



Lower-cost method extends HIP benefits to more casting applications

F oundries have used hot isostatic pressing in argon gas to close internal porosity in castings for many years. The process calls for placing parts in a furnace inside a large pressure vessel and increasing argon pressure to 15 to 25,000 psi (103 to 172 MPa) when the metal is at high temperature. This presses the surface of the metal in, closing internal porosity. For an excellent summary of gas HIPping applications, see Widmer, "The Current Status of HIP Technology and Its Prospects for the 1990s," Industrial Materials Technology, Andover, MA.

but not as dramatically, except for elongation, which often doubles.

Given these benefits, there is little question that the use of HIPping would dramatically increase if the cost were lower.

The Liquid HIPping Process

To provide a lower-cost HIPping process, Metal Casting Technology, a joint venture of General Motors Corp. and Hitchiner, developed and patented a HIP process using molten salts and mechanically generated pressure. LHIP

completely eliminates porosity in castings and gives from 50 to 100% increases in ductility and fatigue life.

Figure 1 shows the first prototype of a production unit, built by the Italian contractor IDRA. This unit is installed in automotive component maker Teksid S.p.A.'s (Turin, Italy) research center in Borgaretto, Italy. As

More manufacturers would use HIPping if it cost less. Gas HIPping unit construction is complex and thus costly. Compressing the gases to high pressures is also costly and time consuming. The stored energy of the gas at such high pressures and temperatures is an omnipresent concern.

Despite its high costs, the use of gas

HIPping is extensive, primarily for applications requiring the ultimate in casting quality. Since HIPping rather than gating makes the casting sound, reduced gating offsets some of the HIPping cost. This is particularly true when casting titanium, for which HIPping is almost a necessity in providing high-quality castings.

HIPping yields major fatigue endurance limit improvements for all common structural alloys. For 17-4PH stainless steel, for example, HIPping increases the endurance limit from 29 ksi (200 MPa) to 52 ksi (358 MPa), a 75% increase. In another example, HIPping increases the typical endurance limit for high-strength, low-alloy steel from 22 ksi (152 MPa) to 39 ksi (269 MPa), a 77% increase. The endurance limit for aluminum alloy 356 just about doubles from 8 ksi (55 MPa) to 15 ksi (103 MPa). Tensile properties also improve,



Figure 1. The first prototype of a production LHIP machine, installed at Teksid S.p.A. (Turin, Italy).

needed, the process will be made more efficient by use of several pressure vessels cycling through a reheat station. Figure 2 describes this process schematically. The pressure vessel containing the salt stays at the desired HIPping temperature during a short cycle—typically only 15 seconds to achieve full density.

If a metal requires HIPping temperatures higher than 1100 °F (593 °C), the pressure vessel and salt are still heated to 1100 °F (593 °C), but the parts are preheated in a higher-temperature salt pot (up to 2300 °F, 1260 °C). A container holding that pot goes into the lower-temperature pressure vessel and salt. Applied pressure densifies the parts before they have a chance to cool significantly. We have successfully LHIPped carbon steels, malleable iron, stainless steels, titanium and some nickel-base superalloys this way using 15-second pressure cycles. While MCT can LHIP at the higher temperatures, Teksid focuses on LHIPping aluminum alloys for applications where there is a great need for aluminum parts with high fatigue-endurance limits.

Hitchiner and Teksid are optimizing the

process and would like to LHIP parts for evaluation by potential users of this new process. It certainly appears that the LHIP process will extend the benefits of isostatic densification of castings to applications for which gas HIPping has been too expensive.



Salt and pressure vessel are preheated independent of the parts. Hot parts are added to the salt at the hipping temperature.



Vessel is moved into press, clamped to seal the vessel, and a ram is lowered to establish the desired isostatic pressure.

Figure 2