Adding Value to the Iron Ore Industry and the Critical Role of Bentonite

S&B Industrial Minerals SA

October 2011
Pellet Industry 2010-2015: A Challenge

Growth:
- Europe, N. America: 5%
- China: 6.5%
- ME: 24%

Capacity Utilisation > 95%

New capacity: 150 mil MT pellets

Decrease of lumps & good quality of fines

Decrease of Price Premium: 20 cts/dtmtu instead of 50 cts/dtmtu

Very Competitive Environment

Need for:
- High Productivity
- Low Production Cost
- High quality
Where is bentonite used in pelletizing?

**From Iron Ore to Steel**

Iron Ore → Iron Concentrate → Pellets → Pig Iron → Steel

**Iron Ore Pelletizing**

- Ore beneficiation
- Additives silo
- Bentonite
- Iron ore, conveyor belt
- 7-10% moisture
- Screw mixer
- PELLETIZING DRUMS
- Pellets (green)
- FIRING UNIT (INDURATION FURNACE)

**Bentonite**

- Where is bentonite used in pelletizing?
What is bentonite?

Crystal structure of montmorillonite
How does Bentonite Work in Pellet?

- **Wet state, T<100 °C**

  - Capillary forces pull the platelets onto the magnetite particles.
  - Electrostatic forces and hydrogen bonds

- **Dry-Fired state 100 °C < T < 300 °C**

  - Break down of Hydrogen bonds

- **Fired state 300 °C < T < 800 °C**

  - Dehydroxylation & Oxide bonding

- **Dry-Fired state T > 800 °C**

  - Collapse of bentonite. Eutectic compounds for slag bonding and pellets strength
How does bentonite influence iron pelletizing?

**BENTONITE PROPERTIES**
1. Water absorption
2. Swelling
3. Electrochemical Properties
4. Thermal Stability
5. Chemical Composition (%SiO$_2$, TiO$_2$, CaO, MgO, Alkalis)

**Pellet Properties**
1. Pellets Plasticity (green drop)
2. Pellet size & shape structure (green strength)

**Processing Cost**
1. Bentonite Consumption
2. Recirculating rate

**Balling**
1. Dry strength (Kg/p)
2. Pellet bed permeability

**Induration**
1. Chemical Composition
2. Tumble index
3. Reducibility index

In red: what we measure in the lab for quality comparison and value in use
Examples of Bentonite influence - 1

**In Balling**

Quality of bentonite is **KEY**.

Water absorption capacity of bentonite is considered as ONE (*but not the only one*) of the main quality index for bentonite.

**In Induration**
• The chemical composition of bentonite influences the final products’ composition (acid gangue, oxides, alkalis etc).

• Increased reducibility of pellets affects positively productivity of Blast and DR furnaces.
Montmorillonite de-hydroxylation

Lower montmorillonite dissociation temperature indicates a lower resistance during firing (lower fired pellets strength)
BENTONITE QUALITY
key to PELLET Quality, Productivity and Cost

Depending on the concentrate and the bentonite, the plant could achieve UP TO:

- 30% less binder
- 12% lower raw materials
- 10% lower energy
- 13% lower recirculation load
- 5% higher reducibility
- 12% higher strength

It makes Business Sense to OPTIMIZE BENTONITE per type of concentrate.
Monitor final pellets properties

Associate bentonite with pellet properties
- Pellet properties
- Firing simulation
- Metal. properties
- Develop qualities

Monitor & adjust bentonite performance in relation to process conditions
- Bentonite consumption
- Properties of wet, dry and fired pellets
- Chemistry of pellets
- Drum and furnace productivity

Select Quality
- Activation
- Quality control

Bentonite Mine → R&D Lab → Pellet plant → End User (Blast Furnace)

End User (Blast Furnace)
Lab: Associate Bentonite Properties with Pelletizing Performance

1. By using statistical analysis of experiments:
   - Reveal significant differences between qualities
   - Set up an empirical mathematical model.

2. By determining mechanisms of bentonite interactions with iron ore
   - Find properties of iron concentrate affecting bentonite performance in agglomeration.
   - Predict the bentonite’s value-in-use in the plant.
   - Reveal “hidden” or potential value, not readily captured in the pellet plants, e.g., bentonite contribution to % plastic deformation of pellets, bentonite resistance to water hardness etc.
1. Analyze plant data regularly and quantify statistically significant differences

2. Build extensive databases with plant results.

3. Use of testing protocols that ensures valid comparison between binders.

4. Launch common development projects.
Calculation of Total Economic Benefit

- Mass and energy balance with various binders.
- Cost data for unit operations
- Benefits – losses
- Calculation of net differential Economic Value.

Economic impact to pellet plants

Economic impact to End-user

Factors:
- Low temperature disintegration
- Tumble index
- Strength of pellets

Benefits – losses:
- Plant losses
- Fines generation
- Electric energy consumption
- Bunker C oil cons.
- Drum productivity
- Raw Materials Consumption

Calculation of net differential Economic Value.
Conclusions

• Due to the high competitive and growth environment in the pellet industry, it makes business sense to optimize the binder’s selection.

• Bentonite acts as a binder and its quality could substantially influence the financials of the pellet plant as well as that of the end – user (Blast or DRI furnace).

• An Economic Model could be used to optimize the binder’s selection and use. This model needs input from the lab and plant’s data as well as a good understanding of the pellet operations.