A new generation of HIP

Liz Nickels

Hot isostatic pressing (HIP) has seen many changes since it was first introduced as a commercial process in the 1960s. Recently, HIP and heating specialist Avure Technologies changed its name to Quintus, reflecting new developments in the industry as a whole. Liz Nickels spoke to Quintus' Peter Henning about what's hot in the world of HIP.

Last year, Avure Technologies in Europe changed the name of its industrial segment to Quintus to reflect the name of its existing wire winding technology and also the company’s existing US subsidiary, Peter Henning, business unit director of advanced material densification at Quintus Technologies, explains the reason behind the renaming. ‘A newer name incorporates a new tradition,’ he told Metal Powder Report. ‘In our case, Avure has two divisions: the industrial side and the food side. Our owners decided to increase the separation between the two in the eyes of our customers, so they renamed the industrial side Quintus. And therefore we have been given our own identity and have a better opportunity to define the technology.’

According to Peter, Quintus will focus on its two main technologies – sheet metal forming and hot isostatic and cold isostatic pressing.

Quintus Technologies is one of the first pioneers of hot isostatic pressing (HIP), developing the technology for over 50 years. ‘Asea, later ABB, were looking at how to process synthetic diamonds,’ Peter says. ‘One of the key challenges for them was to maintain the very high pressure and high temperature required, but in a safe fashion. And that's when Quintus HIP technology was developed.’ At a later stage the company then moved on to the hot isostatic pressing of metal powder parts.

Heat treatment

According to the company, HIP is used to form and densify containerized powder shapes and containerless metal and ceramic parts. With typical pressures from 1035 to 2070 bar (15,000–30,000 psi) and temperatures up to 2000°C (3632 F), HIP can achieve 100% of maximum theoretical density and improve the ductility and fatigue resistance of critical, high-performance materials.

HIP is used to eliminate pores and remove casting defects, and carbides, to dramatically increase the material properties. The components are often of net shape or near net shape configuration.

Common applications for HIP include defect healing of castings, consolidation of powder, and diffusion bonding of dissimilar metals or alloys.

The technology is expanding into new applications such as very large castings, as well as heat treatment of aluminum components by T6 or hardening of iron-based materials by modifying the HIP gas mixtures. Recently, HIP has also been used for the defect healing of AM parts and MIM parts (pore elimination). ‘HIP goes hand in hand with additive manufacturing and metal injection molding,’ says Peter. ‘The better they do, the better we will do. Our products will in turn help those two industries to make products with a much wider use. In particular, HIP can help improve the porosity and finish of molded or printed parts. But the main drive is the performance of the individual components. To improve performance, very often you need to have additional heat treatment after a part has been built. Users can achieve significant improvement in mechanical properties with subsequent HIPs. We are developing equipment to match their technology and also considering machines that can perform densification and simultaneous heat treatment.

‘Sometimes we meet with new users that are not necessarily very experienced manufacturers, and who are not looking to buy a complete HIP facility. The solution for them is some kind of multi-purpose equipment.’

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Safety first

Every Quintus HIP features a vessel and a frame that are pre-stressed and wire-wound with high tensile cold-rolled spring steel wire. The pre-stressing causes the pressure vessel wall to remain in residual compression at maximum operating pressure, eliminating tensile loads and preventing crack propagation and brittle failure.

The company claims that the presses are ‘the safest, most reliable and durable pressure containment system ever designed’. The vessel meets ‘leak-rather-than-burst’ criteria as defined in the ASME code, and typically has a calculated fatigue life of more than 20,000 cycles, if properly used and maintained. Because the load-absorbing wire ribbons in the Quintus design have a tensile strength twice that of a forging, the system is more lightweight and compact, with a reported savings in weight up to 50% compared to non wire-wound forged vessels.

Quintus produces a range of presses from laboratory size to ‘giant’ capacities. Its laboratory HIP systems are designed for HIP research and feasibility studies and feature a pressure vessel, frame, and all other subsystems housed in a single cabinet. Work zone diameters range from 82 to 186 mm, with heights from 160 to 500 mm.

The small HIP systems are smaller versions of the production presses. The pressure vessel, frame and all other subsystems are mounted on a skid with standard vessel diameters of 228–375 mm and heights of 700–1200 mm. These presses are suited for production of smaller parts from the MIM, AM and investment casting industry. The systems can run up to six cycles a day depending on the application.

Quintus’ medium sized HIP systems have standard vessel diameters ranging from 450 mm to 1050 mm and heights of 1100 to 2600 mm. These presses are full production systems which are suited for all markets from AM and MIM to full scale tolling business.

Large-capacity HIP presses can reduce per-unit processing costs, leading the development of ‘Giga-HIPs’ for greater cost efficiency. These giant capacities make it easier to densify ever-larger products and batches.

Research base

Last January, the company opened a new isostatic pressing application center in Västerås, Sweden, to help improve AM, MIM, and investment casting processes. The facility, located next to the Quintus manufacturing plant, is equipped with two hot isostatic presses (HIPs) and one cold isostatic press (CIP).

‘The application center allows us to collaborate further with component fabricators in areas such as additive manufacturing (3D printing), metal injection molding (MIM), and investment casting to ensure they select the best pressing systems to match their needs,’ said Jan Söderström, CEO, at the time. ‘We can help them verify their fabrication processes and determine parameters for cycle optimization before they go into full-scale production.’

The center currently runs projects related to the densification (defect healing) and the removal of residual porosity in investment casting, as well as evaluating recent HIP technology such as quenching under full pressure. ‘Traditionally, HIP has been used for densification, but the trend is now to combine densification with solution treatment, quenching, ageing, and/or other heat treatment processes in the same cycle,’ said Peter Henning.
Installation

We Metal MRP-636; has a work zone of 1.6 m (5.25 ft) in diameter and 2.6 m (8.5 ft) in height.

Quintus Technologies also supplied a hot isostatic press (HIP) to the U.S. Department of Energy’s Manufacturing Demonstration Facility at Oak Ridge National Laboratory. ORNL’s new HIP is used for research for the aerospace, nuclear, gas turbines, and other industries, as part of its mission to improve the competitiveness of American manufacturing. Quintus says that the new press is the fastest and most versatile HIP in the USA, operating at a pressure of 2070 bar (30,000 psi) and a temperature up to 2000°C (3662°F). Installation is scheduled for June 2016.

Quintus Technologies also installed a hot isostatic press (HIP) at the Anhui Yingliu Group Huoshan Casting Co. Ltd. Foundry in Anhui Province, China. The new press, model QIH 1.6 x 2.5–2000–1400M URC, operates at a pressure of 200 MPA (29,000 psi) and temperatures up to 1400°C (2552°F). The HIP has a work zone of 1600 mm (63 in.) in diameter and 2500 mm (98 in.) in height which can accommodate the size requirements for production of large aircraft engine casings and core components for nuclear power, marine engineering, metallurgy, and other applications.

Process trends

We discussed with Peter about much how the technology has developed over the last 20 years. ‘One continuous trend we have seen is that we’re delivering more and more large size presses,’ Peter notes. ‘Also, productivity has been hugely increased. And this higher productivity has significantly improved the cost reduction in owning and operating a press. Our presses can produce twice as much product using the same type of machine as they could twenty years ago.

‘In turn, this has opened up the market for us. Some 20 years ago, HIP technology was generally used for very high end products – very exclusive production. Now, the trend is to produce a much more ‘everyday’ product. This in turn makes it more financially viable to develop the technology to meet certain markets – while ensuring that the quality of the product remains the same.’

But are high end products still in demand? ‘It still is a significant part of our business, using high end materials of course,’ he says. ‘But the main benefit of this increased productivity has been reduced production costs, which in turn have opened up business so that the technology can be applied to many more products in a wider market.’

According to Peter, there is also a move towards quenching in HIP, reaching significant cooling rates and reducing the difficulties of residual stress. The company is also focusing on presses for special purposes and materials. For example, aluminum alloys require different temperature and pressure compared to nickel and titanium.

How has the development of metal powder helped the industry? ‘There is more and more gas atomised powder available on the market than before, which is a positive trend,’ he says. ‘Powder is gradually being adopted more and more into the industry and being used by more and more companies. And powder has a larger role now in the development of metal injection molding, additive manufacturing and increasingly in HIP. So the strong trend of development in the first two industries has also led to an increased demand in HIP.

‘Another exciting trend that has emerged in recent years is the development of simultaneous hot isostatic pressing and heat treatment. The cooling rate has improved in isostatic presses, resulting in a lower lead time for the product. This can improve energy savings as well because it can improve temperature control, resulting in a very uniform temperature.’

What’s unique about Quintus’ HIP technology? ‘We were part of the early crowd developing this type of equipment, and this history and background means that we have a very strong position in the market,’ Peter notes. ‘Besides this, we pride ourselves on excellent temperature uniformity, control from an operator standpoint, and a ‘whole technology’ focus whereby we have software supporting our hardware.

‘There will also be a growth in new users requiring a different type of machines,’ he notes. ‘There will be a focus on quick and complete installation, handled entirely by the supplier. They will also want to have a guarantee that they have a machine that would allow them to produce the exact number of components required. Our aim is to meet these needs and ensure we have a range of machines available for all requirements. The eventual aim is to make HIP machines both easy to own and easy to install.’

Quintus Technologies; www.quintustechnologies.com