ENERGY PRICE

Warm air – window dressing or not?

ABSTRACT

'Preheating supply air which flows into the burning area of a burner saves energy', British researcher found – why not applying this finding on the EAF?

Roland V Müller

eco-e AG, www.eco-eag.com

Warm air – window dressing or not?!

British researchers at the Material Processing Institute (IMMM) have shown that even a small temperature increase in the supply air to a burner of 10°C saves energy (article in the journal 'Material World 12/21' 'UK steel and ceramics sectors join forces to cut CO_2 emissions'). Long before this finding was published, we investigated the preheating of the 'false' furnace air and found that fresh air preheating is quite beneficial. On the one hand, the preheating of the furnace air brings a direct reduction in the energy to be introduced (small temperature difference between the false air and hot air area, higher efficiency of the arc energy and a reduction in the burner output) but also a reduction in nitrogen uptake by a slight increase in the oxygen content in the supplied furnace air. Whether the use of external energy for furnace air preheating is also advantageous would have to be clarified in a special case. In connection with a suitable scrap preheating, in which the surfaces of the preheating containers are cooled by forced air cooling, which allows the energy to be transferred to the furnace air, no additional energy would be necessary. In addition, a heat exchanger that can use the residual heat remaining in the exhaust gas could also be used. The condition is that no subsequent exhaust gas treatment (quench) is required in the process, which is not the case with the existing single-chamber systems. We have calculated that the preheating (increase) of the furnace false air from ambient temperature (30°C) to 350°C represents **a reduction of the energy input of 15kWh/t_{FS}.** If this temperature increase is feasible with simple means, this is certainly a very interesting approach.

Well, an 'open' electric arc furnace sucks in the 'false' furnace air the air required by the arc (about 4000°C), the burners and the plasma zone created around the arc through all possible openings, especially through the slag door and the electrode openings. This results in a strong draft at the slag door and, in the case of hot electrodes, an increased lateral burning.

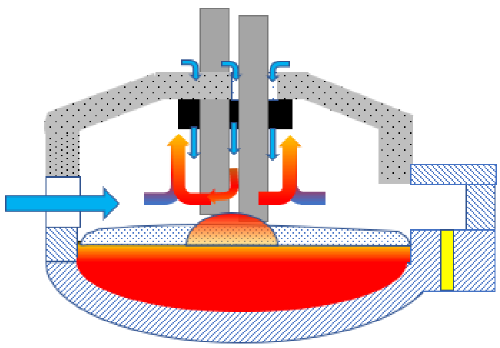

Figure 1 / Air inputs @ traditional EAF

Due to a higher temperature of the furnace supply air, less energy is required to heat the incoming air, the scrap is not constantly cooled around the slag door and the electrodes in the area of the roof heart are not additionally burned. Conclusion: The furnace needs less electrical and chemical energy.

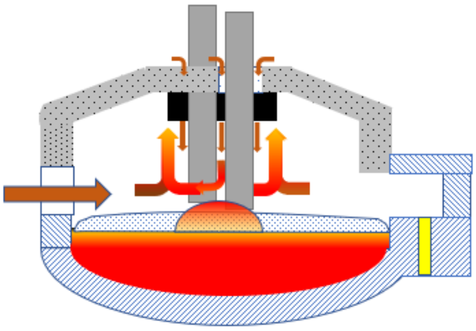

Figure 2 / Preheated air @ traditional EAF

With suitable sealing of the two main inlet areas and the supply of the furnace fresh air at very specific locations, a changed flow of the exhaust gases in the furnace would occur, which supports the thermal balance in the furnace and further saves energy by reducing the thermal load on the wall elements by the downward flowing furnace supply air.

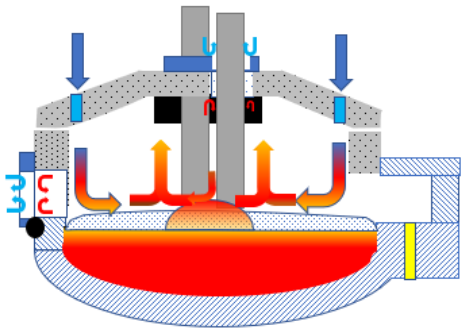

Figure 3 / Modified air draft @ tight EAF

A further step leads to the use of preheated fresh furnace air. As described above, the energetic input into the furnace is further reduced. The cooling effect of the wall elements is still present, albeit less.

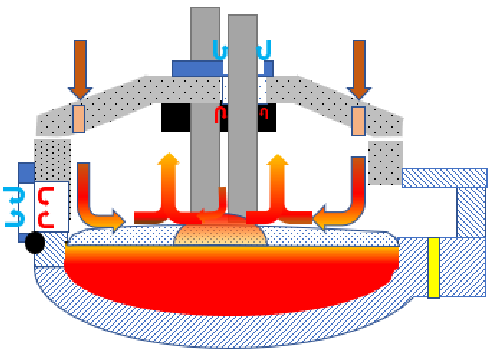

Figure 4 / Optimized air draft @ tight EAF

However, the flow of the off gas in the furnace is not yet optimal, as the exhaust gas is not used sufficiently – too much energy flows away with the off gas and the electrodes are surrounded by hot exhaust gas, which additionally promotes the burning. At the current energy and electrode prices, this is not a desired circumstance.

Mr. Tello Abia, a shrewd metallurgist and experienced steel mill manager and member of the eco-e consulting team, patented and tested a groundbreaking idea a few years ago. Here is the slightly adapted version of his idea.

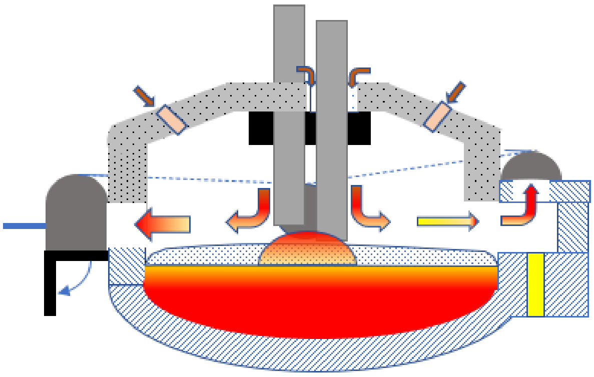

Figure 5 / Optimized off gas draft

The gas flow in the electric arc furnace is now optimal. The cold scrap is flown in from above, the preheated furnace supply air flows down along the electrodes and reaches the plasma zone stored around the arc. This is where the highest temperatures prevail. The hot off gas now flows through the still unmelted scrap, warms it optimally and then flows through three individually controlled openings into the off-gas duct and thus into the scrap preheating. The Taurus, which surrounds the oven on one side, replaces the 4th hole on the furnace roof. The slag door is self-closing. The furnace can be operated with or without scrap preheating. The ECOFEEDER family is ideally suited as a scrap preheating system (see flyer).

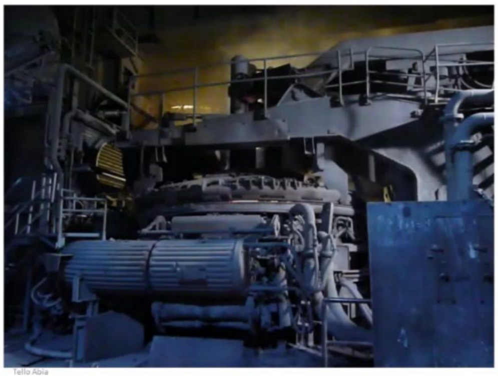

Figure 6 / Realisation of the optimized off gas draft

Energy optimization, off-gas utilization, furnace air preheating and reduction of CO_2 emissions are our specialty. We will be happy to advise you.

eco-e for the environment and the steel mill.

February 2022

Roland V. Müller