

The IIMA Value-in-Use Model
For Evaluation screening of OBM Materials
Version 3.0

Operating Manual

May 29, 2017

Introduction

The IIMA Value-in-use model is meant to provide users of OBMs with a simple method to screen various OBMs with respect to their use in a given electric arc furnace operation. It is not meant to be a fully comprehensive analysis and may not include some parameters that would be of great concern to some operations. If a more comprehensive analysis is desired, the user should consider using a model which performs a full mass and energy balance and consider the full range of parameters that impact on a particular operation. The model has been developed by Continuous Improvement Experts Inc. with input from the International Iron Metallurgy Association.

VIU Model Disclaimer - Intellectual Property Rights and Confidentiality

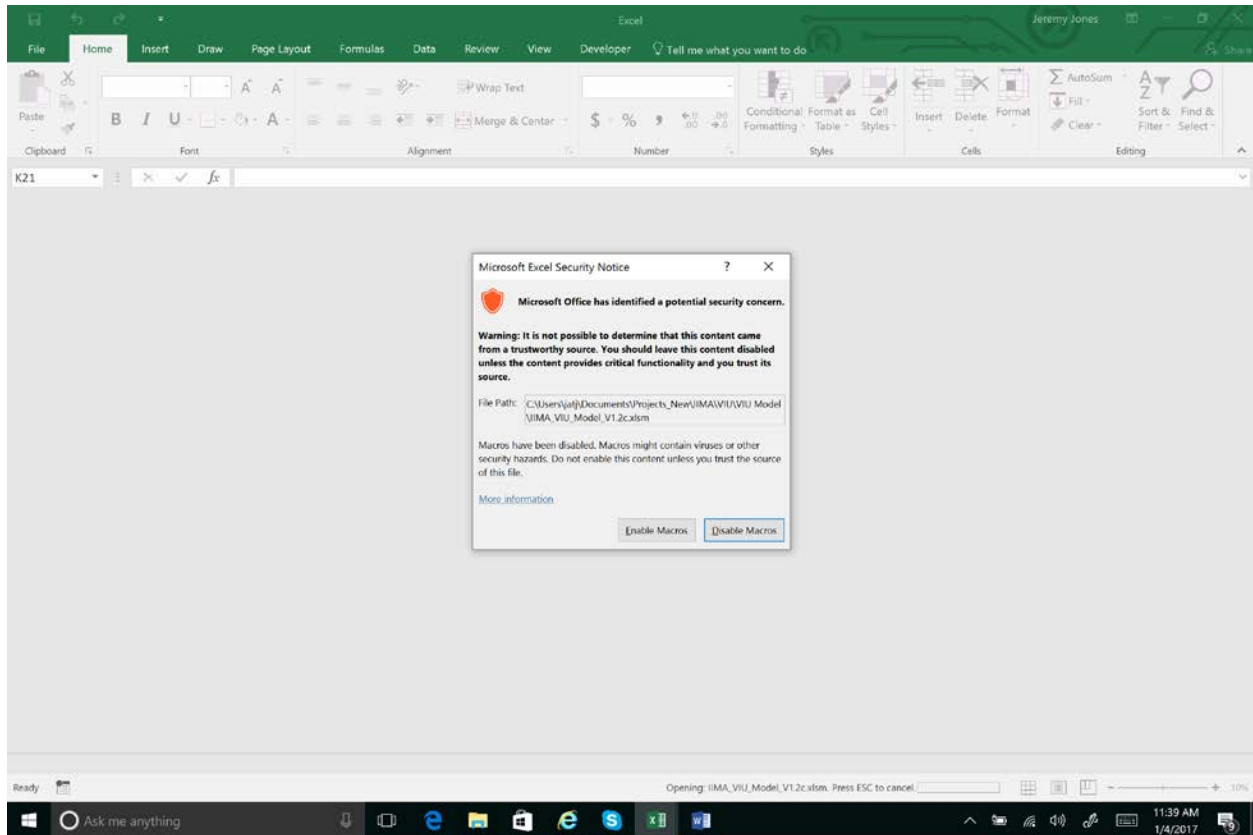
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Current Model Version

The most current model version is version 2.1 released May 2017

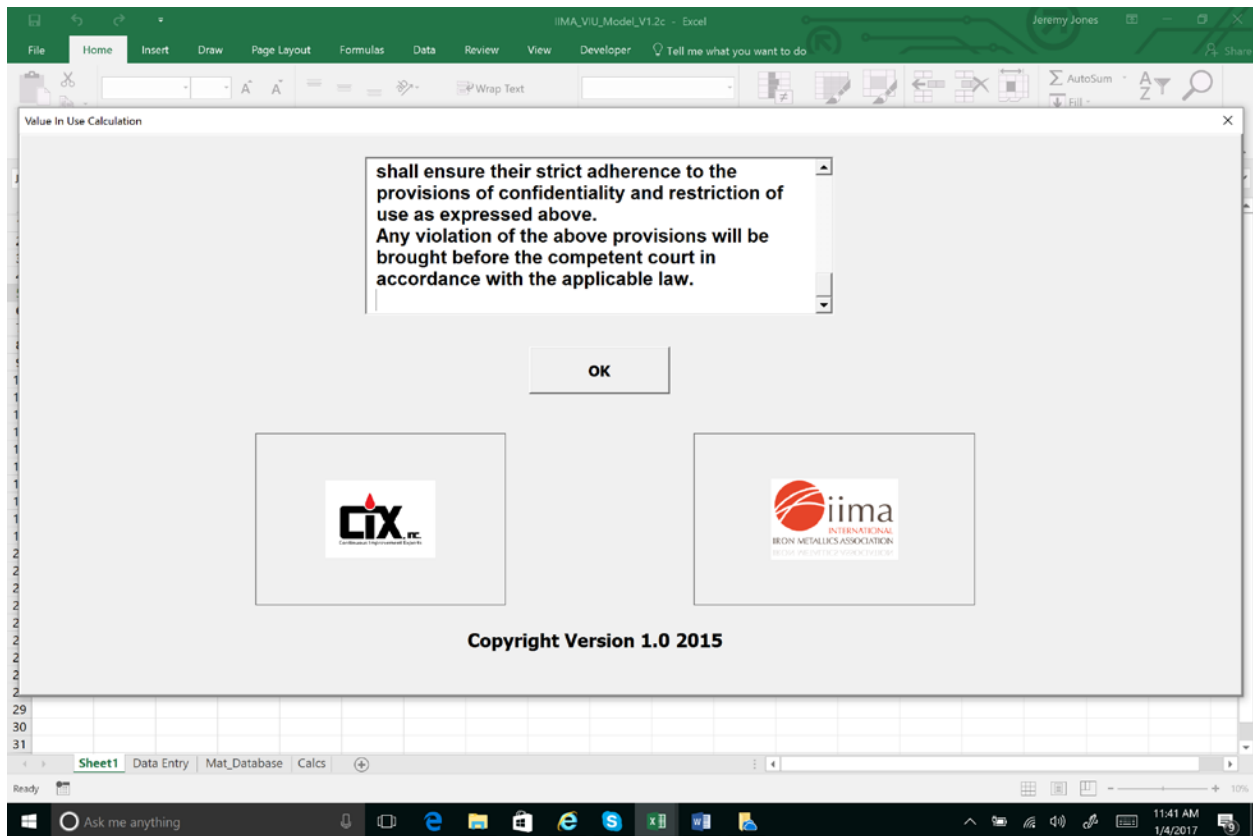
Running the Model

The Value-in-use (VIU) model is contained in a Microsoft Excel Spreadsheet. When the spreadsheet is initially loaded you may see the following pop-up screen:



The model contains macros and if you wish to run the model, you will need to enable macros to run on your PC. Click on the button **Enable Macros**.

When the program loads the following Title page will load:



A text box will display the terms and conditions for use of the model. If the user agrees with these terms and conditions, click on okay and the model will load and take the user to the data entry sheet in the spreadsheet. If the user does not agree with these terms and conditions, the user must exit the program. If the OK button is not selected, the program will not operate.

Data Input Sheet

When the user is directed to the data entry worksheet, the user will see a table where material composition data may be entered.

	Column H	Column J	Column L	Column N
Material Name	Prime Scrap	DRI 1	HBI 1	Pig Iron
\$/tonne	\$ 314.50	\$ 235.00	\$ 255.00	\$ 365.00
Fe Tot	97.200%	91.113%	89.700%	94.300%
Fe Met	95.500%	85.646%	83.900%	94.300%
Metallization	98.25%	94.00%	93.53%	100.00%
C	0.080%	2.500%	1.500%	4.100%
SiO2	0.500%	1.755%	4.210%	0.200%
Al2O3	0.500%	0.810%	0.800%	0.100%
MgO	0.000%	0.135%	0.325%	
CaO	0.000%	0.945%	0.890%	
S		0.040%	0.008%	0.020%
P		0.020%	0.009%	0.060%
Si	0.010%			0.500%
Al	0.020%			
Mn	0.700%			0.700%
Fines < 4 mm	0.000%	3.000%	2.000%	0.500%
Fines < 8 mm			2.000%	0.000%
FeO	2.19%	7.03%	7.46%	0.00%
Metallic Fe	95.50%	85.65%	83.90%	94.30%
H2O	0.500%	0.500%	0.500%	0.000%
Cu wt%	0.080%	0.002%	0.002%	0.000%
Other	0.503%	1.116%	0.896%	0.020%
C req'd to reduce 100 % FeO	0.37%	1.17%	1.25%	0.00%

Data values shown in Blue must be entered. Values in Red are calculated values and should not be edited. Up to four materials can be compared at a time. The data listed in the first column (Column H), is the material composition data for the primary material. When the value-in-use analysis is carried out, the value-in-use of each of the other materials is calculated with respect to the prime OBM material.

In the above table, **Prime Scrap** is the prime material.

The following data must be entered by the user. If this information is not entered, the calculation will not execute properly:

\$/tonne – Enter the cost of the material

Fe Tot – enter the total Fe content of the material

Fe Met – enter the % of metallic Fe in the material

Metallization – Calculated by the program = Metallic Fe / Total Fe

C – enter the carbon content of the material

SiO2 – enter the silica content of the material

Al2O3 – enter the alumina content of the material

- MgO** – enter the MgO content of the material
- CaO** – enter the CaO content of the material
- S** – enter the sulfur content of the material
- P** – enter the phosphorus content of the material
- Si** – enter the silicon content of the material
- Al** – enter the aluminum content of the material
- Mn** – enter the manganese content of the material
- Fines < 4 mm** – enter the fines content of the material
- Fines < 8 mm** – enter the carbon content of the material

Note: All of the above material composition data is on a dry basis

- FeO** - *Calculated by the program*
- Metallic Fe** - *Calculated by the program*
- H2O** – if known, enter the moisture content of the material
- Cu wt%** - enter the copper content of the material
- Other** *Calculated by the program*

Other Data Input

In addition to the material composition data, there is additional data that must be entered by the user. One block of data includes the base productivity data which includes the power-on time, electrical power consumption, % FeO in the slag, % CaO in the slag, slag MgO % target, Productivity value and the amount (%) of the primary OBM material used in the scrap charge.

Base Productivity Conditions

P-On time	34	minutes
Power	380	KwH/tonne
Slag FeO	28.0%	
Slag CaO	34.0%	
MgO Target	9.0%	
Productivity cost	1.00	\$/%
% of OBM in Charge	10.0%	

Another table addresses recovery of materials in the operation. A typical range for these variables is also provided as a guideline. FeO recovery represents the desired recovery of the FeO contained in the OBM. The model will calculate the corresponding carbon requirement and the energy requirement to recover the FeO (i.e. convert it to metallic Fe). C recovery represents the recovery of charge and injection carbon. It is assumed that all carbon contained in the OBM is recovered. Fines losses are broken down into 2 size ranges. Fine materials can be lost during charging or may be sucked out into the fourth hole system during EAF operation.

Operating Data		Range
C recovery	50%	30 to 80%
Energy Efficiency	50%	40 to 60 %
Fines losses < 4 mm	100%	30 to 100%
Fines losses 4 - 8 mm	30%	30 to 100%
FeO recovery	50%	30 to 100%

The cost data table contains commodity costs. Note that a previous study by IIMA determined that the intrinsic value associated with copper content in the charge metallic ranged between \$1.50 to \$2.00 per point of copper. Thus material with lower copper content will have greater value in use compared to a material that has a higher copper content.

Cost Data	\$/unit
Cu cost	\$ 1.75 per pt.
Lime	\$ 110.00 tonne
Dolo-lime	\$ 110.00 tonne
Carbon	\$ 255.00 tonne
Power	\$ 0.05 kWh

The flux data table contains composition data for fluxes as well as the target B3 basicity value.

Flux Data	CaO	MgO
Lime	92.3%	1.1%
Dolo-lime	60.1%	30.1%
Slag Basicity - B3	1.80	

Initiating a Calculation Sequence

Once the data has been entered, the user should select the **Run Calculation** Button. When this button is selected, the user will be prompted for the number of materials that are to be compared. The minimum is 2 and the maximum is 4. The number of materials entered is confirmed in a pop-up text box.

Model Calculations

The VIU model carries out several calculations. It is important to recognize that the model calculates the value-in-use of the material(s) to be evaluated relative to the primary OBM material. Initially, the model calculates the total Fe recovered by taking into account the metallic Fe content, the fines losses and the amount of FeO recovered. Once this is computed, other parameters such as the amounts of carbon, silicon, aluminum, manganese, silica, alumina, MgO and CaO are calculated. Moisture content and copper content are also calculated.

Similar calculations are carried out for the material(s) to be compared to the primary OBM. Once these calculations are carried out, the delta values are computed for each parameter. The delta values are the quantity of a specific parameter for the alternative material – quantity of a specific parameter for the primary OBM. For example $\Delta_{\text{silicon}(1)} = \text{silicon in alternative material 1} - \text{silicon in primary OBM}$.

Once the delta values are computed for each of the elements in each material, the following calculations are carried out:

Calculation of additional charge carbon required in order to provide the same amount of carbon to the EAF as the primary OBM (after adjustments for FeO recovery)

Calculation of additional slag volume generated by the alternative material (based on the slag data inputs - FeO content, Slag CaO content, MgO target, slag B3 target) and the differential amounts of silica and alumina. (note it is possible for the delta slag quantity to be negative if the alternative material contains lower gangue content than the primary OBM).

Calculation of energy requirements taking into account the oxidation of silicon and aluminum, the differential slag volume, FeO recovery and energy to evaporate moisture.

Once the differential energy requirement for the alternative material is calculated, the impact of productivity is calculated.

The costs associated with each parameter are then calculated and the results are written to a summary table

Calculation Results

The following is a results table showing the comparison between the primary OBM (in this case A T PI) against each of the proposed alternative materials. The differential costs associated with each parameter of interest are listed out for each of the alternative materials. (see below)

Results					
Material		Prime Scrap	DRI 1	HBI 1	Pig Iron
\$/tonne		\$ 314.50	\$ 235.00	\$ 255.00	\$ 365.00
\$/t Fines loss			\$ 7.05	\$ 6.63	\$ 1.83
\$/t H2O loss			\$ -	\$ -	\$ (1.83)
\$ Chg C			\$ (9.99)	\$ (4.88)	\$ (21.33)
\$ Dolo Lime			\$ 2.01	\$ 5.49	\$ 0.53
\$ Lime			\$ 0.66	\$ 3.58	\$ 0.31
\$ Cu			\$ (13.65)	\$ (13.65)	\$ (14.00)
\$ Kwh			\$ 1.34	\$ 3.44	\$ (2.27)
\$ Productivity			\$ 0.73	\$ 1.89	\$ (1.25)
Yield kg Fe		963.5	840.8	801.4	934.8
Total\$/T Fe		\$ 326.41	\$ 264.53	\$ 318.96	\$ 351.14
Incl productivity			\$ 265.40	\$ 321.32	\$ 349.81
Price of Primary Material at Break Even					
Without Productivity Effect			\$ 254.87	\$ 307.32	\$ 338.32
With Productivity Effect			\$ 255.71	\$ 309.59	\$ 337.04

Required price of primary OBM for alternative material **DRI1** to be considered for use. If the price **Prime Scrap** is greater than this value then the **DRI1** should be substituted. If it is lower or equal to this value **Prime Scrap** should continue to be used. This value does not consider productivity effects.

Similar to the value above but also considers the impact of productivity

Note that the costs that are calculated for each alternative material are relative to the primary OBM and should not be considered as absolute values. These provide for a comparison of materials head to head and allows the facility to make an educated decision regarding the substitution of an alternative OBM for an OBM currently in use.

Reporting Issues and Problems

This model has been provided on an as-is basis. The model does not currently perform verification or error checking on any of the user inputs. It is possible that the model may crash under certain circumstances. Every effort has been made to keep the model flexible. If you encounter operating errors that you believe the model should be able to accommodate, please forward comments to info@metallics.org or via the contact form at <https://www.metallics.org/contact-us.html>. Alternatively, please contact Jeremy.jones@cixllc.com.