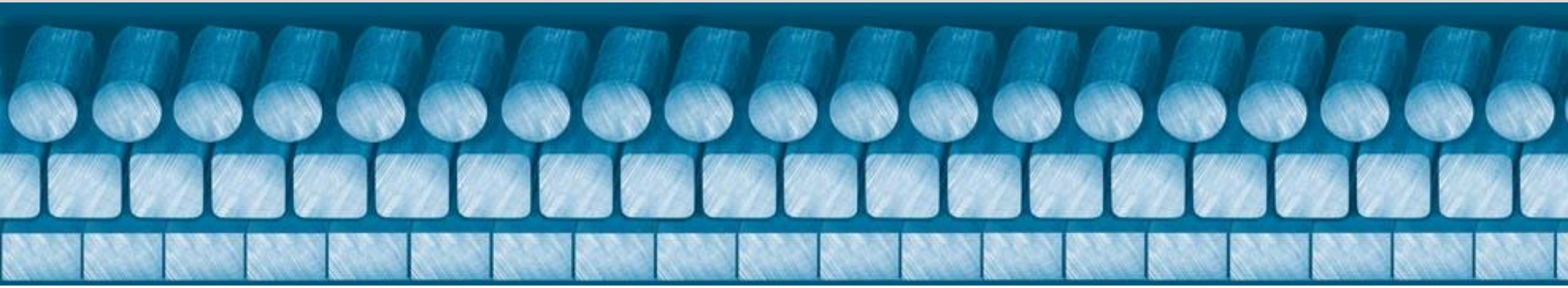
RECYCLING REFRACTORIES FROM AN ENDUSER´S VIEWPOINT



MINERAL RECYCLING FORUM 2016
Inntel Hotels Rotterdam Centre, Rotterdam 14 - 15 March 2016

www.rhi-ag.com EXCELLENCE IN REFRACTORIES RHI

Contents

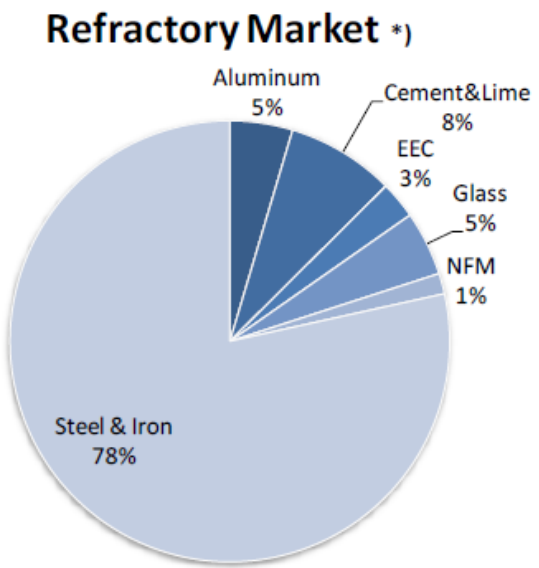
Introduction

Mass Balance of Refractories after Use

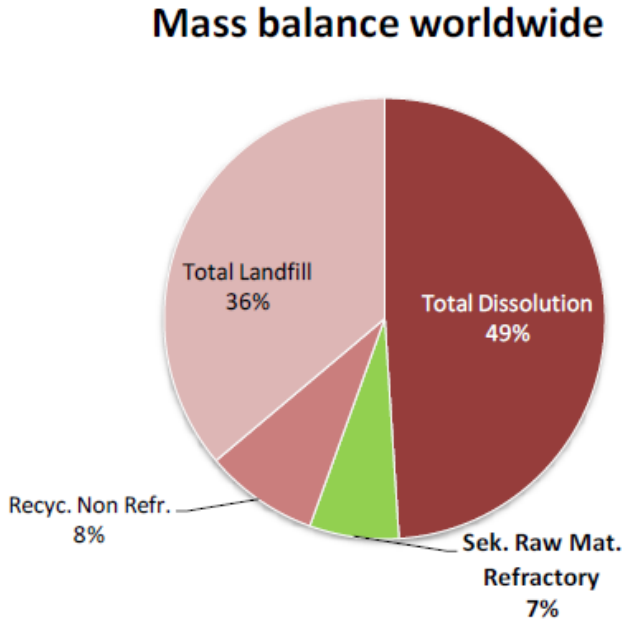
- Based on the original materials installed:
- 35 % dissolved/consumed in within the process
- 27 % is used in non refractory applications
- 20 % can be recycled as secondary refractory material
- 18 % is disposed as waste (mostly fines)

Reference: PRE Position and Reference Paper, Management of Refractories in Europe,
R 53 – December 2002

Market for Secondary Raw Materials - Worldwide



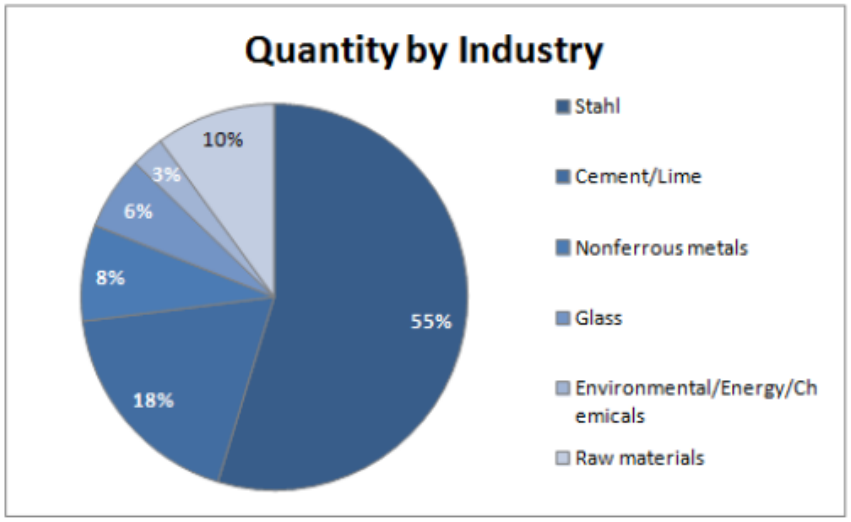
Market refractories: 23 Mio. t



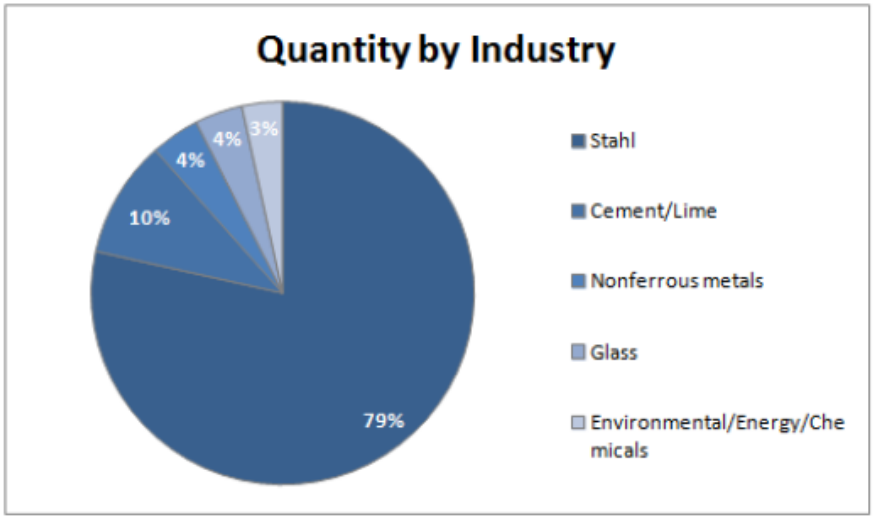
Market sec. raw materials: 1,6 Mio. t

Industries using Products made of Secondary Raw Materials

Industries using RHI products:



Industries using our products made of secondary raw material:



Why Recycle Refractories?

Motivation for Recycling

- Sustainable protection of natural resources
- Less exploitation, thus saving nature
- Lowering CO_2 emissions created by producing raw materials
- Reduce landfill volume
- Save landfill costs
- Reduce liability of land filled material (cradle to grave)

Effects of Recycling

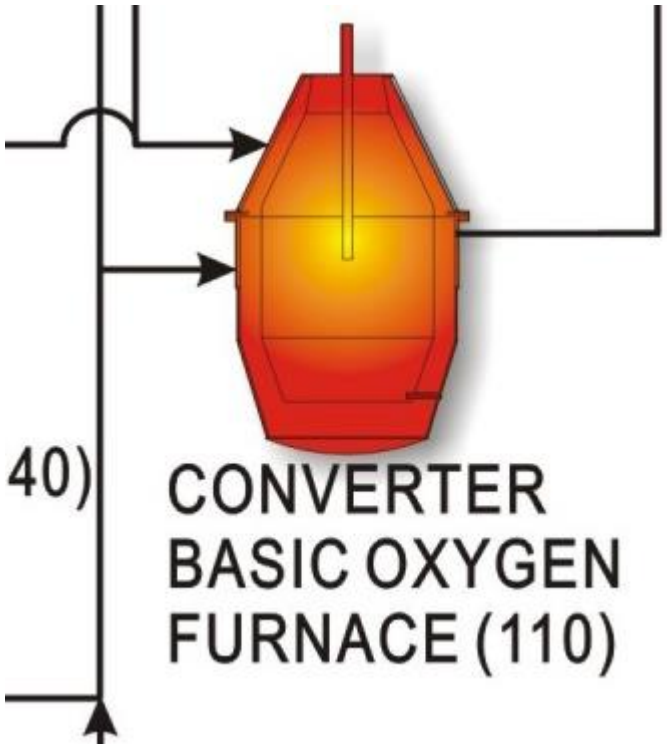
- Save raw material costs
- Improve environmental balances and figures
- Introduce new products in new markets
- Closer cooperation between refractory supplier and customer
- Introduction of recycling specialists to improve treatment and distribution of recycled materials
- Stay ahead of ever changing EPA regulations on landfill materials.

Potential Industries for Recycling

Industries and Furnace Types

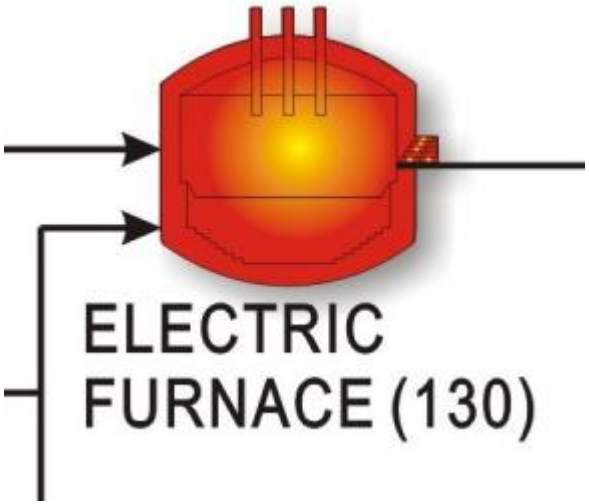
Environmental Energy Chemical	Industrial Incineration
	Power Generation
	Oil Refineries
	Chemical & Petrochemical
	Pulp & Paper
	Kiln Furniture
Non-Ferrous Metals	Primary
	Secondary
Cement and Lime	Cement
	Lime
Glass	Flat Glass
	Container Glass
	Water Glass
	Fibre Glass
	Specialty Glass
	Dinner Ware
Iron/Steel	EAF
	BOF
	Ladles
	Reheat Furnace
	Torpedo Cars
	Flow Control
	Induction Furnace

BOF Converters



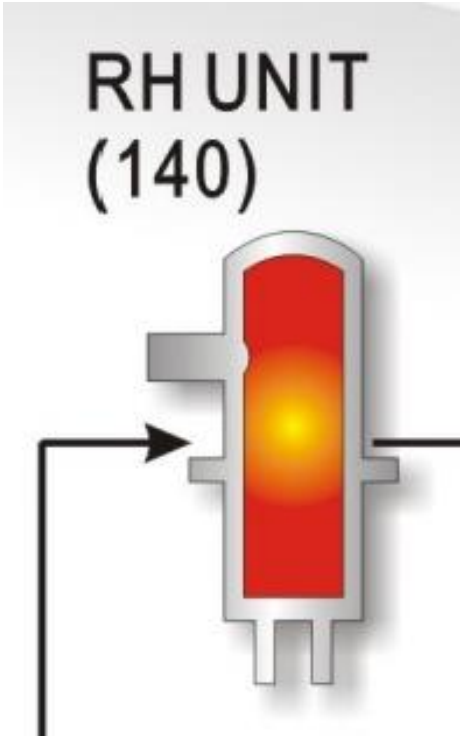
- Desirable
  - MgO-Carbon
  - MgO
- Contaminant
  - Metal/Slag
  - Alumina refractory
  - Fines

Electric Arc Furnace



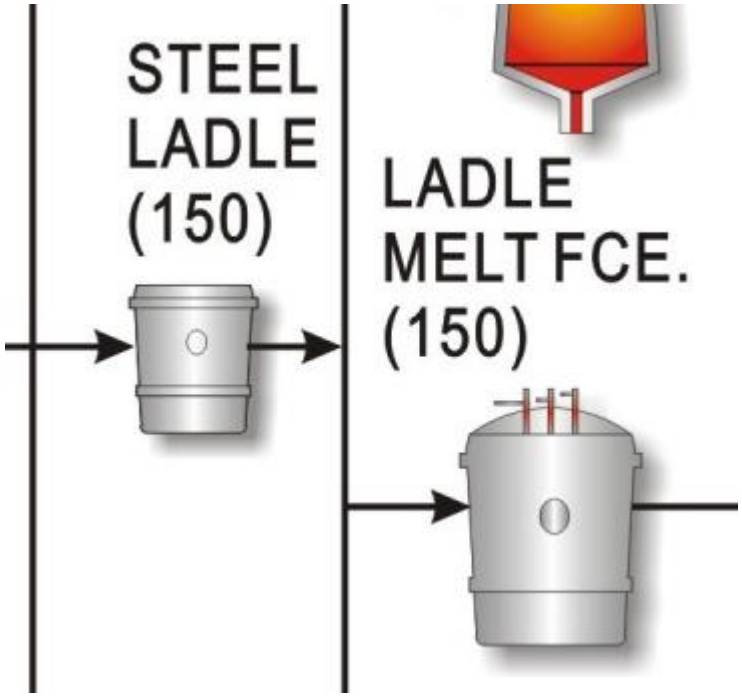
- Desirable
  - MgO-Carbon
  - MgO
  - Electrodes
- Contaminant
  - Metal/Slag
  - Fines

RH/DH Degasser Units



- Desirable
  - MgO
  - MgO-Chrome
- Contaminants
  - Alumina refractory
  - Metal/Slag
  - Fines

Ladles



- Desirable
  - MgO
  - MgO-Carbon
  - AMC
  - Slide Gates
  - Alumina
- Contaminants
  - Dolomite
  - Metal/slag

Example from Steel Industry

Breakout from steel industry before sorting

MgO-C scrap after sorting and cleaning

Close up of Unprocessed Bricks

Yield affected by:

- Steel
- Nozzles
- Fines
- Hydrated Brick
- Hi Alumina castable
- Bricks stuck together

Removing Metal and Slag

Grizzly

- Spacing @ 3” to separate the large pieces.
- Remove alumina and large pieces of brick stuck together.
- Fines separated.
- May elect to remove large pieces for recycling.
- May elect to crush large pieces for melt shop addition.

Example from Glass Industry

Breakout from glass industry before sorting

AZS after sorting and cleaning

Example from Foundry

Alumina Graphite from Foundry before sorting

After cleaning and sorting

Examples from Other Sources

High Alumina Precast Shapes

Porcelain Scrap

Recycling Terminology

European waste management legislation uses following terminology for refractory breakout:

- Materials that have not been used or changed in chemical or mineralogical compositions during use. Can be used directly as secondary raw material.
- Materials that have been used and no changes in composition.
  Pose no environmental risk.
  Can be used as secondary raw material when processed according to the specification for their use as secondary raw material.
- Materials that have been used and pose some environmental risk.
  Only authorized or competent recycling companies are permitted to separate, clean and convert them into non-hazardous secondary raw materials.

Partnership

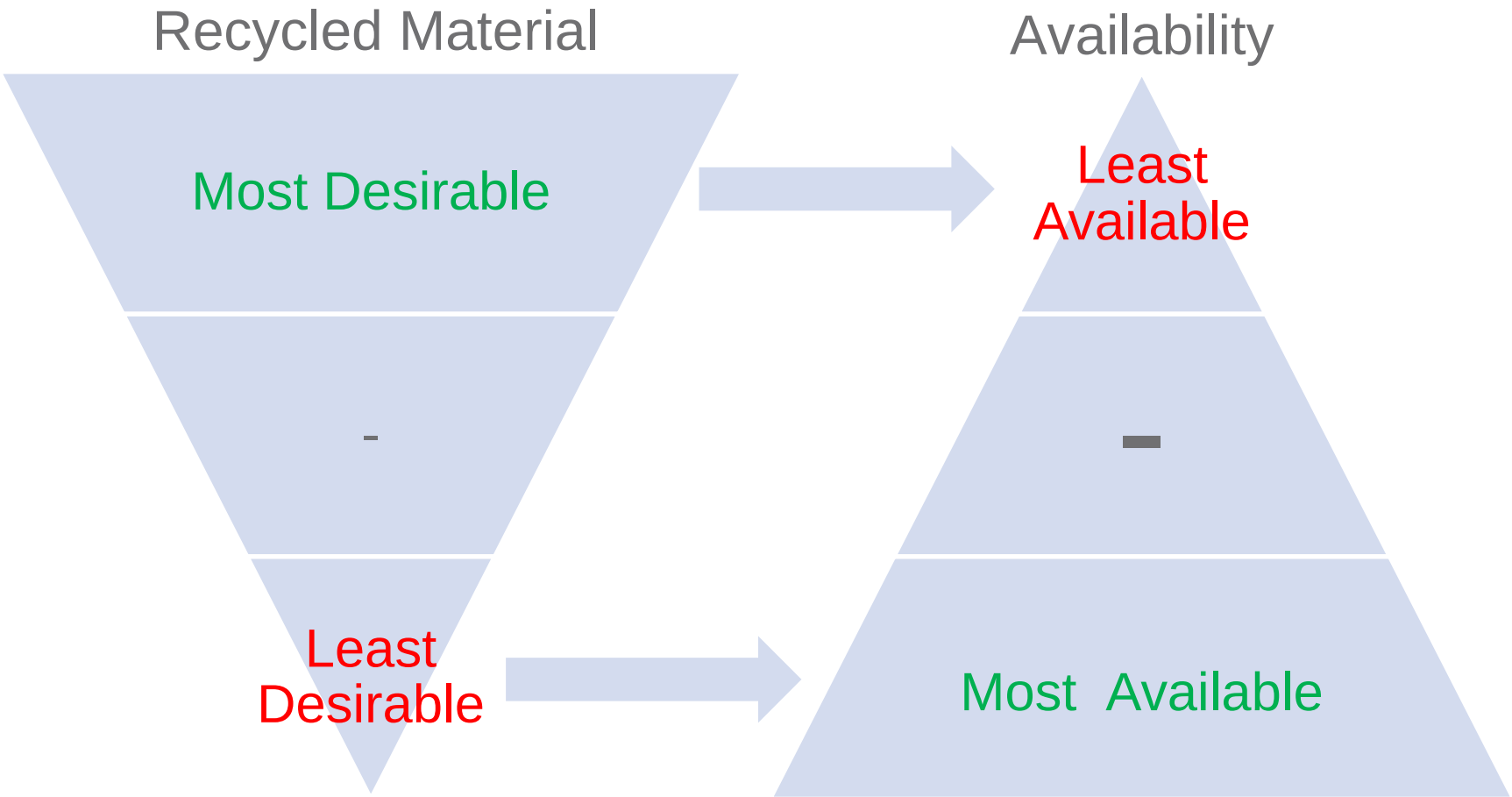
Production Plant

RHI-AG

Processor
To make the spent product usable for recycling

- Processing companies have become increasingly important.
- Closer cooperation between production plant, the processor and the supplier is necessary to increase the consumption rate of secondary raw materials.

Recycled Materials vs Availability



Reference: Mineralen Kollee

Minimising Refractory Waste

Demolition:

- Determine the classes of breakout materials .
- Select and segregate refractory types.
- Supervision during demolition.

Processing:

- Separation of fines, large pieces and debris from the desirable refractory.
- This increases purity of materials with higher value.

Maximising Waste Value

Production Plant

- Selective demolition of spent refractory
  Increase purity of materials with higher value
- Supervision during demolition
  Determine the classes of breakout materials

Recycling Partner

- Improve separation techniques
  Remove infiltration zones to increase the degree of purity
- Improve sorting techniques
  introducing technical equipment to sort the different refractory types
- Find alternative applications for materials that cannot be reused in refractory

Conclusion

A financially and environmentally productive recycling program requires cooperation by all three partners.

This is accomplished by:

- Determining what can be recycled.
- How can the refractory be removed, segregated and stored.
- Establish Standard Operating Parameters (SOP's) throughout the process.
- Maintain communication among all three partners.

Conclusion

Recycling of refractories is one of RHI´s main focuses in regard of raw material availability and cost savings.

Recycling concepts are put in place.

New products based on secondary materials are introduced.

Cooperations with recycling partners allows us to increase the amount of high purity materials.

Advantages include saving natural resources, reduce carbon emissions, reduce landfill, save landfill costs and provide cost savings to our customers.

The refractory industry and it´s partners have made immense progress in improved usage, reuse, recovery, recycling and waste minimization. The achievements to date prove a solid basis for further progress and for improved sustainability.

Conclusion

- Every recycling program is unique but our common goals and the commitment to succeed will overcome any obstacle.
- It is easy to send spent refractory to landfill but rising taxes along with environmental fees and increased pressure on our natural resources will leave us with no option but to utilize this vital secondary raw material.

Questions

Thank You

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