ABSTRACT: A method and apparatus for preventing the vaporization of a cooling liquid used in a boiler which is heated by waste gases from a converter. A circulating pump pumps a constant amount of cooling liquid through a system which includes in addition to the boiler and the pump a heat exchanger in which the liquid is cooled after leaving the boiler and a reservoir which receives the cooled liquid from the heat exchanger and which supplies the liquid to the circulating pump. A compensating or equalizing expansion tank communicates with the reservoir and maintains over a liquid which is in this latter tank a cushion of a noncorrosive gas. As the temperature of the liquid rises, the pressure of the gas in this cushion also rises, so that the pressure of the liquid rises, thus raising the boiling point thereof in such a way as to prevent vaporizing of the liquid. The liquid is continuously circulated during the off-blow as well as during the blow periods of each cycle, so that by the time the end of an off-blow has been reached, the cooling liquid has been cooled down to the temperature which it had initially at the beginning of the blow period.
METHOD AND APPARATUS FOR AVOIDING OF EVAPORATION

The invention concerns a method and an apparatus for preventing (avoiding) of evaporation or vaporizing of a cooling liquid in the walls of a cooling stack or boiler receiving waste gas from a steel plant converter and similar metallurgical furnaces or heating plants with intermittent operation.

The invention is characterized in that the pressure of the cooling liquid flowing in the cooling circuit is increased during a rise in the temperature thereof, e.g. to two or three times its value, by compressing of a gas cushion, and that on falling of the heat yield from the converter and during the off-blow interval the temperature of the cooling liquid in the cooling circuit and thus also its pressure is returned to about its initial value by continued circulation of the liquid by circulating pumps adjusted to operate continuously at a constant capacity. A further characteristic of the invention is that when there is a change in the cycle increasing heating beyond the mean heat yield during a blowing stage, in order to prevent abnormally high pressures in the circuit, a portion of the cooling liquid at high temperature is removed and replaced by cold cooling liquid supplied to the circuit by refeed pumps.

According to a further method step the cooling liquid is taken from a reservoir to which an expansion or compensating tank is connected. The cooling liquid flows through the walls of the stack or boiler and thereafter transmits at least a portion of the heat absorbed there to a cooling unit coupled to the outlet side, and then returns to the reservoir. The circulating amount is selected as a function of the exit temperature of the cooling liquid from the stack or boiler, in such a way that the cooling fluid does not vaporize at any place within the cooling circuit. The apparatus according to the invention is characterized in that the cooling circuit, consisting preferably of circulating pump, cooled stack or chimney, cooling heat exchanging unit and reservoir, is connected to an expansion or compensating tank having connected thereto feeder lines for the cooling liquid and for a noncorrosive gas, preferably nitrogen, for pressure control.

The invention is schematically, and by way of example, illustrated in a single FIGURE. The FIGURE shows a circuit diagram of a cooling stack or boiler used with steel plant converters and connected with further schematically illustrated structure of the invention.

The waste gases of a steel plant converter 8 are cooled in a boiler of cooling stack. In the boiler a cooling liquid, in particular water, is introduced through the top or at least part of the walls of the stack or boiler. The cooling liquid is taken from a reservoir 7. The liquid is withdrawn from the reservoir 7 by means of a circulating pump 4 which is adjusted to operate at a constant capacity. For the sake of operation safety and also to meet particular operating conditions, if with particular charges an increased heat removal is desirable, a second circulating pump, which may work in parallel with the first pump, is provided. The cooling liquid heated in the boiler or cooling stack 5 is, at least partially, cooled in a cooling unit 6 and then returned to the reservoir 7. During the entire process, that is during the blow period as well as during the off-blow period of each cycle of converter operation, the circulating amount of cooling liquid is held constant. The pressure within the installation is held between the limits of from 3 to 10 atm. During the blowing stage the temperature of the cooling liquid in the reservoir 7 increases and thus, as explained below, its pressure also increases. At the increase of pressure of a liquid in a manner known per se the boiling point rises to a higher temperature, so that the heat absorption capacity of the liquid increases without evaporation thereof. In this manner the increase of the feed water temperature in the reservoir is compensated, so that the evaporation or vaporizing of the cooling liquid within the cooling circuit is safely prevented even at the time of the maximum heat yield (blowing peak).
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vaporizing temperature limit. In such cases, the escape of hot water is effectuated already at the beginning of the charge by partly opening the safety valves. Sufficient water is removed so that the minimum water level in the expansion tank is obtained. Thus the refeeder pumps are automatically actuated and continually supply cold cooling liquid. In such a case, self-evidently only a portion of the circulating cooling liquid is removed, so that the larger portion of the cooling liquid continues to circulate in the closed circuit. If the temperatures at the exit of the boiler increase so much that the danger exists that the saturation temperature is reached, the circulating amount for the plant has to be increased. This is practically done by starting the operation of the parallel connected reserve circulating pump, which now operates together with the circulating pump already running.

In controlling the refueling it has to be taken care that the cooling medium is refed when the minimum working liquid level in the expansion tank is reached. The refueling into the gas cushion is effectuated only when the maximum or highest liquid level in the expansion tank is reached. These measures prevent unnecessary control actions which could be cause of opposed oscillations.

The invention is not restricted to the use with cooling chimneys or boilers after steel plant converters. It can be used with any intermittent heat source as long as a heat utilization with regard to the steam production does not seem to be economical.

We claim:

1. In a method of absorbing heat into a cooling liquid in an installation where intermittent heating takes place, such as a steel converter installation where each operating cycle has a blow period followed by an off-blow period, the steps of directing hot gases through a passage around which cooling pipes are distributed for conveying along the passage the cooling liquid which is heated by the hot gases, situating the cooling liquid in a circuit which includes a heat exchanger for cooling the cooling liquid for extracting heat therefrom and a gas cushion the pressure of which increases during an increase in the temperature and volume of the cooling liquid so that the pressure of the liquid increases as its temperature increases to raise its boiling point, and continuously circulating the liquid at a given rate through the circuit during the off-blow period of each cycle as well as during the blow period thereof to return the liquid substantially to the initial temperature which it had at the beginning of a blow period of each cycle, whereby vaporizing of the circulating cooling liquid is prevented.

2. In a method as recited in claim 1, and including, when more than average heat is transferred to the cooling liquid, the steps of removing part of the heated cooling liquid from the circuit while the cooling liquid still has not vaporized, and replacing the removed part of the cooling liquid with additional cooling liquid at a lower temperature.

3. In a method as recited in claim 1, and wherein the cooling liquid is circulated from a reservoir through the pipes around said passage, and is cooled by the heat exchanger before returning to the reservoir, while liquid expanding out of the reservoir by the increasing volume of the heated cooling liquid is maintained in engagement with the gas cushion.

4. In a method as recited in claim 3, and wherein the pressure of the cooling liquid in engagement with the gas cushion is maintained within predetermined limits.

5. In a method as recited in claim 1, and wherein the amount of cooling liquid which is constantly circulated is selected as a function of the highest temperature of said cooling liquid when the latter discharges from the pipes distributed about said passage, in such a way that vaporization of the cooling liquid cannot take place at any part of the circuit.

6. In a method as recited in claim 1 and wherein flow of gas and from the gas cushion is controlled according to the pressure of the gas at a given upper level of the cooling liquid in a tank beneath the gas, while the feeding of additional cooling liquid into the tank is automatically controlled according to the lowest level of the liquid in the tank.

7. In a method as recited in claim 1 and wherein the gas of the gas cushion is a noncorrosive gas such as nitrogen.

8. In an installation where intermittent heating occurs, such as a steel converter installation having blow and off-blow periods, a cooling circuit means for directing a cooling liquid along a path where waste gas from the heating installation flows to absorb heat from the waste gas and to give up heat at a part of the cooling circuit means, a compensating tank communicating with said cooling circuit means and enclosing part of the cooling liquid and a gas cushion situated thereover in the tank, so that as the temperature of the cooling liquid rises its volume increases and the pressure of the gas cushion rises to raise the pressure of the cooling liquid and thus raise its boiling point, and a pair of supply means respectively communicating with the gas and liquid in the compensating tank for respectively supplying gas and cooling liquid thereto.

9. The combination of claim 8 and wherein said cooling circuit means includes a circulating pump, cooling tubes provided with cooling liquid by said circulating pump and situated around a path of flow of the waste gas to receive heat therefrom, a heat-exchanger means communicating with said tubes for receiving the heated cooling liquid therefrom and cooling the cooling liquid, a reservoir communicating with said heat-exchanger means for receiving the cooled liquid therefrom and also communicating with said circulating pump for supplying cooled liquid thereto, and said compensating tank communicating with said reservoir.

10. The combination of claim 9 and wherein a feed pump communicates with said tank for feeding cooling liquid thereto, and control means responding to the level of cooling liquid in said tank and operatively connected with said feed pump for actuating the latter as a function of the liquid level in said tank.

11. The combination of claim 9 and wherein a gas flow control means communicates with the gas cushion for controlling the flow of gas to and from the latter, and control means operatively connected with said gas flow control means and responding automatically to the level of cooling liquid in the tank for withdrawing or supplying the gas to the gas cushion when the liquid level reaches a given upper limit.