



# INVESTIGATIONS OF NON-METALLIC PHASE OBTAINED FROM CONVERTER SLAG REDUCTION PROCESS

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- The objective of the research
- Thermodynamic calculations
- Obtaining the non-metallic phase in the Portland clinker form
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The objective of the research

Utilization of the converter slag to  
obtain the Portland clinker or the  
soil fertilisation

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Realization of the objective

- Thermodynamic calculation of converter slag reduction in an electric-arc furnace base on FactSage software
- Determination of the mass reducer and process temperature base on computational calculation
- Results of the converter slag reduction in the laboratory electric-arc furnace investigations

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Thermodynamic calculation of converter slag reduction - conditions

1. Mass and chemical composition of the converter slag:

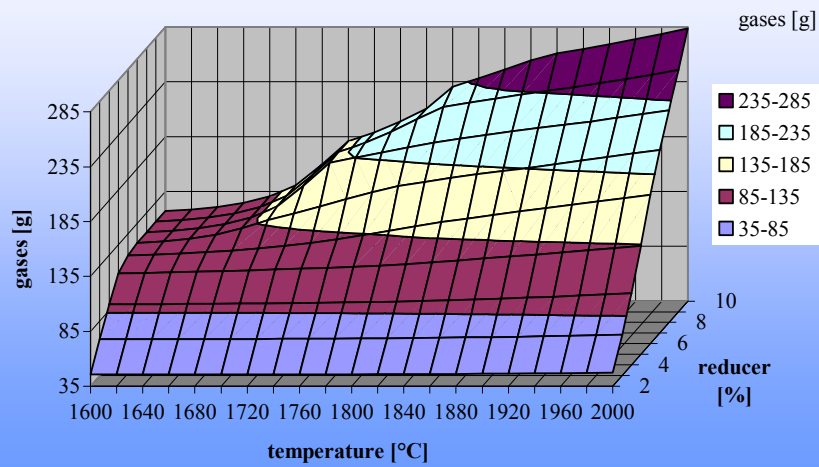
Slag mass, kg	Chemical composition, %								
	CaO	SiO <sub>2</sub>	MgO	FeO	MnO	Cr <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub>	P <sub>2</sub> O <sub>5</sub>	ΣS
1	44.50	16.63	5.26	23.25	5.40	0.16	1.68	1.24	0.15

2. Temperature: 1600 - 2000°C

3. Reducer: 2 – 10 % of mass slag

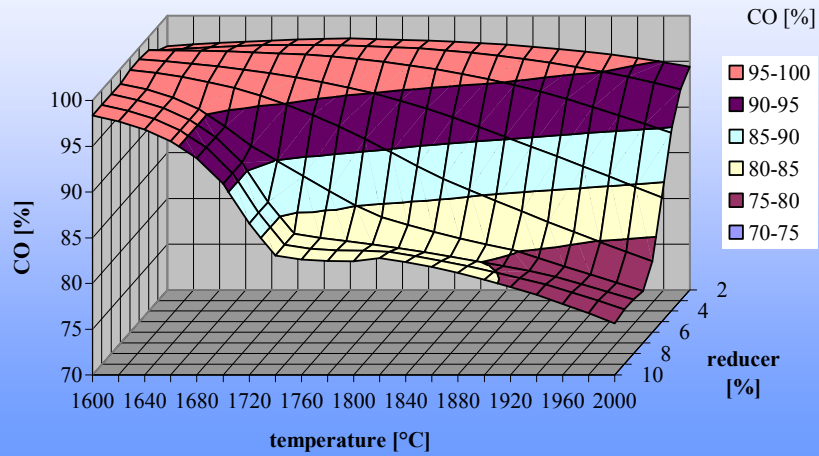
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Thermodynamic calculation results –  
gases mass in equilibrium state



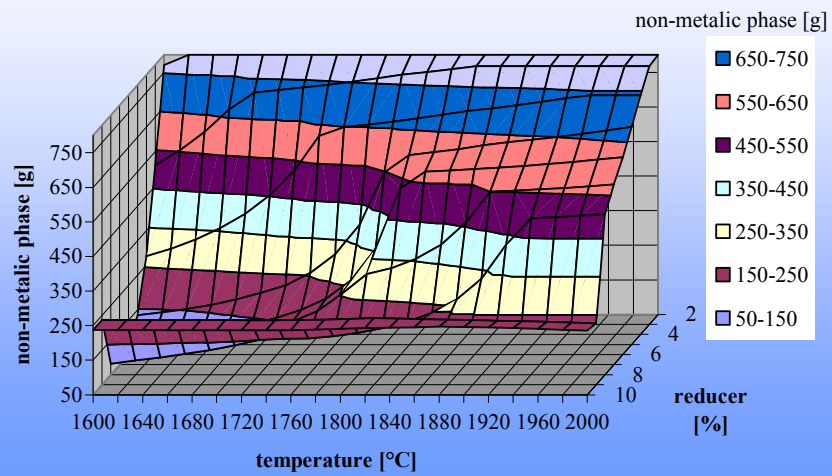
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Thermodynamic calculation results – equilibrium content of CO in the gas phase



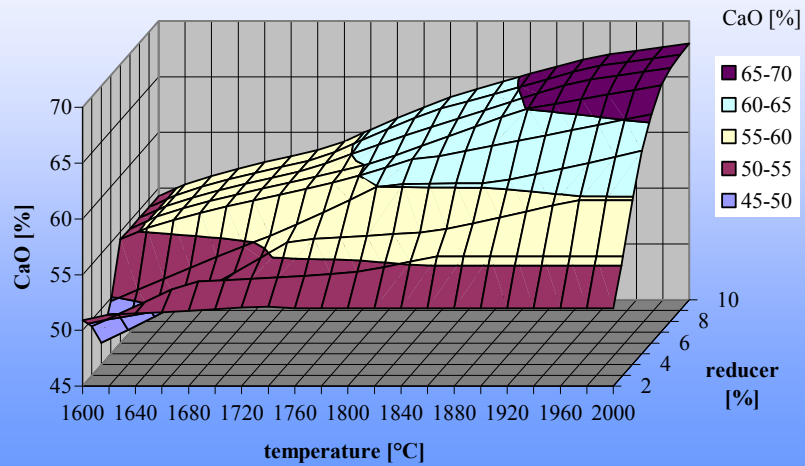
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Thermodynamic calculation results – non-metallic liquid phase mass in equilibrium state



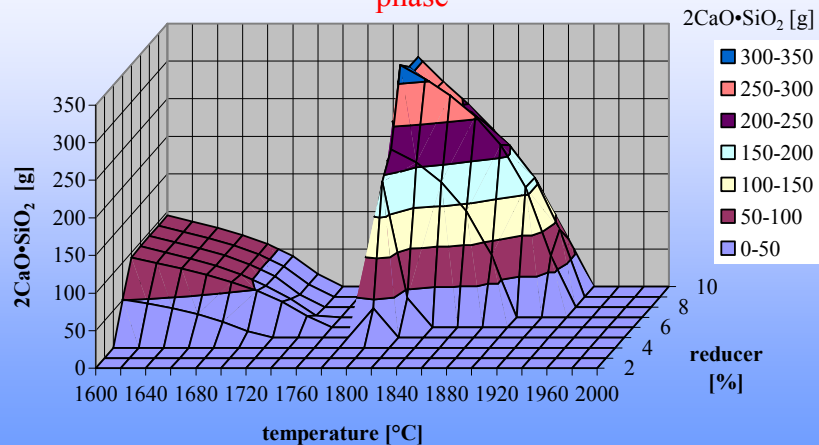
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Thermodynamic calculation results –  
equilibrium content of CaO in the non-metallic liquid phase



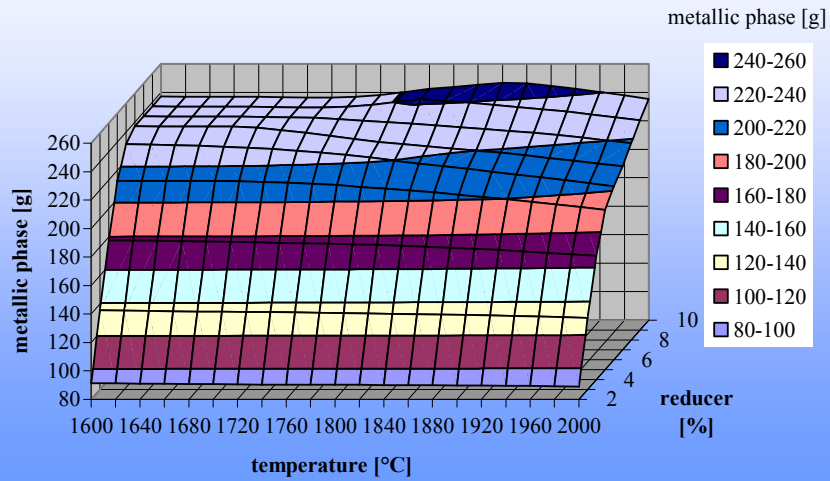
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Thermodynamic calculation results –  
equilibrium content of solid  $2\text{CaO}\cdot\text{SiO}_2$  in the non-metallic liquid  
phase



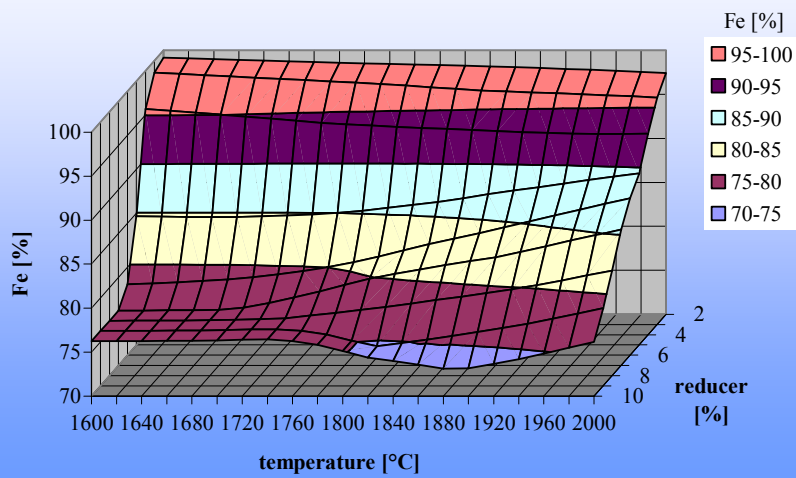
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Thermodynamic calculation results –  
metallic liquid phase mass in equilibrium state



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Thermodynamic calculation results – equilibrium content of Fe in  
the metallic liquid phase



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### Research equipment



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### Obtaining the non-metallic phase in the Portland clinker form - conditions

#### 1. Mass and chemical composition of the converter slag:

Slag mass, kg	Chemical composition, %								
	CaO	SiO <sub>2</sub>	MgO	FeO	MnO	Cr <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub>	P <sub>2</sub> O <sub>5</sub>	ΣS
1	44.50	16.63	5.26	23.25	5.40	0.16	1.68	1.24	0.15

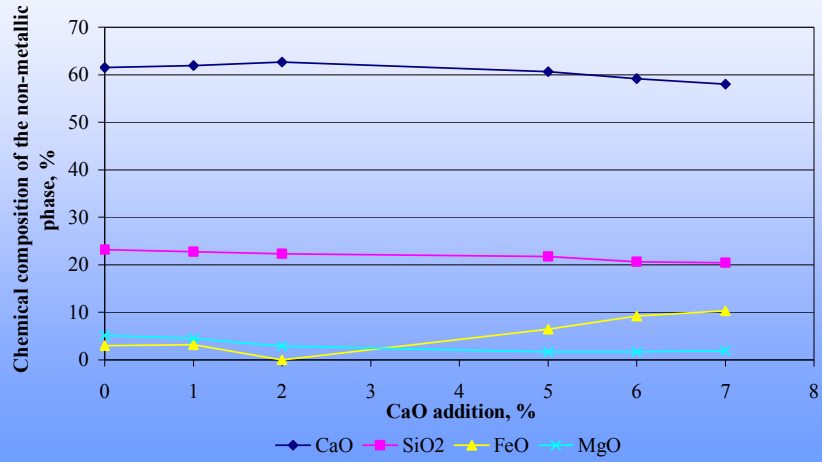
2. CaO addition: 0%, 1%, 2%, 5%, 6%, 7% of slag mass

3. Temperature: 1800°C

4. Reducer: 6 % of slag mass

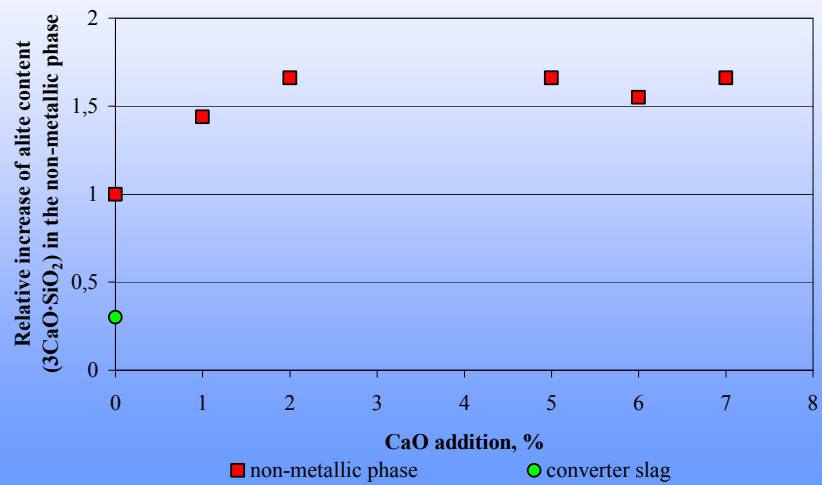
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Obtaining the non-metallic phase in the Portland clinker form –  
results



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Obtaining the non-metallic phase in the Portland clinker form –  
results

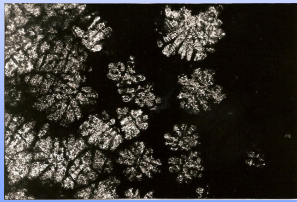


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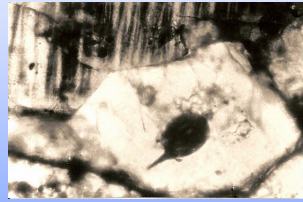


Obtaining the non-metallic phase in the Portland clinker form –  
results

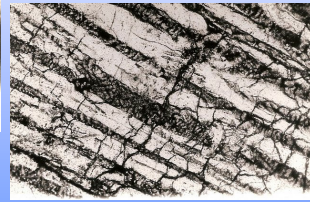
Fragment of skeleton structure non-metallic phase



Belite  
 $\beta 2\text{CaO}\cdot\text{SiO}_2$ , x 136



Rankinite  
 $3\text{CaO}\cdot 2\text{SiO}_2$ , x 34



Alite  
 $3\text{CaO}\cdot\text{SiO}_2$ , x 34

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Obtaining the non-metallic phase in the soil fertilization form -  
condition

1. Mass and chemical composition of the converter slag:

Slag mass, kg	Chemical composition, %								
	CaO	SiO <sub>2</sub>	MgO	FeO	MnO	Cr <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub>	P <sub>2</sub> O <sub>5</sub>	ΣS
5	44.50	16.63	5.26	23.25	5.40	0.16	1.68	1.24	0.15

2. Temperature: 1800°C

3. Reducer: 6 % of mass slag

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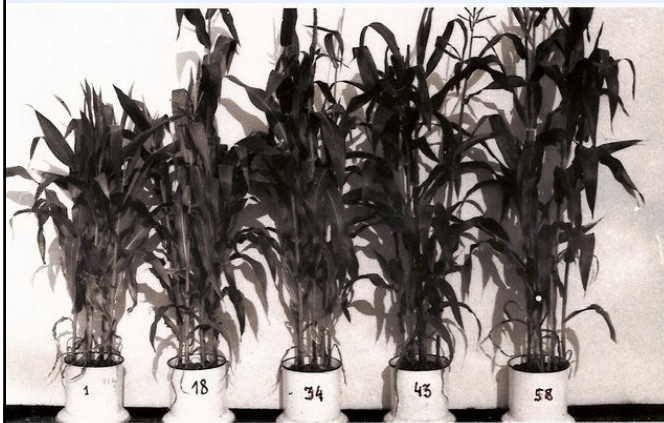
Obtaining the non-metallic phase in the soil fertilisation form -  
results

Non-metallic phase, g	Chemical composition, %						
	CaO	SiO <sub>2</sub>	MgO	FeO	MnO	Cr <sub>2</sub> O <sub>3</sub>	P <sub>2</sub> O <sub>5</sub>
2476.0	62.43	26.67	2.18	3.13	1.40	0.100	0.09

Metallic phase, g	Chemical composition, %							
	C	Fe	Si	Mn	Al	Cr	P	S
916.1	0.92	91.34	0.75	5.40	0.005	0.11	1.40	0.028

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Obtaining the non-metallic phase in the soil fertilisation form -  
results



- 1. NPK,
- 18. NPK + CaCO<sub>3</sub>
- 34. NPK + CaCO<sub>3</sub>·MgCO<sub>3</sub>
- 43. NPK + non-metallic phase,  $\phi < 0.5$  mm
- 58. NPK + non-metallic phase,  $\phi 0.5-2.0$  mm

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### Conclusions

The possibility of converter slag utilisation were presented.

Thermodynamic calculation conditions of converter slag reduction were considered.

Investigations of the converter slag reduction process in EAF have been carried out.

The aim of the investigations was to obtain the non-metallic phase in the Portland clinker or soil fertiliser form.

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