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Aluminium Cylinder Heads: 15 Key Things to Remember

1. Aluminium cylinder heads are precision castings that sit atop the engine block, form combustion chambers, and house valvetrain, ports, guides, seats, and coolant jackets.
2. Main advantages: lower weight, better thermal conductivity, and greater castability/design freedom than cast iron.
3. An aluminium head weighs about half an equivalent iron head, improving vehicle balance, lowering center of gravity, and helping fuel efficiency.
4. Aluminium cylinder-head alloys conduct heat roughly two to three times better than typical cast iron, though exact difference depends on alloys compared.
5. Better heat dissipation can help support higher compression ratios and reduce knock risk, but thermal conductivity alone does not determine allowable compression.
6. Common cylinder-head alloys come from Al-Si-Cu and Al-Si-Mg families, including 319-type and 356/A356 alloys.
7. A356 has tighter impurity limits; 319-type alloys offer elevated-temperature strength for high-temperature and highly loaded cylinder-head applications.
8. Manufacturing sequence: casting, heat treatment where required, machining, and inspection.
9. Casting uses gravity die casting or low-pressure die casting; sand cores may form internal coolant passages and port geometry.
10. The exhaust-valve bridge can exceed 300°C. Many conventional Al-Si cylinder-head alloys lose strength markedly above roughly 250°C.
11. Thermal cycling forces the valve bridge into plastic compression on warm-up and plastic tension on cooling, driving fatigue cracking.
12. Casting defects such as porosity, oxide films, and inclusions act as stress concentrators and crack initiation sites.
13. In one historical Cosworth racing-engine example, about 50% of conventionally cast heads failed by valve-bridge thermal fatigue; improved casting greatly reduced failures.
14. Key limitations: thermal expansion, overheating and warping, fatigue cracking, and strong dependence on casting quality in stressed regions.
15. Aluminium heads dominate modern passenger cars and motorcycles and are widely used in commercial, diesel, marine, aircraft, and industrial engines; some heavy-duty use cast iron.