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SAUDI IRON & STEEL COMPANY (HADEED)

NOVEL DESIGN OF IRON ORE PELLETS FOR DIRECT REDUCTION PROCESS

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قمة الصلب العربي الـ 17
17th Arab Steel Summit

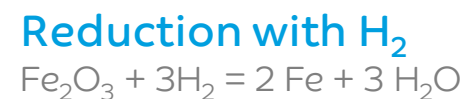
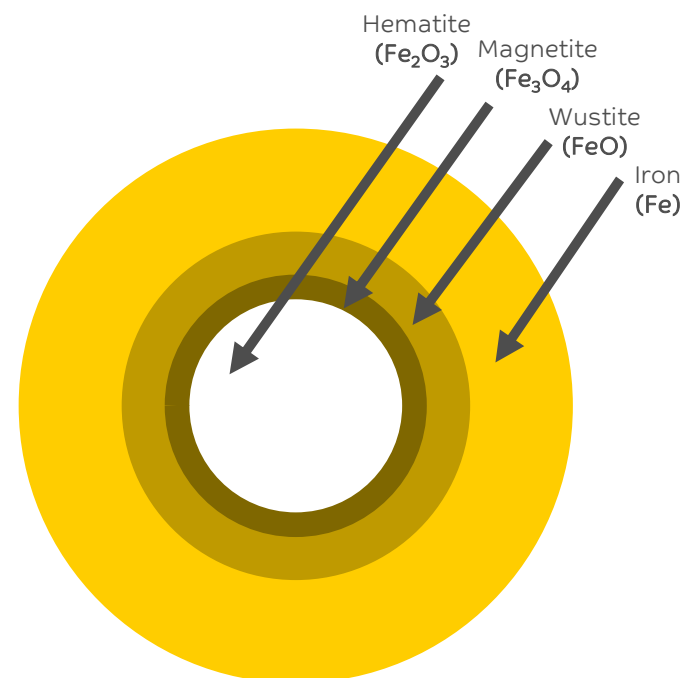
14 - 15 October 2024 | Doha - Qatar





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.



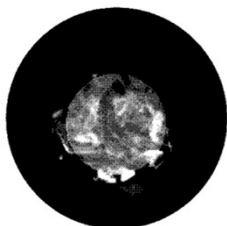
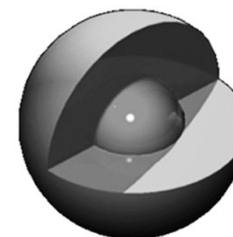
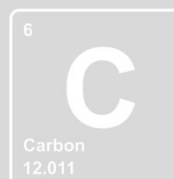


SCOPE OF WORK

01

CARBON ADDITION

Produce core/shell pellets with excess C in the core



PELLET FIRING

Porosity of core part will be increased in fired pellets

02

03

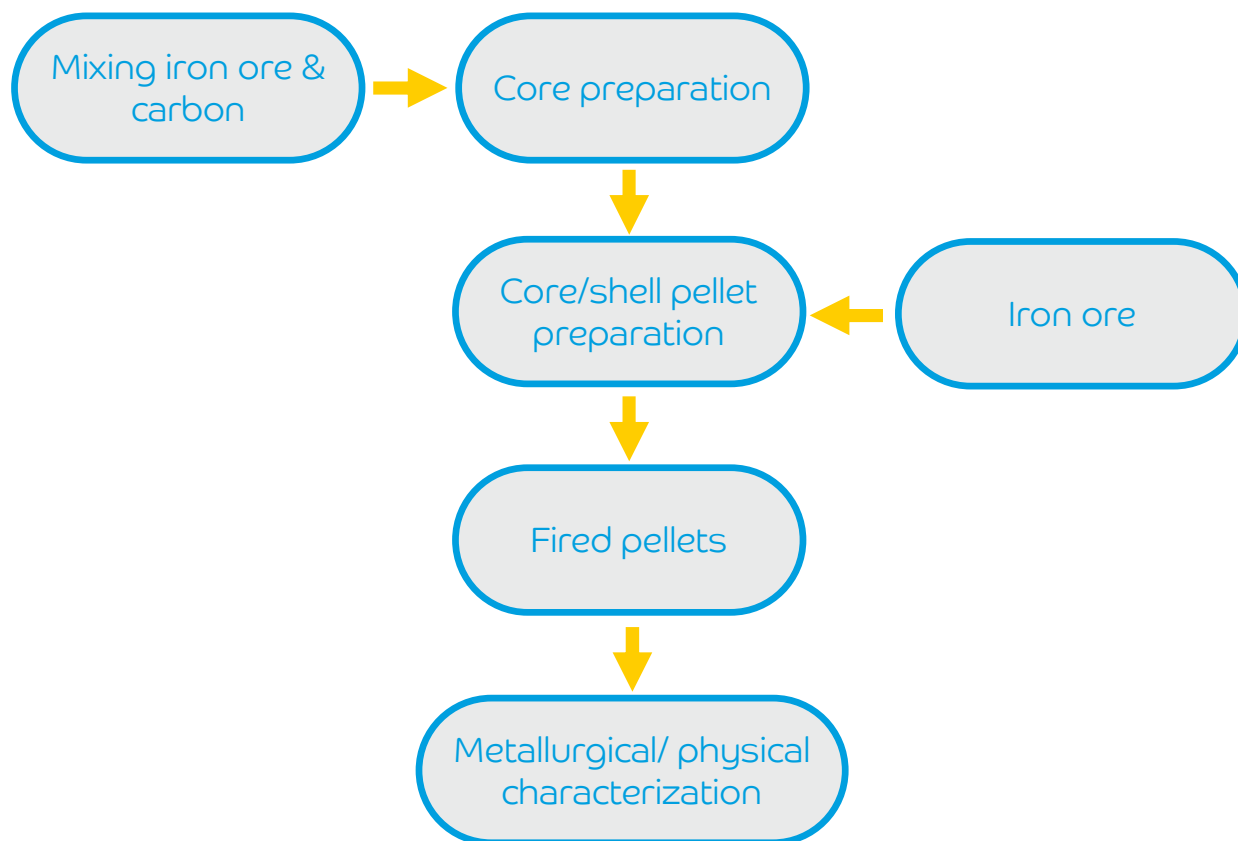
THE RESULT

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



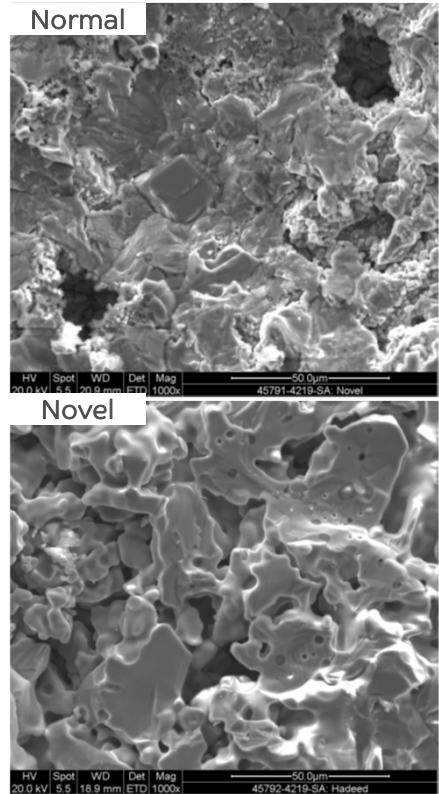
Visual observation for cross section from fired core/shell pellet

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 PELLETS

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 | |



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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  |



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BASKET TEST



HIGHER MET.
+2.8%



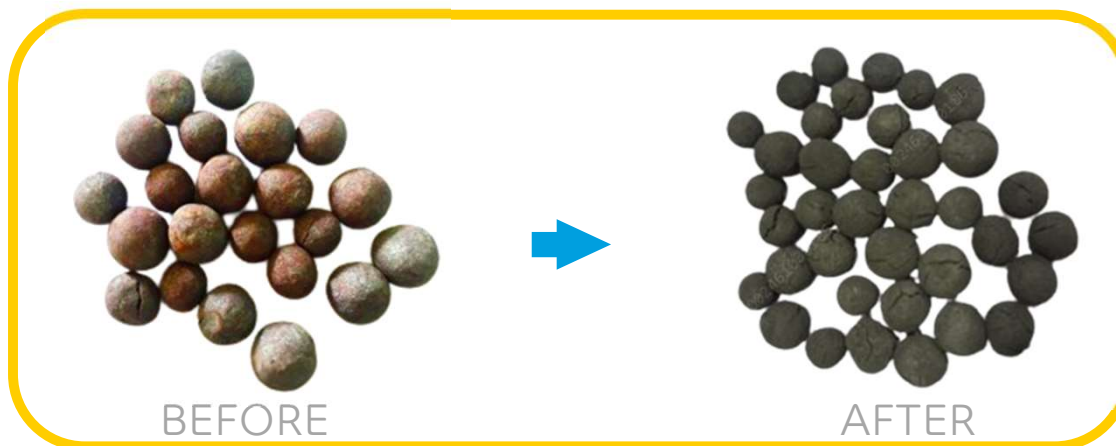
HIGHER CARBON
+1.0% **+11.0%**
(Carbon) (Fe₃C)



NO CLUSTER



LOWER
DISINTEGRATION





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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

A black and white photograph showing a close-up of several vertical steel rebar rods. The rods have a characteristic twisted, ribbed texture. The lighting is dramatic, with the foreground rods in sharp focus and the background rods blurred. The text 'THANK YOU' is overlaid in the center in a clean, white, sans-serif font.

THANK YOU