

Overheating and Hardness

Most modern engines operate within a temperature range of approximately 88° to 105° Celsius (190° to 220° Fahrenheit). If an engine exceeds its normal operating range and overheats, the elevated temperatures can cause extreme stress in the cylinder head. This is particularly true of bi-metal engines, where the difference in the thermal expansion rate of the aluminium cylinder head is two to three times that of the cast iron block. It is important to note at this time that a water temperature gauge only records the average temperature of the engines coolant; it does not indicate the temperature of the engine block or cylinder head castings.

Overheating occurs when the heat generated by the combustion process exceeds the ability of the engines cooling system to absorb and dissipate it. Low coolant, accumulated deposits in the water jackets, defective thermostat or radiator cap, slipping fan clutch or inoperative electric fan, eroded or loose water pump impeller, poor air flow through the radiator, can all contribute to an engine overheating. Other factors such as retarded ignition timing, lean air/fuel mixture, detonation/pre-ignition, exhaust restrictions and overworking the engine will also contribute to overheating.

Checking the hardness of an aluminium cylinder head requires a hardness tester. While this piece of equipment in itself is not overly expensive or complicated, it is often difficult to obtain a specification as to what the allowable hardness figure should be. Each engine manufacturer has their own "blend" of aluminium alloys with the mix of trace elements used differing slightly from one manufacturer to the next. Some further complicate this by using a number of different alloys within their range of engines i.e. the specific alloy used for a Nissan CA20 engine may differ to the alloy used for a Nissan RB30 engine.

Most aluminium cylinder heads will have begun to soften when exposed to temperatures between 200° to 250° Celsius (392° to 482° Fahrenheit). At 250° to 300° Celsius (482° to 572° Fahrenheit) the softening will have become quite severe making the cylinder head unsuitable for service. For this reason, even with the difficulties mentioned above, it is very important to hardness test an aluminium cylinder head when the engine is known to have overheated, or when repair work such as welding has been carried out on the head. Localised hot spots within the cylinder head can result in localised soft spots, so it is essential that the testing is carried out over a number of positions on the head. In addition to the sealing surface of the cylinder head, particular attention should also be paid to the hardness of the bearing surfaces for the cylinder head bolts. Indentations on the head bolt bearing surface resulting from where the bolt head has sunk into the cylinder head is a sure sign of softness.

Cylinder heads that have softened will prevent the correct bolt load to be applied to the cylinder gasket, leading to a premature failure.