Comparison of Fusion with VITRIOX GAS and VITRIOX ELECTRIC

Introduction

Fusion based on gas and based on an electrical muffle oven differ considerably in the heating method. At the same time, the user expects comparable results.

Technical Differences

In the case of the gas-based **VITRIOX GAS**, the crucible and the casting dishes are heated from below by a flame. The flame is formed from gas (propane, butane, natural gas) and oxygen (compressed air and oxygen). The relationship between gas/air/oxygen ultimately determines the temperature of the flame and therefore the temperature in the crucible. It is important that each burner is individually adjustable so that the temperature for each burner can be set exactly. This is equally true for crucible burners as well as for die burners. There is no direct temperature measurement, but the gas flow is regulated so that even for a fluctuating inlet pressure, exactly the same amount of gas is always directed to the burner; leading to a higher temperature stability. The temperature is indirectly determined from the melting point of pure lithium tetraborate. The rule is that 9 g lithium tetraborate (FX-x100) melts in 4 minutes.

Figure 1: VITRIOX GAS

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Figure 2: VITRIOX ELECTRIC

In the case of the **VITRIOX ELECTRIC** electrical fusion machine, the crucible and the casting dishes are evenly heated in a muffle oven. The muffle oven has a thermocouple that indicates the exact temperature. However, the temperature display must be factory calibrated, as the position of the thermocouple in relation to the position of the crucible is slightly different in each oven due to manufacturing tolerances. The goal is that every muffle oven displays the same temperature and also delivers the same analytical result.

- **Illustration**

Figure 4: VITRIOX GAS burners

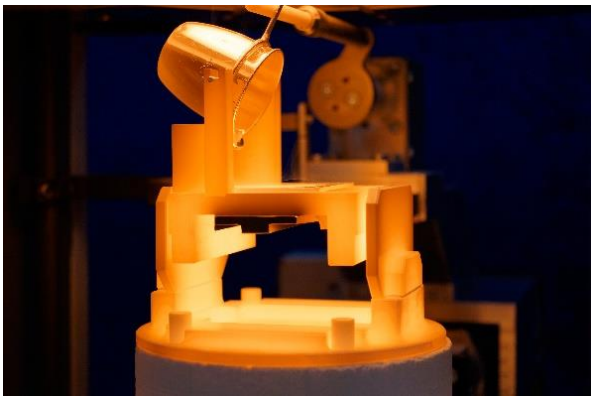

Figure 3: VITRIOX ELECTRIC oven chamber

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▪ Analytical Results

The following tables display the results for real customer samples that were fused with both the VITRIOX GAS gas fusion machine and the VITRIOX ELECTRIC electrical fusion machine. A separate calibration was used for each fusion system, which leads to slightly higher or lower means for one or another result.

Table 1: Fusion of ferrochrome, analyzed with the FLUXANA FERRO application package.

Mass%	GAS	GAS	ELECTRIC	ELECTRIC
Preparation	No 1	No 2	No 1	No 2
Cr	65.75	65.55	66.16	65.63
Fe	23.95	23.33	23.18	23.98
Mn	0.17	0.16	0.11	0.14
Si	1.35	1.28	1.34	1.41

Table 2: Fusion of slag, analyzed with the FLUXANA SLAG application package.

Mass%	GAS	GAS	ELECTRIC	ELECTRIC
Preparation	No 1	No 2	No 1	No 2
Al2O3	10.97	10.99	10.79	10.79
CaO	0.64	0.65	0.63	0.63
Cr2O3	4.44	4.45	4.60	4.63
Fe2O3	0.99	0.99	0.99	0.99
K2O	0.27	0.27	0.29	0.29
MgO	35.85	35.66	35.62	35.68
Mn2O3	0.19	0.19	0.18	0.18
SiO2	46.23	46.12	46.04	46.04
SO3	0.17	0.17	0.19	0.18
SrO	0.14	0.14	0.12	0.12
TiO2	0.20	0.20	0.21	0.21

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Table 3: Fusion of quartzite, analyzed with the FLUXANA RAW-PROF application package.

Mass%	GAS	GAS	ELECTRIC	ELECTRIC
Preparation	No 1	No 2	No 1	No 2
Al2O3	3.25	3.28	3.23	3.29
BaO	0.03	0.03	0.03	0.02
CaO	0.99	0.98	0.96	0.96
Cr2O3	0.35	0.35	0.33	0.33
CuO	0.02	0.00	0.01	0.01
Fe2O3	1.29	1.31	1.34	1.30
K2O	0.98	0.98	1.00	1.02
MgO	0.26	0.25	0.28	0.30
Mn2O3	0.04	0.04	0.03	0.03
Na2O	0.55	0.52	0.42	0.46
P2O5	0.07	0.06	0.07	0.07
SiO2	92.08	91.77	92.03	92.03
TiO2	0.22	0.23	0.23	0.23

Table 4: Fusion of chrome ore, analyzed with the FLUXANA RAW-PROF application package.

Mass%	GAS	GAS	ELECTRIC	ELECTRIC
Preparation	No 1	No 2	No 1	No 2
Al2O3	7.66	7.70	7.73	7.79
Cr2O3	48.28	48.18	48.47	48.48
Fe2O3	14.80	14.79	14.54	14.53
MgO	20.03	20.16	20.26	20.26
NiO	0.23	0.23	0.21	0.22
SiO2	7.81	7.81	7.70	7.72

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Table 5: Fusion of cement, analyzed with the FLUXANA CEM application package.

Mass%	GAS	GAS	ELECTRIC	ELECTRIC
Preparation	No 1	No 2	No 1	No 2
Al2O3	5.58	5.58	5.54	5.55
CaO	64.63	64.68	64.77	64.77
Cr2O3	0.01	0.01	0.01	0.01
Fe2O3	2.61	2.61	2.66	2.65
K2O	0.87	0.87	0.87	0.86
MgO	1.44	1.45	1.40	1.43
Mn2O3	0.06	0.07	0.06	0.06
Na2O	0.24	0.23	0.21	0.23
P2O5	0.16	0.16	0.16	0.16
SiO2	20.92	20.96	20.83	20.86
SO3	2.95	2.91	3.05	3.07
SrO	0.28	0.28	0.29	0.29
TiO2	0.29	0.28	0.29	0.28
ZnO	0.05	0.05	0.05	0.05

Summary

The analytical data shows that with optimized settings both the VITRIOX GAS gas fusion machine and the VITRIOX ELECTRIC electrical fusion machine provide excellent consistent results.

From experience, it can be said that the fusion time of both systems is also approximately the same.

Volatile elements such as the halogens F and Cl escape the fusion in the open system of the gas driven machine but can be determined with sufficient precision in the electrical fusion machine, due to its closed construction.

Another characteristic of the electrical system is the use of quartz crucibles instead of platinum crucibles. In this way, fusions for applications that strongly damage platinum crucibles (e.g., metals or sulfides) can also be performed.

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Literature

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