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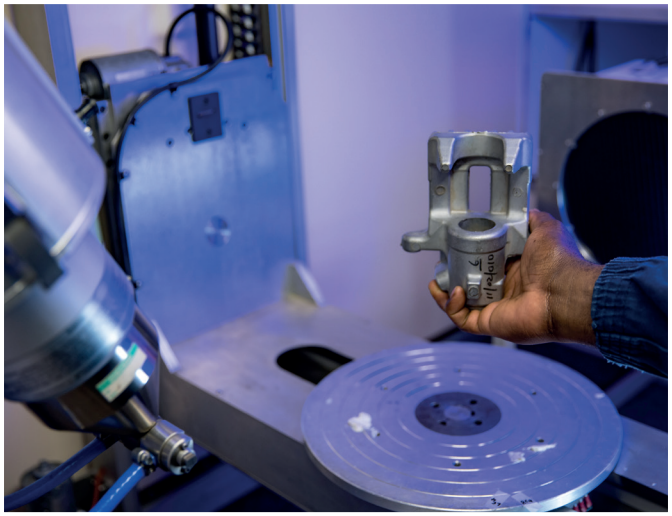
HOT ISOSTATIC PRESSING

FOR IMPROVED MATERIAL PERFORMANCE



Hot Isostatic Pressing (HIP) is a post-processing technology involving elevated temperature and pressure, designed to improve the properties of metal and ceramic components after casting and 3D printing. The technology also uses high temperature and pressure to consolidate metal powders into fully dense parts, eliminating porosity and improving mechanical properties. The system employs a dedicated furnace contained inside a gas pressure vessel. By applying both pressure and temperature, components are compacted to achieve a density close to the theoretical maximum. This implies that internal flaws such as porosity, voids, and microcracks are removed.

The Council for Scientific and Industrial Research has acquired cutting-edge HIP technology capable of executing quenching and heat treatment within a single cycle. HIP typically functions at temperatures comparable to those used in traditional heat treatment processes. Consequently, it is possible to merge both methods into a unified process known as High Pressure Heat Treatment. This innovative approach boosts productivity while reducing the need for additional capital equipment.

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APPLICATIONS

- Densification of castings (HIP eliminates internal porosity and micro shrinkage)
- Metal powder densification (HIP consolidates metal powder into a solid)
- Densification of additive manufacturing parts (HIP is used as the post-processing for additive manufacturing to eliminate porosity and enhance the mechanical properties of printed parts, especially in the aerospace industry)
- Rejuvenation of damaged parts (HIP is to repair and rejuvenate creep-damaged parts, extending their service life)

MATERIALS

- Lightweight materials (aluminium, magnesium, titanium, and alloys)
- High-speed steels (tungsten, cobalt and molybdenum)
- Tool steels (Cold-work tool steel, Hot-work tool steel, and Carbon tool steel)
- Super alloys (Nickel-base super alloy, Iron-base superalloy, cobalt-base super alloy)
- High entropy alloys (AlCoCrFeNi, CoCrFeNi, and AlCrFeNiCoCu)
- Metal powders (PM-HIP)

INDUSTRIES

- Aerospace
- Automotive
- Defence
- Medical Implants and tools
- Space
- Automotive
- Mining
- Power generation.

EQUIPMENT SPECIFICATIONS

Each component of the HIP is integral to ensuring the process's versatility and success of the process.

	Press type	Quintus QIH 32 URC	Quintus QIH 32 URQ
	Maximum operating pressure	207 MPa	207 MPa
	Maximum operating temperature	1 400 °C	1 400 °C
	Maximum height of workload	890 mm	500 mm
	Maximum diameter of workload	300 mm	270 mm
	Design pressure	228 MPa	228 MPa
	Pressure vessel volume	242 dm^3	242 dm^3
	Maximum weight of workload (incl. kg)	350 kg	< 350 kg
	Temperature control	± 8 °C	± 8 °C
	Number of heating zones	3 zones	3 zones

Assessments of components prior to HIP are crucial for determining the initial material condition, powder elemental composition and thermodynamics. This includes density measurements, dimensional analysis and non-destructive testing and may include chemical analysis as well as mechanical testing. Metrological analysis, such as surface profilometry, provides high-resolution data for analysing surface finish and geometrical accuracy.

METROLOGY LABORATORY EQUIPMENT

The following equipment is available within the HIP facility for metrology as an industrial and research service:

- Absolute coolant – proof caliper;
- Digimatic depth micrometer;
- Digital micrometer; and
- Dial test indicator.

NON-DESTRUCTIVE TESTING EQUIPMENT

Pre- and post-non-destructive testing, such as ultrasonic testing or radiography, is typically performed to identify existing defects or irregularities in parts, e.g., cracks or voids.

- Infra-red thermographic testing equipment
- Eddy current flaw detector – NORTEC 600
- Digital ultrasonic flaw detector – Karl Deutch – ECHOGRAPH 1090
- Ultrasonic phase array – M2M – GEKKO 170
- Digital ultrasonic thickness gauge - CYGNUS 4
- X-Ray radiography (basic 2D microfocus X-ray radiography)
- Magnetic particle inspection

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