Recirculation Furnace for Steel Wire Production

by:

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A newly developed furnace for steel wire plants settles a new benchmark for energy efficient, flexible and stable steel wire production.

What final product ever shall be made of steel wire at the end it always starts with conditioning the material in a suitable manner at the very beginning to finally achieve the desired properties. In all steel conditioning processes a heat treatment of the material is necessary.

The furnaces currently used in steel wire production suffer from high energy consumption and a rather small window of stable production loads. Nowadays, as there is very high attention paid to saving natural resources and reducing the CO_2 emissions, in times, where due to the global economic crisis manufacturers have drastically learned the necessity to be able to change production loads day by day, CPA has developed a furnace which is perfectly suited for the demands of today.

The new CPA furnace (patent pending) offers an energy saving of up to 40% and a stable operation down to 30% of the nominal production load. The following lines are going to reveal some of the specialities that have been implemented for realizing the described performance.

It is common knowledge that the total amount of consumed energy by the furnace in equilibrium state depends on:

Energy to increase the wire temperature
Energy loss through the stack
Energy dissipated over the furnace surface
Efficiency of the heat production itself
Efficiency of heat transfer to the wire

To increase the efficiency of heat production the new furnace is equipped with state of the art, highly efficient recuperator burners. These burners have an integrated heat exchanger for preheating the air instantly in the burner head. Additionally, the fresh air is preheated by leading it through the stack. This eliminates leading the hot flue gases to a central air preheating system; in that way saving the transportation losses completely. Still, in the case of recuperator burners one must handle hot flue gases, but at a comparable lower temperature level. Consequently, the lower temperature level of the flue gases (approx. 500-600°C) results in lower transportation losses on the way to further heat exchanger systems for using the flue gas energy for preheating other process fluids in the steel wire plant.

Another important issue when thinking of increasing furnace efficiency is the heat transfer from the furnace to the product. One portion of furnace energy is transferred to the product by radiation of the furnace walls; another smaller portion is transferred by radiation of the triatomic gases in the flames. Finally, the third portion is transferred to the product by convection from the furnace atmosphere. The corresponding heat transfer rates follow the equations:

$$P_{Radiation} \xrightarrow{proportional} \varepsilon\left(T^{4}_{Wall} - T^{4}_{Wire}\right)$$

$$P_{Convection} \xrightarrow{proportional} \alpha\left(T_{Atmosphere} - T_{Wire}\right)$$

The coefficient of emission ε can hardly be influenced since it is a material characteristic, whereas the heat transfer coefficient α can be influenced. In actual installations different methods of increasing the convection portion are installed. High impulse burners are used to induce movement of the oven atmosphere in order to increase the heat transfer coefficient α. One can also find installations with a short passage of slightly forced air flow within the furnace length.

CPA has consequently thought the idea of increasing the convection portion to the end. As a result we introduce the first recirculation furnace in the field of steel wire production. The system is equipped with a high temperature recirculation radial fan. The furnace is separated in a counter-flow chamber and a return-flow chamber. In that way the furnace atmosphere is recirculated at high velocity. In the wire plane the hot gases flow with ~30m/s over the complete

furnace length. The recirculation system exhibits some significant features.

Firstly, the heat transfer coefficient of convection α is increased by a factor of ~30 compared to natural convection furnaces. In combination with the recuperator burners this reduces the specific energy consumption per kg wire by up to 40%.

Secondly, the temperature distribution in the furnace is very even, there are no significant temperature fluctuations across the wire plane which allows for producing a stable quality of up to 60 wires across the furnace width.

Thirdly, the partial load capability is improved significantly. In natural convection furnaces the reduction in heating power is practically limited to approx. -15%. Reducing more leads to a drastically inhomogeneous temperature distribution in the furnace resulting in bad wire quality. Due to the recirculation of the furnace atmosphere a homogeneous temperature distribution can be kept in the furnace down to -75% heating power. This enables the customer to be very flexible in production.

In CPA steel cord plants the new furnace is finally combined with the other processes paying high attention to the energy balance of the complete system. Wherever thermal energy is needed in the processes, as much as possible is extracted from the furnace's waste energy.

As an option the furnace can be equipped with a Wobbe number measuring unit including a corresponding air supply control system.

The user friendliness of the furnace is guaranteed by an integrated string in device which keeps the wires in motion during the string in process as well as by the user-friendly construction of the single furnace modules which are easy to open on the top.

Recirculation fan drive (pat. pend.)

CPA Wire Technologies GmbH is a leading supplier to the steel cord industry as well as market and technology leader in the field of brass plating, the core technology in the steel cord production.
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