

Electron Beam Welding without a vacuum chamber



ebflow

Facilitating very high joint completion rates in thick section steels

20 to 30 times faster than traditional methods

200mm per minute in 150mm thick steel have been achieved

Using a system of sliding seals and precision handling enables fast longitudinal and circumferential welds on large work pieces

A coarse vacuum is established and maintained only where it is needed

Pre-heating is not necessary and consumables are not required during the weld

Minimal distortion, on average only 10% of the weld thickness

Quality and reliability are improved with immediate post weld inspection possible

Achieving the fastest thick section welding rates ever

Applications

1. Tubulars for Wind Farms and Oil and Gas exploration, production and FPSO/FLNG anchors.

Technological innovation in this sector is being driven by the desire to reduce the costs and increase the manufacturing rate of large tubular structures used in tower foundations, anchors and offshore operations of all types.

These structures necessitate the fabrication of tubulars typically 90m long, 9m in diameter with 100mm wall thickness, weighing 1,200 tonnes.

The Ebflow process is particularly suitable for wall thickness's above 40mm and has been proven to be reliable at thickness's up to 200mm.

In comparison to SAW technology, Ebflow tubulars are better quality, quicker to make and much cheaper.



3m long 65mm thick welded in 11 minutes



2. Tower flanges

Many towers, for example for wind energy generation, are made from tubulars joined end on end.

Flanges added to the ends of the tubulars are used to join them together.

Ebflow technology is being deployed to manufacture these flanges from flat sections rather than forging the whole flange in one piece.

Production is quicker, cheaper and less reliant on a small number of manufacturers so easing a production bottleneck.



3. Pressure vessels

The use of large pressure vessels is common in many industries including chemical, LPG and nuclear generation and waste containment.

Ebflow technology is being used to fabricate these structures at a fraction of the cost and time of traditional forged processes.

The high integrity homogeneous welds and near parent metal strength of the Ebflow process make it a particularly suitable technology in these demanding industries where there is a bottleneck in the production of single piece forgings.



Ebflow – Local Vacuum Electron Beam Welding

Benefits

The Ebflow process has many advantages over the technologies currently used (SAW and similar).

1. Time Frame

The local vacuum nature of Ebflow is particularly suitable for large tubulars in thick section material. Welds can be made in a fraction of the time - over 20 times quicker is not unusual.

S355 Grade Steel		Ebflow	SAW	FCAW	"Stick"
Linear Seam	1.3m x 60mm WT	6.0 mins	8.3hrs	31hrs	41hrs
Circ Seam	711mm Ø x 40mm WT	3.5 mins	5.0hrs	47hrs	63hrs

This reduction in cycle time and the elimination of testing "lags" mean factory throughput can be dramatically increased.

2. Quality

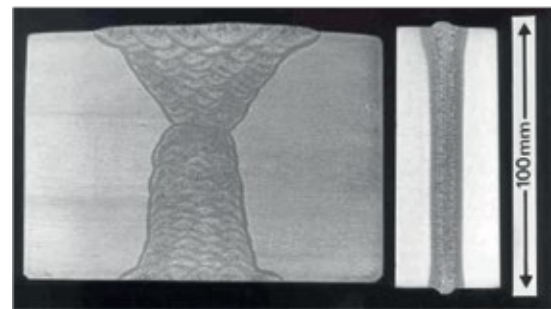
The Ebflow process fuses parent metal together without the need for fillers or flux. The resultant joint is of a higher integrity and less prone to defects caused by inclusion of flux particles in the weld or hydrogen cracking.

The Ebflow process has a lower heat input resulting in a smaller heat-affected zone.

Ebflow is single pass, the weld "cap" requiring minimal finishing operations whereas multi-pass welds are required to be ground flush to improve fatigue strength (or appearance).

Ebflow produces better quality welds in thick metals with considerably less failures that require expensive and time consuming reworking.

The process features simpler surface preparation pre-weld, minimal distortion during the weld and controllable, reproducible quality post weld.



Submerged Arc Welding
90 passes at 500mm/min
= 6mm/min

LVEBW Welding
single pass at 100mm/min
= 18 times faster

3. Cost

In addition to cost savings gained from faster throughput, Ebflow uses no consumable goods, (filler wire, flux powder, shielding gas etc.). These account for a significant proportion of the cost of a traditionally welded joint.

Ebflow plants also use less skilled labour and require less stock to be held.

4. Testing

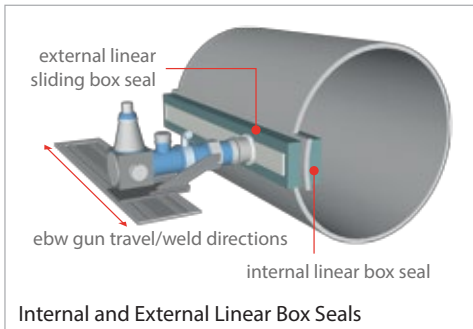
Non-destructive testing can be conducted immediately on completion of the weld (due to the low heat input generated by the Ebflow process and the absence of pre-heat) whereas with SAW produced Joints a statutory delay period of 48 hours must be elapsed before NDT can commence (to allow for cooling of the joint and diffusion of any hydrogen content).

5. Retro-Fitting

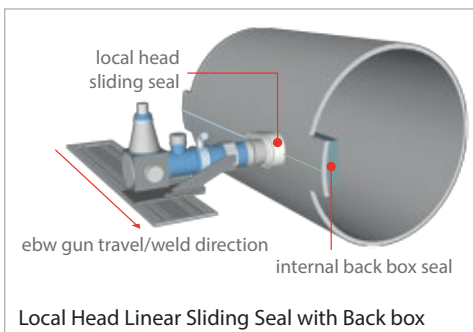
Ebflow machinery can easily be installed in existing arc welding plants, taking up less space and requiring less stock of fabrications and consumables.

Technology Development : Linear Local Vacuum Methods

Ebflow local vacuum technology has been developed to suit specific applications and processes . Utilising sliding box seals or a sliding local head operating along or around the work piece which can remain static or rotate under the beam.



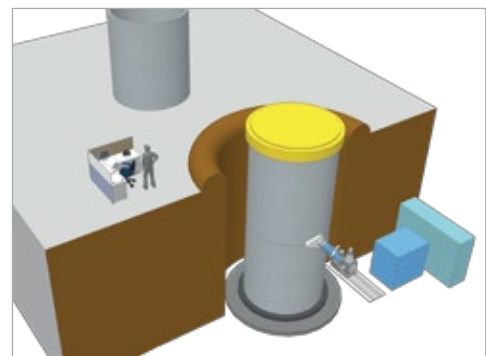
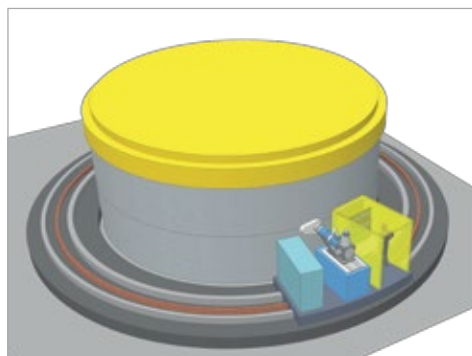
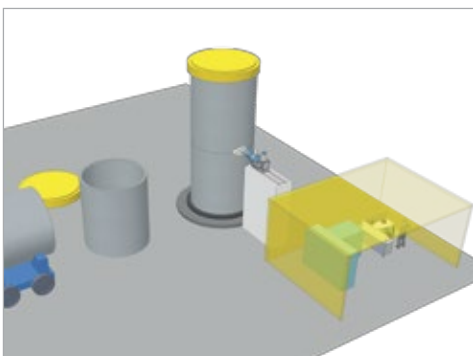
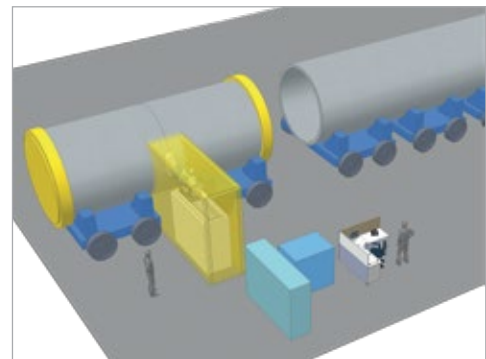
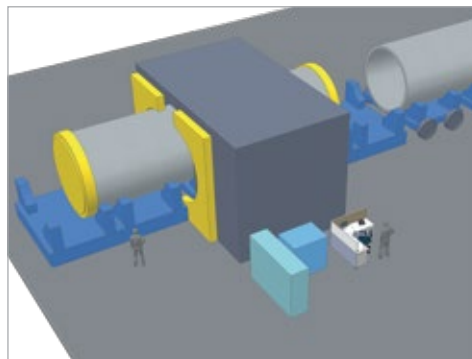
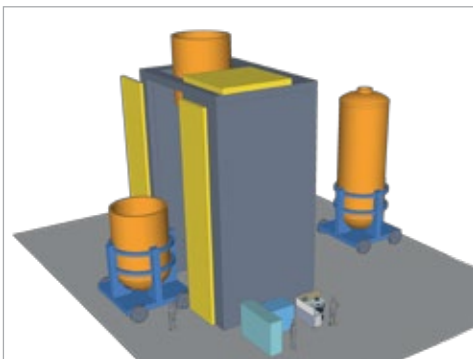
Developed to linearly weld rolled tubular pieces. Linear box seals are deployed internally and externally. The specially designed gun operates in a coarse vacuum created within the box seals. An arrangement of sliding plates maintains the vacuum as the gun station travels along the main axis of the work piece.



In this method the external box seal is replaced with a local head. A coarse vacuum is created between the head and the work piece and is maintained as the gun station travels along the main axis of the work piece.

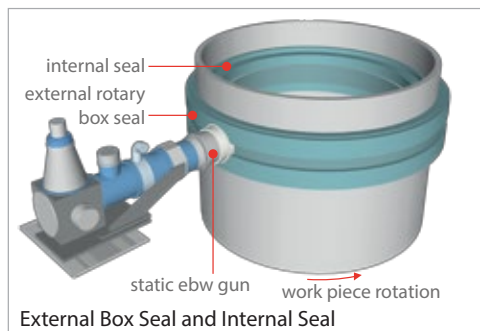
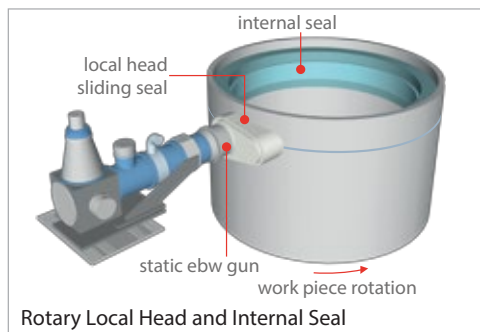
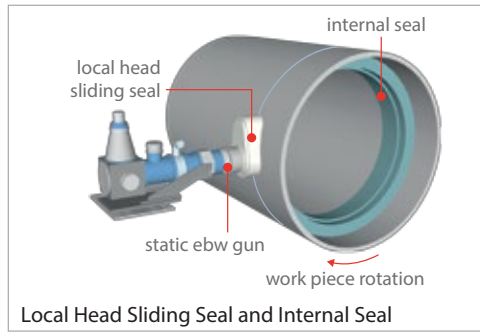
Technology Development : Lead Shielding

Various methods of shielding the welding process with lead containers have been designed. In principle the lead shielding is designed to suit the particular application and process whilst being as efficient as possible. The thickness of steel being welded traps the x-ray emissions enabling full protection with 'local' solutions rather than very large chambers.



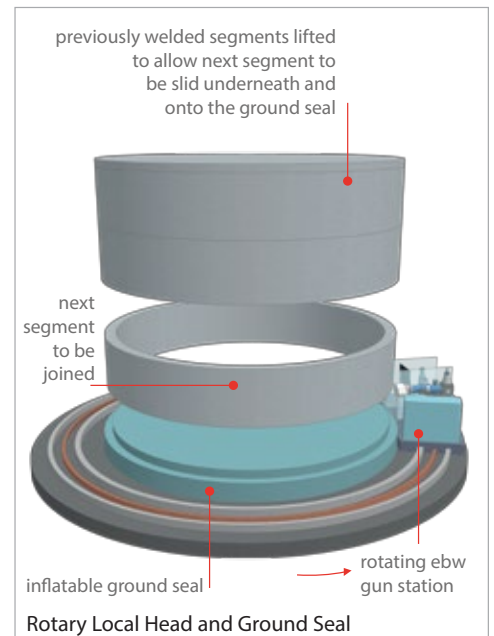
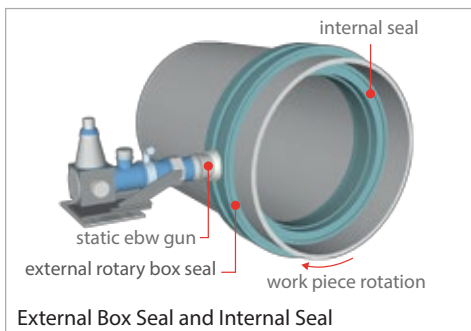
Technology Development : Circumferential Local Vacuum Methods

Internal sealing to maintain the required coarse vacuum can be achieved through a variety of means – flexible and mobile inflatable seals, simple TIG welding or box seals.



Operating on the same principles, the arrangement of sliding seals or local head can be deployed to weld the same large structures circumferentially.

Work pieces are rotated under the gun in either the horizontal or vertical plane. For very large tubulars the gun station with local head rotates around the static work piece.



Technology Approval : Qualifications

To date the Ebflow process has achieved a number of code approvals and certifications.



Ebflow – Local Vacuum Electron Beam Welding

A Breakthrough Innovation

CVE have commercially available production systems designed to carry out linear and circumferential welds in thick steel up to 50m long in a single pass.

This achievement comes following 10 years of research and development with TWI and other global development partners and five years research on a large scale test facility in the UK.

It is the most advanced, high speed and cost effective welding system built for thick section steel large work pieces. Ebflow has achieved a weld rate of 200mm per minute in 150mm thick steel – the fastest thick section joint completion rate outside of a full vacuum chamber – ever.

Weld development

CVE together with TWI can optimise weld procedure development and qualification to customers particular requirements.

Technology demonstrations to interested parties of the flexible and adaptable Ebflow technology can be arranged at their head quarters in Cambridge.



60m monopiles from 100mm plate



Enabling Technology

Ebflow is an enabling technology that, by virtue of its cost and time saving performance over existing methods, will make investment in many energy generation developments more attractive. It has the potential to be revolutionary in the fabrication of large structures across many industries.

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