From Anode slime to silver-doré

Production control by XRF

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1. Production

2. XRF analysis

3. Basics for XRF
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Aurubis

One of the largest copper smelter and refiner produce ca. 1 Mio. t Kupfercathodes from copper concentrates, copper scrap and copper containing residues.

Silver (ca. 1000 t) and Gold (ca. 30 t) from PM containing slimes, sweep and fines, computer scrap and PM alloys.

Anode slime (product from electrolytic refining of copper cathodes), is one of the most important source for precious metals production.

At Aurubis anode slimes are treated in a modern Boliden top blown rotary converter (TBRC) process in two routes and fully controlled by XRF.
Production line 1 (Detail)

Copper line

Roasting, smelting, converting to metal phase

Raw material

Anode slime, Cu-rich (~20 % PM)
PM-dross (~2 % PM)

TBRC 1

PbO, SeO₂, slag
Ag-Doré (~92 % PM)

Raw material

silver anode

TBRC 2

Cupellation process

To analyse by XRF
PM = Ag, Au, Pt, Pd, Rh, Ir, Ru
Impurities = Pb, As, Sb, Se, Sn,
Te, Bi, Ni, Cu, Cl

Production line 2 (Detail)

Lead line

ZnPbAg-crust
ZnPbAgAlloy (~25 % PM)

Raw material

Anode slime, Cu-poor (~7 % PM)
Cu/Pb-matte (~0.3 % PM)
Pb-concentrate (~0.01 % PM)

Electric furnace

Bullion (~4 % PM)

Lead refining

PbO

Silver anode

TBRC 2

Cupellation process

To analyse by XRF
PM = Ag, Au, Pt, Pd, Rh, Ir, Ru
Impurities = Pb, As, Sb, Se, Sn,
Te, Bi, Ni, Cu, Cl
Production lines

Copper line

Anode slime → TBRC 1 → Ag-Doré → TBRS 2 → Silver anode

Lead line

Anode slime → Electric furnace → Lead refining → Silver tankhouse

1. Production

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Sample preparation

Delivering by pneumatic post → preparation → milling → sieving

Ready for analysis → pressing → decomposition → Weighing, mixing with flux

XRF-Analysis

QS check by monitor sample → XRF analysis

Direct pressed → Metall sample decomposed, milled, pressed with binder
1. Production

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Basics for XRF analysis

XRF machines are stupid
They look only intensities
Basics for XRF analysis

Reference essential !!!

Reference samples / Calibration samples

available on the marked ?

create by yourself or
Collecting from the production

if not sufficient

calculation of functionally dependence

analysing all elements >0,1 %, influence of the intensities by attenuation

Example: Determination of Ag in Ag-Doré Calibration ranges

Ag: 0,01 - 100 %

Au: 0,01 - 20,0 %
Pt: 0,002 - 1,0 %
Pd: 0,002 - 2,0 %
Rh: 0,002 - 0,5 %
Ir : 0,001 - 0,4 %
Ru: 0,002 - 0,5 %

Bi : 0,01 - 5,0 %
Cu: 0,01 - 10,0 %
Pb: 0,01 - 30,0 %
Sb: 0,001 - 0,5 %
Se: 0,001 - 5,0 %
Te : 0,001 - 6,0 %

Conclusion
Determination of Ag in Ag-Doré will be interact by 12 elements.
Calibration range will be made by 64 calibration samples.
Calculation of \( \alpha \)-correction only for Ag will be made by 38 calibration samples.
Example: Determination of Ag in Ag-Doré
Calibration range without $\alpha$-correction

Example: Determination of Ag in Ag-Doré
Calibration range after $\alpha$-correction
Basic for correct analysis

Only possible with motivated, well skilled employees