By Grad. Eng. Walter Lutz*

Successful co-operation between CLOOS and Siemens

# How MAG narrow gap welding considerably reduces production times on thick-walled components

BERLIN – For many years, Siemens has belonged to the group of leading manufacturers in the world with innovative gas turbines for power stations. In order to be able to manage the greatly increasing demand and at the same time, improve the working environment for employees, Siemens is, for the first time, using narrow gap welding by means of robots for handling huge turbine housings, which has brought about readiness for production of the group in collaboration with the welding specialists CLOOS from Haiger.

There is scarcely any other industry undergoing a conversion process like the energy industry. Away from coal and nuclear energy, to cleaner technologies such as wind and sun, and also gas, which can burn environmentally friendly. No wonder electric power production by gas turbines, which Siemens produces for the world market in its Berlin factory, is in ever increasing demand. In particular, those countries with natural gas resources are discovering the higher added value of conversion into electricity, in place of simply exporting gas.

Currently, the most powerful Siemens gas turbine provides a whole 375 megawatts and is the largest and most powerful gas turbine in the world. In this process, the population of a city such as Hamburg is completely supplied with power. Siemens belongs to leading companies in this field on a worldwide basis: since 1972 over 800 gas turbines have left the Berlin factory and supply electricity in approx. 60 countries of the world. The 3500 employees on the site are working to full capacity.

## New technologies versus high pressure on production.

”Equally high is the pressure on production” says Uwe Krabetz, group leader responsible for housing production. Siemens can hardly expand at the traditional site with its historical hall ensemble in the centre of Berlin. “It is only possible to optimize production, increase quality and output with the use of modern production technology,” With the individual

housing parts of a gas turbine, measuring up to 4.60 m in diameter and manufactured from up to 100 mm thick structural steel, resistant to elevated temperatures, quality 16 MO3, those responsible have long had focused the area of welding technology since a long time. Siemens has been working with a modern CLOOS robot plant for many years, on which, for example, the 30 ton end piece of the gas turbine is welded. The 140 m fillet and V groove welds are produced in 30% less welding time. And re-work has reduced considerably by around 10%.

A further potential for rationalization has been discovered by the experts in the field of welding large flanges and manholes: “We need up to four 8 hour shifts for the joint welds in a MAG manual welding process. In this process, each weld swallows up approx. 150 kg of welding wire based on the 50 degree V geometry” reminds Uwe Krabetz. Technology was lacking to optimise this time and material intensive procedure. “This is where the idea came from to find a robot based solution with CLOOS”, explains Uwe Krabetz. After all, they have had good experiences in Berlin for many years with the competence and technology from Haiger.

## Wire oscillates in the narrow gap blade

CLOOS has developed a special narrow gap blade – around 30 cm long with a width of 16 mm, that the robot immerses in the gap between the housing shell and the manhole connecting piece respectively flange. Instead of the elaborate and large volume V groove seams, whereby the worker had to ultimately work with the welding torch up to the root, Siemens can use a narrow gap weld with parallel weld edges and a narrow width with the new process, which is only 20 mm. In order to prepare the weld edges, the quality of the conventional flame cut is adequate.

The CLOOS narrow gap blade feeds wire electrodes, shielded gas and cooling water. The welding wire in the blade is moved via a mechanism in such a way that it precisely oscillates over the welding area. In the MAG narrow gap process, over 80 layers are produced in the same consistently high quality on 300 mm thick components. The robot needs less than four hours and only uses 30 kg of weld deposit. “Compared with previous manual welding, this saves around 80% of the time and welding wire”, Uwe Krabetz delights in the enormous potential for savings also in shielded gas and energy. This provides another benefit: the relatively low energy supply with CLOOS narrow gap welding minimizes the material distortion during the welding process.

## Complex robot welding plant: two robots move on a large gantry

Siemens installed a new complex robot welding plant in the summer of 2011 in order to be able to optimally weld large turbine parts with up to 4.60 m diameter and 2m in depth. Two robots were moved on a gantry 32 m in length and over 8 m in height which has a depth of 7.7 m. It extends over four work cells in this process. “The robots weld in two of these whilst in the other two, our employees prepare and rework the components”, Uwe

Krabetz explains the chain of production stages. In this process, robots automatically change between the new narrow gap technology and the MAG single wire process with which thick semi rings are welded in turbine housings. “We can also combine two cells, in order to handle the planned maxi housing for our new turbines”. Siemens wishes to make one unit from two part housings in the future, in order to save one flange section and to further reduce valuable working hours.

The articulated CLOOS robots reach all weld seams on the housing parts which are up to 60 tons in weight, via the gantry with its longitudinal, height and transverse moving gear. The mechanically stable robots are designed in a revolving joint structure and have 6 movement axes. In this process, they reach all of the welding positions on large volume components. Dynamic servo drives enable a high load-bearing capacity of 15 kg and the precise compact gears ensure a high repetition of below 0.1 mm. The robot control controls 6 robot axes plus 3 axes of the gantry.

The robot welding plant is fitted with a torch changing system in order to automatically vary between flame cutting, single wire and narrow gap welding technology. The device is monitored and controlled from a control stand. For example, signals run from six cameras which transfer the Photos from the welding areas. The PC technology for the control software Carola EDI and the RoboPlan Offline programming is housed in this protected area. Once the plant is set up, the work procedures run completely automatically.

Pulsed arc power sources type GLC 603 Quinto supply the high welding currents of 320 A. They have sufficient reserve capacities for future Siemens requirements with a maximum current of up to 600A. Their extremely fast control and micro processor control for programming the characteristic curves are the basis for optimally setting to the material and welding seams. The operator has a large LCD display with all information in plain text. The practical hand wheel ensures a simple and fast way of entering the parameter records, of which up to 20,000 can be stored. The quality once programmed can thus be reproduced at any time.

## Narrow gap welding – in record time

“Narrow gap welding is suitable for machining components with over 35 mm sheet thickness“, states CLOOS branch manager Volker Hedergott based on first-hand knowledge. As the person in charge on site, he has jointly produced the innovative production concept with experts in the CLOOS parent plant in record time. “Hardly a year had passed since the granting of the order, delivery and commissioning of the new plant”. Around 1 million Euros has been invested by Siemens in the new robot plant and the necessary construction steps in the production hall. “However, based on the savings potential this will pay off in the near future”, Uwe Krabetz is convinced.

Contact:
Carl Cloos Schweisstechnik GmbH
Industriestrasse
D – 35708 Haiger
Tel. 0 27 73 / 85 –0
Fax 0 27 73 / 85 – 275
Email: info@cloos.de
www.cloos.de

Photo 1: The CLOOS gantry is over 30 m long extending over four work areas with two robots. The housing parts up to 5000 mm x 6000 mm weigh up to 60 tons (Photos: CLOOS/Dieter Holler)

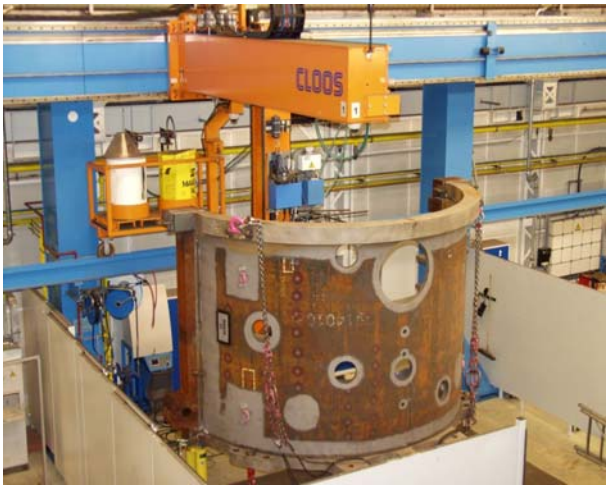


Photo 1a: Part view of a production station: robot based welding on voluminous housing part of a gas turbine.

Photo 2: The robot immerses the narrow gap blade in the gap between the housing shell and manhole connecting piece. Siemens saves 80% weld deposit and working time compared with the conventional V weld.

Photo 3: CLOOS-welding robot with newly developed 300 mm long narrow gap blade.

Photo 4: The blade immerses up to 300 mm in the narrow gap. The welding wire oscillates perfectly over the seam via the mechanism.

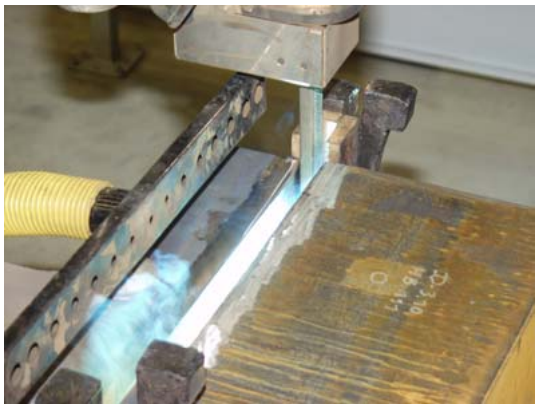

Photo 5a + 5b: When narrow gap welding the conventional V weld (left) with an opening angle of up to 60° is replaced by the narrow gap groove (right) with only 1° opening angle. This saves up to 80% weld deposit (Illustration: CLOOS).

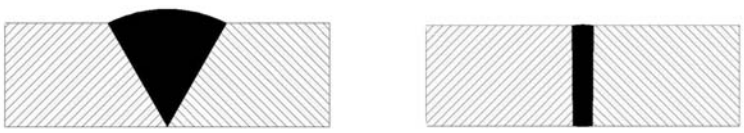

Photo 6: Cross-section of a narrow gap weld, as cleanly and uniformly produced by Siemens on the CLOOS plant in weave bead technology.

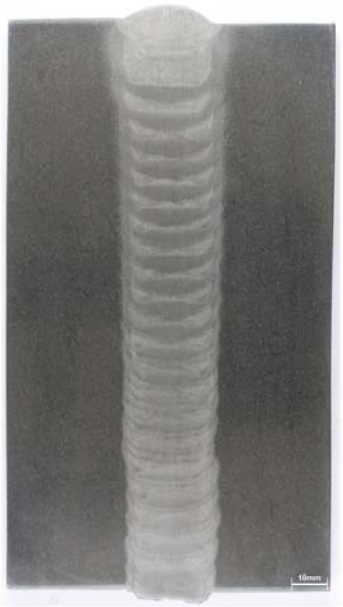

Photo 7: The thick semi rings in the turbine housing are welded by the CLOOS robot using the MAG single wire process. Based on the 9 axes, the torch reaches all welding positions.

Photo 8: Both robots are monitored during the single wire and narrow gap welding by a monitor in the Siemens control stand.

Photo 9: Siemens group leader of housing production Uwe Krabetz (right) and CLOOS branch manager Volker Hedergott are proud of the advances made in technology. The 80% saving in material and time based on the new narrow gap welding procedure can be seen for itself.

Photo 10: View of a completely finished gas turbine for power station construction.

((regarding the author))

*An article by Grad. Eng. Walter Lutz, freelance specialised journalist at werdwelt.info in D - Haiger.

((Info relating to the gas turbine))

# At full power within minutes

Siemens is currently building gas turbines for power stations with a capacity of 113 up to 375 MW. They weigh 200 to 400 tons and can be up to 13 m long and 5 m in height.

Compared to coal and nuclear power stations, these turbines have the advantage of a higher degree of efficiency and good controllability. This type of power station can be working at full power in only 15 minutes. First of all, the generator drives the turbine main shaft as a motor. In this process, the multi stage compressor produces a certain air pressure with its many high precision blades. The gas ignites, the turbine runs up to maximum speed by itself and drives the generator.

In the gas and steam process, hot waste gases above 600° are used in order to produce steam via a heat exchanger which is also used in a secondary (downstream) steam turbine for generating power. The very high degree of efficiency of the gas turbine is increased from almost 40% to a total of 60%.