Environmentally Friendly Welding of LVS Using Lasers

Liquid Vapor Separator (LVS)

Saving gasoline is what counts!

The automobile industry is assuming a leading role in environmentally friendly technology as R & D departments are continuously working on improving processes to boost efficiency and effectiveness. Fuel efficiency is what counts! Customers have come to rely on fuel efficiency and attach great importance to economically and ecologically friendly products. As a result, the decision when purchasing an automobile is often associated with gasoline consumption and emission volume.

The ecological awareness of the customer, combined with legal pressure to reduce emissions such as CO_2, has companies investing more money into environmentally friendly technologies. Therefore, the primary focus of research is in reducing gasoline consumption while retaining efficiency. Any savings, no matter how small, is a step toward achieving this goal – including the use of a liquid vapor separator (LVS). The LVS not only saves gasoline but also reduces the emission of gases.

Multiple components in the tank system supply the automobile's engine with gasoline. However, gasoline and vapor can escape from the system during combustion. In the past, these emissions found their way into the environment without first being filtered. The automobile industry is now attempting to avoid these emissions by employing several methods, including the LVS. The LVS is located between the tank and an activated carbon filter where it separates liquid gasoline from vapor. Temperature differences in the tank system generate differences in pressure and are responsible for the emission of gasoline and vapors. With the aid of the LVS, the gases are separated from the liquids while the gasoline is returned to the tank. The gases are released into the open air after having been filtered with the activated carbon filter. This process not only saves fuel but also is intended to protect the environment.

The consortium

The liquid vapor separator is one of the main components in every modern tank system. It is normally produced using blow molding or injection molding and is individually designed and developed for each vehicle.

A special LVS has been developed by YAPP Automotive Parts Co., for the tank system used in the Volkswagen Polo (for the Indian market). With a volume of 150,000 units per year, Yapp management decided to produce the components from polyoxymethylene (POM); first using the injection molding process and then welding the components. After extensive tests with various welding technologies, YAPP's evaluation determined laser welding produced the highest quality and most reliable joint.

Liquid vapor separator welded with GLOBO technology from Leister.

YAPP, located in Yangzhou, China, supplies complete tank systems to a diverse clientele of automobile manufacturers. With pressure differences that can reach up to 3 bar, each component must correspond to the specific conditions of each unique tank system. In this particular case, the pressure difference would have a negative effect on the sensitive functional areas of the LVS. Therefore, additional joining points were integrated to reinforce the component.

Yangzhou Olive Sensors Co., a supplier and component manufacturer, accompanied YAPP during the development and testing

of several joining methods such as ultrasonic, vibration, laser and heating element welding. Laser welding, particularly the GLOBO technique, proved to be highly-effective and was adopted into the production process.

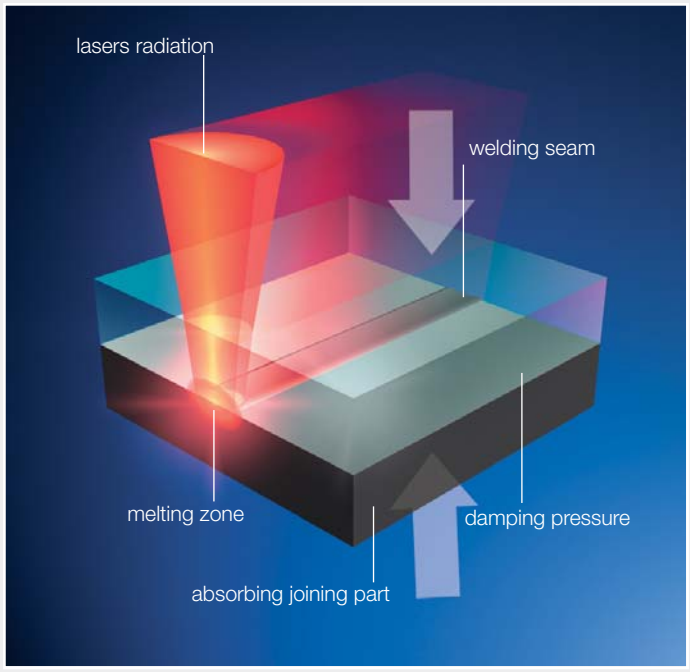
As a specialist in the laser welding of plastic components, Leister was integrated into the process and selected as a laser supplier at an early stage. The product portfolio of Leister Lasersystems not only comprises all conventional welding methods but also unique solutions such as GLOBO, mask and radial welding. All of Leister's welding concepts can be integrated into production plants or supplied as individual workstation solutions.

Novolas Basic AT workstation from Leister (lower right).

Within the consortium, Shenzhen Yuanwang Industry Automation Equipment Co. – a provider of highly sophisticated industrial automation for tank system suppliers – integrated Leister's NOVOLAS Basic AT with GLOBO optics into an individual workstation solution corresponding to international standards.

Laser welding principle

The use of lasers in the welding of plastic components calls for two different optical properties of the plastic. The laser beam penetrates the top laser-transmissive (transparent) thermoplastic and is converted into heat by either a bottom laser absorbent thermoplastic or by a laser absorbent dye at the weld interface. During the welding process an external force is applied which clamps together both thermoplastic



Depiction of the laser welding principle.

parts allowing for a conduction of heat from the laser-absorbent thermoplastic to the laser-transmissive thermoplastic, melting both parts and creating a bond. Thermal expansion in the welding zone creates an internal pressure and leads to a strong weld between the parts. By focusing the laser beam, the process ensures that the effect of the heat is precise, resulting in a clean weld void of particles, threads and smoke.

The pressure for joining, normally applied via a clamping device, ensures a form closure of the component to be welded, yet allows the laser beam to pass through unimpeded. The patented solution behind the GLOBO welding process integrates an air bearing, freely rotating glass sphere. The glass sphere not only focuses – it also serves as a mechanical clamping tool. While the sphere rolls on the component, it applies continuous pressure at a point on the joining plane, ensuring that the laser beam is only incident at the point at which the contact pressure is also applied. This system ensures that the lens rolls almost friction-free over the surface, thereby welding the component perfectly – both visually and functionally.

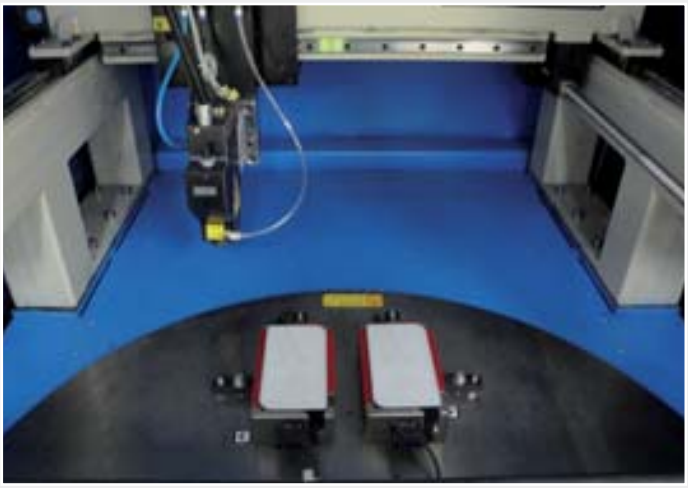
The challenge

As previously mentioned, the LVS pressure has sensitive functional areas that require additional support. A housing,

when under pressure, will “blow up” like a balloon. This pressure was countered by fastening points or areas arranged in a targeted manner. YAPP developed a combination of pillars and bars, which were spread throughout the housing and can be welded to the cover without impairing the function. Welds of this nature posed a tremendous challenge that could not be overcome reliably using conventional welding methods. As a result of production, the five pillars and fork-like bars had different heights making them more difficult to weld and increasing the complexity of both the clamping and welding concepts. With a combination of local energy transfer and simultaneously applied local pressure, the GLOBO method provided a simple and effective solution for this component and successfully attained welds with the utmost reliability.

Realization

Yuanwang, an authorized automation company for Olive, was entrusted with the production of an individual workstation system for the laser welding of plastics using Leister welding technology. After several welding trials at Leister in Shanghai, Yuanwang implemented the GLOBO welding principle into a machine concept. The short process times required are now achieved by an integral two-cycle rotary indexing table with four holders.



Two-cycle rotary indexing table with four holders.

The operator positions two sets of housings with the covers into the holders and presses the start button to let the table move into the welding position. During the process, linear axis move the GLOBO sphere along the welding contour, creating the bond in the desired area. The required pressure is applied via a pneumatic cylinder mounted on the side of the optic. The GLOBO process has the advantage of compensating for height differences. While the initial two sets are sequentially welded, the operator is loading the next sets. As soon as the welding process has finished, the operator presses the start button again and the completed set rotates to the front for unloading and reloading while the other sets are being welded. The GLOBO sphere allows for simultaneous laser energy and precise clamping at the point of welding ensuring a repeatable and hermetic seal.

GLOBO welding has arrived on the scene in China’s industrial sector as well. Its application is not confined merely to the automobile segment. As the LVS example shows, welding with laser radiation represents an efficient, reliable and calculable solution for highly complex applications.

GLOBO laser head from Leister.

Plastic tank system producer:	YAPP Automotive Parts Co., Ltd /China / www.yapp.com
LVS component manufacturer:	Yangzhou Olive Sensors Co., Ltd / China
Lasersystem integrator:	Shenzhen Yuanwang Industry Automation Equipment Co., Ltd /China / www.ywzdh.com
Lasersystem manufacturer:	Leister Technologies AG / Switzerland / www.leister.com/lasersystems
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