Recovery Error from Assay Errors (Two-Product Formula)

Standard deviation and 95 % range of the metal recovery from the two-product formula, propagated from the assay errors of feed, concentrate and tailings.

Method: Wills and Finch; Wills' Mineral Processing Technology; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Feed assay	3.9300	%
Concentrate assay	52.070	%
Tailings assay	0.49000	%
Standard deviation of the feed assay (absolute)	0.050000	%
Standard deviation of the concentrate assay	0.50000	%
Standard deviation of the tailings assay	0.020000	%

Calculated results

Parameter	Value	Unit
Metal recovery	88.363	%
Standard deviation of recovery	0.50558	%
95 % half-range of recovery	0.99093	%
Share of variance from the feed assay	10.032	%
Share from the concentrate assay	0.025419	%
Share from the tailings assay	89.942	%

Notes for this case

• First-order propagation with the assay errors independent (no covariance), Wills eq. 3.30. The error grows as concentrate and tailings assays approach each other: then reconcile the balance with more components or measured flows.

Formula and method

$$V_R = \left(\frac{\partial R}{\partial f}\right)^2 V_f + \left(\frac{\partial R}{\partial c}\right)^2 V_c + \left(\frac{\partial R}{\partial t}\right)^2 V_t, \quad R = \frac{c(f-t)}{f(c-t)}$$

Variables

f	Feed assay	-
c	Concentrate assay	-
t	Tailings assay	-
σ_f	Standard deviation of the feed assay (absolute)	-
σ_c	Standard deviation of the concentrate assay	-
σ_t	Standard deviation of the tailings assay	-
R	Metal recovery	-
σ_R	Standard deviation of recovery	-
$1.96\sigma_R$	95 % half-range of recovery	-
V_f	Share of variance from the feed assay	-
V_c	Share from the concentrate assay	-
V_t	Share from the tailings assay	-

Method and standards

First-order error propagation.

Assumptions and limits

- Independent, unbiased assay errors.

References

- Wills and Finch
- Wills' Mineral Processing Technology
- 8th ed. (Butterworth-Heinemann, 2016)
- ch. 3
- eqs. 3.30-3.33 and Example 3.9

Report details

Report reference	FCC-ACM7-8A24 (the same inputs always give the same reference)
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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/civil/mining-minerals/two-product-recovery-error

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Reopens the calculator with the inputs of this report.