열간 등방압 성형 장비의 개발 역사와 향후 전망
Historical Review and Future of Hot Isostatic Pressing Equipment

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1. Introduction

The development of the hot isostatic processing (HIP) process from the time of its conception at Battelle in 1955 up to the past few years has continued to lead the availability of adequate HIP systems. Hipping is invaluable in the precision casting, powder metal, metal bonding, and ceramics industries. The process improves the performance and strength of precision castings, and is a production technology for diffusion bonding of similar and dissimilar materials. In the near future in Korea, to expect the development of HIP equipment, this article reviews the foreign history of HIP equipment and introduces the future trend.

2. Development history of HIP equipment

The first development for HIP equipment by battelle scientists were conducted in a vessel consisting of a 91.44cm long piece of Type 304 Stainless steel high pressure tubing 14.29mm O.D. by 4.76mm I.D. During this time, two of these utilized as hot wall units, did have rupture failures in the region of the heated end. These failures and the realization that the hot-wall vessel would be limited in size, temperature, pressure and life capabilities, brought about the idea of the cold-wall gas-pressure vessel.

The initial cold-wall vessel developed at battelle was placed in the center of the pit upon a 24-inch high stand because of safety reason, and the compressor positioned at the back of the pit on on floor level in 1956, as shown in fig. 1. The HIP system, was pressurized from the helium manifold to

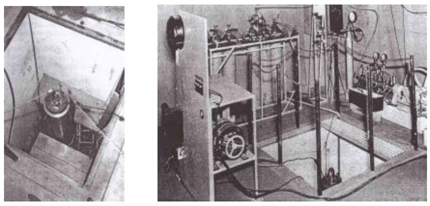


Fig. 1 The initial cold-wall gas-pressure HIP system, as first assembled in 1956.

3.45Mpa. There were several gas leaks throughout the system. The Leaks were noted and after releasing the pressure, they were repaired.

The period of 1963 brought about a number of changes and improvements in the components that go to make up a HIP system. The equipment manufactures began to engineering and offer complete packaged HIP systems. In addition to Autoclave Engineers, Inc., and Pressure Products Industries, Inc., other high pressure manufacturers started supplying HIP systems. These included the National Forge Company, American Instrument Company, Harwood Engineering Company, Inc., and most notably, due to its unique wire wound design, ASEA, as illustrated in Fig. 2.

The first hot isostatic press built by ASEA, in 1965, was intended for operation for both HIP with an argon pressure of 199.9Mpa. The vessel was wire wound, with threaded closures, shown in Fig. 2(a). The first Hip system with a wire wound vessel and frame was delivered to ASEA's own lab in 1969, shown in Fig. 2(b).

In 1965, Kennametal, with Battelle's assistance, began its adaptation of the HIP process to the improvement of tungsten carbide parts. With the,

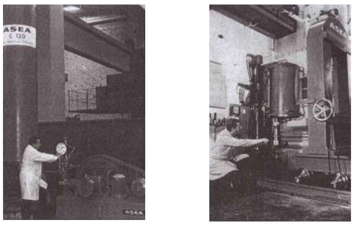
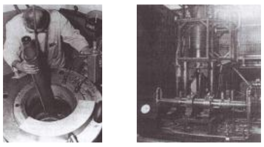


Fig. 2 Sectional view of a wire-wound pressure vessel and supporting frame.

application of HIP, internal porosity was removed improving the properties of cemented carbide parts and in many cases, eliminating pits and flaws. Kennametal purchased their first production HIP systems(Fig. 3(a)) from A/E in 1967 under strict secrecy. In 1964, The Kobe Steel had developed the first HIP system in Japan for their own lab with the purpose of continuous developments, as shown in Fig. 3(b)



(a) (b)

Fig. 3 The loading of a tungsten carbide part into one of Kennametal's vessel(a) and the first Japanese HIP system developed by Kobe Steel(b).

3. Future trend of HIP equipment

In America, American Isostatic Presses, Inc. was found in 1991. This company usually uses fully threaded monolithic forged vessel, as shown in Fig. 4. This is the most economical vessel. It is also the most widely used. There is a long history of design and understanding involving these vessels. It can be ultrasonically checked for defects at any point in it's life. The analysis of design is straightforward and universally understood. It is simple to operate and maintain. It is a medium weight vessel and is not as susceptible to overheating damage as some other designs are. If damaged during it's life there have been no failures of the fully threaded monolithic forged vessel until now. Typical cyclic life is chosen at around 10,000 cycles, however designs can offer higher cyclic life at added cost, but often replacement is a more effective savings. It can be manufactured in both small and large vessels.

Fig. 4 HIP system built by the AIP in America

4. Conclusions

Foreign HIP developmental history in many ways mirrors the research history of advanced materials such as cemented carbide tools, P/M tool steels, ferrite recording heads, and engineering ceramics. The requirements for HIP for each application area calls for special design. for example, to achieve higher productivity, higher working temperatures, and, often, a special atmosphere inside the processing chamber are called for. Today, many innovative processing are still challenging the imagination and design skills of the HIP system suppliers. In the near future, it is anticipated that the Korean manufactures will develop the HIP system with excellent performance.

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