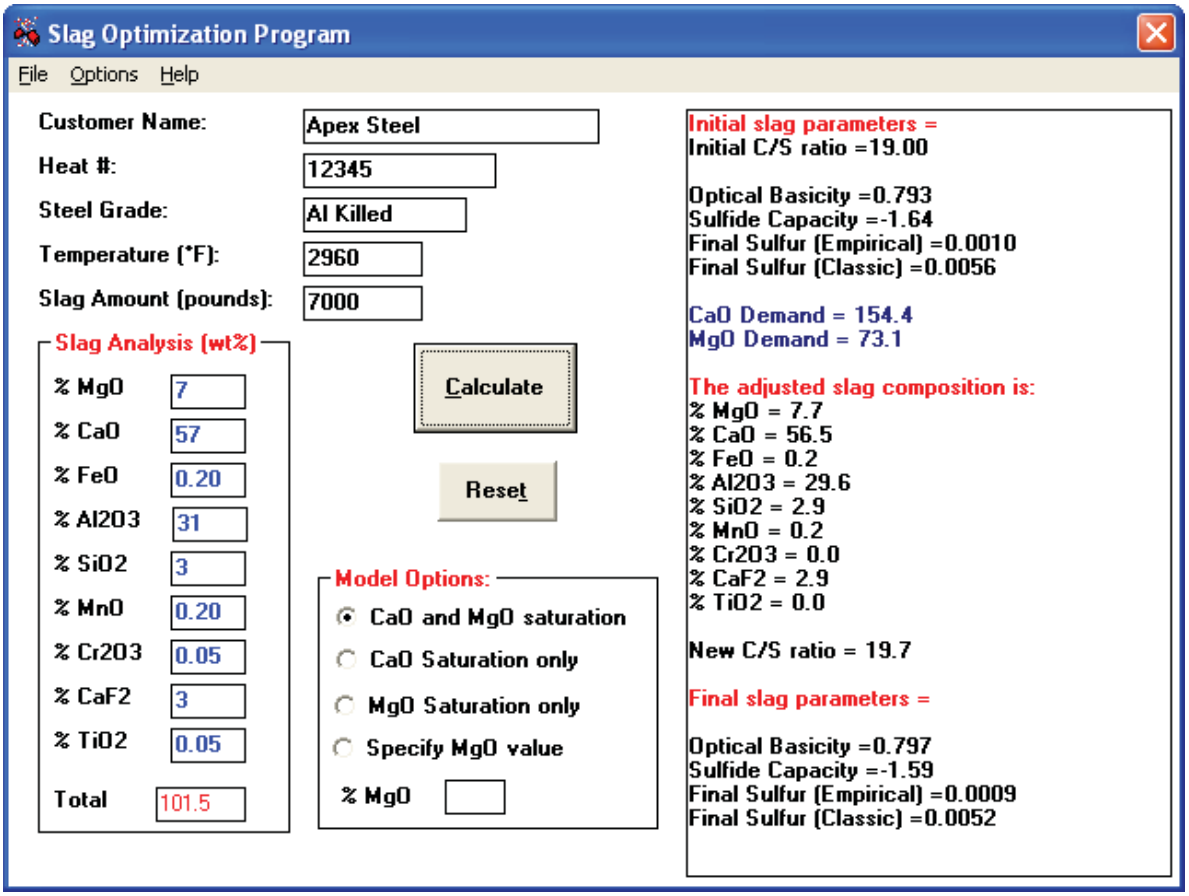
LWB Refractories
Process Technology Group Services

LWB refractories

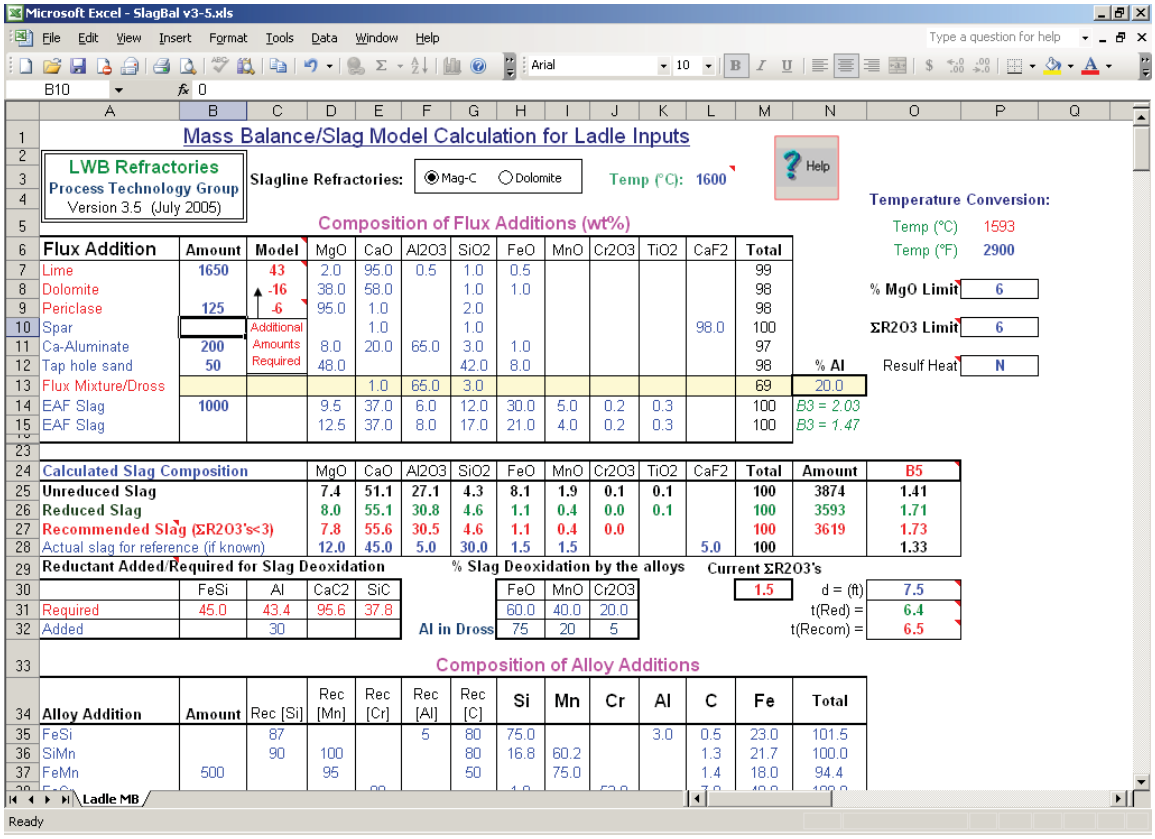
Process Technology Group

The Process Technology Group (PTG) provides technical support services to the customers of LWB Refractories with a strong focus on slag and steelmaking practices. The PTG uses a comprehensive range of technical models/tools for evaluation of metallurgical processes ranging from foamy slag in the EAF to inclusion control in the ladle and casting process. The e-Tech website provides the customer access to metallurgical theory for reference, and the practical models/tools that apply the theory to the shop floor. These valuable computer models and process expertise, coupled with our high quality refractory products, enable LWB to assist our customers to lower their overall cost/ton of steel produced.

Example of a model used to evaluate ladle slags: screenshot of Slag Optimization Program.



Example of a model used to develop Si Killed ladle slags: Ladle Mass Balance Model.



Microsoft Excel - SlagBal v3-5.xls

Mass Balance/Slag Model Calculation for Ladle Inputs

LWB Refractories
Process Technology Group
Version 3.5 (July 2005)

Slagline Refractories: Mag-C / Dolomite — Temp (°C): 1600

Temperature Conversion: Temp (°C) 1593; Temp (°F) 2900

Composition of Flux Additions (wt%)

Flux Addition	Amount	Model	MgO	CaO	Al2O3	SiO2	FeO	MnO	Cr2O3	TiO2	CaF2	Total	
Lime	1650	43	2.0	95.0	0.5	1.0	0.5					99	
Dolomite		-16	38.0	58.0		1.0	1.0					98	
Periclase	125	-6	95.0	1.0		2.0						98	
Spar		Additional Amounts Required		1.0		1.0					98.0	100	
Ca-Aluminate	200		8.0	20.0	65.0	3.0	1.0					97	
Tap hole sand	50		48.0			42.0	8.0					98	% Al
Flux Mixture/Dross				1.0	65.0	3.0						69	20.0
EAF Slag	1000		9.5	37.0	6.0	12.0	30.0	5.0	0.2	0.3		100	B3 = 2.03
EAF Slag			12.5	37.0	8.0	17.0	21.0	4.0	0.2	0.3		100	B3 = 1.47

% MgO Limit: 6 — ΣR2O3 Limit: 6 — Resulf Heat: N

Calculated Slag Composition	MgO	CaO	Al2O3	SiO2	FeO	MnO	Cr2O3	TiO2	CaF2	Total	Amount	B5
Unreduced Slag	7.4	51.1	27.1	4.3	8.1	1.9	0.1	0.1		100	3874	1.41
Reduced Slag	8.0	55.1	30.8	4.6	1.1	0.4	0.0	0.1		100	3593	1.71
Recommended Slag (ΣR2O3's<3)	7.8	55.6	30.5	4.6	1.1	0.4	0.0			100	3619	1.73
Actual slag for reference (if known)	12.0	45.0	5.0	30.0	1.5	1.5			5.0	100		1.33

Reductant Added/Required for Slag Deoxidation

	FeSi	Al	CaC2	SiC
Required	45.0	43.4	95.6	37.8
Added		30		

% Slag Deoxidation by the alloys

	FeO	MnO	Cr2O3
	60.0	40.0	20.0
Al in Dross	75	20	5

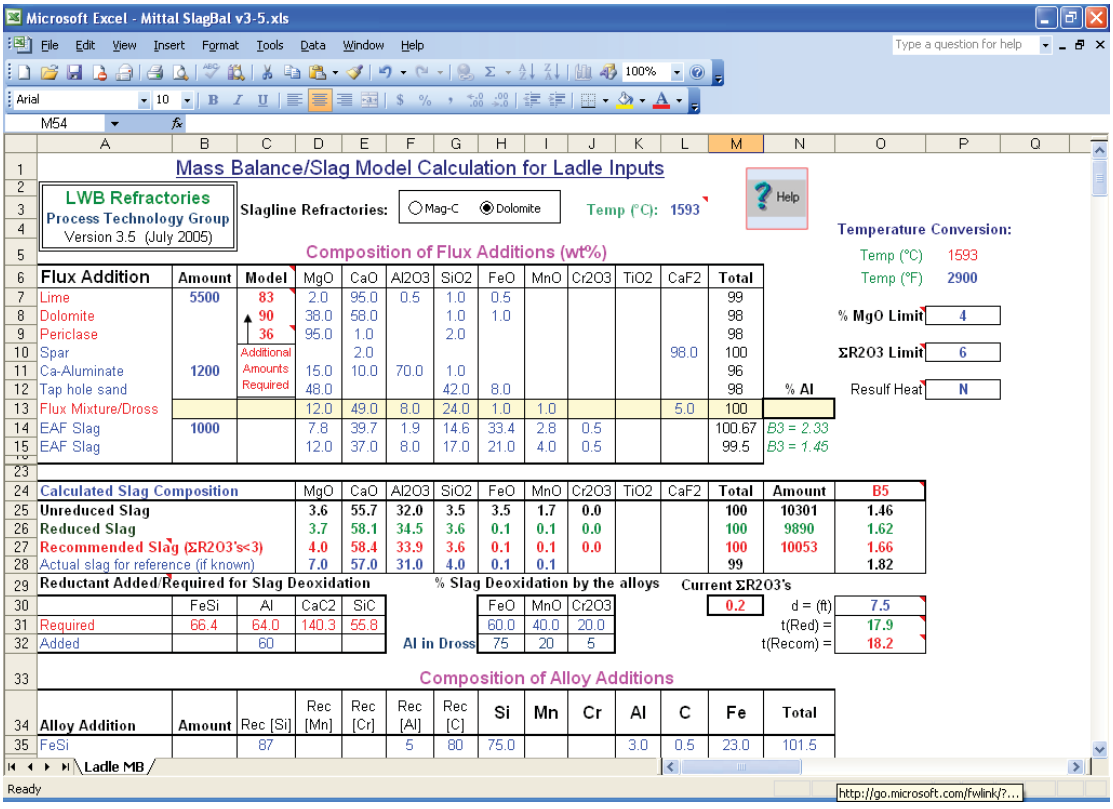
Current ΣR2O3's: 1.5 — d = (ft): 7.5; t(Red) = 6.4; t(Recom) = 6.5

Composition of Alloy Additions

Alloy Addition	Amount	Rec [Si]	Rec [Mn]	Rec [Cr]	Rec [Al]	Rec [C]	Si	Mn	Cr	Al	C	Fe	Total
FeSi		87			5	80	75.0			3.0	0.5	23.0	101.5
SiMn		90	100			80	16.8	60.2			1.3	21.7	100.0
FeMn	500		95			50		75.0			1.4	18.0	94.4

Ladle MB — Ready

Example of a model used to develop Al Killed ladle slags: AL Killed Mass Balance Model.



Microsoft Excel - Mittal SlagBal v3-5.xls

Mass Balance/Slag Model Calculation for Ladle Inputs

LWB Refractories
Process Technology Group
Version 3.5 (July 2005)

Slagline Refractories: Mag-C / Dolomite — Temp (°C): 1593

Temperature Conversion: Temp (°C) 1593; Temp (°F) 2900

Composition of Flux Additions (wt%)

Flux Addition	Amount	Model	MgO	CaO	Al2O3	SiO2	FeO	MnO	Cr2O3	TiO2	CaF2	Total	
Lime	5500	83	2.0	95.0	0.5	1.0	0.5					99	
Dolomite		90	38.0	58.0		1.0	1.0					98	
Periclase		36	95.0	1.0		2.0						98	
Spar		Additional Amounts Required		2.0							98.0	100	
Ca-Aluminate	1200		15.0	10.0	70.0	1.0						96	
Tap hole sand			48.0			42.0	8.0					98	% Al
Flux Mixture/Dross			12.0	49.0	8.0	24.0	1.0	1.0			5.0	100	
EAF Slag	1000		7.8	39.7	1.9	14.6	33.4	2.8	0.5			100.67	B3 = 2.33
EAF Slag			12.0	37.0	8.0	17.0	21.0	4.0	0.5			99.5	B3 = 1.45

% MgO Limit: 4 — ΣR2O3 Limit: 6 — Resulf Heat: N

Calculated Slag Composition	MgO	CaO	Al2O3	SiO2	FeO	MnO	Cr2O3	TiO2	CaF2	Total	Amount	B5
Unreduced Slag	3.6	55.7	32.0	3.5	3.5	1.7	0.0			100	10301	1.46
Reduced Slag	3.7	58.1	34.5	3.6	0.1	0.1	0.0			100	9890	1.62
Recommended Slag (ΣR2O3's<3)	4.0	58.4	33.9	3.6	0.1	0.1	0.0			100	10053	1.66
Actual slag for reference (if known)	7.0	57.0	31.0	4.0	0.1	0.1				99		1.82

Reductant Added/Required for Slag Deoxidation

	FeSi	Al	CaC2	SiC
Required	66.4	64.0	140.3	55.8
Added		60		

% Slag Deoxidation by the alloys

	FeO	MnO	Cr2O3
	60.0	40.0	20.0
Al in Dross	75	20	5

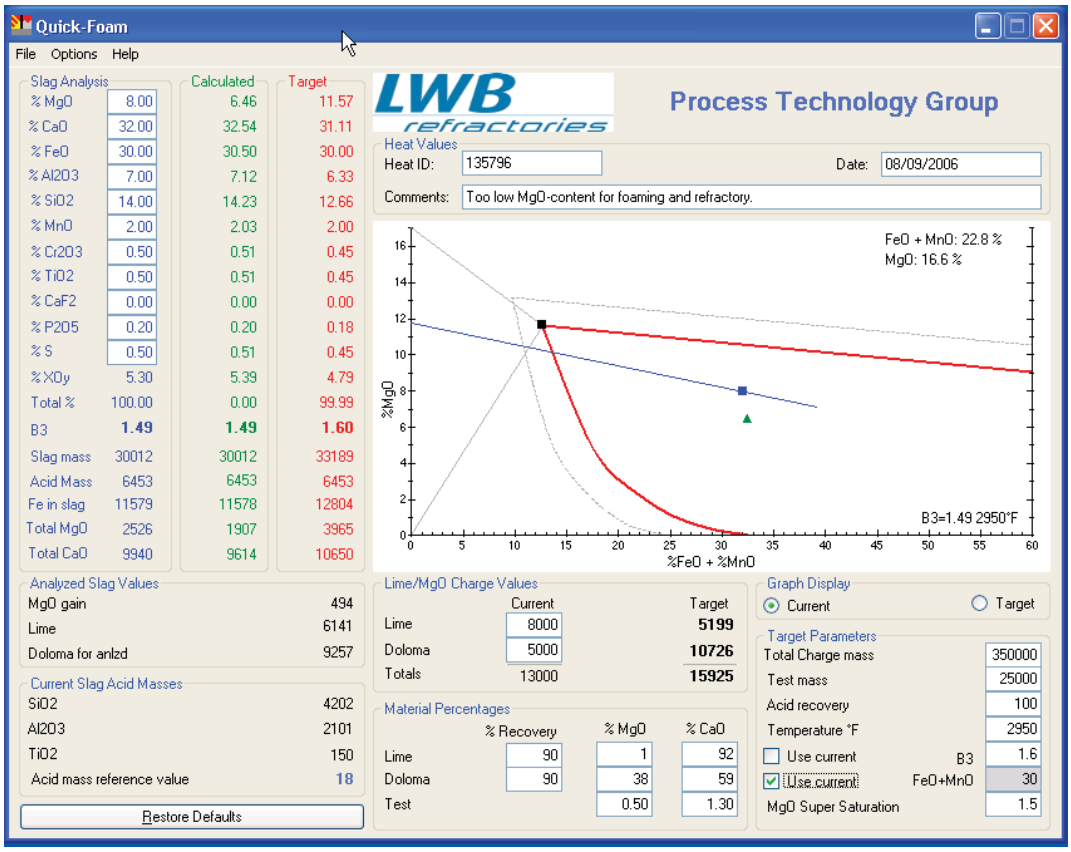
Current ΣR2O3's: 0.2 — d = (ft): 7.5; t(Red) = 17.9; t(Recom) = 18.2

Composition of Alloy Additions

Alloy Addition	Amount	Rec [Si]	Rec [Mn]	Rec [Cr]	Rec [Al]	Rec [C]	Si	Mn	Cr	Al	C	Fe	Total
FeSi		87			5	80	75.0			3.0	0.5	23.0	101.5

Ladle MB — Ready

Example of model used to evaluate EAF slag basicity and foaming characteristics: FoamyMB.

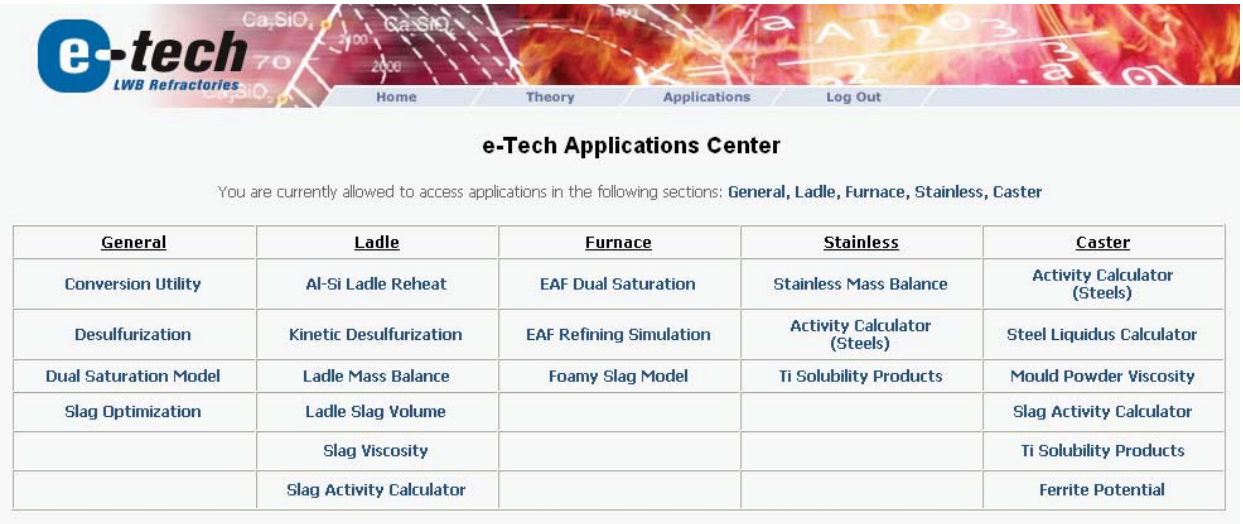


Main functions of the PTG

- Metallurgical process technology and refractory support to carbon and stainless steel producing customers.
- Work with the customer to solve metallurgical process issues and develop practices that achieve the goal of producing a quality steel product at a low overall cost per ton.
- Training of customer personnel in slag and steelmaking practices.
- Develop and maintain slag and metallurgical process models that evaluate and control various aspects of the EAF, AOD, VOD, ladle slag and inclusion formation processes.
- Maintain high-level technical website for reference to metallurgical theory and a portal to provide customers with access to the models.
- This PTG technical service package is aimed at supporting and growing LWB's refractory business and is therefore available to customers based on their level of refractory business with LWB.

e-Tech website (http://etech.lwbref.com)

Customers can access valuable technical reference information and process models on the technical website 24 hours a day. The website has different sections devoted to the Ladle, Furnace (EAF), Stainless and the Caster. Access is controlled by secure log-in and is linked to the level of business with LWB in each area. A screenshot of the website showing the applications available is shown below.



Technical Support

The technical support provided to customers can range from refractory and slag practice recommendations to more involved process studies and optimization. A large part of the PTG's involvement has traditionally been in evaluating and modifying slag practices to optimize the steelmaking process and refractory performance. This has been applied to the EAF and ladle in carbon steel, and to the AOD/VOD for stainless production. A variety of slag models and mass balance tools are used in the process – some of these are available to customers on the e-Tech website or by license agreement on their own PCs. LWB is well known for its expertise in foaming slag for the EAF and for slag practice design for a range of mini-mill process routes and stainless steel production.

Training

The training LWB provides to its customers is an integral part of the program and is highly valued in industry. Training ranges from a classroom setting to on-the-job training of operational personnel to "read slags" and respond appropriately. This helps operators to deal with the inherent variability in the steel making process and make the required adjustments. The accent is on transferring knowledge in an easy to understand fashion and implementing the academic/theoretical knowledge on the shop floor – this empowers the operators to make better decisions based on a better understanding of the process.

Metallurgical Models/Tools

There are a variety of valuable models that are based on Excel, and certain models that have been developed into professional applications that can be licensed to customers for direct use on their own PCs. For example, the group of foaming slag applications (EAF Foamy Mass Balance and QuickFoam) evaluates slag chemistry and process data to enable rapid reaction to variations in charge (scrap) quality in order to maintain good foaming slag chemistry. Other models evaluate the ability to remove phosphorous and sulfur, or relate the balance of carbon and oxygen in the EAF process to %FeO in the slag (and thus Fe-yield). A mass and energy balance is also available for more detailed evaluations.

Our new version of Foaming Mass Balance (FMB) software allows automatic data loading from plant-level database systems for rapid result display and heat-by-heat evaluation of the process. History records will be maintained in the FMB and can be sorted and searched easily.

The LWB Slag Model and comprehensive ladle mass balance are applied to ladle processes to design slag practices that first enhance rapid liquid slag formation and then achieve a slag balanced with respect to refining requirements and refractory compatibility. Desulfurization and inclusion control are the most important refining reactions considered for the ladle treatment. More advanced metallurgical problems may require application of models for slag and metal activity and the associated interactions, especially with regard to oxygen potential and inclusion control. The Titanium Inclusion Model (TIM) is an advanced model that calculates the type and mass of solubility product inclusions that form from a certain steel chemistry over a temperature interval. The TIM is a valuable tool for evaluation of inclusion control practices and sensitivity to chemistry variations.

Summary

A strong metallurgical background and valuable computer process models, combined with practical experience and expertise, enables the PTG to assist our customers with a variety of steelmaking related issues. Teamed with LWB's sales, marketing, and research personnel, The PTG works with our customers to improve their operating practices and refractory performance - with the ultimate goal of producing a quality steel product at low cost.

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