

# How Aluminum Extrusion Dies Wear Out

An extrusion die wears, softens and cracks at the same time, and the wear is concentrated on the bearing because that is the only surface in sliding contact with hot aluminium. The tables below give the mechanisms that consume a die, the extrusion the source measured, and the variables that deepen the wear.

**Reference only.** This is a reference summary of published practice and it is not a specification of ours. The values are reproduced from the source. What a particular press produces depends on the press, the shape, the alloy and the run. Final design is confirmed on the job.

## Three mechanisms consume a die

| Mechanism           | What it is                                                                                                                                                                                             |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hot wear, adhesive  | Aluminum has a strong tendency to stick to steel, so a layer of aluminum builds on the die bearing and then breaks off. The break off takes die steel with it and leaves the aluminum in the extrusion |
| Hot wear, abrasive  | Die wash. The moving metal grinds the bearing away. Abrasive wear is gradual at low temperature and much faster once the bearing is hot, and adhesive wear makes it worse                              |
| Plastic deformation | The die loses hardness at temperature. On a long run the bearing reaches the softening temperature, the tongues deform, the opening grows and the dimensions are lost                                  |
| Cracking            | Repeated heating and cooling plus the load of the press crack the die, on the bearing and at the mandrel bridges                                                                                       |

The mechanisms that consume an aluminum extrusion die. The source names hot wear, plastic deformation and cracking as the most common failure mechanisms, and hot wear is split here into the adhesive and abrasive forms the chapter describes.

## Wear is measured at the bearing, and it has a shape

| Parameter                    | Value                                                     |
|------------------------------|-----------------------------------------------------------|
| Billet diameter              | 6 in. (152 mm)                                            |
| Billet length                | 19 to 21 in. (482 to 533 mm)                              |
| Billet temperature, front    | 860 °F (460 °C)                                           |
| Billet temperature, middle   | 801 °F (427 °C)                                           |
| Billet temperature, back     | 759 °F (404 °C)                                           |
| Container bore               | 6.38 in. (162 mm)                                         |
| Container temperature        | 806 °F (430 °C)                                           |
| Die                          | Hollow square, 2 in. <sup>2</sup> (50.8 mm <sup>2</sup> ) |
| Die bearing length           | 0.08 to 0.14 in. (2.0 to 3.5 mm), blended                 |
| Die temperature at the start | 824 °F (440 °C)                                           |
| Extrusion ratio              | 90                                                        |

Extrusion parameters of the die the wear and temperature work was measured on. The die is a tapered seal hollow die with a nitrided bearing, and the bearing length is given as a blended range rather than one figure.

## What makes the wear go faster

| Variable                                | Effect on wear depth                                                     | Reason                                                                                                               |
|-----------------------------------------|--------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| Press cycles, the number of billets run | Wear depth rises with every billet                                       | The bearing gets hotter as the run goes on, and the hotter it is the faster the adhesive layer builds and breaks off |
| Billet length                           | Longer billets wear the bearing more                                     | A longer billet lengthens the extrusion cycle, so the bearing spends longer at its peak temperature                  |
| Ram speed                               | Higher ram speed gives deeper wear                                       | A higher ram speed raises the exit temperature, and the exit temperature raises the bearing temperature              |
| Bearing surface condition               | A new nitrided bearing wears more slowly than an old one                 | A hard nitrided surface sticks to the aluminum less than a softened old surface, so less friction heat is generated  |
| Position on the die                     | The mandrel wears more than the cap, and wear starts at the leading edge | More heat is generated inside the mandrel, where the metal is deformed and rubbed again before it leaves the die     |

The variables that control wear depth on the die bearing. Wear depth is the maximum depth of the wear spot, averaged over three identical tests for each point. The source ran each die with the same die steel, heat treatment and nitriding, from one die maker.

## Wear changes the flow, and the flow changes the shape

### Where this leaves a die steel order

## Aobo Steel, tool steel supplier

Aobo Steel supplies tool steel to distributors and mold, tool and die shops, including D2, D3, DC53, A2, O1, H13, H11, H10, H21, S7, M2, M42, L6, P20 and 420 and 440C stainless. Forged or hot rolled, annealed or pre-hardened, cut to your sizes, with test certificates.

Source, Aluminum Extrusion Technology, P. K. Saha, ASM International, 2000.

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