Extending equipment life at alumina refinery

Weld overlay cladding and fabrication company Arc Energy Resources has recently completed a complex on-site repair to a set of expansion bellows for an alumina refinery. This article reviews the problems encountered and explores solutions provided.

By Alan Robinson*

Typically alumina plants refine bauxite to produce the aluminium oxide used in the production of aluminium metal.

In the first stage of the process bauxite slurry is pumped into a large pressure vessel called a Digester, where it is mixed with a hot solution of caustic soda and steam, and reacted at temperatures in excess of 250oC.

Due to the corrosive nature of the hot caustic soda, UK group Arc Energy Resources provides services to protect critical items of equipment such as steel pipes and valves, by applying a weld overlay coating of nickel to protect the steel from corrosion.

The electro-plating often used to protect the equipment has a limited life and also suffers from pitting, which is both difficult to detect and manage, and can cause localised breakdowns and leaks. The company's weld overlay cladding provides greater thickness and a more robust nickel coating. As well as corrosion, plants also have areas that suffer erosion, and Arc Energy is often called upon to carry out repair work using Hastelloy 'C'. The company employs many experienced people including managing director Alan Robinson who is a UK registered European Welding Engineer. Its teams of welders are qualified to a wide range of procedures, and undertake specialised on-site repair work when required.

Most of the equipment in alumina plants is traditionally manufactured in carbon steel but more exotic nickel-based alloys are needed in harsher environments such as the digestion area and the evaporation area, where heating and evaporation is used to concentrate the liquor and crystallise impurities.

Recent work

Arc's most recent example of on-site repair work - a heat exchanger expansion bellows - is fitted to an eight-foot diameter heater, one of two live steam heaters in a run of seven mounted horizontally on an elevated process area one storey up. The location meant that all equipment and materials had to be lifted into position. The work area also needed to be scaffolded and clad with plastic sheeting to protect the welders from the elements for the duration of the repair.

The outer shell of the heat exchangers expand and contract due to the high operating temperatures, so bellows are fitted to compensate for the movement and protect the internal tubes from distortion. One of the two sets of bellows, which have been operating for around 30 years, was suffering from pin-hole leaks caused by cracking at the point where the stainless steel bellows is welded to the carbon steel vessel.

As steam was escaping, the heat exchanger was shut and the standby unit brought into service. At the time, there was a three week window of opportunity to repair the bellows, and as the customer's own welders were not qualified to undertake the repair nor were there suitable qualified welding procedures, Arc was contacted. A two-man team was despatched – both highly skilled welders and one acting as site supervisor – equipped with all the necessary equipment and materials.

The bellows were encased in sixteen 25mm thick carbon steel retaining straps that were installed when the heat exchangers were built, to prevent the bellows from flexing during transport. To gain access to the vessel these had to be cut and removed together with some of the side plates of the supporting structure. This left little space underneath the vessel to excavate the old weld and reinstate it with new.

The new weld was created using a two-pass procedure with 309L alloy designed to weld stainless steel base metal to carbon steel, and ensure a leak-free joint.

On completion, the bellows were hydro tested to a pressure of 13 bar and the welds passed first time. The job was completed half a day earlier than the one week expected. The heat exchanger is now operational again. Arc Energy has made items such as an injection heater and tee-piece and, after the customer had experienced such poor performance from replacement electroplated spools, Arc Energy worked with them to make the weld overlay spools more affordable.

Since then the customer has purchased only Arc Energy spools, including replacing a complete line of electroplated spools with weld overlay spools.

Arc's welders undertake specialised on-site repair work

Other projects

For other projects Arc's welders have refurbished heavy-duty 24" cast steel valves, cladding them with a protective nickel coating; and converted plain steel valves into nickel clad valves, which has proved to be very cost-effective compared to buying new nickel clad valves. Another contract has involved the manufacture of an injection heater that would normally have been electro-plated but, as it was destined for a particularly arduous duty, weld overlay cladding was applied instead.

Alan Robinson continues: "Comparing the service life of electro-plating and weld overlay cladding is difficult. Some electro-plated spools have failed after 12 years but more recently spools have been failing on average after six just years. The main problem with electro-plating lies in the defects in the plating, which allow liquids through the surface to attack the steel underneath. Electro-plating applies a 0.8mm coating where our weld overlay cladding applies at least 4mm."

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