Investing in innovation – Linde expanding its AM test facility

By Stephen Harrison, Rob Cockerill | 30 October 2018

Linde is continuing to invest in innovation with the completion of a second atmosphere-controlled AM (additive manufacturing) test cell expected by the end of the year.

The new facility will double Linde's available work space and will be complemented by the company's third and largest AM machine yet, with a 300mm diameter working platform.

AM is a fast-growing application for the industrial gases business.

AMazing – Industrial gas innovation showcased at MTC2

While arc welding is a relatively old space for industrial gas technologies, when combined with modern AM the arc welding process is enjoying a new lease of life.

The combination of these two techniques has raced up the innovation agenda at Linde's sophisticated R&D complex, north of Munich, over the past few years. It has now fledged into a synergistic collaboration between the established arc welding team and the growing additive manufacturing group.

Pierre Forêt, responsible for additive manufacturing research and development (R&D) at Linde, explained, "Four years ago, there was no Additive Manufacturing (AM) R&D team. Since then we have recruited internationally in Europe and from as far afield as Singapore to bring together PhD scientists, engineers and leading experts in this field. We are now a team of 10 and, we are still recruiting! But, the key to our success is that we work as an integrated Innovation Management team to leverage ideas and experience from other R&D programmes."

Investment in innovation

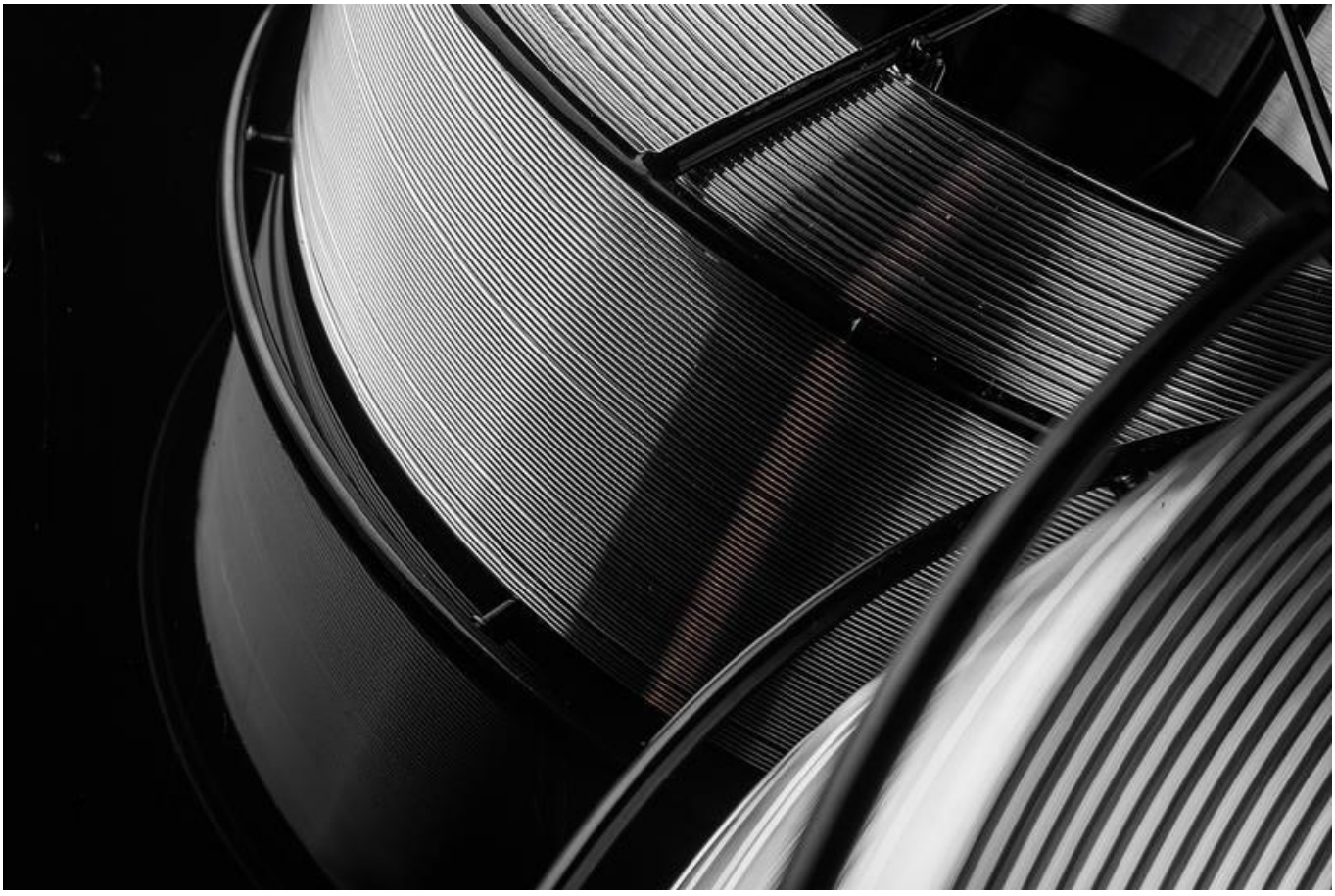
It's not just the number of people in the AM team that's growing – there has also been a rolling programme of R&D infrastructure investment, with board level sponsorship, to maintain the

momentum.

An industry refocused

Forêt revealed the news of the company's new facility, "By the end of this year, we will build a second atmosphere-controlled AM test cell to double our available work space. And, the investment does not end there, our third, and largest AM machine yet, with a 300mm diameter working platform, will be delivered by Trumpf in the coming weeks."

"It's vitally important that we have a range of different AM machines, so that we can test various gas mixtures and parameters under the same conditions as our customers. And, having more machines means that we can accelerate the pace of our development activity to test new gas mixture compositions across a range of substrates. Bear in mind that a single AM part can take anything between 3 and 30 hours to make, so each single test is not a matter of minutes, but days."



Explosive growth

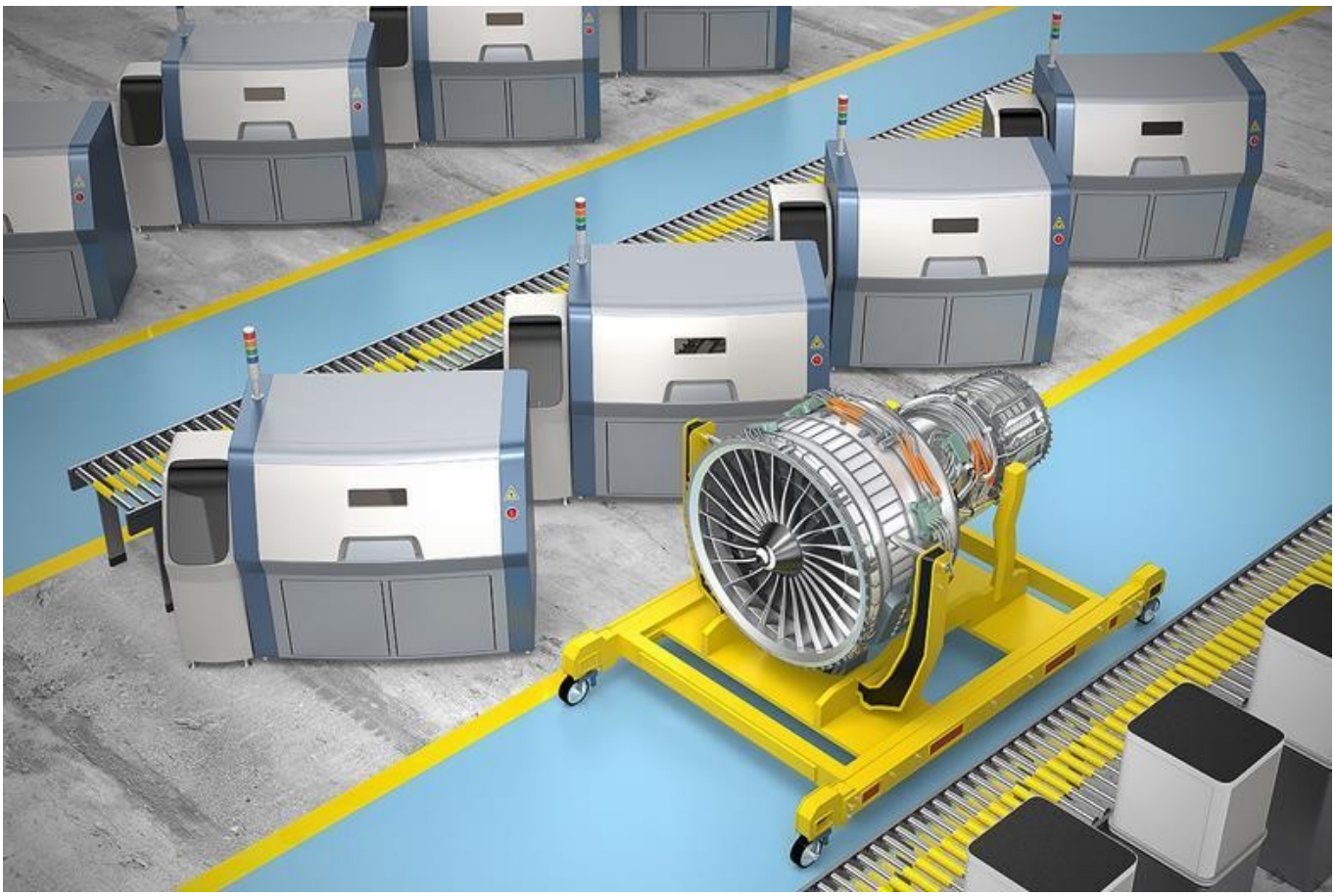
The motivation for R&D investment is clear. As a technology, AM has existed for more than 30 years. But, the explosion in its industrial application has intensified in the past five years.

According to Linde, it sees the market development at between 25-30% per year with all main

geographic regions participating in the uptake of the process, and the usage of gases being equally important in the powder production, AM machine and post treatment processes.

The first and last links in the value chain are relatively consolidated. There are only a handful of major powder producers globally in locations such as Japan, Canada and Europe. The post treatment processes tend to leverage established infrastructure in large heat treatment facilities taking batch-based contract work. However, the companies operating the AM machines are still in an embryonic stage and range from hundreds of smaller outfits with just one or two machines, to some big factories with 20-30 machines and a few exceptional facilities with more than 100 machines installed in a single location.

“Keeping our customers across the AM value chain supplied with argon gas, as they continue to grow, is core to our business mindset,” declared Forêt. “Smaller AM machine operators will take several cylinders, or a bundle, of argon per week. For the larger powder making factories, they might be consuming one bulk tanker load of liquid argon per day. But, we are lucky to be able to offer a wide range of supply modes to our customers worldwide, which will suit their usage profile.”



The elixir of youth

In the range of AM techniques, the largest parts are not produced using powders, but use a process known as WAAM, or wire arc additive manufacturing. Linde is keen to partner with other leading

organisations to drive this technology to new places. To strengthen its WAAM innovation programme, Linde has partnered with academia, end-users in the aerospace sector and GEFERTEC GmbH of Berlin, a cutting-edge manufacturer of WAAM machines.

The collaboration is not just external, but also internal.

Erwan Siewert, a colleague of Pierre Forêt at Linde in Munich, with global responsibility for Arc Welding Development, enthused, "The partnership that has emerged between the R&D team focused on AM and my arc welding innovation team has been like an elixir of youth for us."

"Welding is, and always has been, an additive process. In the industry, stick electrodes, solid wire electrodes are used to add filler material to the weld. But, the emergence of sophisticated AM machines has taken welding to a new dimension. Years ago, the industry was using hard-facing electrodes to create digging or cutting surfaces on cheaper substrate materials. Or, MIG/MAG techniques were common to lay down a thin layer of expensive corrosion-resistant alloy onto a cheaper structural substrate. Now, some of these processes are transferring to the world of AM and 3D printing."

The AM news – Trends in additive manufacturing

Low-emission welding gas mixtures

The big reason to use WAAM, in favour of metal powder-based AM techniques, is simply that it can produce significantly bigger parts. The largest parts, for example a turbine, might spend between 30 and 60 days in the machine and weigh up to 200 tonnes.

The WAAM machines operate in the open factory, so they are almost unlimited in size, and robots can be used to handle the larger parts. To intensify the metal deposition speeds, multiple synchronous arcs can be used on one machine.

In the turbine manufacturing example, with such a large welding machine operating continuously for days on end, welding fume mitigation becomes a key issue. Toxic gases, such as NO, NO_2 and ozone are emitted close to the weld and emissions can be reduced with the selection of appropriate shielding gas mixtures. Siewert added, "This is one of the main synergies between our classical arc welding R&D programme and the cross over into the AM innovation efforts. Both techniques are driving us in the direction of ultra-low-emission welding gas mixtures."

To test various shielding gas mixtures, Linde has recently built a unique test chamber, which has full control of the ambient air conditions around the weld. It is a dedicated room with full air filtration for the elimination of background NOx and ozone so that, when measuring the welding

emissions using its suite of high-tech laboratory gas analysers, Linde can be certain that there is a clean baseline air quality with no interference from variables such as sunny weather, car exhaust gases or other welding activities taking place nearby.

As with MIG, MAG or plasma arc welding, WAAM machines require shielding gases to protect the molten weld metal from atmospheric oxygen and moisture. And, if a plasma-arc is used, the WAAM process will also require pure argon. The development programme at Linde has established that many of the lessons from decades of arc welding expertise can be transferred to the WAAM process, but that fine tuning of the gas mixtures is also advantageous.

Since the WAAM process is a relatively high-volume consumer of industrial gases, mix-on-site supply from pure gases supplied in bundles is realistic.