KOBELCO Pelletizing System - Contributing to Outstanding Ironmaking Operations





Kobe Steel, Ltd. (KSL)
March 3rd, 2015

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1. Corporate Profile of KSL
2. KOBELCO Pelletizing System
3. Contribution to BF & DR Operations
4. Collaborations
5. Project Reference

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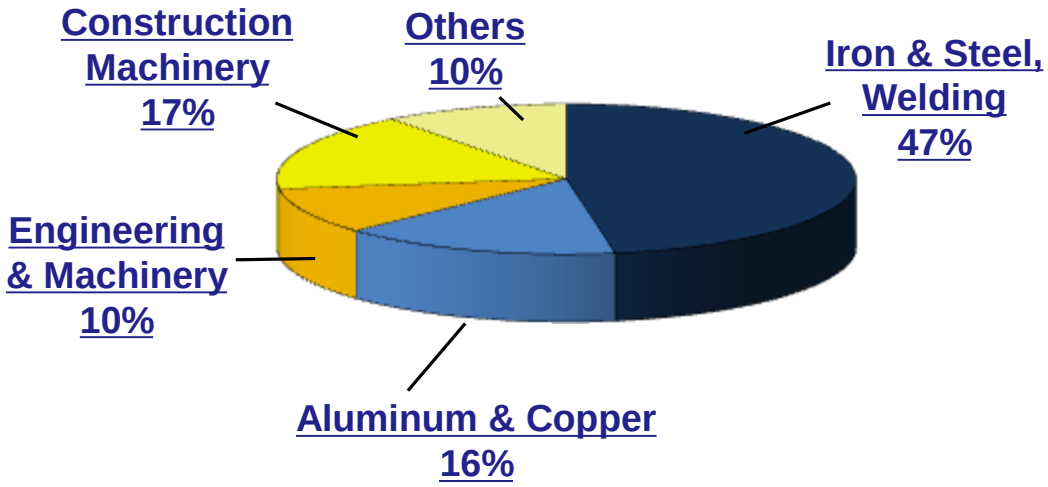
Corporate Profile

KSL is composed of ;



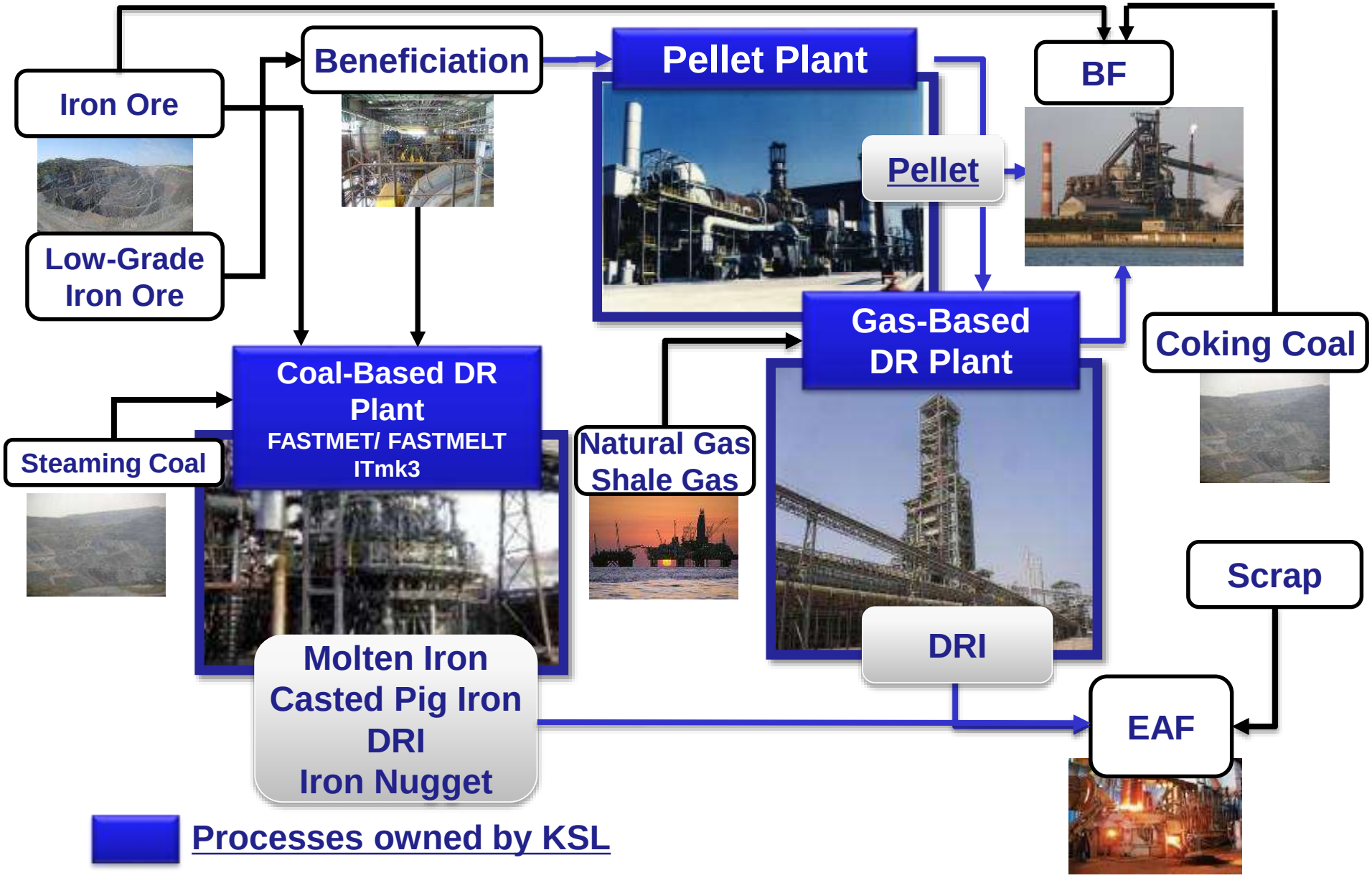
Name:	**Kobe Steel, Ltd.**
Founded :	**September 1, 1905**
Net Sales :	**USD 17.73 billion* (FY 2013)**
Capital :	**USD 2.44 billion* (FY 2013)**
Related Companies:	**209 subsidiaries** **62 equity-valued affiliates** **(FY 2013)**
Employees :	**36,019***

*Consolidated (KSL + subsidiaries , excluding affiliates)
*Ex-rate: JP¥ 102.92 / USD



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Outline of Iron Making Processes



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Recently Built Plants - Unique Technologies



Pellet Plant – Vale Oman



Jindal Shadeed DRI Plant - Oman



Qatar Steel Company – HBI/DRI Combo plant



RHF based technology
Fastmet - Japan



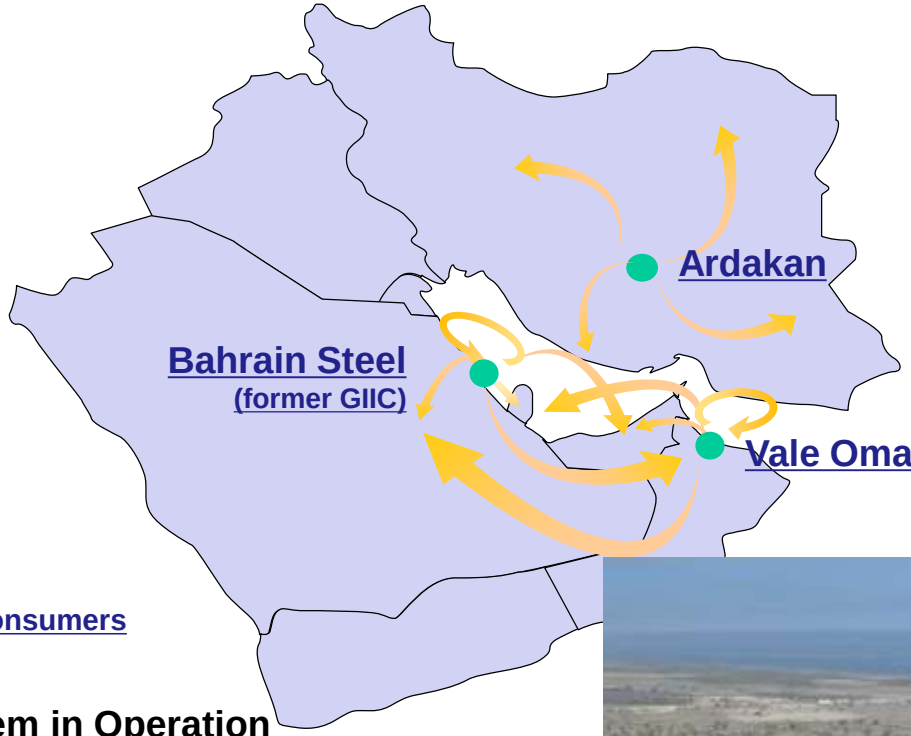
Pellet Plant – Bahrain Steel No2 (Former GIIC)

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Presence of KOBELCO Pelletizing System in Middle East



Bahrain Steel
(former GIIC)
No.2, Bahrain





Ardakan, Iran

Flow of pellet product to consumers

Kobelco Pelletizing System in Operation

Pellet Plant	Capacity	Process
Bahrain Steel (former GIIC)	11MTPY 5MTPY* x1 6MTPY x1	GK
Chador Malu Mining & Industrial Co. (Ardakan)	3.4MTPY	GK
Vale Oman Pelletizing Company L.L.C.	9MTPY (4.5MTPYx2)	GK
Total	**23.4MTPY**	

*Originally 4MTPY



Vale / Sohar, Oman

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References on Pelletizing Field

- Long and rich experiences in pelletizing plant construction since 1966.
- Long and rich experiences in pelletizing plant operation since 1966
- Delivery of the world largest grate kiln pelletizing plant for Bahrain Steel (former GIIC) No.2.
- Capability to support operation & maintenance

Kakogawa No.1 plant



Bahrain Steel No.2
(Capacity: 6.0 MTPA)



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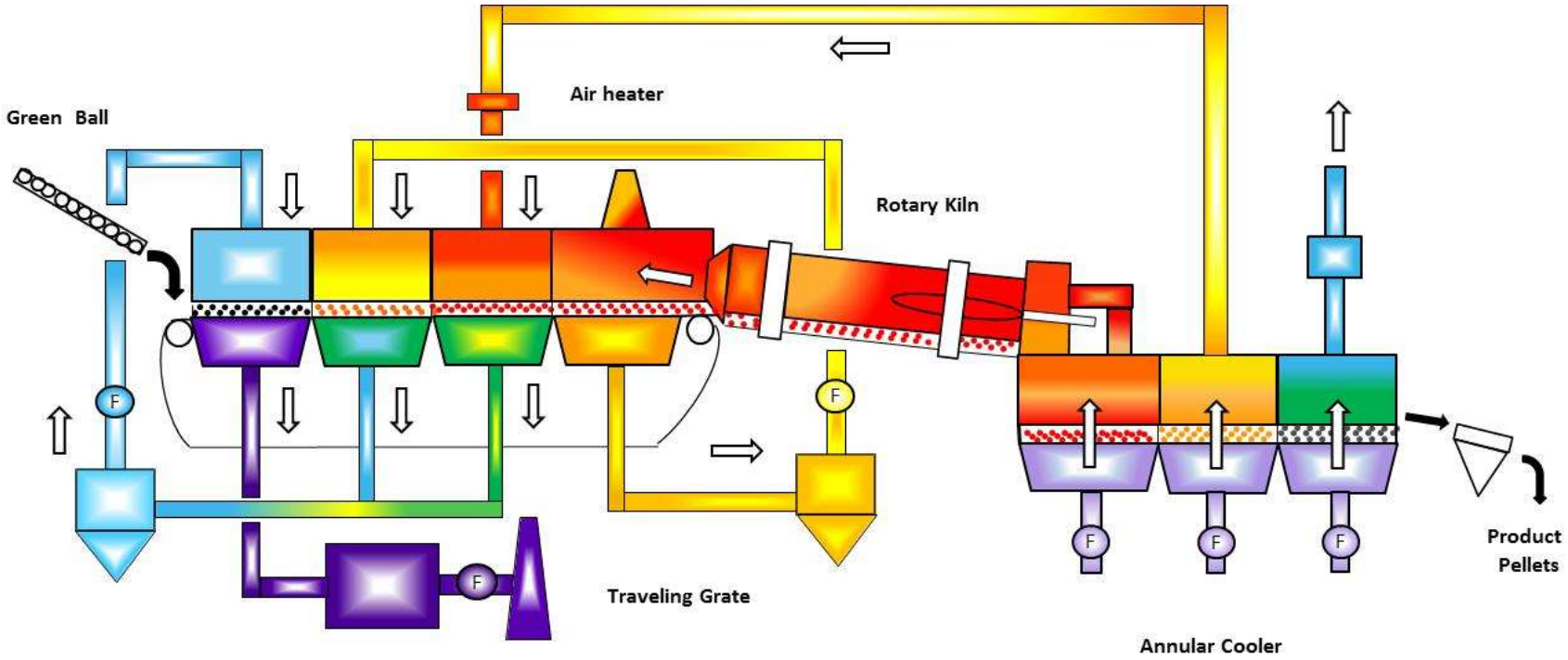
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Typical Process Flow

KOBELCO Pelletizing System



Pellet



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Grate-Kiln & KOBELCO Pelletizing system

- The Origin
  - Developed by Allis-Chalmers

- Grate Kiln Process
  - Lepol Grate-Kiln System (Cement process) is the basis.
  - Developed by Allis-Chalmers in 1960 with the improvements by KSL
    1. Production of high quality pellet
    2. Utilization of coal in the main burner

- KOBELCO Pelletizing System
  - Kobe Steel acquired the license of Grate-Kiln process in 1995 and our own brand “KOBELCO Pelletizing System” was born.

- Applicable to Various Kinds of Iron Ore and Variety of Fuels
  - Hematite, magnetite, limonite (LOI = 3.5~10%).
  - Gas, oil, cokes and thermal coal.

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Typical Unit Consumption

Assumption: 100% Hematite Iron Ore

Raw Material / Utility	Unit Consumption
• Iron Ore:	1,000 - 1,050 kg/t-pellets (depending on LOI) (All spillages are recycled in the process.)
• Limestone:	Depending on the chemical requirements of Pellet.
• Bentonite:	5 - 8 kg/t-pellets
• Anthracite (or Coke Breeze):	5 - 10kg/t-pellets (Hematite ore)
• Fuel :	190Mcal/t-pellets incl. anthracite heat (Hematite ore)
• Power:	23kWh/t-pellets (Induration process)
• Water:	0.07m3/t-pellets (In case of wet concentrate receiving)

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Typical Pellet Quality

Quality items	Measuring Method	Criteria	
		For BF Pellet	For DR pellet
Size distribution (9-16mm)	ISO 2194	> 93 %	
Size distribution (-5mm)	ISO 2194	< 0.5 %	
Cold compression strength (Average)	ISO 4700	> 300 kg	
Cold compression strength (-100kg)	ISO 4700	< 0.5 %	
Tumble index (+6.3mm)	ISO 3271	> 97 %	
Abrasion index (-0.5mm)	ISO 3271	< 3.5 %	
Porosity	JIS M 8716	> 24 %	
Swelling index	ISO 4698	< 16 %	-
Reducibility	ISO 7215	> 65 %	-
Metallization	ISO 11257	-	> 95 %
Fragmentation (+6.3mm)	ISO 11257	-	> 99 %
Fragmentation (-0.5mm)	ISO 11257	-	< 0.5 %

Note: Pellet quality is adjustable in accordance with the client's requirement.

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Capacity Lineup

1. Capacity Lineup

Small Range:	2.0 - 2.5 mtpa	
Medium Range	3.0 mtpa	
	4.0 mtpa	
	5.0 mtpa	
Large	6.0 mtpa	(Largest KPS in operation in Bahrain)

2. Tailor-Made Design

To meet the customers' requirements (capacity of the plant, characteristics of raw materials, product quality, kind of fuel), KSL can offer tailor-made design with the following standard equipment size.

Traveling Grate	Width:	4.716 m, 5.782 m
Rotary Kiln	Shell i.d.:	5.8 m, 6 m, 6.6 m, 6.9 m, 7.2 m
Annular Cooler	Nominal dia.:	17 m, 18.5 m, 20 m, 22 m

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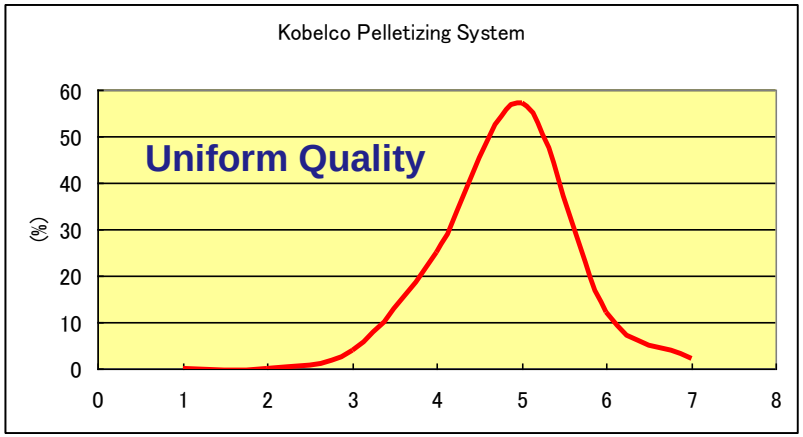
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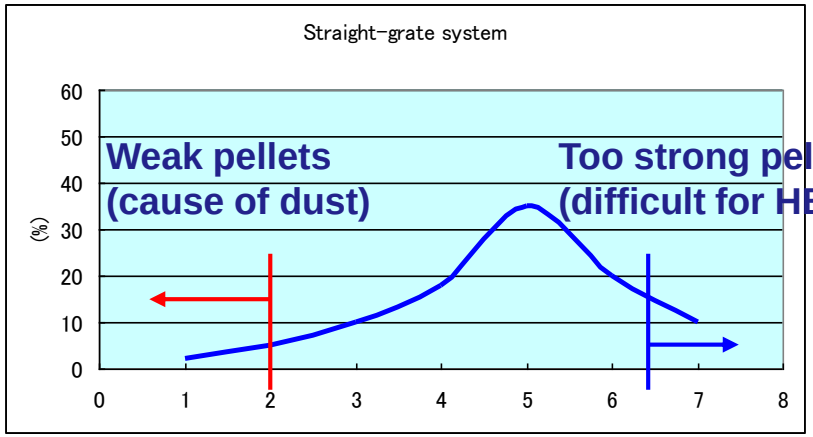
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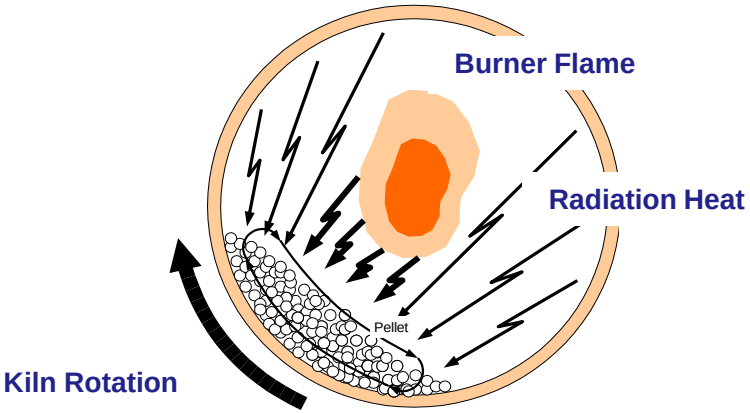
Better quality pellet

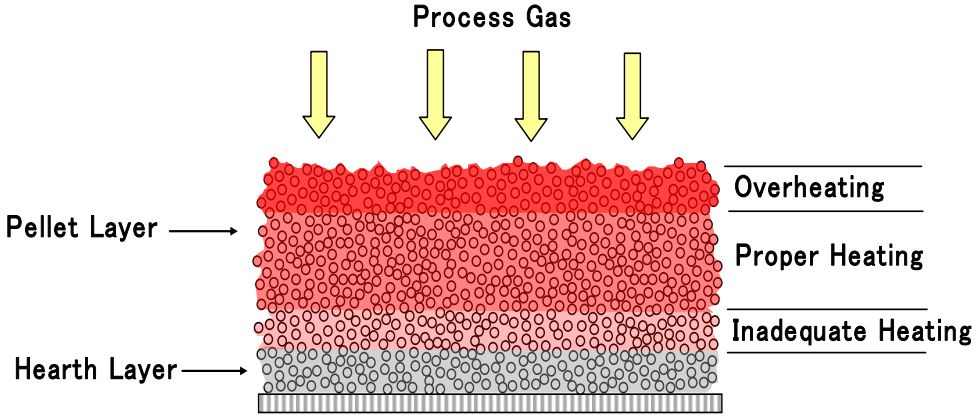
Uniform Quality / Preferable CCS

Comparison of Compression Strength Variation









Product Pellets of KOBELCO Pelletizing System can achieve a more uniform quality with less variation and high CCS.

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Uniform induration



Actual view inside the kiln

All pellets inside the kiln are uniformly indurated. This achieves less fine generation, and clean view inside the kiln can be seen.

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Quality difference on pellets (example)

Typical comparison between KPS and SG

	KOBELCO Pelletizing System (KPS)	Straight Grate System (SG)
Cold compression strength (kg)	> 300	250 - 300
< 100 kg inclusion (%)	Approx. 0.5	Approx. 2
Tumble index (%)	> 97	94.5 – 96
Abrasion index (%)	2.5 - 3	4 – 6
Porosity (%)	> 24	26 – 30

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Influences by pellet quality differences

Product loss by weak pellets

	KPS	SG	Difference
Weak Pellet Ratio	0.5%	2%	1.5%
Abrasion index	3.3%	5%	1.7%

Total 3.2%

Economic study on end-user

Assumption:

- **Pellet price: $105/t, Sinter feed price: $70/t**
- **Loss inside the client's plant site vs Recover the value by selling those fine**

Estimated calculation:

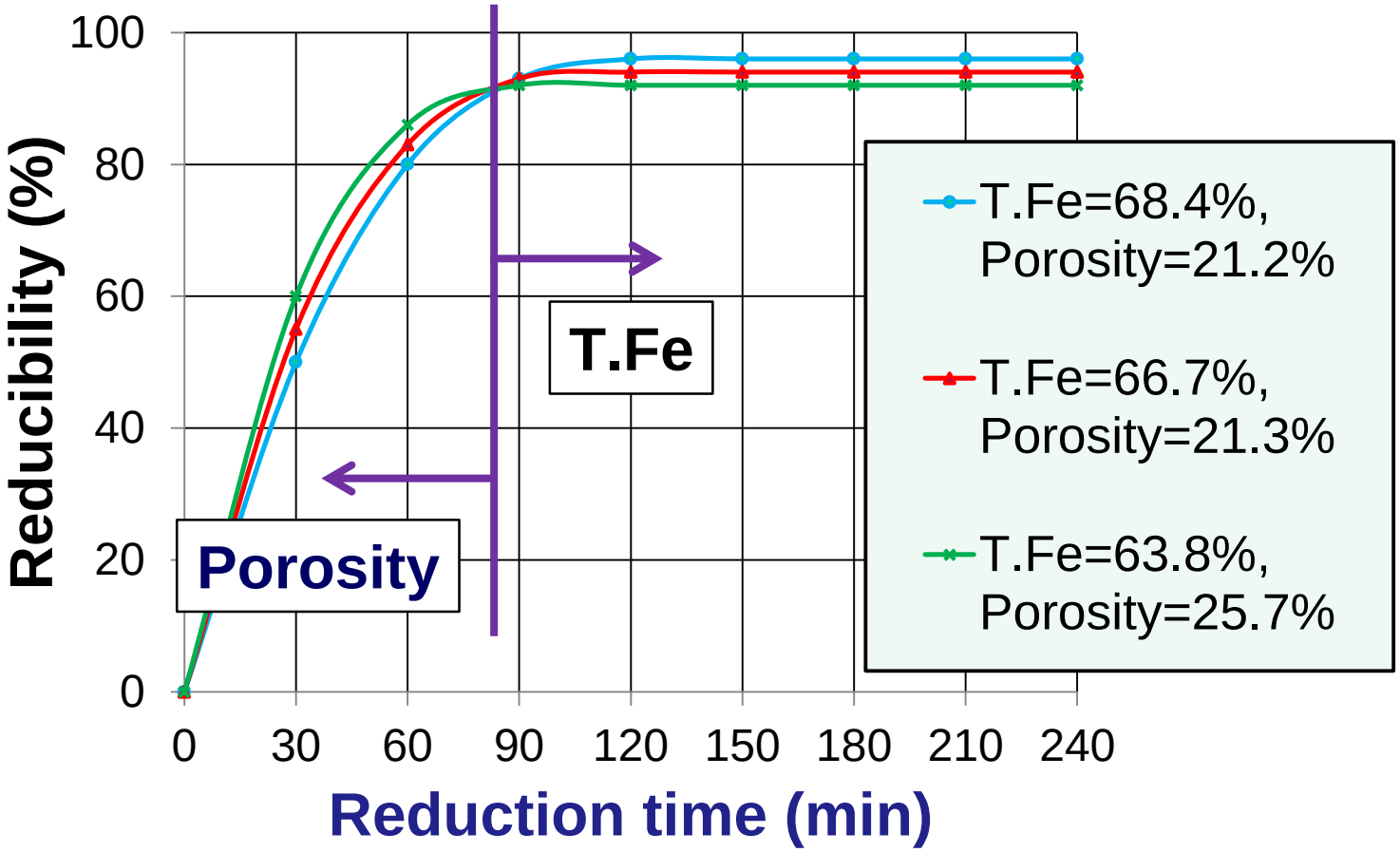
- **Loss; 4.0mtpy x 3.2% x $105 = $14.1M/y**
- **Recover; 4.0mtpy x 3.2% x $ 70 = $ 9.6M/y**

Economical disadvantage from product loss = $ 4.5M/y

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Relation of each quality parameter

T.Fe + porosity vs Reducibility



Reducibility correlates with T.Fe.

Source: "Evaluation of raw materials for gaseous direct reduction process" by KSL

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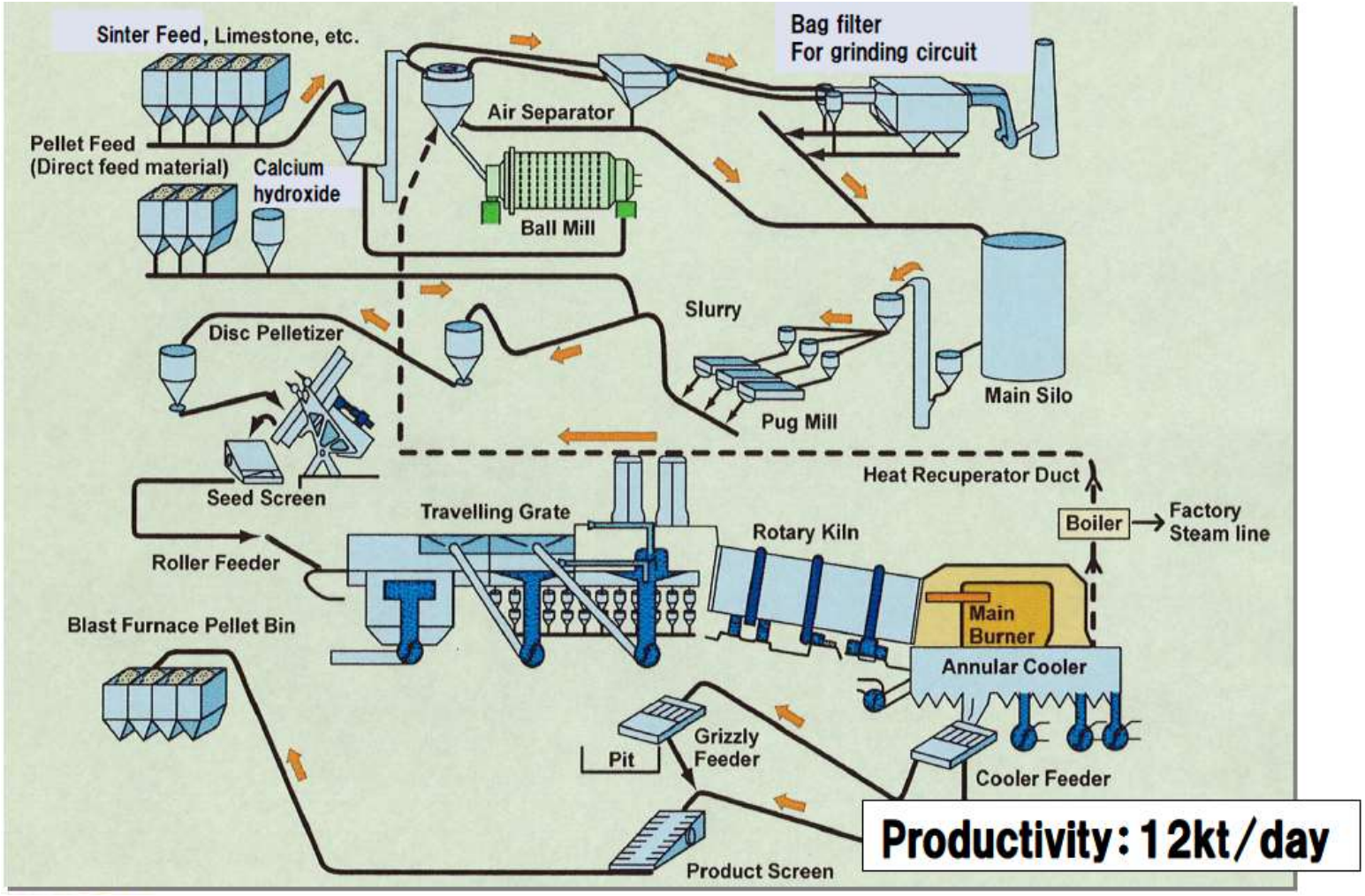
History of Pelletizing plant operations

- Long operation and maintenance experiences from 1966.
- Capacity enhancement
- Minimizing production cost
- Successive pellet quality development for BF



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Process flow of Kakogawa No,1 plant



Date; 3rd Symposium iron ore pelletizing in Quebec city, prepared by Kakogawa works

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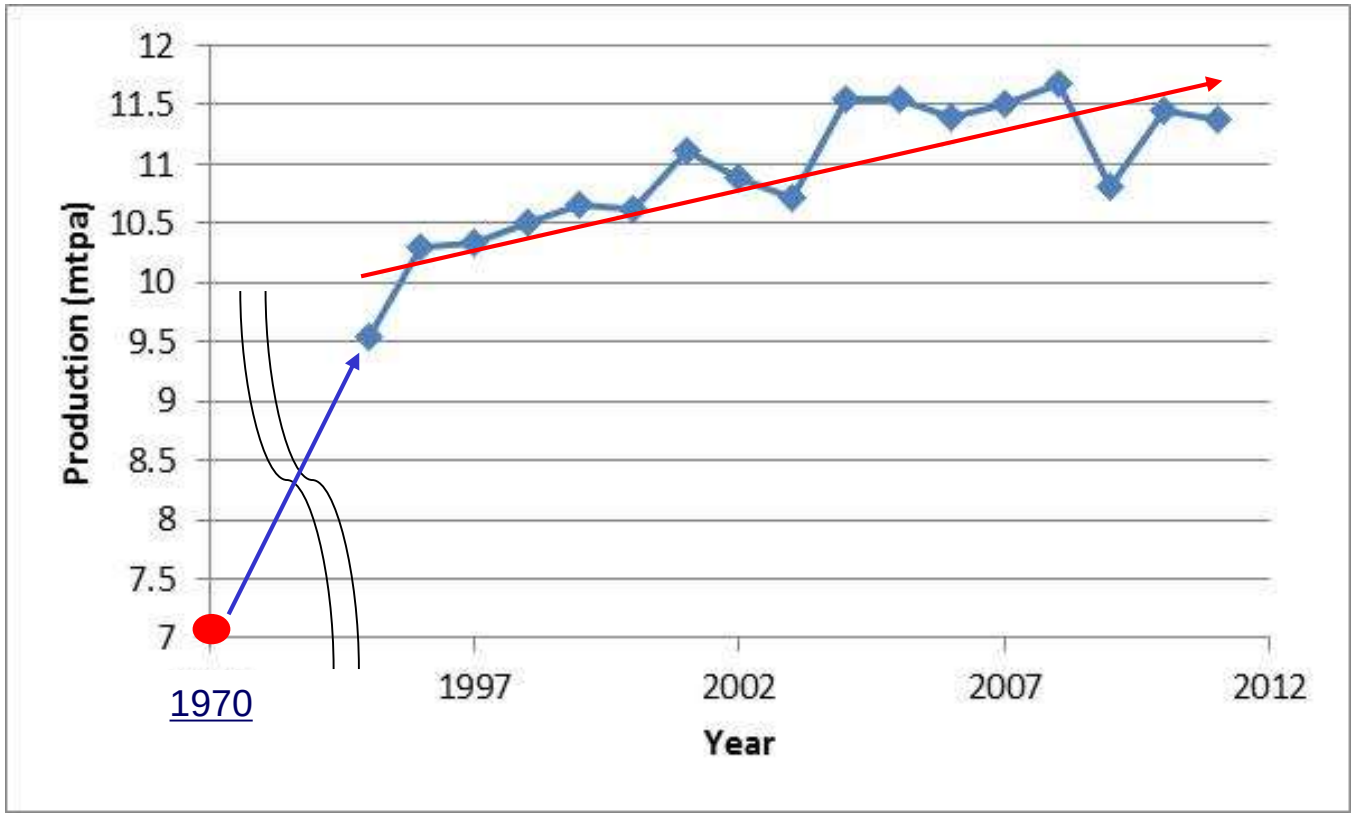
Features of Kakogawa No.1 plant

- Multi-use of iron ores, more than 10 brands at the same time
- Closed & dry circuit and mix grinding
  (together with iron ore and additives)
- No binder is used for balling
- Coal firing operation
- Higher fuel efficiency,

  - Recuperation for dry grinding
  - Heat recovery boiler

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Production history in Kakogawa No.1 plant

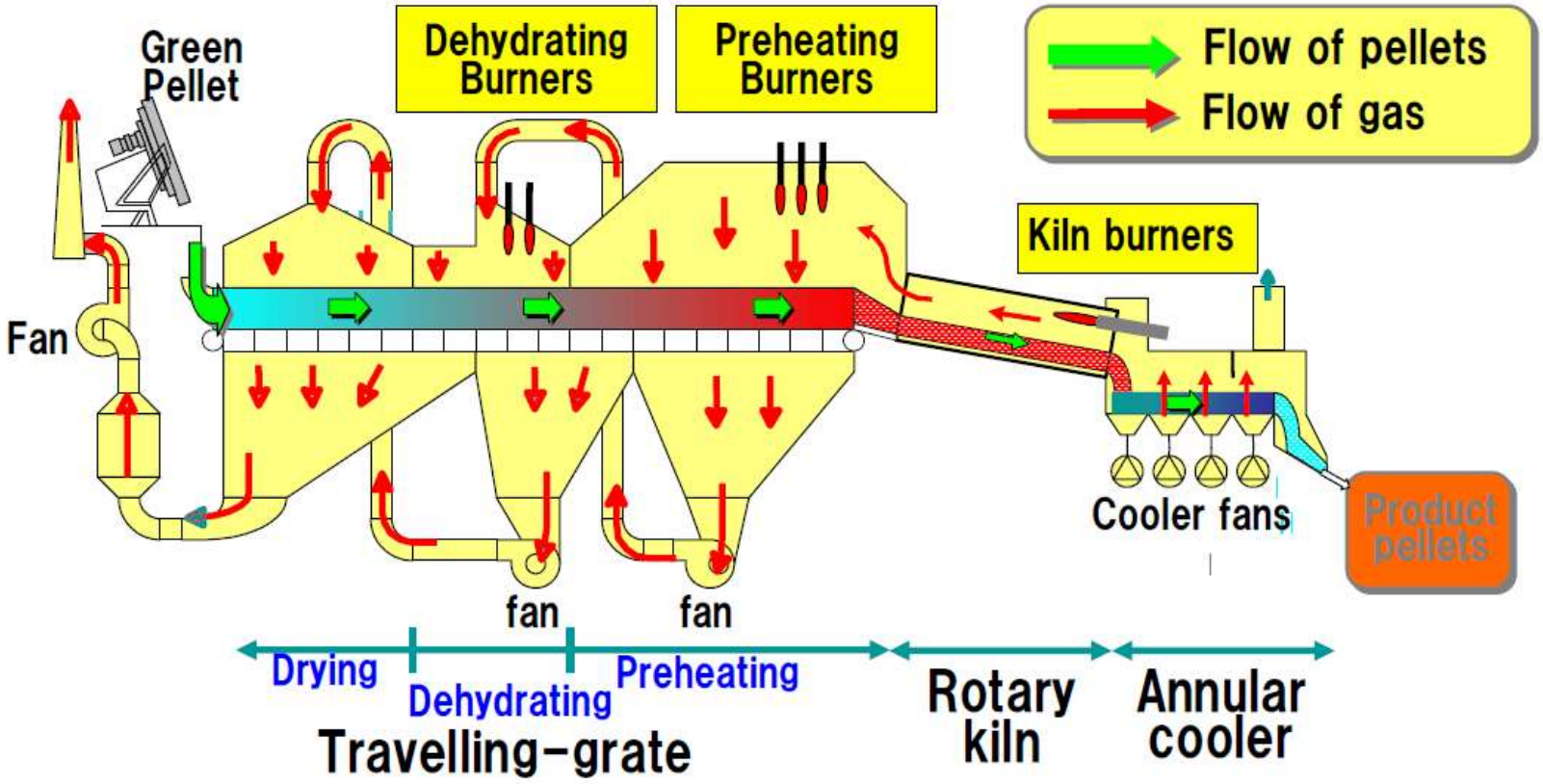


Date; 3rd Symposium iron ore pelletizing in Quebec city, prepared by Kakogawa works

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Capacity enhancement measures

- Extension of PH zone
- Operational improvements (grate bed control, etc.)
- PH and TPH burners



Date; 3rd Symposium iron ore pelletizing in Quebec city, prepared by Kakogawa works

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Higher basicity / Fluxed pellets (CaO/SiO2 > 1)

Limestone addition requires more heat for decomposition ($CaCO_3 \rightarrow CaO + CO_2$).

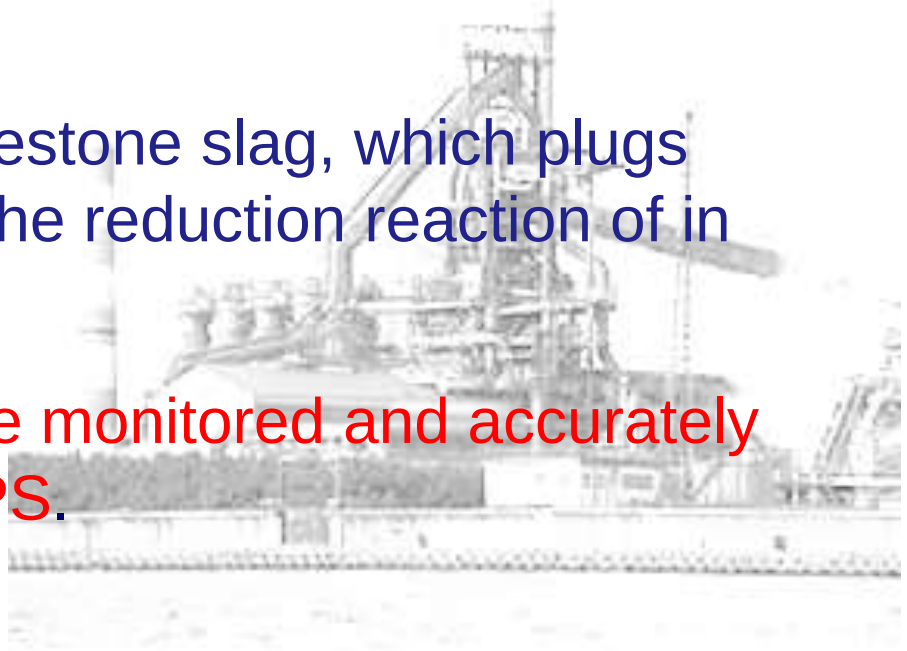
->> Green pellets inside the Kiln receive higher induration temperature from the Kiln Burner by radiation .

->> Appropriate heat pattern is designed for KPS

Uniform Quality

Overheated pellets generates limestone slag, which plugs pores of the pellets and disturbs the reduction reaction of in blast furnace.

->> Induration temperature can be monitored and accurately controlled by on-line sensor at KPS.

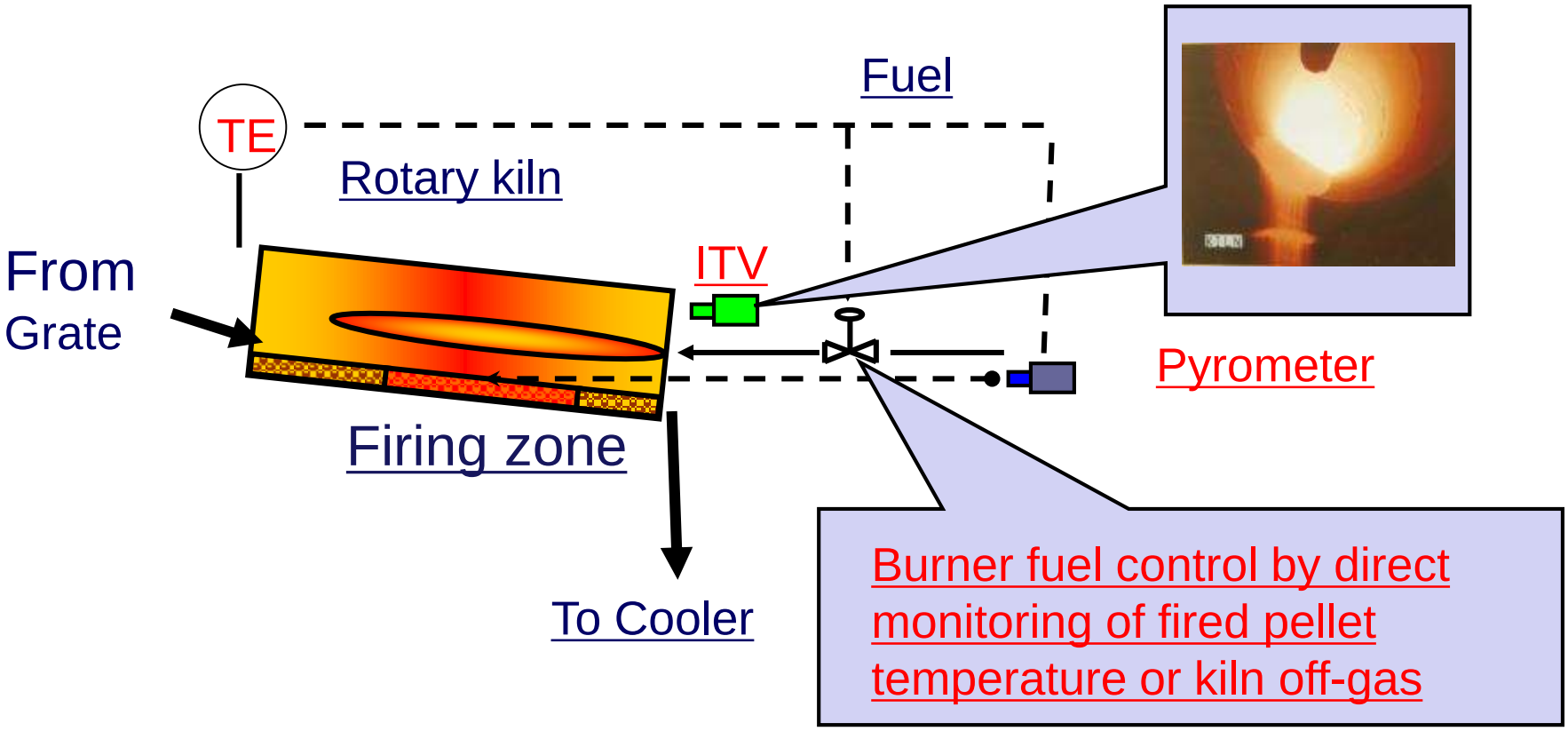


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Accurate quality control

On-time adjustment of operation parameters depending on the ore quality

Actual Monitoring of Burner flame & fired pellet



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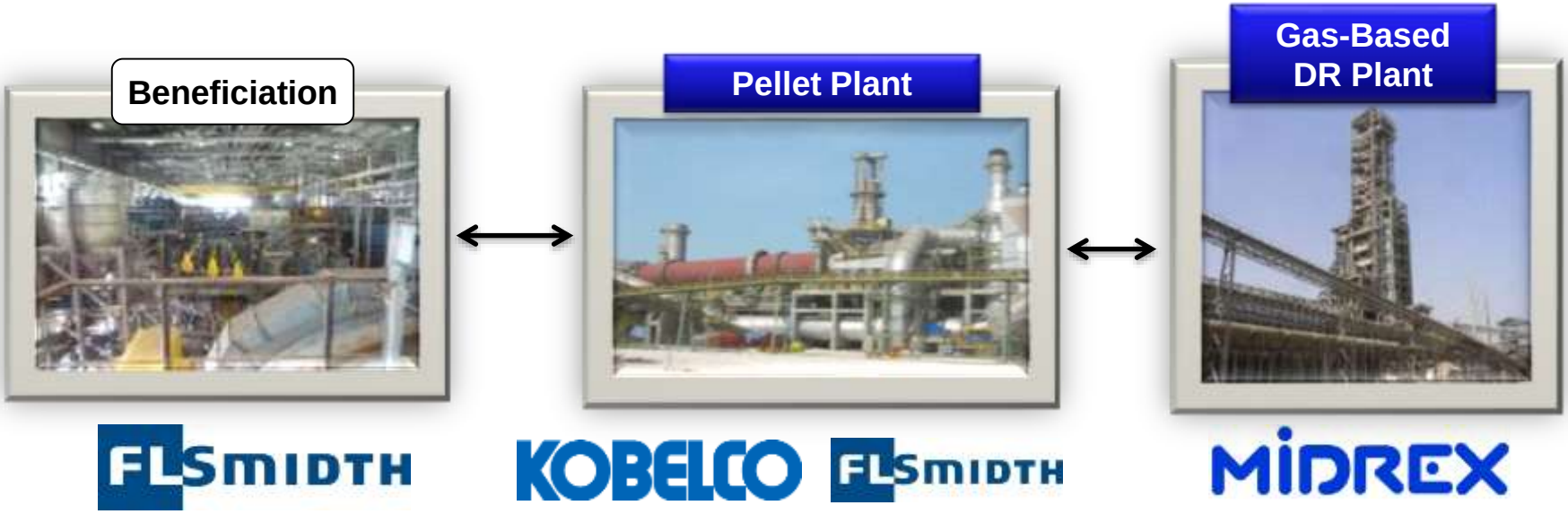
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Integrated Solution

Integrated Service to Customers from Beneficiation to DR production



(Licensee of KOBELCO Pelletizing System)

(KSL's 100% subsidiary)

Collaborative Effect

- Unify the technology interface, standards and codes, procurement source, etc.
- Integrated project management and schedule control.
- Optimization of the plant layout.
- Consistent laboratory testing

Advantages

- Easy for future expansion.
- Lower the technical risk.
- Lower CAPEX
- Lower burden for entire project management & coordination.

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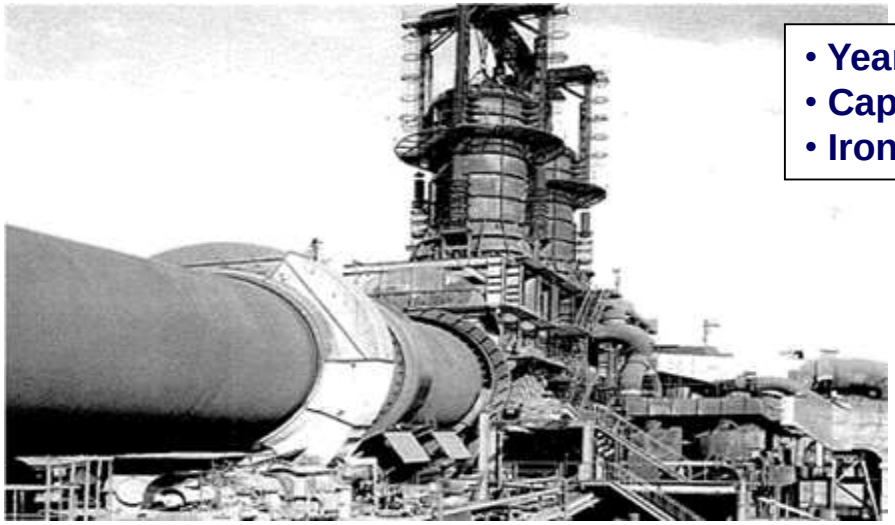
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References of Pellet plant

Kobe Steel, Kakogawa Works



- Year of Completion: 1970
- Capacity: 4.0 mtpa
- Iron ore: Mag. + Hema

CMP, Chile



- Year of Completion: 1978
- Capacity: 3.5 mtpa
- Iron ore: Magnetite

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Reference

FMO, Venezuela



- Year of Completion: 1994
- Capacity: 4.0 mtpa
  (Upgraded by KSL from 3.3mtpa in 2007)
- Iron ore: Hematite

Ardakan, Iran

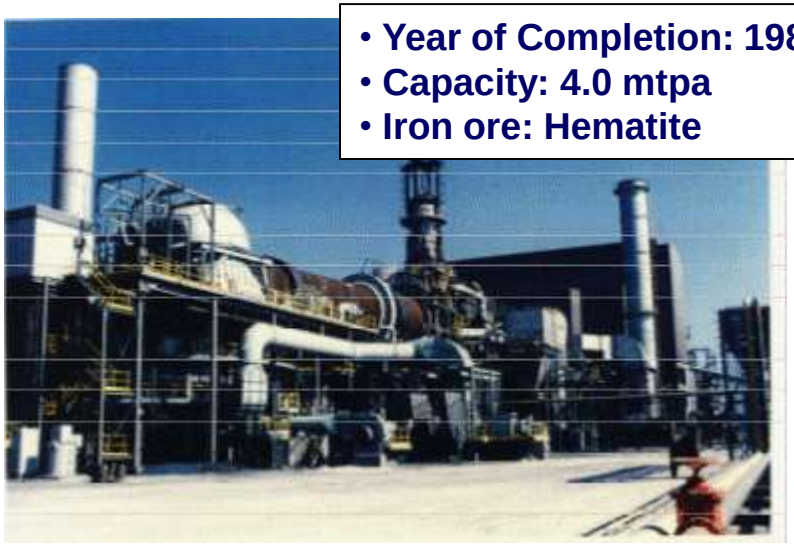


- Year of Completion: 2008
- Capacity: 3.4 mtpa
- Iron ore: Mag. + Hema

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Reference

Bahrain Steel (former GIIC No. 1 & No.2)



- Year of Completion: 1985
- Capacity: 4.0 mtpa
- Iron ore: Hematite

- Year of Completion: 2010
- Capacity: 6.0 mtpa
- Iron ore: Hematite





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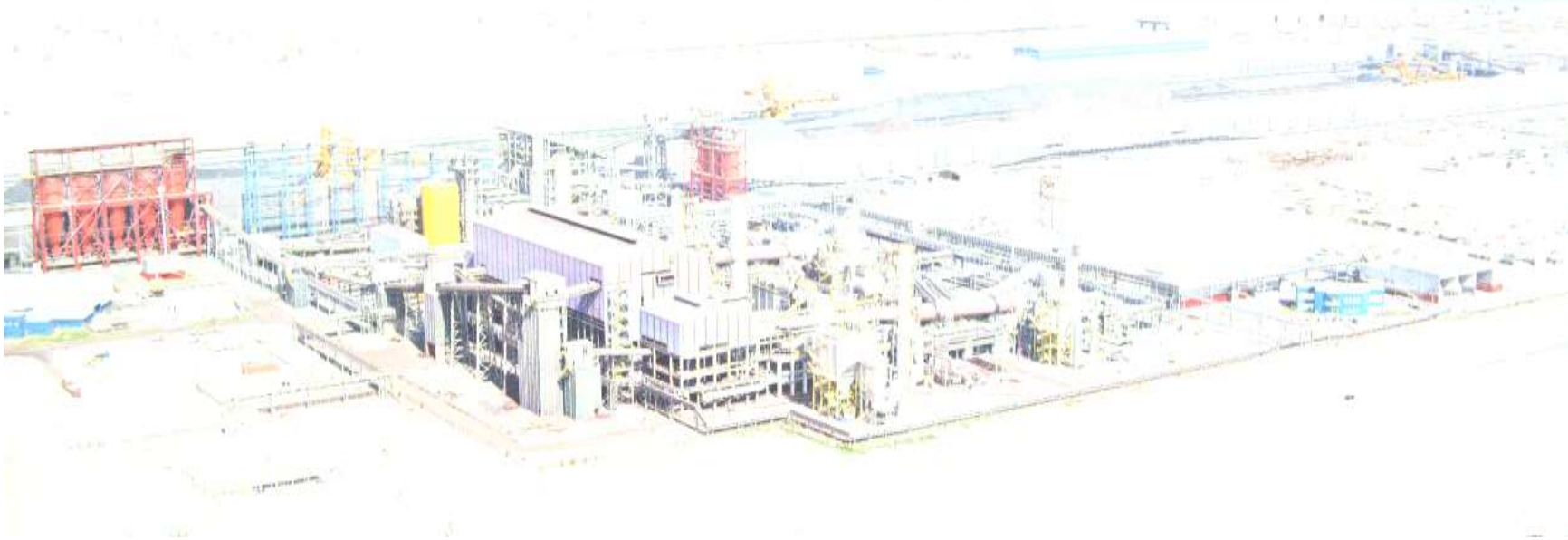
Vale / Sohar, Oman

- Year of Completion: 2011
- Capacity: 4.5 mtpa x 2 lines
- Iron ore: Hematite
- Present status: In operation



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Thank you very much for your kind attention



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