HEAT TREATMENT OF METALLIC STRIP MATERIAL

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8 Claims. (Cl. 148—16)

This invention relates to the heat treatment of elongate material and particularly to means for improving the rate of heat transfer from or to the elongate material.

In a previous arrangement for cooling elongate metallic material in the form of strip, the hot strip is passed between a plurality of cooling gas streams directed towards the strip surfaces.

With this arrangement it has been found that a laminar sub-layer of the cooling gas exists over the surface of the strip, and to some extent, this insulates the strip from the main turbulent flow of the cooling gas, thus reducing the rate of heat transfer between the strip and the gas.

The present invention provides a method of heat treating elongate metallic material in which a stream of particulate material entrained in a gas at a different temperature from that of the material is directed towards the surface of the travelling material. With this arrangement the inertia of the particles of entrained material causes them to penetrate and break up the laminar sub-layer of gas, thus improving the heat transfer coefficient between the gas and the material.

The stream of entrained particulate material may have a component of motion in a direction opposite to that of the travel of the strip.

Apparatus for carrying out the method according to the present invention may include, a container through which the strip is passed in a substantially vertical direction, means to provide a stream of particulate material entrained in a gas and directed towards the surface of the strip, means to withdraw the particulate material from the container, and means to exhaust the gas from the container.

The following description relates to the accompanying drawing which shows, by way of example only, apparatus for cooling metallic strip.

In the drawing, a container 11 has an inlet 12 through which steel strip 13 passes horizontally into the container, and over a guide roll 14 to pass upwardly and out of the container via an outlet 15.

A compressor 16 driven by a motor 17 supplies compressed nitrogen at a pressure of about 10 lbs./sq. in. via an outlet 18 to a series of manifold pipes 19 suitably arranged adjacent the container 11. The supply lines from the compressor 16 to the manifold pipes 19 are omitted for clarity.

Hoppers 20 containing sand at an average particle size of 250 microns, though the size may vary over a wide range, are connected by pipes 21 to supply sand to each jet pipe 22 connected to an associated manifold pipe 19. Nozzles 23, of the jet pipes, extend across the width of the strip and are inclined in a direction opposing the motion of the strip, so that the streams emitted from the nozzles have a component of motion which is opposite to the direction of travel of the strip. The sand to gas ratio is about 1:2.

A plate 24 is provided above the roller 14 and the horizontal portion of the strip to prevent the sand particles falling on to the roller 14 and the horizontal portion of the strip within the container, and so becoming trapped between the roller and the strip.

An outlet 25 conveys the sand to an ejector 26, the primary nozzle 27 of which may conventionally be supplied with nitrogen from the compressor 16 to transmit the sand via a pipe 28 to a cyclone separator 29. The sand is returned to the hoppers 20 via pipes 30, and the nitrogen is returned to the inlet of the compressor 16 via a pipe 31 and the hot-gas of a suitable heat-exchanger 32.

A suitable cooling fluid is circulated through the cold pass of the heat-exchanger 42 via an inlet 33 and outlet 34.

A magnetic separator 35 having a permanent magnet therein, is provided to separate scale from the sand withdrawn from the container 11.

In operation the streams of entrained sand from the nozzles 23 penetrate and break up the laminar sub-layer of nitrogen over the surfaces of the strip and reduce its insulating property, thereby increasing the rate of heat transfer from the strip to the main body of cooling nitrogen.

The ejector 26 and the pipe 28 are arranged to convey away from the container 11 the same quantity of nitrogen and sand as is admitted to the container by the nozzles 23.

The increase in the heat transfer coefficient using the method of the invention as compared with ordinary jet cooling is about 100%, and in addition it is more economical in its use of machinery such as fans and blowers, since the required gas mass flow is less.

If the arrangement according to the invention is used in association with a steel plant having an oxygen tonnage plant, the surplus liquid nitrogen from the oxygen plant can be used to provide the nitrogen gas for cooling the strip. In this case the nitrogen from the cyclone 29 may be exhausted to atmosphere and the heat exchanger 32 may be dispensed with.

If the method according to the invention is applied to the cooling of rod, then an arrangement as shown in our co-pending application 6,618/63 may be modified to provide annular jets in the wall of the duct 14, through which annular jets, the streams of particulate material entrained in the nitrogen gas may be directed towards the surface of the rod 12.

I claim:
1. In the method of continuously heating elongate metallic strip material wherein the heated material is passed between a plurality of cooling gas streams directed against the strip surfaces and having a component of motion opposite to that of the motion of the strip, the improvement which comprises projecting with said gas a particulate material entrained therein which will penetrate and break up any laminar sub-layer of gas which forms adjacent the strip surface thus improving the heat transfer coefficient between the gas and the material.

2. A method as claimed in claim 1 which comprises continuously passing the strip between a plurality of nozzles, while continuously directing a stream of said particles entrained in said gas, at a lower temperature than that of the strip, through the nozzles towards the strip.

3. A method according to claim 1 in which the elongate metallic material is steel.

4. A method according to claim 1 which includes separating from one another the particles and gas which have
been used to heat treat the metallic material, and continuously recycling the particles and gas.

5. A method according to claim 4 which includes passing the gas through a heat exchanger.

6. A method according to claim 4 which includes passing the particles through a magnetic filter to filter out scale.

7. A method according to claim 1 in which the particles are sand.

8. A method according to claim 1 in which the gas is nitrogen.