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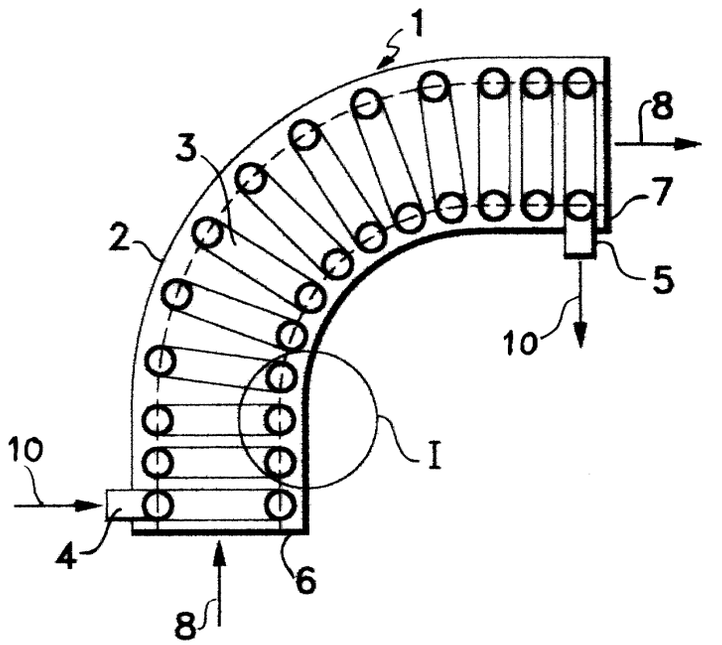
(54) Device and method for cooling fume intakes

(57) A cooling device for fume intakes for exhausted gases from foundry furnaces comprises a flue pipe for extracting the fumes produced in premises containing a source of fumes, a cooling system consisting of a tube (3) made of steel lined in appropriate areas of its surface and length and wound in a spiral. In the tube (3) there circulates cooling water with a temperature of the water at entry and in operation kept constantly between 50 and 120°C, with a temperature variation between the inlet (4) and the outlet (5) of the tube (3) in a range of 10-30°C. The lining of the tube (3) may be made of special martensitic stainless steel, or of glassy alloy, or of Ni/Cr cermet.

Fig.1



EP 1 143 198 A1

Description

Scope of the invention

[0001] The present invention refers to a cooling device for fume intakes of the water-tube type, in particular for exhausted fumes from foundry furnaces, and to the corresponding method of use.

State of the art

[0002] In intakes or pipes for extraction of high-temperature fumes generated in the furnaces of foundries, forced-cooling systems are provided consisting of pipes or ducts which are set in the intakes and in which water under forced circulation is made to flow. These ducts, which in general are made of steel, are wound in spirals, or else arranged in another way, and are enveloped by the current of fumes that comes out of the furnace.

[0003] The fumes are rich in CO and also contain other gases of various types with components, such as sulphates and chlorides, which, in particular thermo-chemical conditions, produce corrosive substances, such as sulphuric acid and hydrochloric acid. Consequently, the intakes for discharging furnace fumes correspond to areas of foundry plants that are very subject both to erosion phenomena and to corrosion phenomena. Such phenomena are in particular accentuated by the addition of contaminants in scrap or during melting operations.

[0004] Other factors influencing the intensity of corrosion/erosion are the composition, hardness and microstructure of the surface of the tube, and the energy of the particles that impinge on it. A further factor that influences the intensity of erosion or corrosion is the geometry of the pipe or intake, which has a direct influence on the angle of incidence of the current of fumes on the walls of the tubes.

[0005] It has been noted that the maximum corrosive/erosive effect is reached in the initial area of the intake, where the CO contained in the fumes is burnt, bringing the temperature of the latter to the maximum levels. In addition, fluid dynamic phenomena of turbulence are generated in the intake which are assumed to increase the erosive effect of the fumes on the walls of the cooling tubes.

[0006] The corrosion and erosion occur principally in the areas affected directly by the current of the fumes, but in particular cases it has been found that also some areas of the surface of the tubes set downstream of the section, the areas "in the shade" of the tube, are affected by the phenomenon. It is believed that these areas are involved in the deposit of corrosive substances in particular conditions of temperature and composition of the fumes. Another factor increasing the damage caused by the corrosive phenomenon is the presence of irregularities caused by the corrosion due to pitting, which results in a localized and perforating form of damage. The corrosion due to pitting can perforate the tubes causing leakages of water, which still further accelerate the kinetics of corrosion, also in relatively new tubes.

[0007] The protection of the components that make up the intakes against corrosion and erosion is essential for minimizing the maintenance costs and production losses caused by interruptions for maintenance or replacement of components. Consequently, solutions are sought for protecting such intakes and pipes more effectively and for ensuring a longer service life of the cooling system, with consequent reduction in down time. At present, the operating life of the cooling pipes covers a very wide range, between 2 and 8 years, according to the type of material or alloy used, the mode of operation of the furnaces, the geometrical characteristics of the plant for eliminating the fumes, and the influence of the latter on the fluid dynamics of the current of fumes.

[0008] Attempts have been made to modify the geometry of the system of the intake, the kinetic energy of the current, and the angles of impact on the tubes, as well as paying attention to adequate selection of the material. As regards the modifications of the geometrical structure of the components of the system there is, however, little margin for manoeuvre.

[0009] As regards the choice of the materials, some attempts have been made to select materials having high hardness and capable of absorbing a significant amount of energy before reaching the limit of resistance. Among these, stainless steels, and Ni-based and Co-based alloys have been proposed.

[0010] Stainless steels are not recommended for applications in environments where it is necessary to combat the effects of sulphuric acid. These steels are very costly and offer good resistance to corrosion only at low temperatures and when the corrosive solutions are very diluted.

[0011] Nickel-based steel alloys, generally of the Ni-Cr-Mo-W type, present an increased resistance both to uniform corrosion and to pointwise corrosion. However, such alloys have low surface hardness, and hence low resistance to erosion, as well as a high cost.

[0012] Cobalt-based steel alloys, in particular Co-Cr ones, yield good results, but their cost, which is even higher than that of nickel-based steel alloys, renders their use far from economic.

[0013] Another solution proposed by the prior art is that of lining the tubes with refractory material. The use of refractory material for protecting the tubes, albeit a relatively low-cost solution, has failed to yield good results because it involves a big reduction in the capacity for transfer of the heat of the coolant.

[0014] A further solution to the problem has also been proposed which consists in manufacturing the tubes with thicker walls to reduce maintenance interventions or the replacement of components. The disadvantage of the latter solution is its higher cost, and the increase in overall dimensions, weight and costs that it involves for the fume-abatement system, as well as the reduced capacity for transfer of thermal energy.

Summary of the invention

[0015] A primary purpose of the present invention is to overcome the problems referred to above by providing a cooling device for fume intakes of the water-tube type that present a high resistance to corrosion and a long service life, minimizing the necessity for maintenance operations, at the same time keeping the costs of implementation down.

[0016] A further purpose of the present invention is to maintain the efficiency of the heat exchange of the cooling system inside the intakes or flue pipes of foundry furnaces, whilst maintaining the same fluid dynamics.

[0017] These purposes, together with others, which will be further clarified in what follows, are achieved by a cooling device for fume intakes, in accordance with Claim 1, which consists of a tube bundle, in which a coolant flows, and of means for maintaining the coolant in the range between 50 and 120°C and for maintaining the temperature variation of the coolant in said tube bundle between 10 and 30°C, said tube bundle being provided with a lining in appropriate areas of its surface and length.

[0018] Thanks to this arrangement, the cooling device presents characteristics of resistance to corrosion and to erosion higher than those of previously known cooling devices.

[0019] According to a further aspect of the invention, a method is provided which, in accordance with Claim 8, is characterized in that it comprises the following steps:

a) immission of the water in the tube of the cooling system at a predetermined temperature in the range between 50 and 120°C; and

b) circulation of the water at a predetermined rate and pressure, according to the temperature of entry of the water itself, the output temperature of the latter, and the temperature of the fumes, so that the jump in temperature of the water between said inlet and said outlet of the tube stays within a predefined range.

Brief description of the figures

[0020] Further characteristics and advantages of the invention will appear more clearly from the detailed description of a preferred, but not exclusive, embodiment of a cooling device for fume intakes illustrated purely to provide a non-limiting example with the aid of the attached drawings, in which:

Fig. 1 is a longitudinal sectional view of the device according to the invention; and

Fig. 2 is a sectional view of a detail of the device of Fig. 1.

Detailed description of preferred embodiments of the invention

[0021] With particular reference to Figure 1 above, a cooling device for fume intakes according to the invention, designated as a whole by the reference number 1, comprises an intake or pipe 2 for the evacuation of the fumes generated in a foundry furnace of the electric-arc ladle type or the like (not illustrated), and a tube or pipe 3 containing the coolant 9, in general water, which circulates in the direction indicated by the arrows 10.

[0022] The tube 3 is wound in a spiral and extends advantageously throughout the length of the intake 2. The spirals of the tube may be made with a suitable pitch to obtain the best cooling effect, or may also be set in contact with one another. The tube 3 is provided with an inlet 4 for the liquid and with an outlet 5 by means of which it is connected to a system for supplying forced circulation of water (not illustrated). The current of the fumes evacuated from the furnace enters the intake from the inlet 6 and comes out from the outlet 7, following the direction indicated by the arrows 8.

[0023] With particular reference to Fig. 2, an enlarged view of the detail of Fig. 1 is shown. The spirals of the tubes 3 are sectioned by a plane of symmetry of the breeching. They are lapped by the current of the fumes, which flows in the direction of the arrow 8. In known intakes of the prior art, phenomena of corrosion and erosion occur on the surface of the tubes with a tangent parallel to the direction 8 of the current. In addition, also phenomena of erosion occur in the areas of the surface of the tubes indicated by the reference number 11.

[0024] To eliminate these problems, the invention proposes to operate in combination both on the constitution of the surface of the tubes 3 and on the innovation of the operating mode of the coolant circuit 9.

[0025] In conformance with the invention, it has therefore been proposed to work with a cooling system at high input temperature, maintaining the temperature variation of the cooling water within a limited range, i.e., between 10 and 30°C. This result is obtained by means of known techniques, such as by thermostatic control of the heat exchangers.

Such a device keeps the spirals of the tubes 3 always above the temperature of condensation of chemically aggressive species, such as sulphuric acid, hydrochloric acid and their combinations. In addition, the invention proposes combining to this first measure a lining of the tube made of a particular material and applied in predetermined areas of the intake or pipe for the fumes.

[0026] The most suitable material to make the lining on cooling tubes made of ordinary steel are of three kinds:

- martensitic stainless steels
- glassy alloy linings
- linings made of Ni/Cr cermet,

and may be used alternatively according to the operating requirements.

[0027] Martensitic stainless steels present a resistance to perforating corrosion with a good hardness.

[0028] Glassy alloy linings, which vitrify in erosive and/or abrasive conditions, form a particularly smooth surface structure that prevents corrosive substances from depositing on the surface and improves the hardness of the surface of the tubes in contact with the fumes. This lining can also be applied by means of arc spraying, using portable equipment if necessary.

[0029] Linings made of nickel-based cermet reinforced with WC-TiC or else Cr_3C_2 offer an effective barrier against corrosion and/or erosion because they possess a high resistance to compression and an extremely high hardness and resistance to wear, as well as a matrix which is inert to attack from H_2SO_4, HCl and their combinations. Various known methods are available for applying such linings, both in the factory and on the plant itself.

[0030] Table 1 lists preferred combinations of temperature ranges for cooling water according to the input temperature of the water itself, for two different areas of the cooling circuit and with two different thicknesses of the tube.

Table 1: INTERNAL TEMPERATURE OF THE COOLING PIPE

	SETTLING CHAMBER		PIPE AT OUTPUT FROM THE SETTLING CHAMBER	
Temperature of entry of cooling water	Thickness of tube 5.6 mm	Thickness of tube 11 mm	Thickness of tube 5.6 mm	Thickness of tube 11 mm
50°C	89-102	93-109	88-105	93-112
85°C	124-135	127-143	123-136	127-145
100°C	138-149	142-156	138-151	142-159

[0031] The thickness of the lining was about 800 μm. However, it has been noted that the thickness of the lining has little influence on the cooling performance. Various types of linings have been studied that have all yielded good results. For economic reasons and reasons of expedience, the lining may be applied only in some areas appropriately selected in relation to the type of plant and to the type of process. Such a choice depends on various factors, such as the variation in the temperature of the gas along the intake or flue pipe, the dew point and the gas deposit curve along the duct, the fluid dynamic model of the current of the fumes for identifying the areas subject to corrosion, the variation of the temperatures in the metal of the pipe carrying cooling water at different points along the path, and the chemical nature of the substances that are deposited.

[0032] The operating life of the lining depends on periodic repairs and on the rate of thinning of its thickness caused by erosion/corrosion. In principle, with a yearly intervention of maintenance/repair, the lining can remain in service indefinitely.

[0033] The advantage of the proposed solution is that it does not entail big changes in the existing systems of forced

circulation and may be used also on plants already installed, if necessary. From the tests carried out, the device and method according to the invention have yielded excellent results in decreasing both the corrosion caused by H_2SO_4 and HCl, and the corrosion caused by pure H_2SO_4, as well as an excellent resistance to erosion, with a minimal investment.

[0034] With the solution according to the invention major savings are obtained, as well as a reduction in plant down time and a longer operating life of the cooling pipes. In addition, a greater flexibility of use is obtained by means of a reduction in the need for spare parts in conditions of prompt use of the foundry.

[0035] The solution in accordance with the invention is suitable for use both with conventional furnaces and with ultrafast furnaces and/or with preheating systems.

Claims

1. A cooling device for fume intakes (2) comprising a tube bundle (3) in which a coolant flows, and means for maintaining the coolant in the range between 50 and 120°C and for maintaining the temperature variation of the coolant in said nest of tubes between 10 and 30°C, and in which said tube bundle (3) is provided with a lining in appropriate areas of its surface and length.

2. A device according to Claim 1, wherein said tube (3) is lined with martensitic stainless steels.

3. A device according to Claim 1, wherein said tube (3) is lined with a metallic-glass lining.

4. A device according to Claim 1, wherein said tube (3) is lined in Ni/Cr cermet with chromium carbides and/or tungsten carbides, and/or titanium carbides and their combinations.

5. A device according to any of Claims 2 to 4, wherein the coolant is kept at said temperature also in periods of charging and tapping.

6. A device according to Claim 5, wherein the temperature of the water at said inlet (4) of the tube (3) is between 50 and 100°C.

7. A device according to Claim 6, wherein means are provided for regulating the rate of circulation of the water in said tube (3) according to the initial temperature of the water itself and to the variation of said temperature inside said tube (3).

8. A method for cooling fume intakes, in particular for exhausted fumes from foundry furnaces, by means of a device according to Claim 1, comprising the following steps:

   a) immission of water in a bundle of tubes (3) of the cooling device at a predetermined temperature in the range between 50 and 120°C; and
   b) circulation of the water at a predetermined rate and pressure, according to the temperature of entry of the water itself, the output temperature of the latter, and the temperature of the fumes, so that the jump in temperature of the water between said inlet (4) and said outlet (5) of the tube (3) stays within a predefined range.

9. A process according to Claim 8, wherein said predefined temperature range at which the water in the tube (3) is maintained is between 10 and 30°C.

Fig.1

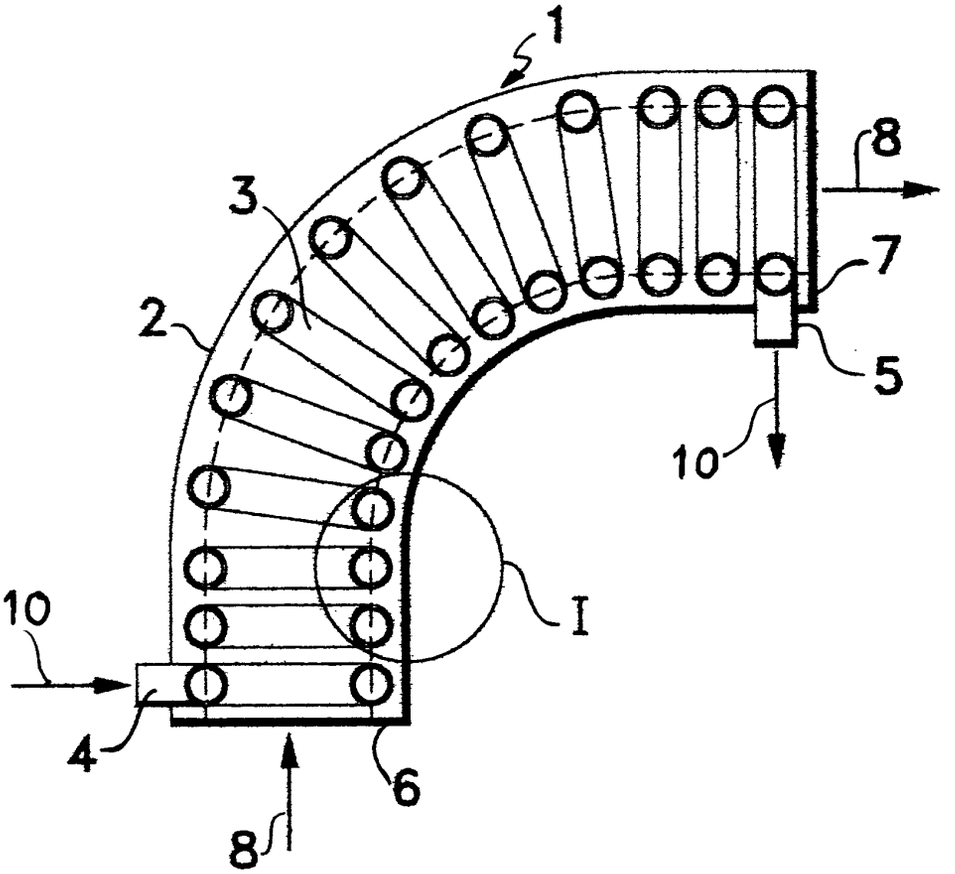
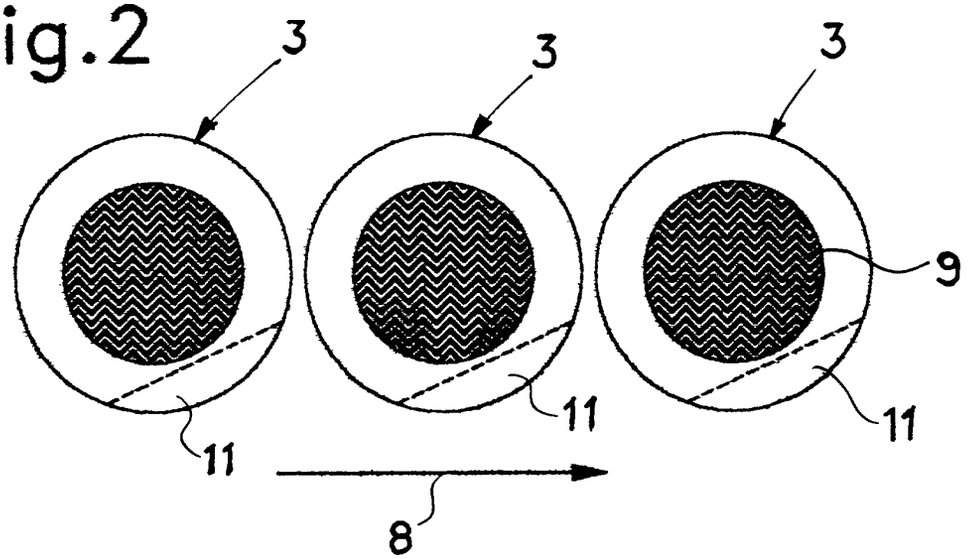


Fig.2



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EUROPEAN SEARCH REPORT

Application Number
EP 01 10 7573

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	19 July 2001	Mougey, M

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