# Anodising: Oxide Film Thickness from Current and Time

Aluminium oxide film thickness, coating mass and metal consumed from anodising current density, time and current efficiency by Faraday's law.

**Method:** Faraday's law applied to anodic oxide growth

## Input parameters

Unit system: SI

| Parameter | Value | Unit |
|---|---|---|
| Current density | 1.5000 | A/dm² |
| Anodising time | 30.000 | min |
| Current efficiency to oxide | 70.000 | % |
| Film density (porous oxide) | 2,600.0 | kg/m³ |
| Aluminium density | 2,700.0 | kg/m³ |

## Calculated results

| Parameter | Value | Unit |
|---|---|---|
| Charge per area (C/m²) | 270,000 | |
| Oxide mass per area | 33.288 | g/m² |
| Film thickness | 12.803 | µm |
| Aluminium thickness consumed | 6.5250 | µm |
| Growth ratio | 1.9621 | |

### Notes for this case

• $2Al + 3H_2O \rightarrow Al_2O_3 + 6H^+ + 6e^-$: each mole of oxide needs 6 faradays. Oxide mass = ηit·M/(6F); thickness = mass/film density (porous sulphuric films about 2.4–3.0 g/cm³). Part of the current dissolves oxide back into the acid, so efficiency is below 1. Practical rule: about 0.3 µm per A/dm² per minute in sulphuric acid at 20 °C. The film grows partly into the metal (it consumes aluminium) and partly outward.

## Formula and method

$$m'' = \frac{\eta i t}{6F} M_{Al_2O_3}, \quad t_{ox} = \frac{m''}{\rho_{ox}}, \quad t_{Al} = \frac{2\eta i t}{6F} \frac{M_{Al}}{\rho_{Al}}$$

### Variables

| | | |
|---|---|---|
| $i$ | Current density | A/m² |
| $t$ | Anodising time | s |
| $\eta$ | Current efficiency to oxide | - |
| $\rho_{ox}$ | Film density (porous oxide) | kg/m³ |
| $\rho_{Al}$ | Aluminium density | kg/m³ |
| $Q''$ | Charge per area (C/m²) | - |
| $m''$ | Oxide mass per area | kg/m² |
| $t_{ox}$ | Film thickness | m |
| $t_{Al}$ | Aluminium thickness consumed | m |
| $t_{ox}/t_{Al}$ | Growth ratio | - |

### Method and standards

Anodising.

### Assumptions and limits

- Uniform current; film density constant.

### References

Faraday's law applied to anodic oxide growth

## Report details

| | |
|---|---|
| Report reference | FCC-5C1W-94XP (the same inputs always give the same reference) |
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| Calculator | Anodising: Oxide Film Thickness from Current and Time |
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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/materials/corrosion/anodising-film-thickness

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.