LEADING WELDING TECHNOLOGIES AND EQUIPMENTS FOR WIND TOWERS PRODUCTION

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Abstract :

The assembling of wind towers are made by using tubular shaped segments which are fabricated by by welding to each other of individual cans. The cans are produced by both internal and external longitudinal welding. During the formation of wind towers, aligning, tacking, and welding are successively performed. Nevertheless, there are areas as well where welding is needed like manholes, flanges and other subcompononents.

In order to achieve here reproducible higyh quality welded joints, a precise and reliable welding automatisation is needed. The involved automation sysems during the foemation of the wind towers mainly three kind of automation components are needed:

Process tools and equipments (welding heads, power sources)

Carrying equipments (Column and Booms, Beam carriages, Tractors , Manhole equipments)

Handling equipments (Roller beds, Fit-up beds, Head and Tail stocks)

Focusing to the welding tasks to performed Submerged Arc Welding (SAW) is the best and most convenient welding procedure for welding of thick material steel plates which are used for the cans of the wind towers. Starting from the single wire welding heads there are many process variants with increasing deposition rate such as twin wire, tandem, tandem twin, multi wire including narrow gap heads to save on the welding technology and still to be more effectiv.

1. INTRODUCTION

The current global demand for wind energy is at an all time high with even greater demand forecast for the future (*fig.1.)*. The greatest demands for wind turbines come from North America, Europe and Asia (China), followed by a lesser demand from South America, Russia and the Middle East.

Considering the current and expected future demands for renewable wind energy, and taking into account the relatively simple base structure and principle of an industrial wind turbine, it might be expected that many companies would be making good profits producing wind towers. However, looking more carefully at the details of wind tower production, it is clear that this is a complex environment where rigorous demands on quality and strength need to be carefully balanced against tough productivity levels in order to reach even modest revenue margins.

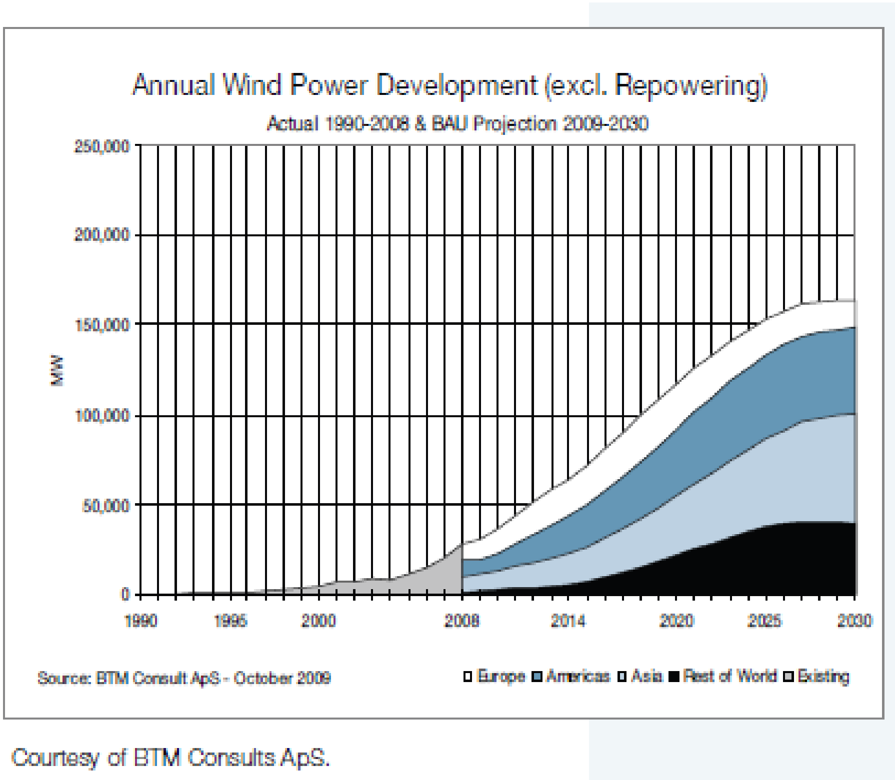


***Fig.1.** Annual Wind Power Development .*

2. CHALLENGES IN THE PRODUCTION

To fully understand the production challenges, we must first look at wind tower construction. A wind turbine consists of three main sections: the foundation at ground level; the nacelle with generator and blades; and the tower which has to guide all forces to the ground and sustain the weight at the top. A modern on-shore wind tower varies between 90 and 140 metres in height and is, in most cases, lightly conical. Most towers are of steel construction with a typical diameter of 4.5 metres and weight of 250 tons. Plate thickness varies from 16 mm to 60 mm throughout the tower wall. For off-shore towers, the wall thickness can reach 100 mm or even 140 mm in a monopile foundation. As on-shore wind towers are transported by road to the erection site, the infrastructure sets the limitations for the design. Thus, towers are made in segments of between 27-30 metres that are screwed together on-site to create the entire tower. The segments are made from a number of circular cans usually 3 to 3.5 metres long, a segment thus made from 8-10 cans. The cans in turn are rolled steel plates that again are subject to infrastructure and transport limitations.

When assembling the cans into the wind tower segments a few variants exist: the growing line principle, where one can at a time is added to the growing segment; the added line principle where cans are added two-by-two, then four-by-four and, finally, eight-by-eight; and also a mixed layout. There are also variants when flanges are added to the cans or segment (pre-assembly or to the finished can-segment-shape). The choice of variant is more dependent on shop floor limitations and other preferences, and are not subject to any universal logic.

It is evident that welding and cutting are the major elements in wind tower segment production in terms of time and value-added processes. The costs for welding and cutting account for only a small part of the tower cost (1-2%) but, at the same time, take up most of the production time. When striving to improve productivity in wind tower production, welding and cutting are good areas on which to focus.

3. WELDING

The welding involved in wind tower production is dependent on the society rules that set the toughness levels. Based on these, bead shape, tensile strength, etc, can be determined. With demands set, the welding joint geometry and welding process can be considered – in the majority of cases submerged arc welding (SAW) is the preferred choice. SAW offers the highest rate of deposited weld metal compared with other suitable welding methods.With the process and joint types identified, the details of the joint geometry can be settled. To achieve high productivity, welding of joints should be in as short a time as possible. Actual welding time can be adjusted by varying two factors – the deposition rate and the total joint volume.

Submerged arc welding variants for all applications.

Submerged Arc Welding (SAW) is the ideal welding process for the welding of thick materials such as the steel plates in wind tower production. There are a number of process variants with increasing deposition rates for which ESAB has developed welding heads, including narrow gap heads to save on weld volume. The main difference between these variants is the number of wires used and how these wires are powered. Each process variant requires an individual arrangement of welding equipment (*fig.2.)*.

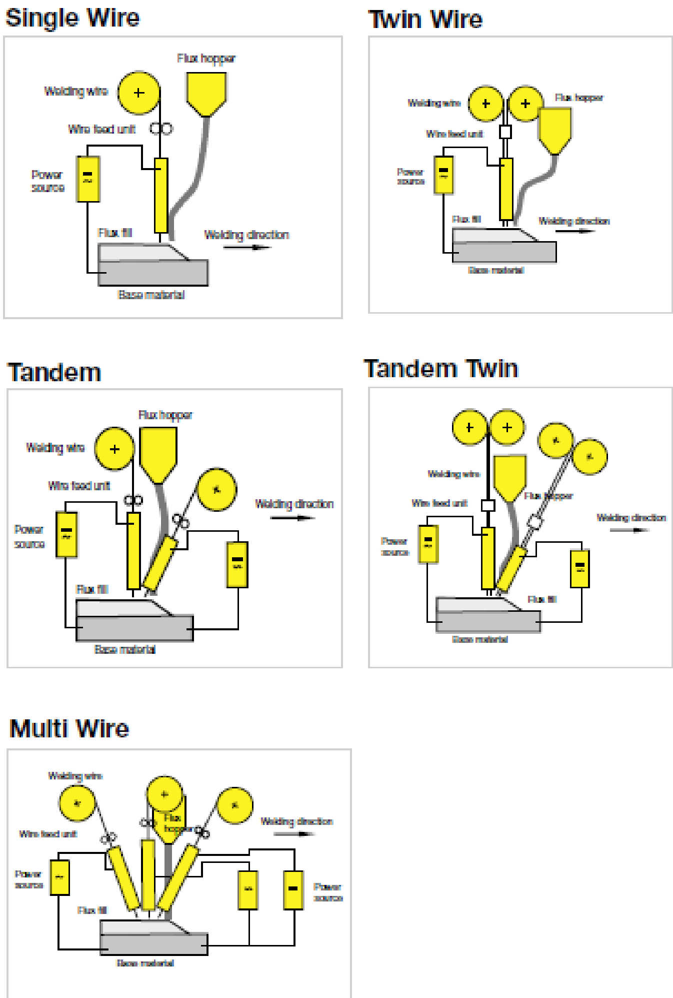
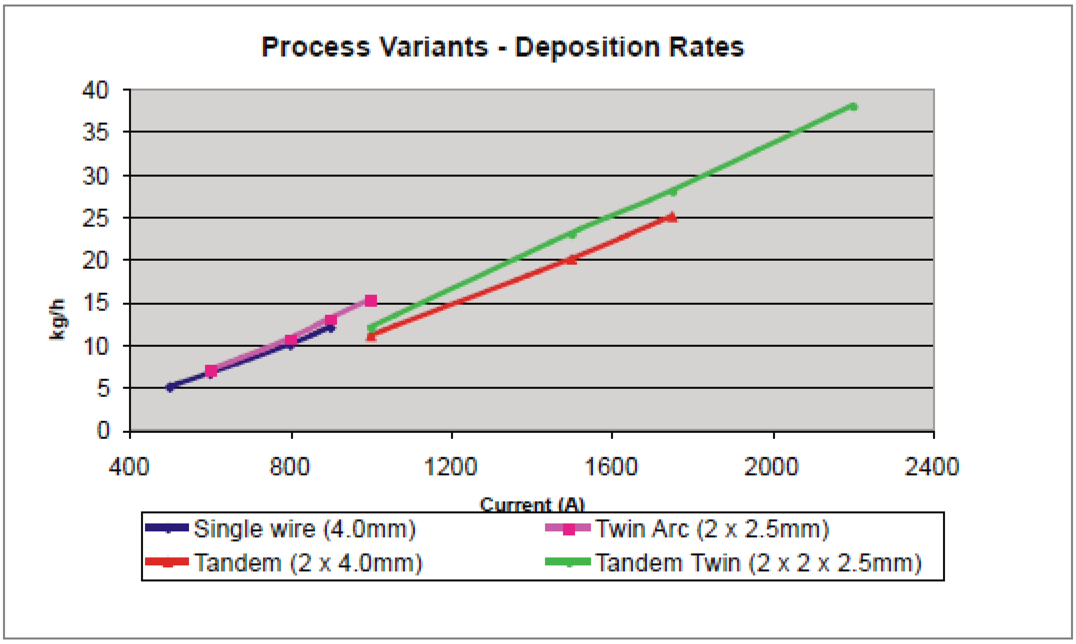


Fig 2. *SAW variants .*

Deposition rate – welding speed

Focusing in the deposition rate although the smallest possible joint volume and joint opening angle might appear the most appealing, the choice of SAW variant must be taken into account (*fig.3.)*. By choosing a variant with higher deposition rate, overall welding time can be lowered, even when the welding process demands a slightly larger joint opening than a lower deposition rate alternative. By increasing the number of welding wires and optimising wire diameters, deposition rate can be dramatically changed.



Comparison table of SAW variants [8

SAW Variant	Single Wire	Twin Wire	Tandem	Tandem Twin	Multi Wire
Number of Wires	1	2	2	4	3 – 6
Max. total deposition rate solid wire (kg/h)	up to 12	up to 15	up to 25	up to 38	up to 90

Fig 3. *SAW deposition rates .*

Submerged arc welding being one of the most productive welding process, however, productivity during sub arc welding should be hold from technological point of view at a certain level by the need to limit heat input. The new innovation and design within the SAW technology of ESAB Welding & Cutting Products reduces the heat input to increase the productivity. ESAB introduces ICE^{TM} technology. ICE^{TM} is a revolutionary submerged arc welding technology that enhances productivity by using an Integrated Cold Electrode.

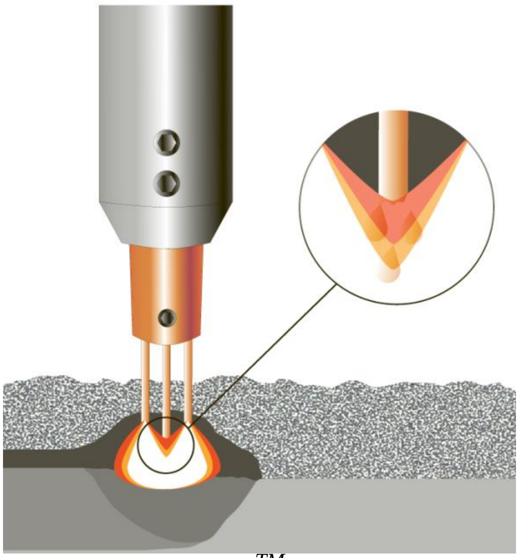


Fig 4. *ICE^{TM} welding head .*

4. WHY ICE^{TM} WORKS?

ICE^{TM} instead of adding more energy uses the excess heat already available to melt an additional, non-powered welding electrode. ESAB's patented 3 wire welding process drastically increase productivity and speed of welding with the SAW process (*fig.4.)*. The following major benefits can be achieved by this new world first process:

Up to 50% higher deposition rate

Submerged arc welding is already the most productive welding process. But as with any other welding process, the need to limit heat input inhibits productivity. Instead of adding more energy, ICE™ utilizes the excess heat available to melt more wire. This boosts productivity by up to 50%, depending on the application.

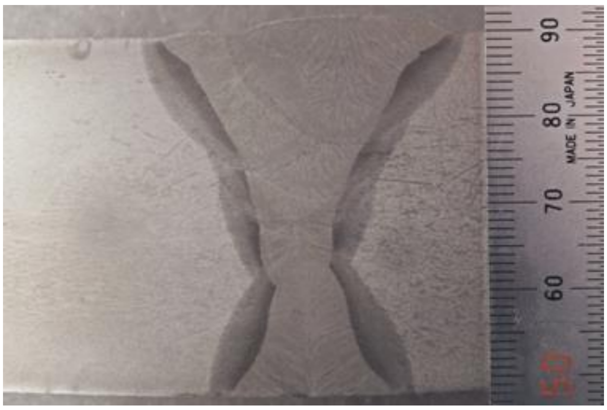


Fig.5. *40mm asymmetrical x-joint 355NL. Six runs to complete the weld.*

High Deposition Root ™

ICE™ technology enables the use of tandem welding in root passes, for improved penetration and high productivity and eliminating the need for back gouging. High Deposition Root can increase productivity up to 100% in root welding, depending on the application.

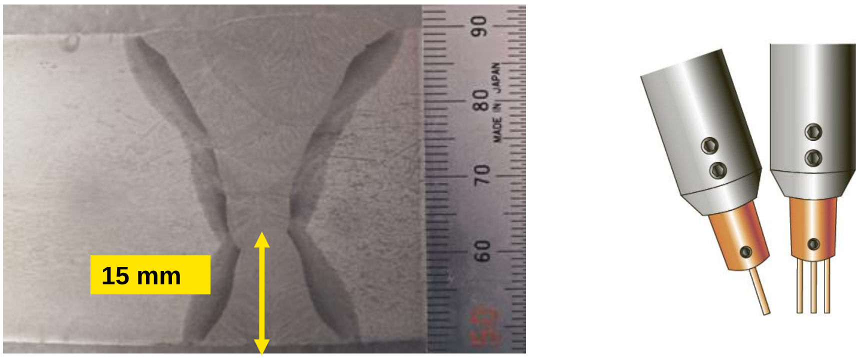


Fig.6. *40mm asymmetrical x-joint 355NL. Root side operation time reduced significantly*

ICE™ afford the possibility for new joint configurations towards smaller joint volume reducing consumables consumption:

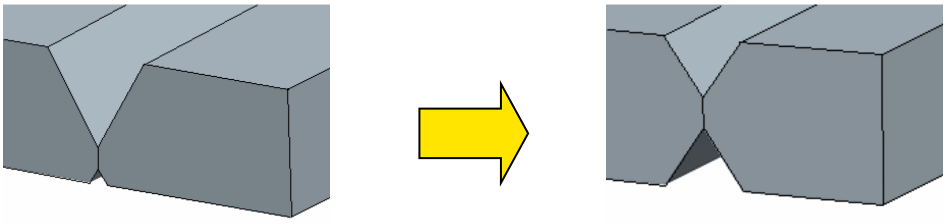


Fig.7. *Smaller joint volumes as a positive consequence of using ICE™*

Higher welding speed

The increased deposition rate can also be utilized to increase welding speed. This can significantly improve productivity in applications where welding speed is the key to maximising productivity. Up to 35% increase in welding speed can be achieved when only one run is needed.

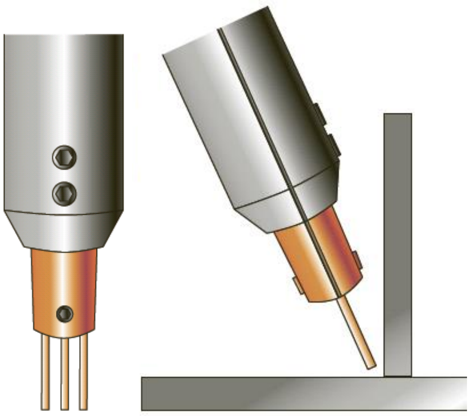


Fig.8. *Higher welding speed when fillet welding performed*

Innovative Flat Cap Control™

Adjusting the ratio of "cold wire" used for cap runs makes it possible to produce a flatter cap to the weld. This increases fatigue resistance and reduces the need for post weld treatment. Just one more boost to your productivity.

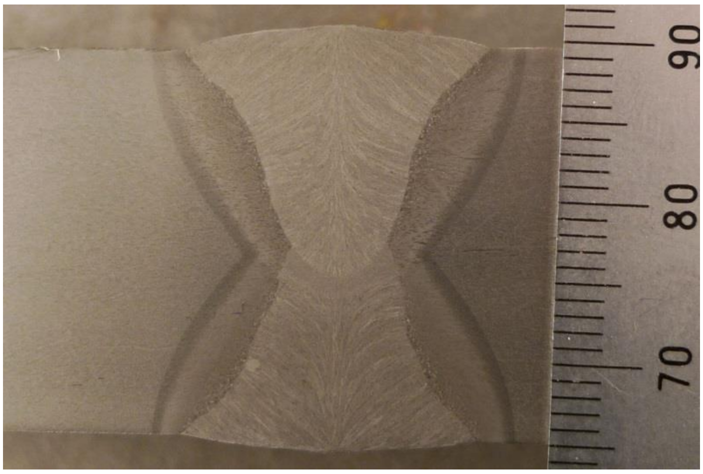


Fig.9. *25mm symmetrical x-joint 355NL*

Reduced flux consumption

The significant productivity improvement provided by ICE™ enables many applications to be completed with fewer runs. In this way, flux consumption can be reduced by up to 20% when welding with a 50% higher deposition rate.

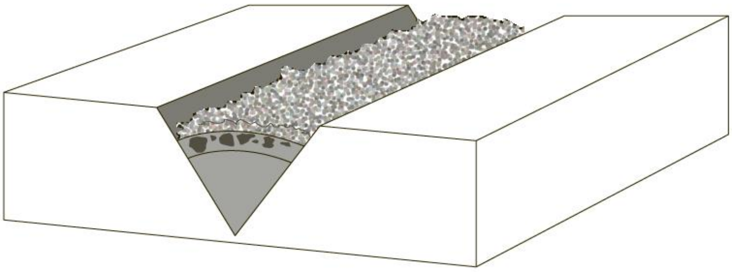


Fig.10. *25mm symmetrical x-joint 355NL*

Reduced energy consumption

Welding is an energy intensive manufacturing operation. The ICE™ process enables an increase in deposition rate by up to 50%, without adding more energy. This combines environ-mental benefits with significantly reduced energy consumption. It can be concluded that by using ICETM technology leads to significant productivity benefits. Very important that this can be achieved without the investment in new welding systems or in highly skilled welding personnel. Just an accordingly designed welding head must be used.

Fig.11. *ICE™ patented welding head*

The technology can be successfully applied in several industrial markets where high-volume welding like: onshore, offshore, wind towers, pipe welding, general heavy fabrication, shipbuilding. Higher productivity and lower energy consumption will definitely improve profitability.

5. CONCLUSION

ESAB is committed to providing cost effective solutions for its customers. The wide range of welding consumables, patnered with ICE™ technology delivers the most productive SAW solution for customers application.

Looking at the market potential for wind towers there are plenty of opportunities for fabricators to make good profits, now and in the future. Considering the production steps involved - cutting, rolling, welding and painting the tower segments – it is clear that cutting and welding are the most important areas. By optimising weld geometry and joint volume, matched with a high deposition submerged arc welding process,

productivity can be increased dramatically.

6. REFERENCES

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