Łukasiewicz GIT

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# CERTIFICATE OF ANALYSIS

# IMZ 3.58

## CERTIFIED REFERENCE MATERIAL
## IRON ORE PELLET

Analysis listed as percent by weight [% m/m]

| | Certified value | Expanded uncertainty | | Certified value | Expanded uncertainty |
|---|---|---|---|---|---|
| Fe | 66.08 | ± 0.15 | MgO | 0.23 | ± 0.01 |
| Mn | 0.027 | ± 0.002 | FeO | 0.84 | ± 0.10 |
| $TiO_2$ | 0.022 | ± 0.002 | $Na_2O$ | 0.032 | ± 0.003 |
| CaO | 2.61 | ± 0.03 | C | 0.030 | ± 0.007 |
| $K_2O$ | 0.029 | ± 0.001 | Cr | 0.0034 | ± 0.0007 |
| S | 0.0103 | ± 0.0005 | Cu | 0.0008 | ± 0.0003 |
| P | 0.0066 | ± 0.0005 | V | 0.0015 | ± 0.0003 |
| $SiO_2$ | 2.60 | ± 0.03 | LOI | 0.051 | ± 0.009 |
| $Al_2O_3$ | 0.214 | ± 0.008 | | | |

- the uncertainty bases on statistical evaluation of the contributions of the material homogeneity and the interlaboratory certification analysis

Informational values:

| | | | |
|---|---|---|---|
| Zn | (0.0013) | Ni | (0.0016) |
| Pb | (0.0011) | Co | (0.0016) |
| As | (0.0008) | | |

Certificate Number: IMZ3.58-170225
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| Analysis | Fe | * | Mn | * | $TiO_2$ | * | CaO | * | $K_2O$ | * | S | * | P | * | $SiO_2$ | * |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 65.54 | 1 | 0.022 | 1 | 0.015 | 3 | 2.50 | 1 | 0.027 | 3 | 0.0080 | 2 | 0.0051 | 7 | 2.45 | 5 |
| 2 | 65.57 | 1 | 0.023 | 3 | 0.017 | 1 | 2.50 | 3 | 0.028 | 1 | 0.010 | 1 | 0.006 | 3 | 2.52 | 3 |
| 3 | 65.8 | 4 | 0.024 | 3 | 0.017 | 1 | 2.54 | 1 | 0.028 | 1 | 0.010 | 3 | 0.006 | 3 | 2.56 | 1 |
| 4 | 65.95 | 4 | 0.025 | 10 | 0.02 | 3 | 2.56 | 3 | 0.028 | 1 | 0.010 | 8 | 0.006 | 13 | 2.56 | 3 |
| 5 | 65.97 | 4 | 0.026 | 3 | 0.022 | 3 | 2.58 | 3 | 0.028 | 6 | 0.010 | 2 | 0.006 | 1 | 2.57 | 1 |
| 6 | 65.97 | 4 | 0.027 | 1 | 0.022 | 3 | 2.58 | 1 | 0.029 | 3 | 0.0101 | 2 | 0.006 | 3 | 2.58 | 5 |
| 7 | 66.0 | 4 | 0.028 | 1 | 0.022 | 3 | 2.58 | 1 | 0.029 | 1 | 0.0103 | 2 | 0.0061 | 3 | 2.60 | 5 |
| 8 | 66.13 | 1 | 0.028 | 1 | 0.0221 | 3 | 2.60 | 1 | 0.029 | 3 | 0.011 | 2 | 0.0067 | 1 | 2.60 | 5 |
| 9 | 66.14 | 1 | 0.028 | 3 | 0.023 | 1 | 2.62 |  | 0.030 | 3 | 0.011 | 2 | 0.007 | 1 | 2.617 | 1 |
| 10 | 66.185 | 3 | 0.028 | 1 | 0.0232 | 3 | 2.62 | 1 | 0.03 | 12 | 0.0122 | 2 | 0,0074 | 7 | 2.62 | 3 |
| 11 | 66.20 | 4 | 0.0297 | 3 | 0.0235 | 7 | 2.63 | 1 | 0.03 | 3 | 0.0127 | 3 | 0.0076 | 1 | 2.63 | 1 |
| 12 | 66.20 | 4 | 0.030 | 1 | 0.024 | 1 | 2.64 | 3 | 0.0308 | 3 |  |  | 0.008 | 1 | 2.74 | 1 |
| 13 | 66.26 | 4 | 0.030 | 1 | 0.025 | 1 | 2.646 | 3 |  |  |  |  | 0.0084 | 3 | 2.74 | 5 |
| 14 | 66.37 | 4 | 0.03 | 3 | 0.028 | 3 | 2.66 | 3 |  |  |  |  | 0.0084 | 3 |  |  |
| 15 | 66.43 | 1 |  |  |  |  | 2.73 | 10 |  |  |  |  |  |  |  |  |
| 16 |  |  |  |  |  |  | 2.78 | 3 |  |  |  |  |  |  |  |  |
| 17 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 18 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Average[1] | 66.077 |  | 0.0272 |  | 0.0220 |  | 2.606 |  | 0.0289 |  | 0.0103 |  | 0.0066 |  | 2.595 |  |
| SD[2] | 0.2064 |  | 0.0024 |  | 0.0025 |  | 0.0495 |  | 0.0011 |  | 0.0006 |  | 0.0008 |  | 0.0443 |  |
| u characterization[3] | 0.0668 |  | 0.00081 |  | 0.00082 |  | 0.0155 |  | 0.00041 |  | 0.00023 |  | 0.00026 |  | 0.0154 |  |
| u homogeneity[4] | 0.028 |  | 0.00006 |  | 0.00013 |  | 0.0037 |  | 0.00008 |  | 0.00009 |  | 0.00004 |  | 0.0040 |  |
| Certified value[5] | **66.08** |  | **0.027** |  | **0.022** |  | **2.61** |  | **0.029** |  | **0.0103** |  | **0.0066** |  | **2.60** |  |
| Expanded uncertainty[6] | **0.15** |  | **0.002** |  | **0.002** |  | **0.03** |  | **0.001** |  | **0.0005** |  | **0.0005** |  | **0.03** |  |

| Analysis | $Al_2O_3$ | * | MgO | * | $Na_2O$ | * | FeO | * | C | * | Cr | * | V | * | LOI | * |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.20 | 3 | 0.20 | 1 | 0.0265 | 12 | 0.70 | 4 | 0.02 | 2 | 0.0022 | 3 | 0.0012 | 3 | 0.04 | 5 |
| 2 | 0.20 | 3 | 0.21 | 10 | 0.0290 | 1 | 0.709 | 4 | 0.026 | 8 | 0.0027 | 3 | 0.0012 | 3 | 0.04 | 5 |
| 3 | 0.20 | 3 | 0.213 | 3 | 0.0297 | 6 | 0.76 | 4 | 0.026 | 8 | 0.0031 | 1 | 0.0012 | 3 | 0.05 | 5 |
| 4 | 0.204 | 1 | 0.2135 | 3 | 0.03 | 3 | 0.76 | 4 | 0.027 | 2 | 0.0033 | 3 | 0.0014 | 1 | 0.05 | 5 |
| 5 | 0.21 | 1 | 0.217 | 1 | 0.031 | 3 | 0.850 | 4 | 0.0343 | 2 | 0.0035 | 1 | 0.0015 | 3 | 0.05 | 5 |
| 6 | 0.21 | 1 | 0.22 | 1 | 0.032 | 10 | 0.85 | 4 | 0.036 | 2 | 0.0037 | 1 | 0.002 | 3 | 0.06 | 5 |
| 7 | 0.21 | 3 | 0.22 | 3 | 0.033 | 3 | 0.93 | 4 | 0.05 | 2 | 0.004 | 3 | 0.0025 | 1 | 0.065 | 5 |
| 8 | 0.211 | 3 | 0.232 | 1 | 0.0380 | 3 | 0.95 | 4 |  |  | 0.0043 | 3 |  |  |  |  |
| 9 | 0.22 | 1 | 0.233 | 3 | 0.04 | 12 | 1.03 | 4 |  |  |  |  |  |  |  |  |
| 10 | 0.22 | 3 | 0.238 | 1 | 0.0409 | 3 |  |  |  |  |  |  |  |  |  |  |
| 11 | 0.22 | 1 | 0.24 | 3 |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 | 0.23 | 10 | 0.242 | 10 |  |  |  |  |  |  |  |  |  |  |  |  |
| 13 | 0.24 | 1 | 0.247 | 3 |  |  |  |  |  |  |  |  |  |  |  |  |
| 14 | 0.24 | 1 | 0.254 | 3 |  |  |  |  |  |  |  |  |  |  |  |  |
| 15 |  |  | 0.27 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |
| 16 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 17 |  |  | - |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 18 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Average[1] | 0.214 |  | 0.2292 |  | 0.0320 |  | 0.8377 |  | 0.0303 |  | 0.0034 |  | 0.0015 |  | 0.051 |  |
| SD[2] | 0.0115 |  | 0.0174 |  | 0.0034 |  | 0.1151 |  | 0.0077 |  | 0.0006 |  | 0.0003 |  | 0.0093 |  |
| u characterization[3] | 0.0039 |  | 0.0056 |  | 0.0013 |  | 0.0481 |  | 0.0036 |  | 0.00028 |  | 0.00014 |  | 0.0044 |  |
| u homogeneity[4] | 0.00101 |  | 0.0018 |  | 0.00056 |  | 0.0061 |  | 0.00017 |  | 0.00017 |  | 0.00010 |  | 0.0013 |  |
| Certified value[5] | **0.214** |  | **0.23** |  | **0.032** |  | **0.84** |  | **0.030** |  | **0.0034** |  | **0.0015** |  | **0.051** |  |
| Expanded uncertainty[6] | **0.008** |  | **0.01** |  | **0.003** |  | **0.10** |  | **0.007** |  | **0.0007** |  | **0.0003** |  | **0.009** |  |

All values are based on recommendations of the ISO GUIDE 35:2017(E) standard:

1. Average is calculated according to Algorithm A (Guide clause A.2.3.4: Robust statistics);
2. Standard deviation is calculated according to Algorithm A (Guide clause A.2.3.4: Robust statistics);
3. Uncertainty of material characterization is based on the data obtained from the analysis performer by Network of competent labs (Guide clause 9.5) and calculated according to Guide clause B.5.2;
4. Uncertainty associated with homogeneity of material is calculated in agreement with Guide clause 7.11 (Uncertainty evaluation from homogeneity studies);
5. Certified value is the average value rounded to one or two significant digits of expanded uncertainty;
6. Expanded uncertainty is an geometric average of u characterization and u homogeneity multiplied by coverage factor k = 2.

| Analysis | **Zn**** | * | **Cu** | * | **Co**** | * | **Ba** | * | **Pb**** | * | **As**** | * | **Ni**** | * | **Cl** | * |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0004 | 3 | 0.0005 | 3 | 0.0003 | 3 | 0.001 | 3 | 0.0004 | 3 | 0.0003 | 1 | 0.0002 | 3 | 0.0031 | 3 |
| 2 | 0.0006 | 10 | 0.0005 | 6 | 0.0015 | 1 | 0.0021 | 3 | 0.0005 | 6 | 0.0008 | 3 | 0.0016 | 1 | 0.0040 | 7 |
| 3 | 0.0008 | 1 | 0.0009 | 1 | 0.0019 | 3 | 0.0024 | 3 | 0.0010 | 1 | 0.0009 | 3 | 0.0017 | 3 | 0.0080 | 3 |
| 4 | 0.0008 | 3 | 0.0009 | 3 | 0.0026 | 3 | | | 0.0012 | 3 | 0.001 | 1 | 0.002 | 1 | | |
| 5 | 0.001 | 1 | 0.001 | 3 | | | | | 0.0015 | 1 | | | | | | |
| 6 | 0.0010 | 1 | 0.0012 | 3 | | | | | 0.0018 | 3 | | | | | | |
| 7 | 0.0012 | 3 | | | | | | | | | | | | | | |
| 8 | 0.0015 | 3 | | | | | | | | | | | | | | |
| 9 | 0.0019 | 3 | | | | | | | | | | | | | | |
| 10 | 0.0020 | 6 | | | | | | | | | | | | | | |
| 11 | 0.0022 | 1 | | | | | | | | | | | | | | |
| 12 | 0.003 | 1 | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| Average[1] | 0.0013 | | 0.0008 | | 0.0016 | | | | 0.0011 | | 0.0008 | | 0.0016 | | | |
| SD[2] | 0.0006 | | 0.0003 | | 0.0009 | | | | 0.0006 | | 0.0002 | | 0.0003 | | | |
| u characterization[3] | 0.00022 | | 0.00014 | | 0.00056 | | | | 0.00038 | | 0.0001 | | 0.00021 | | | |
| u homogeneity[4] | 0.00015 | | 0.00011 | | 0.00009 | | 0.00019 | | 0.00013 | | 0.00007 | | 0.00015 | | 0.00024 | |
| Certified value[5] | | | **0.0008** | | | | | | | | | | | | | |
| Expanded uncertainty[6] | | | **0.0003** | | | | | | | | | | | | | |

* - analytical method used
** informative value

**Certification Process:** Both preparation of this reference material and certification process were prepared according to requirements PN-EN 17034 and ISO GUIDE 35:2017(E).

**Chemical Analysis:** Chemical analyses were carried out on powder samples. Single values in the above table are the means obtained by individual laboratories. The following methods were used for analysis:

1 - wavelength dispersive x-ray fluorescence spectrometry (WD XRF),
2 - high frequency infrared absorption (HFIR),
3 - inductive coupled plasma atomic emission spectrometry (ICP OES),
4 - titrimetry,
5 - gravimetry,
6 - inductive coupled plasma mass spectrometry (ICP MS),
7 - spectrophotometry,
8 - coulometry,
10 - flame atomic absorption spectrometry (FA AAS),
12 - flame emission spectrometry (FES),
13 - alkalimetric titration.

**The laboratories participating in certification analysis:**

- ArcelorMittal, Dąbrowa Górnicza, Poland, PCA 17025 – AB 1449,
- ArcelorMittal, Ostrava, Czech Republic, Accreditation Certificate No. 593/2017 by the Czech Accreditation Institute; ČSN EN ISO/IEC 17025:2005,
- ArcelorMittal, Maizières-lès-Metz Cedex, France,
- Envivorm a.s., Třinec, Czech Republic; Testing Laboratory Nr 1371; Accreditation Certificate No, 219/2016 by the Czech Accreditation Institute; ČSN EN ISO/IEC 17025:2005,
- Institute for Certified Reference Materials, Jekatierinburg, Russia, accreditation RU.0001.510008,
- Instytut Metalurgii Żelaza, Gliwice, Poland; PCA 17025 – AB554,
- LABTIUM Oy, Kuopio, Finland, (FINAS, T0 25 (EN/ISO/IEC 17025),
- Lithea, Ltd. Brno, Czech Republic,
- PJSC Elektrometallurgical Works Dneprospetsstal, Zaporozhe, Ukraine,
- Dnieper Metallurgical Combine, Kamianske, Ukraine,
- U.S. Steel Košice, Slovakia; Slovenská národná akreditačná služba ISO/IEC 17025:2005, Reg. No. 026/S-010 and 026/S-011,

- Vitkovice Testing Center, Ostrava, Czech Republic, Testing Laboratory Nr 1036; Accreditation Certificate No. 531/2018 by the Czech Accreditation Institute; ČSN EN ISO/IEC 17025:2005,
- Polcargo Medyka, Poland; PCA 17025 - AB 914.

**Homogeneity:** The homogeneity of this Reference Material was evaluated in accordance with guidelines of ISO GUIDE 35:2017(E) for subsample masses of at least 0,2g. Wavelength dispersive x-ray fluorescence spectrometry method, titrimetric method and high frequency infrared absorption method were used.

**Traceability:** This Reference Material was found traceable to the following CRMs: JK29, EU 680-1, SARM12, ICRM R38, ICRM 37, ICRM 39, ICRM 8/3, ICRM 5/6, ICRM 25/1, IMZ 2.61/1, IMZ 2.62/1, IPT23A, JSS814-1, JSS831-2, PI 3.20, PI3.21, PI3-23, PI3-24, PI3-25, Č1-1-22, EU687-1, ASCRM 04, SARM11, JK28, Č1-1-21, Č1-1-24, Č1-1-25, DILL1105, DILL1131, DILL1132, DILL 1133, Č1-1-27, PI3-10, PI3-11, PI3-12, PI3-30, PI3-31.

**Origin of the material:** Russia (L-GOK).

**Basic mineralogical composition:**

| | | | |
|---|---|---|---|
| magnetite $Fe_3O_4$ | – 1,0 ± 0,8 % | quartz $SiO_2$ | – 0,7 ± 0,2 % |
| hematite $\alpha$-$Fe_2O_3$ | – 72,4 ± 1,0 % | magnesite $MgCO_3$ | – 1,3 ± 0,2 % |
| dolomite $CaMg(CO_3)_2$ | – 0,6 ± 0,2 % | | |

**Available form:** 100g of powder sample, grain size less than 0,1 mm.

**Intended use:** This Reference Material is intended for use in determination of chemical composition of iron ores by x-ray fluorescence spectrometry, UV-Vis spectrometry, AAS, ICP-AES and C,S-analyzers and other wet methods. Chemical analyses should be carried out on samples dried at 105$^{O}$C.

**Validity of certification:** The certification of IMZ3.58 is valid for 15 years - until December 2033, within the uncertainty specified provided this Reference Material is stored in accordance with the instructions given in this certificate (see Storage). The certification is nullified if this Reference Material is damaged, contaminated or otherwise modified.

**Storage:** This Reference Material should be stored in dry place and in environment free from chemical or other aggressive vapours and should be protected against vibration. If the contents become changed (for example oxidized) because of contamination, the whole contents of bottle should be discarded.

**Safety:** This Reference Material and packing do not contain substances which can directly influence health. Radioactivity less than 0.12 Bq/g equivalent of 60Co.

**Inquiries** regarding this Reference Material should be directed to rm@git.lukasiewicz.gov.pl

Approved by
Director of the Institute

Prof. Dr. Hab. Eng. Adam Zieliński

**Certificate issue date:** 17 February 2025

Certificate revision history:
17 February 2025 (editional change); 7 February 2020 (change of information regarding validity of certification, editorial changes; 03th of December 2018 (Original certificate date)