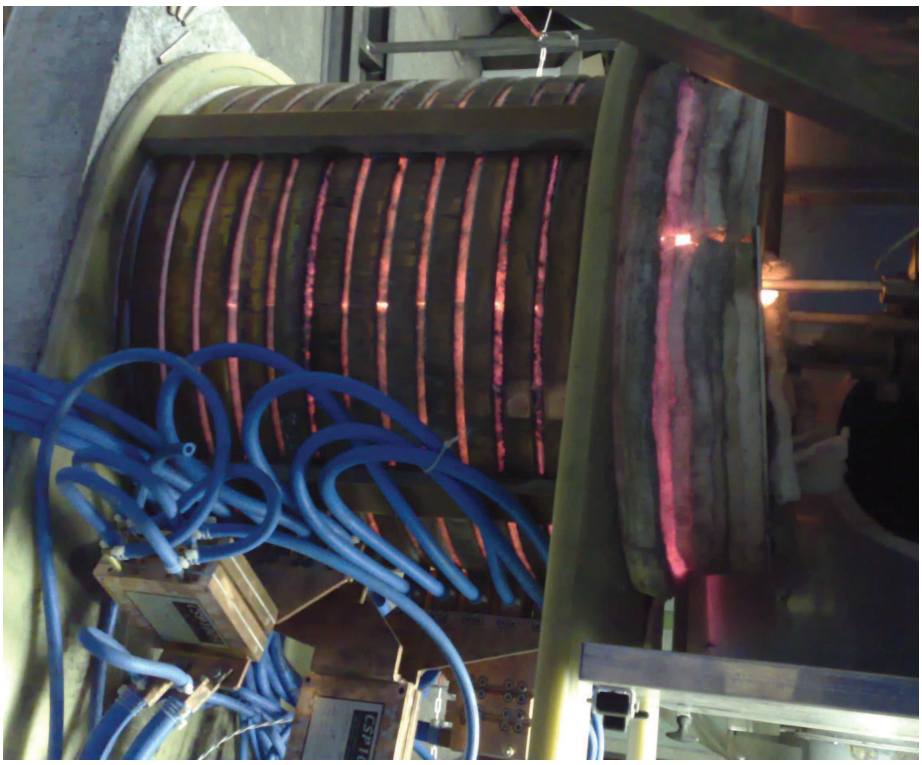

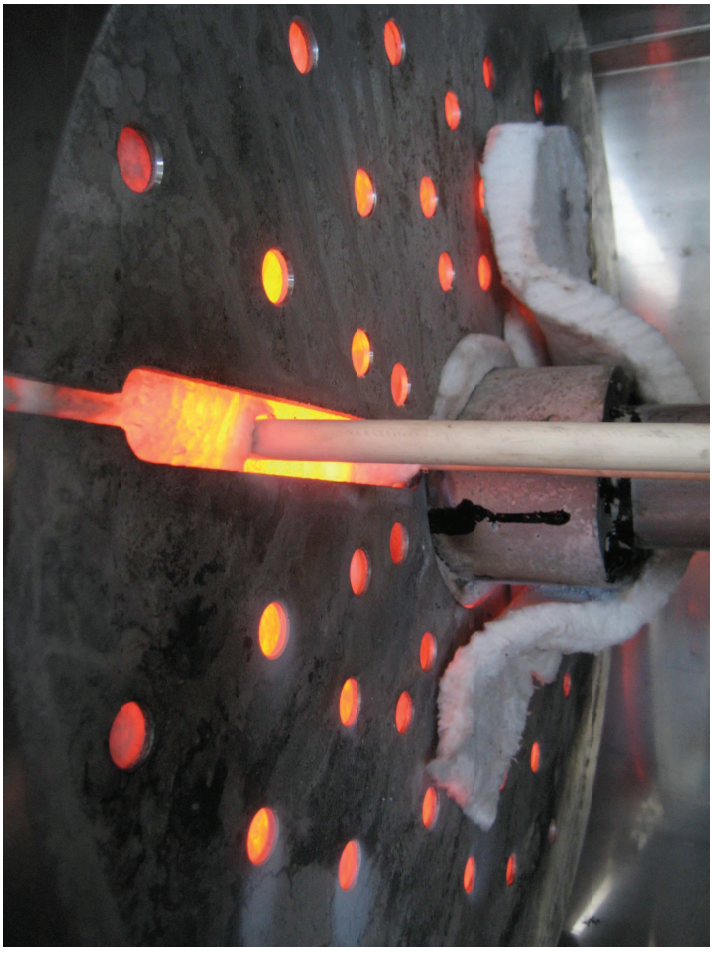

InduCarb, 600 mm

# Some development Projects (References)

- HOLCIM: Blastfurnace Slag Atomisation
- RioTinto/HIsmelt: Optimisation of phosphouros containing Slags
- D. Swarowski :Recycling of lead containing special glasses
- Swarco: Process - Development of microspherical glasparticles
- Montanwerke Brixlegg: Atomising Blackcopper – Converter
- Lafarge: Deslagging process for CKD
- Cementos Polpaico: Production of artificial Blastfurnace Slag and Pozzolana
- Böhler – Edelstahl /VDEh/CSM (Rom): EU – Project „URIOM“ (InduCarb)
- Recmix/ALZ (Belgium): direct charged InduCarb
- Böhler – Edelstahl: RecoDust
- Voestalpine/Montanuniversität Leoben: Evaluation Project, semi industrial plant Flashreactor

- **Total R&D Tribovent investment (2000-2008): EUR 6,5 mio.**

ECONOVIUS

Die Firma

**TRIBOVENT**
**Verfahrensentwicklung GmbH**
**6700 Bludenz/Lorüns**

wurde mit dem Projekt

**„InduCarb-Technologie"**
**(elektro-induktiv erhitzter Koksbettreaktor)**

mit dem „Econovius 2007"

**ausgezeichnet**

Der „Econovius" zeichnet kleine oder mittlere österreichische Unternehmen für besonders hohe innovative Leistungen aus.

Dr. Martin Bartenstein
Bundesminister für Wirtschaft und Arbeit

Dr. Christoph Leitl
Präsident
Wirtschaftskammer Österreich

Dr. Peter Takacs
Geschäftsführer
Austria Wirtschaftsservice Gesellschaft mbH

Wien, am 06. Februar 2008

BMWA Bundesministerium für Wirtschaft und Arbeit
WKO Wirtschaftskammer Österreich
aws erp-fonds

## Several Innovation Awards

- 2 x Genius
- Vorarlberg Innovation
- Austrian State Econovius

# Thank you for your attention !