CARMEUSE™
NATURAL CHEMICALS

TECHNICAL BULLETIN

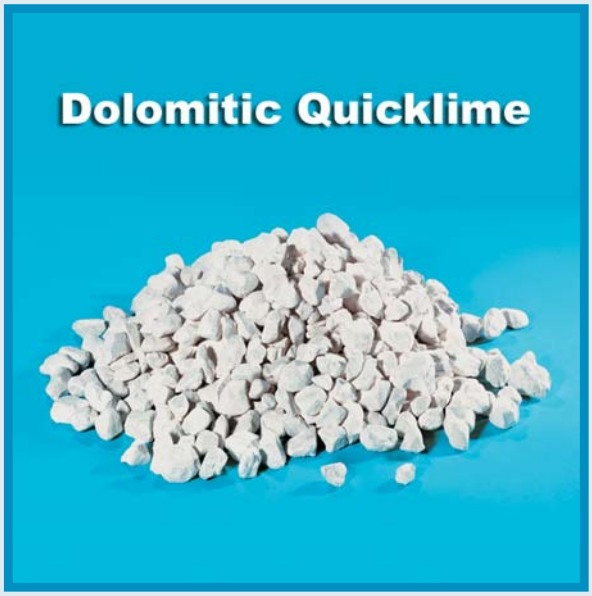
There is no Genie in the Furnace!

Dolomitic Lime has Superior Cost Performance over "MgO Based Slag Conditioners"

The Facts:

- Significant cost savings are realized using dolomitic lime instead of MgO briquettes
- Dolomitic lime is superior in chemical consistency
- Dissolution rate of dolomitic lime and MgO briquettes are the same.
- Additional CaO contained in dolomitic lime provides early protection against acidic oxides
- Slag chemistry consistency is based on science and solid slag practices.

Depend on Dolomitic Lime for your MgO slag requirements-- a flux practice that demonstrates large savings in manufacturing cost without reduction in technical performance or product quality.



Lime, the Proven Solution!

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Technical Discussion

A recent study[1,2] by Dr. Richard Fruehan of Carnegie Mellon Univerisity in a paper on comparative dissolution rates of magnesite and dolomitic lime, found that "The rate of dissolution of magnesite and dolomite are essentially the same for similar conditions…as long as the basicity is below about two...The MgO content of the slag must also be significantly below saturation for rapid dissolution."

The advantage of dolomitic lime is its ability to lower the saturation point for MgO contained in the dolomitic lime by increasing the basicity when the acidic oxides are forming early in the heat as compared to just magnesite by itself.

The following graph shows the relative dissolution of material over time for dolomitic lime, magnesite, and magnesite with high calcium lime. Scientific evidence proves there is little difference in dissolution rates during steelmaking conditions.

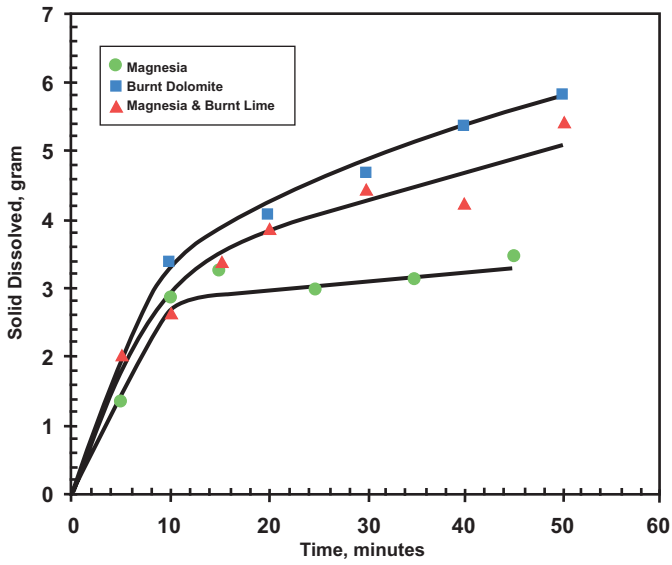

Figure 1: Amount of material dissolved for additions of magnesite, dolomitic lime and magnesite plus lime.

The MgO in dolomitic lime is part of the natural occurring mixture of CaO and MgO particles. This gives dolomitic lime the "ultimate" in terms of consistency -- it is chemically inherent in the natural product.

Based on work[3] done by Dr. Eugene Pretorius at Baker Refractories on slag requirements for the electric arc furnace, "optimum slags...have a 'creamy' consistency and are normally just saturated with respect to CaO, MgO or both."

There is no magic in this concept. The correct basicity ratio with the correct MgO content and FeO content provides the properties needed for optimum slag foaming to reduce electrical consumption and protect the refractory. The balance of refractory oxides with fluxing oxides to obtain the correct B_3 ratio and MgO saturation to provide early foaming and a "creamy slag" is fundamental science and not magic!

Technical Discussion (cont.)

When the correct slag chemistry is designed with solid slag models, the MgO source is only important when considering the cost it adds per ton of steel. Chemical analysis comparisons of slags using "MgO based briquettes" and dolomitic lime shows that there is no difference in practices when the slag is designed correctly to produce a creamy slag.

The comparisons in the graph shown in Figure 2 to the right were done at a twin shell furnace shop producing over 1 million tons per year of flat rolled product.

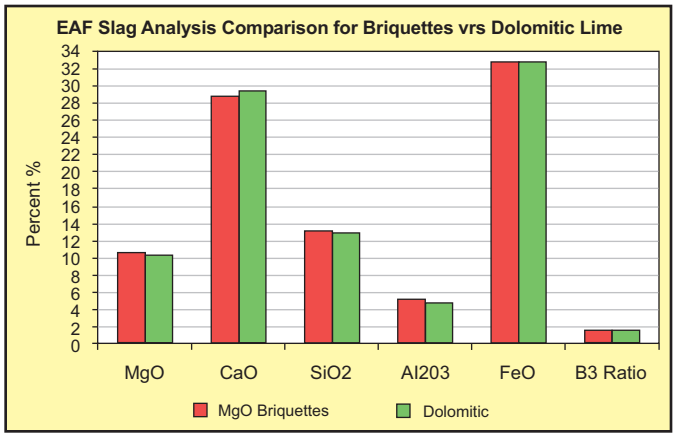

Figure 2: Slag analysis comparisons using dolomitic lime and magnesite briquettes.

Dolomitic Lime -- The Quality Product

Dolomitic lime has superior consistency for chemical quality over "MgO based slag conditioners" and lower LOI. This is related to how the product is produced with using superior technology at Carmeuse lime plants as compared to many areas in China where the MgO briquettes are produced. Analysis of MgO content in briquettes across 10 truckloads of product and 10 truckloads of dolomitic quicklime shows the variability in chemistry of the two products.

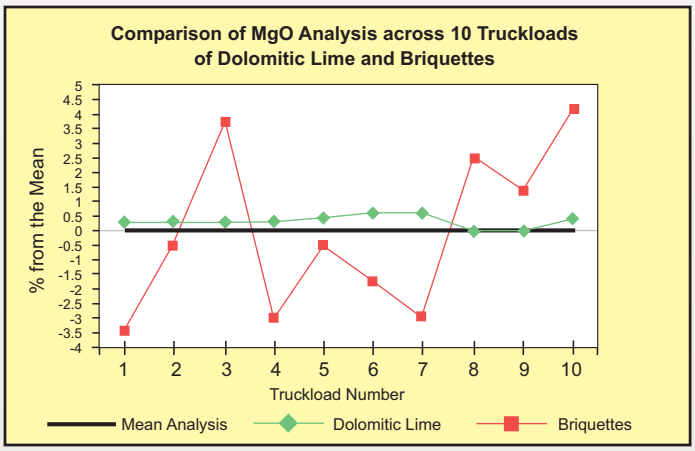

Figure 3: MgO Analysis of 10 truck load samplings for briquettes and dolomitic lime.

Figure 3 shows the MgO variability of the briquettes around the mean analysis having a total range of 7.5%, while the MgO variability for dolomitic lime had a total range less than 1.0%. Imagine the impact this has on consistency in your slag practice!

Other claims of improved performance with briquettes include those of carbon contained and reduced electrical performance. The analysis of these trucks also showed the variability of the briquettes with carbon content having a range from 7.8% to 13.2% and a standard deviation of 1.731. The variability of LOI in the briquettes had a range from 21.6% to 28.8% with a standard deviation of 1.970 while the variability of LOI for the dolomitic lime ranged from 0.11% to 0.84% and a standard deviation of 0.212.

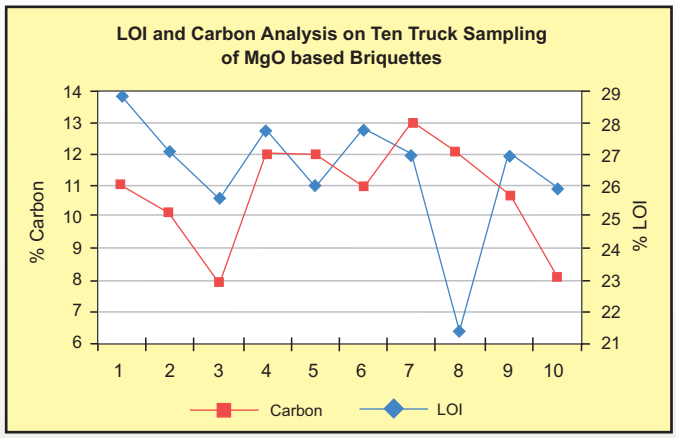

Figure 4: LOI and carbon analysis of briquettes.

The graph in Figure 4 shows the large variability in the carbon and LOI in the 10 truck sampling. The design of slag's for the electric arc furnace is dependent on:

- Use of consistent quality products when considering mass balance inputs for the electric arc furnace slag.
- Value of dolomitic lime in cost comparisons for slag practices using dolomitic lime in place of MgO based slag conditioner or even magnesite.

Cost Savings for Steelmakers

When electric furnace operations have the steelmaking practices based on science to produce the optimum foamy slag, no other alternates can be as cost effective. The spreadsheet on the back page for a twin shell shop producing over a million tons of flat rolled steel shows savings that could be realized in a shop that had converted from the briquette practice to a dolomitic lime practice. The spreadsheet comparison based on typical market prices for fluxes and identical pounds per ton of MgO and pounds per ton of CaO for both practices.

EAF SHOP EXAMPLE (WORKSHEET)

EAF SHOP EXAMPLE (Worksheet)	Steel Customer Briquette Practice	Equivalent Dolomitic Lime Practice
Tons of steel per Heat	185	185
Pounds of High Calcium Lime per Heat	11,000	6000
Pounds of Dolomitic Lime per Heat	0	8000
Pounds of Chinese Briquettes per Heat	6000	0
Pounds of Carbon per heat	100	1150
% CaO in High Calcium Lime	92.0%	92.0%
% MgO in High Calcium Lime	2.0%	2.0%
% CaO in Dolomitic Lime	57.0%	57.0%
% MgO in Dolomitic Lime	40.0%	40.0%
% CaO in Chinese Briquettes	1.9%	1.9%
% MgO in Chinese Briquettes	55.0%	55.0%
% C in Chinese Briquettes	15.0%	15.0%
% C used for Furnace	86.0%	86.0%
Approximate price of High Calcium Lime	100	100
Approximate price of Dolomitic Lime per ton	100	100
Approximate price of Chinese Briquettes per ton	150	150
Approximate price of Carbon for Briquettes per ton	150	150
Approximate price of Carbon per ton	150	250
Pounds of CaO per Heat	10,232	10,080
Pounds of MgO per Heat	3,300	3,320
Pounds of C per Heat	986	989
Pounds of CaO/ton	55.31	54.49
Pounds of Mgo/ton	17.84	17.95
Pounds of Carbon/ton	5.33	5.35
Cost per Heat - High Calcium Lime	550.00	300.00
Cost per Heat - Dolomitic Lime	0.00	400.00
Cost per Heat - Chinese Briquettes	450.00	0.00
Cost per heat - Carbon	73.95	123.63
TOTAL FLUX COST PER HEAT	$ 1,073.95	$ 823.63
FLUX COST PER HEAT	$ 5.81	$ 4.45
TONS OF STEEL PER YEAR	1,200,000	1,200,000
FLUX SAVINGS PER TON OF STEEL		1.353
ANNUAL SAVINGS		$ 1,624,000

Figure 5: Cost analysis for briquette flux practice and dolomitic quicklime flux practice.

Annual savings of over $1 million using dolomitic lime vs. the MgO based briquettes! Don't be fooled by promises of "magic" in your EAF when you are responsible for cost effective steelmaking practices.

References:

1 -- R.J. Fruehan, Y.Li, and L. Brabie, "Dissolution of Magnesite and Dolomitic in Simulated EAF Slags," ISS Tech Conference, 2003

2 -- Rex McClanahan and Lawrence Kibler, Larry Wolfe, Alan C. Dyar and James Compton, "Comparative Analysis of Dolomitic Lime and Chinese Magnesite Practices in Electric Arc Furnace Steelmaking," AISE Conference, 2004

3 -- E.B. Pretorius and R. Marr, "The Effect of Slag Modeling to Improve Steelmaking Process," ISS Course at 56th Electric Furnace Conference, 1998.