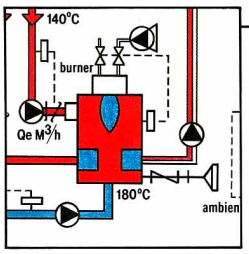


CERAMIC RECUPERATORS APPLIED TO FORCING FURNACES

CONTEXT

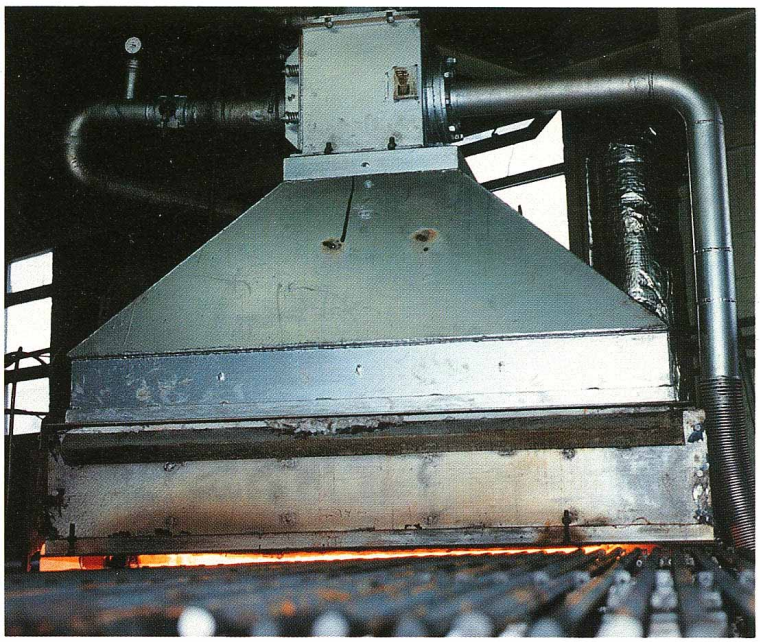
Forging is a technique by which metals are shaped in furnaces heated to temperatures of up to 1,200°C. Industrial use of this technique is quite widespread.

THE PROBLEM

Conventional forging furnaces are experiencing increasing difficulty in meeting modem industrial standards with regard to efficiency, productivity and the quality of materials. Generally speaking, the efficiency of conventional forging furnaces is only about 5 % over HHV (High Heating Value).

THE SOLUTION

The energy efficiency of a furnace can be improved considerably by preheating the air fed to the burner, using heat recovered from the combustion process itself. Productivity can be further increased by insulating the furnace walls with ceramic fibres and using a mechanized conveyor system.



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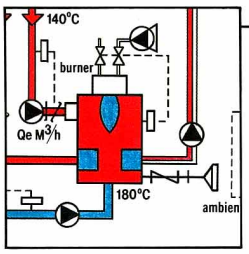


THE THEORY

Simultaneous application of the three procedures described above will improve the performance of forging furnaces.

This can be achieved by using a ceramic matrix recuperator to recover part of the heat normaly lost through the products of combustion. The recuperator, as seen in Figure 1, is made of cordierite that can resist temperatures up to 1,400°C. By passing through the recuperator, the combustion air is preheated to about 800°C. This type of matrix recuperator, as installed on the furnace in Figure 2, recovers the heat transferred from the products of combustion to the ceramic matrix, which, in turn, transfers it to the ambient air. A recuperator alone can result in energy savings of approximately 45 %. However, using air preheated to temperatures greater than 600°C causes increased production of nitrogen oxides ($N0_x$) : tests conducted on forging furnaces have shown $N0_x$ concentrations of about 300 ppm (at 3 % 02) in the chimney.

Nevertheless, several methods are effective in reducing $N0_x$ concentrations to acceptable levels (e.g. internal recirculation of the products of combustion and stage combustion). Figure 2 also shows how a recuperator mounted on the chimney can increase pressure in the furnace, thus reducing the infiltration of cold air through the furnace slot. Cold air reduces thermal efficiency and the additional oxygen promotes furnace scale. Ceramic recuperators are extremely reliable and maintenance costs represent only about 5-10% of the annual energy savings.

The refractory ceramic fibres applied to the inside walls of the furnace are made of a silicon-alumina material with exceedingly high insulating properties. Available in rigid or pliant panels, they can be used for temperatures as high as 1,400°C and for sulphur-free fuels, like natural gas. The furnace responds very quickly to temperature changes, since the refractory fibres have a very low density (0.1-0.2). Consequently, more precise temperature-regulating controls are required than with conventional furnaces.

DESCRIPTION OF THE FURNACE

Figure 2 shows a forging furnace with a ceramic recuperator mounted on the chimney. The combustion air is preheated in the recuperator before being fed to the burner.

The load (metal rod or bar) is placed on the conveyor belt. Operating at a steady speed, the conveyor takes the load to the furnace. When they reach the edge of the furnace, the metal rods are approximately 1,100°C and are hot enough to be forged.

The advantage of using refractory fibres with low thermal inertia can be seen in the time required to fire up the furnace : it takes only 10 to 15 minutes for a cold furnace to reach 1,000°C. In addition, the intensity of the flame can be reduced when production is interrupted. The temperature of the loads inside the furnace will drop, thus preventing decarburization and scale.

When production resumes, the furnace can be at operating temperature within minutes.

BENEFITS

- Potential energy savings of up to 75 %, due to preheating of combustion air and low thermal inertia of the furnace.
- Reduced heating time for the load, which translates into increased productivity.
- Possibility of pressurizing the furnace, thereby reducing infiltration of cold air.
- Reduced scale, resulting in a higher-quality product.
- Improved work environment.

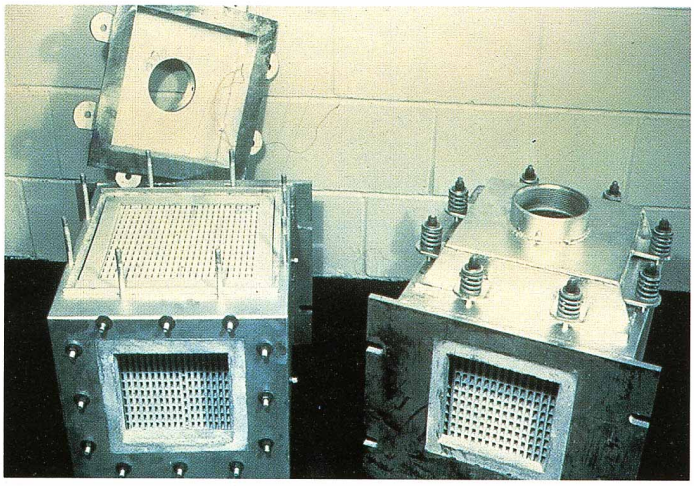
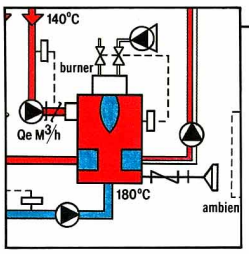


Figure 1 : Ceramic Matrix Recuperator



OTHER APPLICATIONS

Ceramic heat recuperators can also be useful in the following areas:

- Thermal treatment
- Laddle heating
- Incineration
- Reverberatory furnaces for aluminum

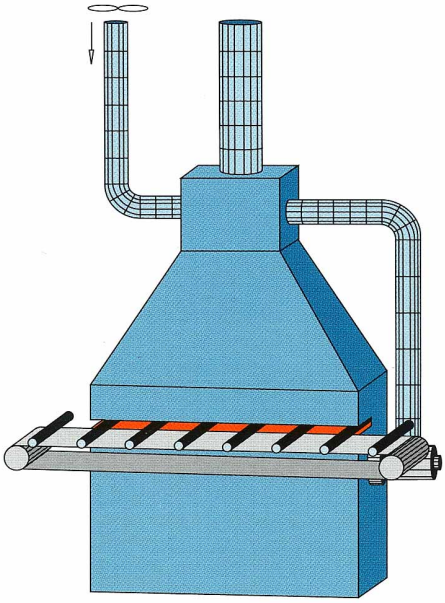
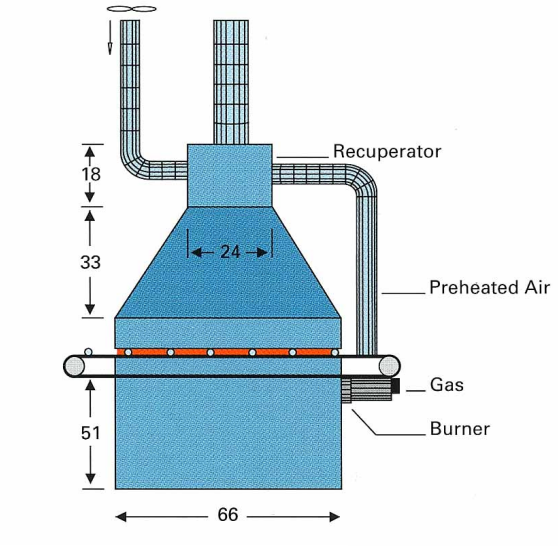
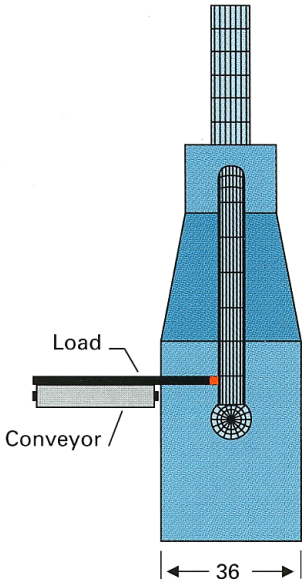


Figure 2 : Forging Furnace with Ceramic Heat Recuperator





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