

Did you know that stainless steel can accidentally "cold-weld"?



Although it sounds contradictory, stainless steel can bond permanently without the need for a torch or electrodes. This mechanical phenomenon is called galling (or seizing), and it is more common than it seems in threaded connections.

What is galling and why does it occur?

Galling is a process of adhesive wear. It occurs when two metal surfaces, under pressure and friction, remove their protective barriers and end up fusing at an atomic level, blocking any movement.

In the case of stainless steel, this occurs due to a combination of factors:

1. **Vulnerability of the passive layer:** stainless steel resists corrosion thanks to a very thin film of chromium oxide. Under the friction of tightening, this layer breaks easily.
2. **Exposure of "naked" metal:** when the film breaks, highly reactive metal atoms are exposed. Without that barrier, metals have a natural tendency to create metallic bonds with each other.
3. **Pressure micro-welding:** friction generates localized heat spikes. When combined with the tightening pressure, the atoms of both parts interlock, creating a solid bond as if it were a weld.

There is no fusion by external heat, but rather a bond by atomic affinity and plastic deformation.

When does it occur most easily?

The risk of a nut becoming "welded" to a bolt increases drastically when:

- **Same alloy and hardness:** using identical parts (e.g., bolt and nut both AISI 304) facilitates material transfer.
- **Excessive assembly speed:** the use of pneumatic or electric tools generates instantaneous heat that stainless steel, due to its low thermal conductivity, cannot dissipate.
- **Lack of lubrication:** without a physical barrier, metal-to-metal contact is inevitable.

How to avoid galling?

To guarantee that your joints are reversible and safe, follow these engineering tips:

- **Specialized Lubrication:** the use of anti-seize pastes (nickel, ceramic, or molybdenum disulfide) creates an invincible physical separation.
- **Hardness Combination:** use different alloys. For example, an A2 (304) bolt with an A4 (316) nut reduces atomic affinity and material dragging.
- **Control of Speed:** performing the tightening manually or at low revolutions avoids localized overheating.
- **Absolute Cleanliness:** any residue acts as an abrasive, destroying the passive layer prematurely.
- **Tightening Torque:** respecting load specifications avoids excessive deformation of the threads.

Galling is not a defect of stainless steel, but a consequence of its own nature. When you control friction, pressure, and compatibility of materials, stainless steel remains one of the most reliable and durable materials in engineering.