2024

قمة الصلب العربي الـ 17
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Novel Design of Iron Ore Pellets For Direct Reduction Process

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hadeed

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قمة الصلب العربي الـ17
17 th Arab Steel Summit
14 - 15 October 2024 | Doha - Qatar

NOVEL DESIGN OF IRON ORE PELLETS FOR DIRECT REDUCTION PROCESS

OCTOBER 2024

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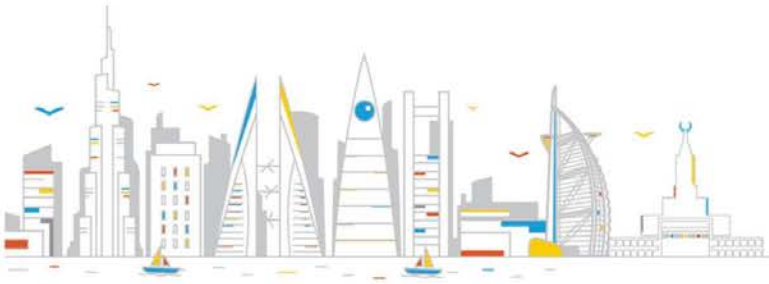
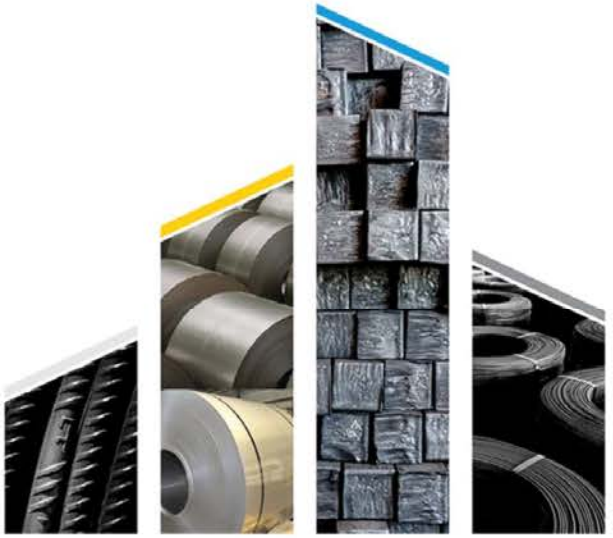


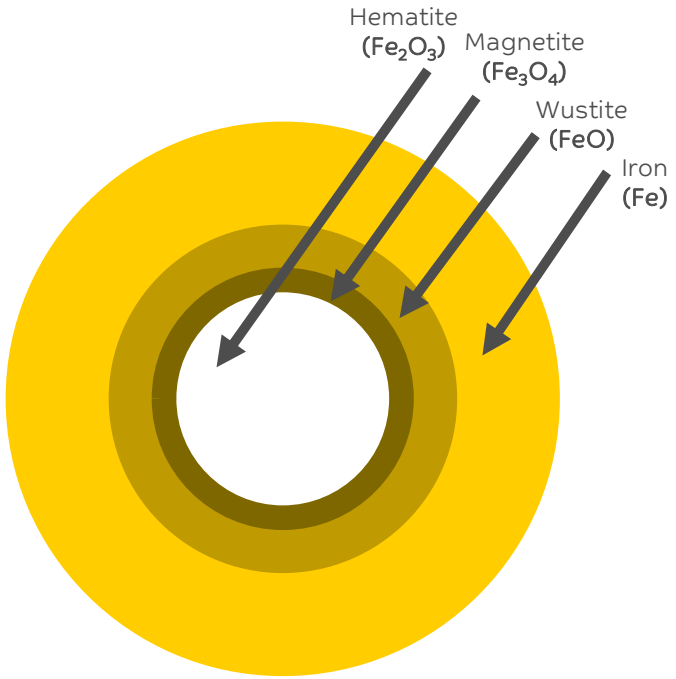


INTRODUCTION

HIGH REDUCIBILITY
is one of the desired properties of iron oxide pellets for DR processes.

REDUCIBILITY MECHANISM
is controlled by gas diffusion and chemical reaction.

EXPECTED CHALLENGE
is reduction of the core part due to reducing gas penetration and chemical reaction progress.



Reduction with H_2

$Fe_2O_3 + 3H_2 = 2\,Fe + 3\,H_2O$

Reduction with CO

$Fe_2O_3 + 3CO = 2\,Fe + 3\,CO_2$

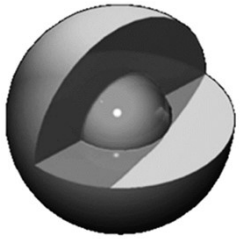
SCOPE OF WORK

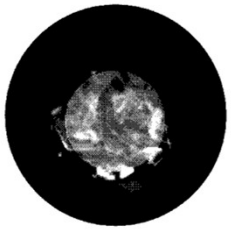
01

CARBON ADDITION

Produce core/shell pellets with excess C in the core

6
C
Carbon
12.011





02

PELLET FIRING

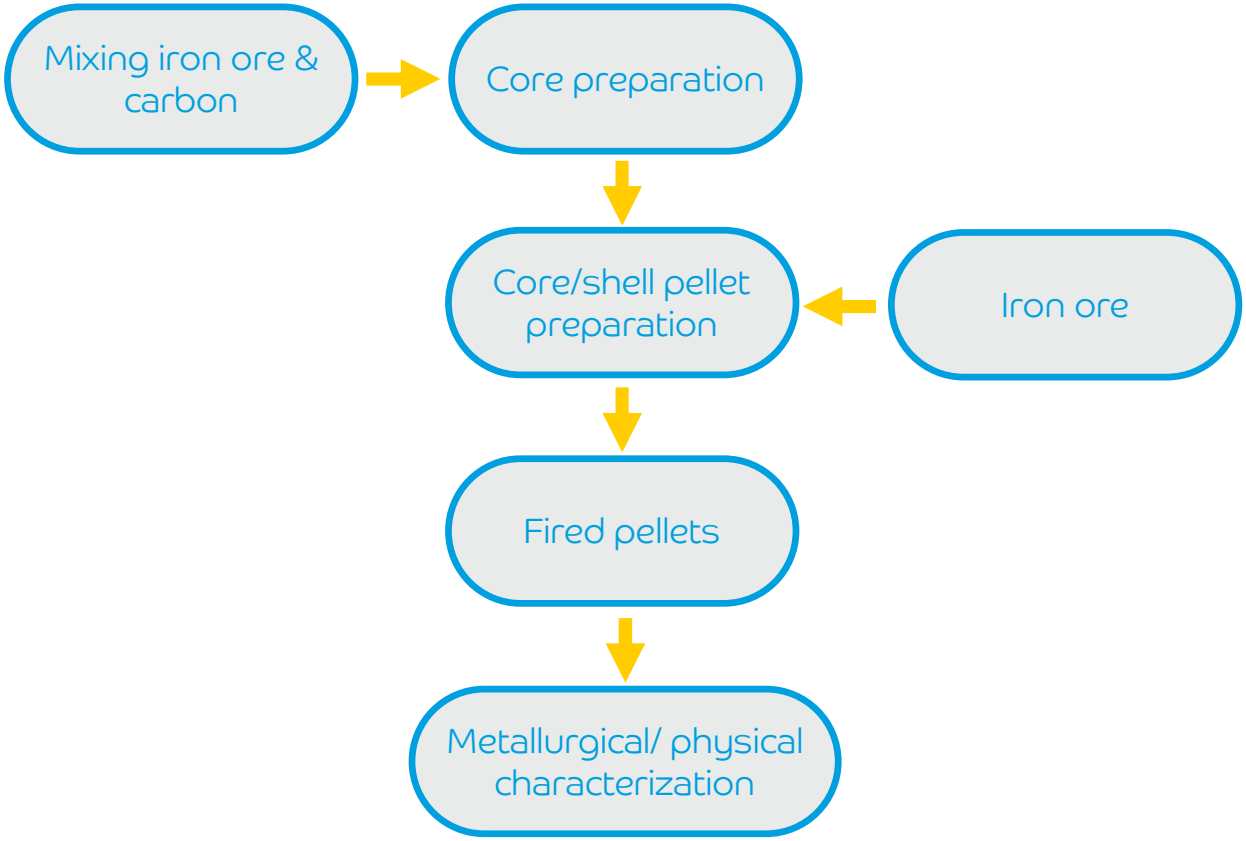
Porosity of core part will be increased in fired pellets

03

THE RESULT

Improved reducibility: Save Gas Consumption and Gain Higher Productivity

EXPERIMENTAL WORK



NOTES

- Semi-pilot study was conducted through highly qualified third party **(SGA, Germany)**
- Pellet feed: **68.0 % Fe**
- Core/shell thickness: **25-75 / 75-25 % diameter**
- Carbon % : **0 - 9 wt%** from the core mixture
- Firing profile

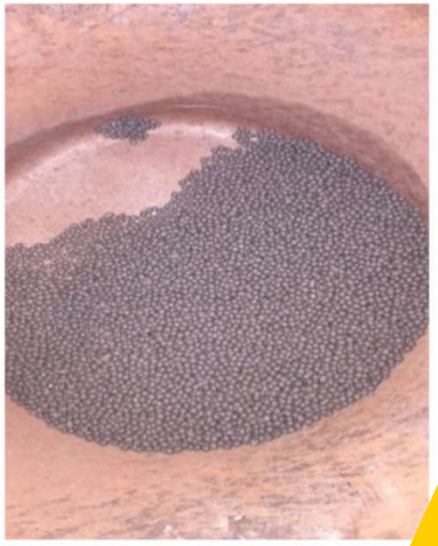
EXPERIMENTAL WORK

1

Mixing the content of core/shell pellet.

2

Rotating disc pelletizer.



3

Exact shape of core part.

4

Exact shape of core/shell Novel pellet.

RESULTS & DISCUSSION

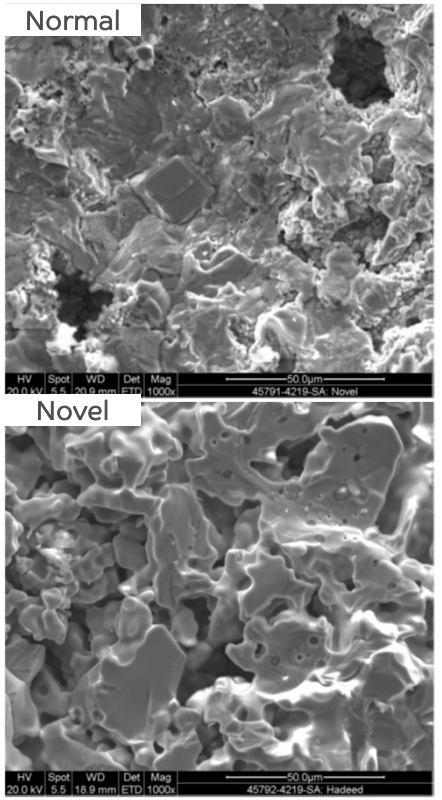
Visual observation for cross section from fired core/shell pellet

FIRED PELLETS

Fe	67.8%
acidic	≤ 2.0
basic	< 1.0

CHARACTERIZATION

Tumbler test	(ISO-3271)
Crushing strength	(ISO-4700)
Sticking test	(ISO-11256)
Linder test	(ISO-11257)
Red. test	(ISO-11258)



SEM photo for core part from fired pellet

RESULTS & DISCUSSION

GREEN PELLET

Characterization

	Ref.	Novel pellet	Standard
Drop number	8.0	5.0-10.0	4.0
Shock temp.(°C)	340	325-405	300
Green strength [daN/p]	1.5	1.4-1.8	1.0
Dry strength [daN/p]	5.3	5.0-6.5	4.0

FIRED PELLETS

Physical Characterization

	Ref.	Novel pellet	Standard
Tumbler-strength (%)	96.0	92.3-95.9	90.0 min
Abrasion (%)	3.6	3.5-4.6	5.0 max
Crushing strength [daN/p]	311	156-351	250 min

FIRED PELLETS

Metallurgical Characterization

	Ref.	Novel pellet	Standard
Cluster index	2.5	1.8-5.7	0 after 10 rev.
RDI (%)	1.1	0.8-1.1	2.0 max
Met.(%)	93.6	93.7-94.6	93.0
Reducibility R_{40}/R_{90} (%/min)	1.6/ 0.29	1.6/0.3 - 1.72/0.31	

RESULTS & DISCUSSION

FIRED PELLETS

Optimum Results

Optimum results	Novel pellet
Tumbler-s (%)	95.9
Abrasion (%)	3.5
CCS [daN/p]	351
C.I. (%)	5.0
RDI (%)	0.8
Met.(%)	94.6 ↑
R_{40}/R_{90}(%/min)	1.72/0.31 ↑

BASKET TEST

HIGHER MET.

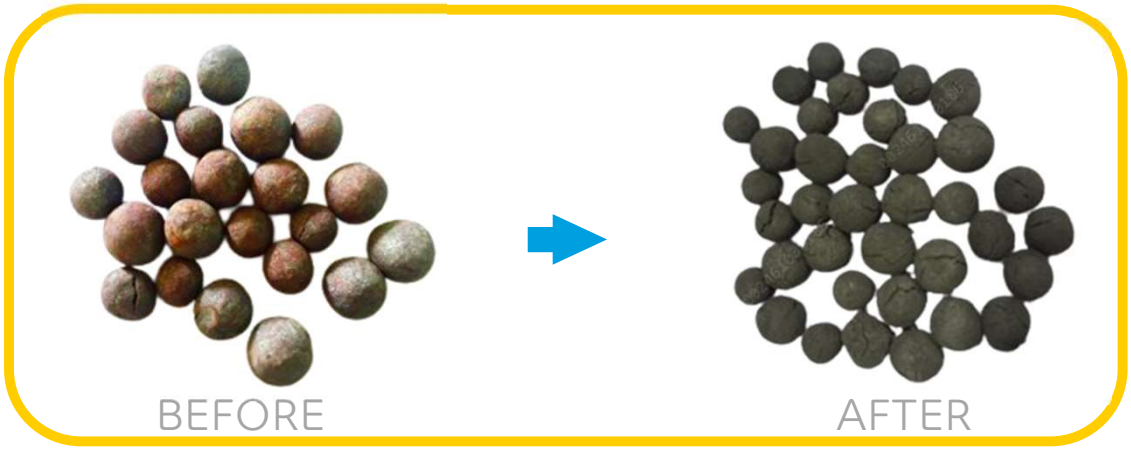
+2.8%

HIGHER CARBON

+1.0% (Carbon) **+11.0%** (Fe_3C)

NO CLUSTER

LOWER DISINTEGRATION



CONCLUSIONS: CORE/SHELL DESIGN

COMPARED TO NORMAL PELLET

It exhibits favorable physical & metallurgical properties:

- Higher metallization
- Higher carbon content
- Higher DRI productivity
- Energy saving (NG & Elec.)
- No special handling needed

VALIDATION/TRIALS

- The promised characterization of the Novel pellets was validated by basket test at Hadeed Company
- Preparation for full plant trial at Hadeed is ongoing

BENEFITS

Expected Potential Benefits at DRP and steel plant is 11.2 M$/yr

Two Granted Patents

(1) #10,214,788B2

(2) #105934526


THANK YOU