Press Kit
MALEX

November 2014

A faster, more reliable, versatile technology, which reduces the stress felt by operators

A Charleroi SME develops a ground-breaking welding machine for special steels, which pairs laser and conventional resistance welding technology.

To meet the challenges of the European steel industry, including the development of special1 steels with high added value – the only credible response to the mass production of Chinese and Indian steel - Europe launched a European Innovation Partnership on Raw Materials (EIP) which fosters innovation through the value chain of steel, from exploration and extraction, to efficient processing, recycling and substitution. In this context, an SME from Charleroi, SA Malex, associated with a Walloon research centre, CEWAC (Walloon Research Centre for Assembly and Control of Materials), developed a technology which is the only one of its kind in the world. Indeed, in Europe, current steels are more and more efficient, but they have become difficult to resistance weld – the main technique used to connect coils2 in the steel industry.

HYBWELDCUT demonstrator

To meet this challenge, Malex developed **a ground-breaking hybrid welding machine** which pairs laser and resistance technologies. A triple benefit: besides the fact that it reduces costs to alter existing equipment by adding this hybrid technology, if users of this innovative technology are experiencing problems with the laser part or the conventional part, they can easily switch from one to the other. Finally, they can also choose the most appropriate technology based on the type of steel to be welded. A **technology demonstrator** - called **HybWeldCut** – was completed after 2 years of research with CEWAC as part of a CWALity research programme, co-financed by the Walloon Region (DG06), with a budget of € 1.5 million over a 2 year period. The results are surprising in terms of timeliness compared to current technology, reliability and versatility. In addition, this technology reduces the stress felt by operators.

[1] From steels for prestressing cables to controlled expansion nickel iron, special steels cover a very vast range of use and physical and mechanical properties. This includes alloy and non-alloy structural special steels, carbon chromium steels, non-alloy and alloy tool steels, high-speed steels, stainless and heatresisting steels, anti-corrosion alloys, steels and alloys with special physical properties.

[2] Consist in joining end to end two hot or cold-rolled steel sheet reels.

Ensuring a Future for Steel in Europe

In a statement released June 11, 2013, entitled 'Ensuring a Future for Steel in Europe', the European Commission stressed **the importance of technological innovation in the steel industry**. "*The European steel industry is constantly developing new types of steel for specific applications. To further boost this competitive edge, there is a need to stimulate innovative R&D to a much greater extent than in the past, particularly the economically risky and very expensive pilot and demonstration phases*."
The Commission intends to:

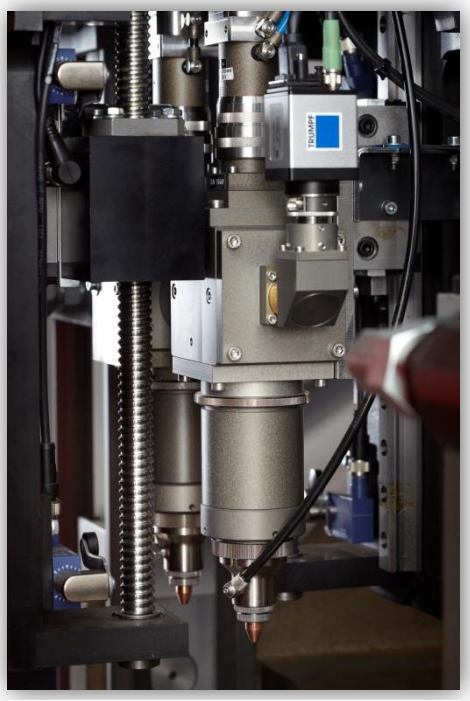
• give adequate support, in the context of Horizon 2020, to R&D demonstration and pilot projects for new technologies for cleaner, more resource and energy-efficient technologies, including Public Private Partnerships such as SPIRE (Sustainable Process Industry through Resource and Energy Efficiency) and the Strategic Energy Technology Plan (SET);

• focus financial support on the up-scaling and piloting phase going beyond the research phase;

• explore, in the framework of the European Innovation Partnership on Raw Materials, all the options to foster innovation in the steel industry along the raw materials value chain, including recycling.

As already stated above, in the steel industry current steels are more and more efficient, but this means they have become difficult to resistance weld – the main technique used in the steel industry. It is in this context that the Charleroi company MALEX S.A., and in particular its co-founder Alex QUARANTA, developed and patented its concept. It includes the solid-state laser technology (different from CO2 lasers using gas) to simultaneously double cut and weld special steels. In addition, the resistance welding offers here the added benefit to weld and anneal in a single operation.

"*I have been working on this project for ten years*, says Mr Quaranta, who has been part of the welding world for over forty years, first as an employee and then heading Malex for 25 years. *We took huge risks by developing this innovation, particularly in financial terms, but the results are exceptional*."



Laser cutting heads

The History of Malex, Step by Step

• In the sixties, the American company Taylor Winfield, a pioneer amongst the manufacturers of welding machines to connect coils, granted an operating licence to Electromécanique, a Belgian company. It allowed Electromécanique to manufacture and maintain the equipment in its range: the Limited-overlap, the Narrow-Lap, the Prep-Lap, the Pres-Lap and the Flash-Butt.

• In 1981, Electromécanique S.A. went bankrupt and was bought by the VERSON EUROPA Group. As a result, VERSON EUROPA got Electromécanique's operating licence and resumed the manufacture of coil-joining equipment. Alex Quaranta was promoted to Manufacturing Director and Mario Vivone became Assistant Director of Welding Machines Studies.

• In 1987, VERSON EUROPA encountered severe difficulty. Alex Quaranta and Mario Vivone founded MALEX S.A. and launched their operations by providing their customers with engineering services, automated mechanical manufacturing, metal manufacturing and machining.

• In 1996, VERSON EUROPA went bankrupt. MALEX S.A. decided to use its knowledge of the welding processes and specialised in the research, manufacture, maintenance and modernisation of resistance seam and flash-butt coil-joining welding machines. MALEX S.A. became a partner of Coil-Joining International, the Belgian subsidiary of the welding machines world leader.

One of Malex's workshops

• In the early 2000s, MALEX S.A. decided to stand on its own feet and terminated its exclusive contract. It developed its operations in the Benelux.

• In 2005, the company obtained a welding machines maintenance contract for the Arcelor Group.

• In 2008, MALEX S.A. filed a patent for a hybrid 'arc-laser-resistance' device which cuts and welds for coil-joining. It included a novel laser technology which had never been used before for this purpose. Maurice Casagrande, who had been a mechanical, electrical and hydraulic designer of coil-joining welding machines at VERSON-EUROPA for 18 years, left his position within the Estom-Debelle workshops and became Director of MALEX S.A.'s Engineering Department.

• In 2010, Coil-Joining International dissolved. Christian Cardon, the Deputy Director General of the company brought his skills to MALEX S.A. and became its Director of Sales.

• MALEX S.A. expanded its operations throughout Europe with groups like ArcelorMittal, NLMK, Tata Steel, Thyssenkrupp, Riva, Tenova, Voestalpine and in North Africa with the Group Maghreb Steel. Malex SA also provided spare parts in Mexico, Korea, the Philippines and Taiwan. Its export sales continued to grow.

• In 2013, while its project called HybWeldCut was still in the development phase, MALEX S.A. reinforced its position as a developer of coil-joining solutions by laying the groundwork for a second project to provide the steel industry with an innovative solution to weld their 1.5 to 6 mm special steels.

HybWeldCut

In 2011, MALEX S.A. was chosen after a major call for innovation projects launched in the context of the CWALity research programme initiated by the Walloon public service DGO6. Funded by the Walloon Region, this project developed by MALEX S.A. in partnership with the non-profit research centre CEWAC gave the company a hybrid 'laser-resistance' welding-cutting machine demonstrator. It provides an innovative, flexible and lasting solution to the problems of coil-joining when it concerns the 0.2 to 3 mm special steels currently developed in the steel industry.

The project of the MALEX-CEWAC partnership was selected late 2011. With a € 1.5 million subsidy from the Walloon Region, the research project, called 'HybWeldCut', began in January 2012.

The Project (2012-2013)

The objective of the project was to study, design, build and test the technology demonstrator of a hybrid 'laser-resistance' cutting-welding machine, on the company's premises, with the help of CEWAC.

With a total cycle time of less than 30 seconds for joining steel plates, post-welding annealing operation included, this innovative process is faster and more reliable than the current technology. It is versatile and reduces the stress felt by operators.

This demonstrator has several advantages for MALEX S.A:

- Showing actual and potential customers the full-sized, operational production equipment;
- Pointing out the feasibility of adding this new laser cutting and welding technology through a refurbishing of Pres-Lap or Prep-Lap-type machines, widely represented in the current steel industry;
- Conducting tests on customers' steels in order to demonstrate in a practical way the benefits of this technology;
- Finalising the development of the settings prior to the implantation into production;
- Training MALEX S.A.'s staff in the refurbishing and maintenance of its equipment;
- Training the customers' staff without stopping the production.

Technology

The hybrid welding-cutting machine technology demonstrator has been designed to weld 0.2 mm to 3 mm cold-rolled special steels and, in its laser application, it:

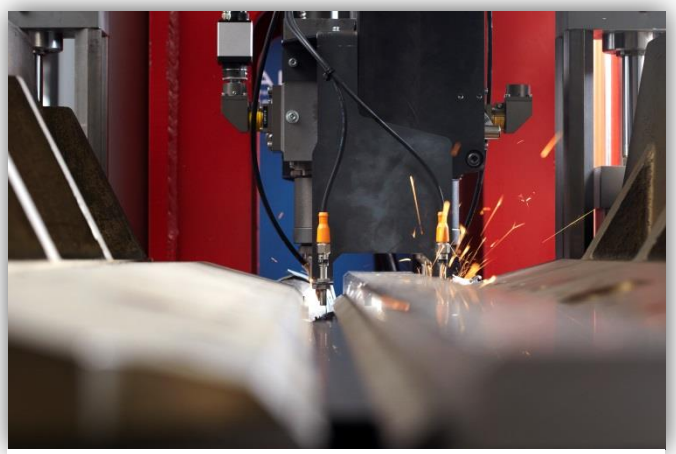
- laser cuts;
- laser welds;
- anneals the weld with the welding wheels.

In this respect, the innovation concerns 3 different aspects:

1. A novel Yag laser technology;
2. A hybrid device combining two welding technologies;
3. A device which can be fitted on some types of welding machines widely represented in the current steel industry, to upgrade the equipment.

"A Yag laser technology which had never been used before for this purpose"

MALEX S.A. opted for the Yag laser technology for several reasons.



Laser welding

First, Yag lasers have the advantage, compared to CO2 lasers, of using optical fibres to transport the beam several tens of meters away, thanks to their 1.06 µm wavelength (over a 10.6 µm wavelength for CO2 lasers which means that treated and cooled metallic mirrors have to be used to deflect the beam). As a consequence, only one laser source is needed and it is not embedded in the welding machine, since the beam is carried by optical fibres. The installation is therefore much lighter, requires significantly less maintenance and is more energy-efficient compared to the CO2 laser welding solutions on the market. Moreover, fibre-optic transport allows a far better control of the beam, resulting in greater welding flexibility, better assembly and neat welds.

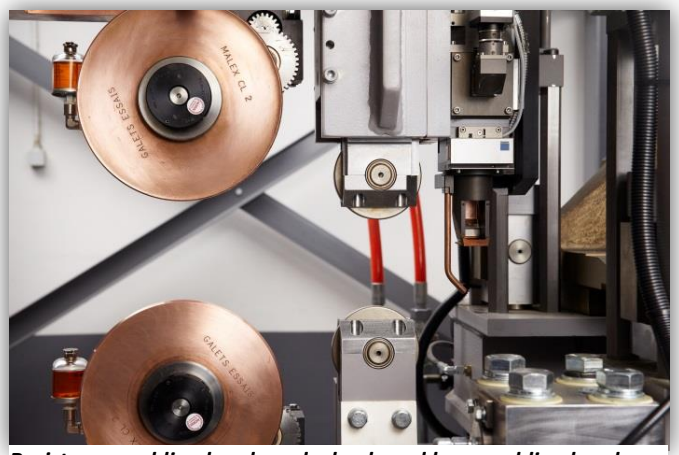
Then, the Yag laser wavelength is well absorbed by metallic materials, unlike the low absorption rate of the CO2 laser large wavelength. In the case of steel, the Yag beam absorption rate is 20-25% compared to 5-10% for the CO2 laser. Due to this low absorption rate, it takes a significantly greater laser power with CO2 than with Yag laser, for the same result.

In addition, the use of Yag laser has other advantages:

- a high welding speed;
- a source that does not need preheating;
- the possibility of using very long (up to 200 m) and very fine optical fibres, which would enable two laser devices to be powered with a single source;
- the possibility of increasing the power of the source by adding power modules;
- the small size of the laser source.

"A hybrid device combining two welding technologies"

This hybrid system has the following advantages:



Resistance welding heads and wheels and laser welding head

- **Versatile**, it provides the flexibility to choose between either of two welding technologies according to the type and thickness of the steel to be welded;
- **Reliable**, it offers the possibility to switch quickly from one technology to the other should a problem occur with one technology or the other (in case of malfunction or during maintenance for example);
- **Complete**, it offers the ability to make a laser double cut, the laser weld and the annealing with welding wheels in a single pass;

- **Economical:**
  - ✓ It enables those two or three operations to be carried out with a dramatically shortened cycle time and therefore generates significant production gains;
  - ✓ The highly accurate laser double cutting offers a cutting quality that makes a fine, precise and strong weld possible → less offcuts, less tool breakages, less line stoppages;
- **Fas**t: it offers an unparalleled cycle time of 26 seconds3 for the laser double cutting, the laser welding and the annealing with welding wheels in a single pass;
- **Sustainable**: besides being reliable, energy-efficient and easy to maintain, the device also reduces the stress felt by operators who continue to use a piece of equipment they know and expand their skills through the use of laser technology.

[3] Average cycle time established on the basis of tests carried out with steel sheets 1500 mm wide and 2 mm thick.

"A device that can be fitted on existing welding machines to upgrade the equipment"

The HybWeldCut device may be fitted on any Pres-Lap or Prep-Lap-based welding machines. These resistance seam welding machines, initially developed by Taylor Winfield and also manufactured under licence by Electromécanique and Verson, still remain on many steel lines.

The option of revamping these welding machines with the hybrid device provides the following benefits:

- More economical than purchasing a new piece of equipment because the original frame is retained;
- There is no need for civil engineering because it retains the original equipment;
- After the mechanical changes, all resistance welding parameters are stored and the laser settings are enabled;
- The operator only receives training in the laser process;
- The start-up time is dramatically reduced, the preparation being made mostly offline, which limits productivity loss.

In practical terms, the demonstrator consists of a frame, similar to that of Pres-Lap or Prep-Lap-type welding machines, which is connected to a disk laser source by 3 optical fibres, of which 2 are used by the laser cutting heads and the last one by the laser welding head. Resistance welding heads and wheels are added to the laser technology to anneal the weld when the operator uses the laser technology. The laser piece of equipment is a commercial product.

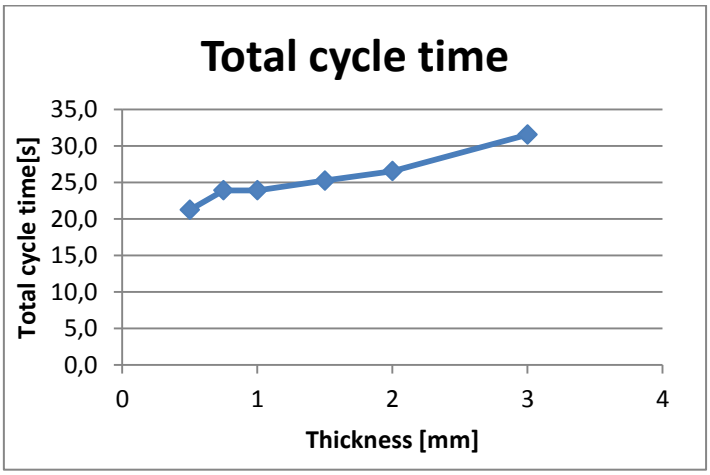
"*The laser technology is provided by TRUMPF, a world leader in laser technology via its distributor VAC Machines.*"

TRUMPF laser source powering the HYBWELDCUT demonstrator

The characteristics of this type of innovative technology are as follows:

- Width of steel plates to be welded: up to 1600 mm
- Resistance seam welding speed: from 1 to 10 m/min
- Laser cutting speed: from 1 to 20 m/min
- Laser welding speed: from 1 to 10 m/min

The full cycle time depends on the steel plate thickness and width.



Graph depicting the cycle time for a maximum width of 1600 mm

Tests were successfully performed both on standard steel plates and on newly developed special steels (objective) with thicknesses ranging from 0.5 to 3 mm. Metallographic, tensile and alternating bending tests were carried out in CEWAC to assess the welds produced on the demonstrator.

A Patented Technology

Laser cutting

MALEX S.A. successfully completed this ambitious and extremely innovative project (European patent EP2039458). Thanks to the research carried out on this project, MALEX S.A. and its partner, CEWAC, gained significant and unique technological knowledge. This exclusive, high-tech product, which takes account of developments in the steel industry and of the well-being of line operators, but which also respond to environmental concerns, complement the product range and the services of the Charleroi company. It provides an innovative, versatile and sustainable solution to the current and anticipated problems of coil-joining for 0.2 to 3 mm special steels.

The marketing of this product will enable the company to develop its operations in Belgium and on the international market. Furthermore, the company is already considering hiring additional staff in 2015.

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