Columbus Stainless

Columbus Stainless in South Africa, part of the Acerinox Group, refines steel using steam to reduce argon consumption.

By Carl Johan Rick, Manager Process Engineering at Utan Hagfors Teknologi AB.

The steel plant was originally designed for a combined blown CLU process in the refining unit. However, this unit was decommissioned in 2002, after which the converters were operated as traditional AOD converters. Figure 1 shows the twin converter configuration.

In 2007, the decision was made to reintroduce the CLU process. The AOD process had proven to consume excessive amounts of argon for the product programme in relation to the availability of crude argon in South Africa.

Steel Plant Manager, Theuns Coetzee, explains why this investment decision was made, "Steam decreases the consumption of crude argon, and since 2007, the plant has been forced to schedule our production according to crude argon availability in South Africa. The boiler will reduce our crude argon requirements and allow us to schedule our programme according to orders and to allow additional orders in ferritics. I am optimistic that the maintenance problems experienced with our old boiler have been rectified with this new design and the availability should be very high."

Után Hagfors Teknologi AB (UHT), which owns all rights and patents to the CLU process, received an order to manage the installation of the alternative CLU process and steam generation in January 2008, and in early August, the first heat using steam was processed. The start-up proceeded smoothly and the initial production results have been highly encouraging.

Stainless steel refining includes a number of basic features, such as carbon removal, deoxidation and desulphurisation. These operations are generally combined with some alloying with solid material, as well as nitrogen control by means of gas introduction. From an operational point of view, stainless steel refining is a matter of controlling the generated energy in the converter.

Submerged inert gas

Today, most of the world’s stainless steel is produced in converters that are able to add large amounts of inert gases under the steel surface, along with submerged or top-blown oxygen. The introduction of submerged inert gas lowers the partial pressure of carbon monoxide and the inert gas enables decarburisation of stainless steel at low carbon activities without applying a vacuum.

Gas blowing leads to a rapid energy turnover that changes the steel’s heat content dramatically.

When a situation involving an energy deficit arises in the converter, it is normally handled by utilising surplus oxygen during decarburisation. Although this result in excessive chromium-oxidation, the chrome is later recovered using silicon or aluminium. Energy

![Simple business model to determine when steam blowing is beneficial.](image)
Returns to CLU

Uván Hagfors Teknologi

UHT AB is privately owned and was formed in 2007 from the engineering department of Uddeholms Teknologi AB. UHT AB provides engineering, processes, systems and machines to the iron and steel industries and their raw-material suppliers.

UHT AB mainly focuses on granulation in the Granshot process and refining using AOD and CLU processes, an area in which the UTCAS level 2 process control system is a key product.

Deficits are avoided whenever possible by melting as much as possible in the electric arc furnace, where the energy is cheaper.

Situations involving energy surpluses are more challenging to handle. Energy surpluses usually occur during periods when heat is processed in large converters. There are essentially two practical strategies for dealing with energy surpluses:

1. To absorb the surplus by melting solid materials.
2. To neutralize the surplus through energy-consuming reactions.

The use of superheated steam in the converter is an example of the second strategy. Steam is decomposed into hydrogen and oxygen in an endothermic reaction. Hydrogen is utilised as a diluent gas and favours decarburisation. The oxygen adds to the injected oxygen gas. Figure 2 shows a typical blowing pattern where steam is included.

To make low-nitrogen stainless steel, it is often necessary to avoid nitrogen as an inert gas during much of the refining process. However, nitrogen is significantly cheaper and more readily available than argon. When nitrogen cannot be used, steam is an alternative that behaves in a similar manner to argon during decarburisation.

The installation of steam-blowing capacity and the process change from AOD to CLU was accomplished without production disturbances. The entire steam-boiler generation system was commissioned in full before it was connected to the process and process control system. Process models where thoroughly tested before the commissioning of the new process. Figure 3 shows the configuration of the plug-in steam blowing capacity. What is interesting is that only the AOD gas preheater and the AOD gas and steam T-junction take up space in the area of the converter. Therefore, installation can easily be accommodated in most AOD plants.

Impressive results

Prior to the installation, it was estimated that a 12-hour shutdown would be sufficient to weld in the new gas connection points for the two converters and that this would be the total duration of the production disturbance. In fact, the actual shutdown time was even shorter, and the new process produced steel of similar quality, but at a lower cost, from the time production commenced.

The project was executed in close cooperation between UHT and Columbus, with UHT concentrating on the process design and equipment to generate and distribute steam while Columbus worked on local adaptations of buildings and infrastructure. The process change has now been fully functioning for six months and the results have been highly impressive.

The change from one process to the other may seem complicated, but is easily overcome by the level 2 process control system – UTCAS – which was previously provided by UHT.

Johan Roet, Production Superintendent of the refining operations, explains, “The operators do not need to know the details about the process when they have UTCAS to support them. They really only have to ensure that the inputs to the process are reliable.”

Michael Engholm, Manager for Process Control System Development at UHT, continues, “We have put every effort into making it easy to alter the process without having to retrain the operators. In fact, Columbus and OutoKumpu Avesta use the same platform to make completely different steel types, with greatly differing processes.”

As mentioned previously, the use of steam in this case was originally caused by an argon shortage. Generally, a heat surplus with a corresponding lack of economic cooling alternatives is the primary driver for using steam as a process gas.

The use of steam as a coolant is mainly justified by the following arguments:

1. Steam is readily available.
2. Steam avoids the processing of scrap before it can be used in the converter.
3. Steam does not require a particularly advanced infrastructure compared with scrap or ferro-alloys and, thus, can be added to an existing operation.

The use of steam as an argon substitute for nitrogen-sensitive production is justified by the following arguments:

1. Steam is cheaper than argon.
2. Argon supply may be limited.
3. Argon storage on site may be limited.

The benefits of combining steam as a substitute for nitrogen and coolants can be determined using a simple business model. Refer to Figure 5.

Per-Ake Lundstrom, CEO of UHT, emphasises the importance of the project for UHT, “This really shows the potential of CLU in terms of enabling the production of stainless steel without having to invest in extra gas separation availability. The cost of steam is only a fraction of the cost of the argon it substitutes. The investment cost for the equipment is also marginal compared with the investment necessary to make argon.”

Columbus Stainless

Acerinox, S.A. owns 76% of Columbus Stainless (Pty) Ltd. The remaining shares are held equally by Samancor Lhick (which is an Anglo American and BHP Billiton PLC joint venture) and the IDC (Industrial Development Corporation of South Africa).

Columbus Stainless was initially commissioned in 1995 as a fully integrated, single-site greenfield operation.

Columbus Stainless is situated in Middelburg in the Mpumalanga Province of South Africa.

A total of 25% of the company’s products are sold in South Africa, while the rest are exported.

CLU and steam

CLU refers to the Creusot-Loire Uddeholms process for stainless steel refining. It was developed in the early 1970s to allow for cheaper refining than the patented AOD process, which relied on expensive argon.

The converter in the Swedish city of Degerfors was operated for 30 years as a CLU before it was decommissioned in 2003.

Steam is generated on demand in a boiler using about 60 kilograms of LPG per tonne.

1,000 kilograms of steam substitute 2,218 kilograms of argon during decarburisation in terms of nitrogen removal capacity.

1,000 kilograms of steam substitute 888 kilograms of oxygen in terms of oxygen supply.

1,000 kilograms of steam substitute eight to ten tonnes of cooling scrap.