

Description

This invention relates to control systems for heat exchangers.

As described hereinbelow, the invention may be applied to controlling heat absorption in a heat exchanger to maintain the temperature of fluid discharged from the heat exchanger at a set point value. More particularly, the invention may be applied to the control of the temperature of steam leaving a secondary superheater or reheater of a large size fossil fuel fired drum or separator type steam generator supplying steam to a turbine having a high and a low pressure unit. As an order of magnitude, such steam generators may be rated at upwards of 2.7 Gg (6 Mlb) of steam per hour at 17.24 MPa (2,500 lbf/in²) and 538°C (1,000°F). The generic term "superheater" as used hereafter should be understood to include a secondary superheater, a reheater or primary superheater, since control systems embodying this invention are applicable to the control of each of these types of heat exchanger.

The steam-water and air-gas cycles for such steam generators are well known in the art and are illustrated and described in the book "Steam, Its Generation and Use" published by The Babcock & Wilcox Company, Library of Congress Catalogue Card No. 75-7696. Typically, in such steam generators, saturated steam leaving the drum or separator passes through a convection primary superheater and a convection or radiant secondary superheater, and then through the high pressure turbine unit and a convection or radiant reheater to the low pressure turbine unit. Flue gas leaving the furnace passes in reverse order across the secondary superheater, the reheater and the primary superheater. To prevent physical damage to the steam generator and turbine and to maintain maximum cycle efficiency, it is essential that the steam leaving the secondary superheater and reheater be maintained at set point values.

It is well known in the art that the heat absorption in a heat exchanger such as a superheater or reheater is a function of the mass gas flow across the heat transfer surface and of the gas temperature. Accordingly, if uncontrolled, the temperature of the steam leaving a convection superheater or reheater will increase with steam generation load and excess air, whereas the temperature of the steam leaving a radiant superheater or reheater will decrease with steam generator load.

The functional relationship between boiler load and uncontrolled final steam temperature at standard or design conditions is usually available from historical data, or may be calculated from test data. From such functional relationship, it is possible to calculate the relationship between boiler load and flow of a convective agent, such as flow of water to a spray attenuator, required to maintain the temperature of the

steam discharged from the superheater at a set point value. Seldom, if ever, does a steam generator operate at standard or design conditions, so that while the general characteristic between steam generator load and temperature of the steam discharged from the superheater may remain constant, the heat absorption in a superheater or reheater, and hence the temperature of the steam discharged from a superheater, will, at constant load, change in accordance with system variables, such as (but not limited to) changes in excess air, feed water temperature and heat transfer surface cleanliness.

Control systems presently in use, as illustrated and described in The Babcock & Wilcox Company's publication, are of the one or two element type. In the one element type a feed back signal responsive to the temperature of the steam discharged from the superheater adjusts a convective agent, such as water or steam flow to a spray attenuator. In the two element type a feed forward signal responsive to changes in steam flow or air flow adjusts the convective agent which is then readjusted from the temperature of the steam discharged from the superheater. It is evident that neither of these control systems can correct for changes in the heat absorption of the superheater caused by changes in system variables.

European Patent Application No. EP-A-0181783 discloses a control system for a heat exchanger which forms part of a process heater and in which heat is exchanged between a product and gas resulting from combustion of a fuel. The control system comprises means for generating a feed forward control signal corresponding to a calculated value of heat to be absorbed in the product from the gas in order to maintain a parameter (temperature) of the product leaving the heat exchanger at a predetermined value. After combination with a signal representing calculated total actual heat flow from the combusted fuel to the process heater, and a heat flow demand signal based upon the product outlet temperature, the feed forward signal is passed to a valve adjusting the supply of fuel to the process heater in order to adjust the heat absorption in the product. Also, the feed forward signal is passed directly to control means for controlling the position of an exhaust damper of the process heater.

US Patent No. US-A-4549503 discloses a control system for a heat exchanger in the form of a superheater in which the output temperature of the superheater is maximised, the temperature being controlled by adjusting the flow of attenuating water into steam flowing into the superheater in accordance with (inter alia) a feed forward signal obtained from heat balance equations.

According to the invention there is provided a control system for a heat exchanger in which heat is exchanged between two heat carriers, the control system comprising :

generating means for generating a feed forward control signal corresponding to a calculated value of the heat to be absorbed in one of the heat carriers from the other in order to maintain a parameter of said one heat carrier leaving the heat exchanger at a predetermined value ; and adjustment means under the control of the feed forward signal for adjusting the heat absorption in said one heat carrier ; characterised in that :
 a regressor is operative to update the values of the coefficients in a multivariable non-linear regression equation due to changes in system variables and to provide signals indicative of said updated coefficients ;
 the generating means is operative to generate a feed forward coolant flow set point signal based upon said updated coefficients and corresponding to the calculated value of the heat to be absorbed in said one heat carrier from the other to maintain the enthalpy of said one heat carrier leaving the heat exchanger at the predetermined value ; and
 the adjustment means is responsive to the feed forward coolant set point signal to adjust the heat absorption in said one heat carrier by adjusting the rate of flow of a coolant modifying the enthalpy of said one heat carrier.

According to an embodiment of the invention described below, thermodynamic properties are used to arrive at a calculated value of a corrective agent or parameter which may be, for example, water or steam flow to a spray attemperator, required to maintain the enthalpy of steam discharged from a superheater at a set point value. To this end, a feed forward signal is derived which includes a computed value for heat absorption in the superheater required to maintain the enthalpy of steam discharged from the superheater at a set point value. The computed value for the heat absorption in the superheater is updated on a regular basis to account for changes in system variables such as, for example, changes in excess air, feed water temperature, fuel composition and heating surface cleanliness. The computed value of the heat absorption in the superheater is updated under steady state conditions, at selected points along a load range.

The invention will now be further described, by way of illustrative and non-limiting example, with reference to the accompanying drawings, in which :

Figure 1 is a fragmentary, diagrammatic view of a steam generator and superheater ; and

Figure 2 is a logic diagram of a control system embodying this invention.

The control system embodying the invention which is now to be described is a two element system for maintaining the temperature T_4 of steam discharged from a superheater 1, the steam having been heated by convection from flue gas flowing over heat transfer surfaces. In the control system, a feed for-

ward signal F_{2c} is developed which adjusts the heat absorption ΔH in the superheater 1 in anticipation of change required by changes in system variables, such as a change in load, a change in excess air, or a change in feedwater temperature.

Figure 1 shows the superheater 1 heated by flue gas discharged from a furnace 3 to which fuel and air are supplied through conduits 5 and 7, respectively. Steam from any suitable source, such as a primary superheater (not shown) is admitted into the superheater 1 through a conduit 9 and discharged therefrom through a conduit 11. A valve 8 in a conduit 12 regulates the flow of a coolant, such as water or steam, to a spray attemperator 10 for adjusting the heat absorption ΔH in the superheater 1. In Figure 1, physical measurements required to implement the control system are identified by descriptive letters F, T and P that represent flow rate, temperature and pressure, respectively, each letter having a numeral subscript denoting the location where the associated measurement is made. (A similar numerical subscript convention is used hereinbelow to signify the locations of heat flow H and enthalpy h). Transducers for translating such measurements into analog or digital signals are well known in the art.

The above-mentioned feed forward signal F_{2c} , which in the present embodiment represents a set point for the rate of flow of coolant to the superheater 1 required to maintain the enthalpy h_4 of the steam discharged from the superheater at a predetermined value, regardless of changes in system variables, can be computed as follows.

It will be apparent from Figure 1 that :

$$H_1 + H_2 + \Delta H = H_4 \quad (1)$$

where H = heat flow (in W (Btu/h)) ; and that

$$F_1 h_1 + F_2 h_2 + \Delta H = h_4 (F_1 + F_2) \quad (2)$$

where h = enthalpy = f(T, P).

Rearranging Equation (2) gives :

$$F_{2c} = F_1 (h_1 - h_4) / (h_4 - h_2) + \Delta H_c / (h_4 - h_2) \quad (3)$$

where F_{2c} = the computed feed forward coolant flow set point signal and ΔH_c = a computed value of heat absorption in the superheater 1.

That is to say, if F_1 is measured, the enthalpies h_1 , h_2 and h_4 are determined from measurements of P_1 , T_1 , P_2 , T_2 , P_4 and T_4 , and ΔH_c is computed, the feed forward coolant flow set point signal F_{2c} can be computed.

The functional relationship between enthalpy, pressure and temperature ($h = f(T, P)$) is determined from steam tables stored in a computer 15 (Figure 2), or from techniques illustrated and discussed in US Patent No. US-A-4244216 entitled "Heat Flowmeter",

whereby the enthalpies in Equation (3) can readily be determined.

The control system computes the heat absorption ΔH_c in the superheater 1 using historical data, updated on a regular basis using a multivariable regression calculation. Significantly, this computation uses a uniform distribution of load points over the entire load range. This uniform distribution permits the maintaining of load related data from other than common operating loads. Thus ΔH_c will, under all operating conditions, closely approximate that required to maintain the enthalpy h_4 of the steam discharged from the superheater 1 at set point value.

As shown in Figure 2, a signal proportional to F_4 is introduced into a logic unit 14 which, if the signal is within preselected steady state conditions, allows the signal to pass to a load point finder unit 17 and then to a regressor 13 within the computer 15. For purposes of illustration, the load point finder unit 17 is shown as dividing the load range into ten segments. However, fewer or more segments can be used, depending on system requirements.

The independent variables selected for this application are steam flow and excess air flow or flue gas flow. Based on historical data, it is known that the heat absorption in a convection superheater, if uncontrolled, varies as $(F_4)^2$ and linearly with the rate of flow of excess air (X_A), or rate of flow of flue gas, and can be expressed as :

$$\Delta H_A = a(F_4)^2 + b(F_4) + c(X_A) + d \quad (4)$$

where :

$$X_A = (F_5 - F_4) ;$$

a, b, c and d are coefficients computed in the regressor 13 based on least square fit ; and

$$\Delta H_A = F_4 (h_4 - h_3) \quad (5)$$

From Equation (4) it is evident that the fundamental relationship between heat absorption, steam flow and excess air flow remains constant regardless of changes in system variables, but that the constants (coefficients) a, b, c will vary in accordance with changes in system variables. Under steady state conditions, these constants are recomputed so that ΔH_c will be that required to maintain the enthalpy h_4 and, accordingly, the temperature T_4 of the steam exiting the superheater 1, at predetermined set point values within close limits.

Once the coefficients a to d are determined, the heat absorption ΔH_c can be computed as shown in an arithmetical unit 21 housed in the computer 15. Knowing ΔH_c , the feed forward coolant flow set point signal F_{2c} is computed in the arithmetical unit 21 in accordance with Equation (3) and is transmitted to a sum-

ming unit 23, the output signal of which is introduced into a difference unit 25 where it functions as the set point of a local feedback control adjusting the valve 8 to maintain the actual value F_{2A} of the coolant flow rate equal to F_{2c} .

The control system includes a conventional feedback control loop which modifies the calculated signal F_{2c} as required to maintain T_4 at a set point. A signal proportional to T_4 is inputted to a difference unit 27, which outputs a signal proportional to the difference between the T_4 signal and a set point signal generated in an adjustable signal generator 29 and proportional to the T_4 set point. The output signal from the difference unit 27 is inputted to a PID (proportional, integral, derivative) control unit 31 which generates a signal varying as required to maintain T_4 at its set point. The output signal from the unit 31 is inputted to the summing unit 23, and serves to modify the feed forward signal F_{2c} .

The control system shown is by way of example only. The control principle embodied in the example can be applied to other types of heat exchanger and to other types of superheater. It will further be apparent to those familiar with the art that a signal T_{3c} (representing the temperature of steam entering the superheater 1) can be developed, in place of the signal F_{2c} , for adjusting the flow of coolant to the attenuator 10 as required to maintain the enthalpy h_4 of the steam leaving the superheater 1 at substantially the set point value. Although the preferred embodiment is described as being for application to a large size fossil fuel fired drum or separator type steam generator, the principle described herein can be equally applied to other steam generator types, including nuclear fuelled units, and to smaller heat exchangers.

Claims

1. A control system for a heat exchanger (1) in which heat is exchanged between two heat carriers, the control system comprising :

generating means (21) for generating a feed forward control signal corresponding to a calculated value (ΔH_c) of the heat to be absorbed in one of the heat carriers from the other in order to maintain a parameter of said one heat carrier leaving the heat exchanger at a predetermined value ; and

adjustment means (8) under the control of the feed forward signal for adjusting the heat absorption in said one heat carrier ; characterised in that :

a regressor (13) is operative to update the values of the coefficients (a, b, c, d) in a multivariable non-linear regression equation due to changes in system variables and to provide signals indicative of said updated coefficients ;

whereby the enthalpies in Equation (3) can readily be determined.

The control system computes the heat absorption ΔH_c in the superheater 1 using historical data, updated on a regular basis using a multivariable regression calculation. Significantly, this computation uses a uniform distribution of load points over the entire load range. This uniform distribution permits the maintaining of load related data from other than common operating loads. Thus ΔH_c will, under all operating conditions, closely approximate that required to maintain the enthalpy h_4 of the steam discharged from the superheater 1 at set point value.

As shown in Figure 2, a signal proportional to F_4 is introduced into a logic unit 14 which, if the signal is within preselected steady state conditions, allows the signal to pass to a load point finder unit 17 and then to a regressor 13 within the computer 15. For purposes of illustration, the load point finder unit 17 is shown as dividing the load range into ten segments. However, fewer or more segments can be used, depending on system requirements.

The independent variables selected for this application are steam flow and excess air flow or flue gas flow. Based on historical data, it is known that the heat absorption in a convection superheater, if uncontrolled, varies as $(F_4)^2$ and linearly with the rate of flow of excess air (X_A), or rate of flow of flue gas, and can be expressed as :

$$\Delta H_A = a(F_4)^2 + b(F_4) + c(X_A) + d \quad (4)$$

where :

$$X_A = (F_5 - F_4) ;$$

a, b, c and d are coefficients computed in the regressor 13 based on least square fit ; and

$$\Delta H_A = F_4 (h_4 - h_3) \quad (5)$$

From Equation (4) it is evident that the fundamental relationship between heat absorption, steam flow and excess air flow remains constant regardless of changes in system variables, but that the constants (coefficients) a, b, c will vary in accordance with changes in system variables. Under steady state conditions, these constants are recomputed so that ΔH_c will be that required to maintain the enthalpy h_4 and, accordingly, the temperature T_4 of the steam exiting the superheater 1, at predetermined set point values within close limits.

Once the coefficients a to d are determined, the heat absorption ΔH_c can be computed as shown in an arithmetical unit 21 housed in the computer 15. Knowing ΔH_c , the feed forward coolant flow set point signal F_{2c} is computed in the arithmetical unit 21 in accordance with Equation (3) and is transmitted to a sum-

ming unit 23, the output signal of which is introduced into a difference unit 25 where it functions as the set point of a local feedback control adjusting the valve 8 to maintain the actual value F_{2A} of the coolant flow rate equal to F_{2c} .

The control system includes a conventional feedback control loop which modifies the calculated signal F_{2c} as required to maintain T_4 at a set point. A signal proportional to T_4 is inputted to a difference unit 27, which outputs a signal proportional to the difference between the T_4 signal and a set point signal generated in an adjustable signal generator 29 and proportional to the T_4 set point. The output signal from the difference unit 27 is inputted to a PID (proportional, integral, derivative) control unit 31 which generates a signal varying as required to maintain T_4 at its set point. The output signal from the unit 31 is inputted to the summing unit 23, and serves to modify the feed forward signal F_{2c} .

The control system shown is by way of example only. The control principle embodied in the example can be applied to other types of heat exchanger and to other types of superheater. It will further be apparent to those familiar with the art that a signal T_{3c} (representing the temperature of steam entering the superheater 1) can be developed, in place of the signal F_{2c} , for adjusting the flow of coolant to the attenuator 10 as required to maintain the enthalpy h_4 of the steam leaving the superheater 1 at substantially the set point value. Although the preferred embodiment is described as being for application to a large size fossil fuel fired drum or separator type steam generator, the principle described herein can be equally applied to other steam generator types, including nuclear fuelled units, and to smaller heat exchangers.

Claims

1. A control system for a heat exchanger (1) in which heat is exchanged between two heat carriers, the control system comprising :

generating means (21) for generating a feed forward control signal corresponding to a calculated value (ΔH_c) of the heat to be absorbed in one of the heat carriers from the other in order to maintain a parameter of said one heat carrier leaving the heat exchanger at a predetermined value ; and

adjustment means (8) under the control of the feed forward signal for adjusting the heat absorption in said one heat carrier ; characterised in that :

a regressor (13) is operative to update the values of the coefficients (a, b, c, d) in a multivariable non-linear regression equation due to changes in system variables and to provide signals indicative of said updated coefficients ;



the generating means (21) is operative to generate a feed forward coolant flow set point signal (F_{2c}) based upon said updated coefficients and corresponding to the calculated value (ΔH_c) of the heat to be absorbed in said one heat carrier from the other to maintain the enthalpy of said one heat carrier leaving the heat exchanger (1) at the predetermined value ; and

the adjustment means (8) is responsive to the feed forward coolant flow set point signal (F_{2c}) to adjust the heat absorption in said one heat carrier by adjusting the rate of flow (F_{2A}) of a coolant modifying the enthalpy of said one heat carrier.

2. A system according to claim 1, including means (27, 31) for generating a feedback control signal corresponding to the difference between the temperature (T_4) of said one heat carrier leaving the heat exchanger (1) and a predetermined set point temperature (29), and means (23) under the control of said feedback control signal for modifying said feed forward coolant flow set point signal (F_{2c}) as required to maintain the temperature (T_4) of said one heat carrier leaving the heat exchanger (1) at the predetermined set point temperature (29).

3. A system according to claim 1 or claim 2, for a heat exchanger (1) which is a convection superheater heated by flue gas from a fossil fuel fired steam generator, wherein the adjustant means (8) is operative to adjust the rate of flow (F_{2A}) of a coolant modifying the enthalpy of the steam entering the superheater (1).

4. A system according to claim 1 or claim 2, for a heat exchanger (1) which is a convection superheater heated by flue gas from a fossil fuel fired steam generator, wherein the adjustment means (8) is operative to adjust the rate of flow of a coolant in the form of water discharged into the steam entering the superheater (1) and thereby modifying the enthalpy and the rate of flow of steam entering the superheater.

5. A system according to any one of claims 1 to 4, wherein the generating means (21) is connected to receive said signals indicative of said updated coefficients and is responsive to the rate of flow (F_4) of said one heat carrier through the heat exchanger (1) to generate an output signal (ΔH_c) varying in non-linear relationship to said rate of flow (F_4).

6. A system according to claim 5, which includes steady state determining means (14) responsive to said rate of flow (F_4) being within preselected steady state conditions to supply a signal representing said rate of flow (F_4) to the regressor (13) to enable said updating to take place in accordance with a change in the rate of heat transfer between the two heat carriers.

7. A system according to claim 6, including a load point finder (17) connected between the steady state determining means (14) and the regressor (13) to provide a uniform distribution of load point data to the regressor from other than common operating loads.

8. A system according to any one of claims 1 to 4, for a heat exchanger (1) which is a convection superheater heated by flue gas from a steam generator supplied (5, 7) with fuel and air for combustion, wherein the generating means (21) is connected to receive said signals indicative of said updated coefficients and is responsive to the rate of flow of steam through and flue gas across the superheater (1).

9. A system according to claim 8, wherein the rate of flow of flue gas is determined by means responsive to the difference ($F_5 - F_4$) between the rate of flow (F_5) of air supplied for combustion and the rate (F_4) of steam generation.

Patentansprüche

1. Steuersystem für einen Wärmetauscher (1), bei welchem Wärme zwischen zwei Wärmeträgern ausgetauscht wird, wobei das Steuersystem aufweist :

eine Erzeugungseinrichtung (21) zum Erzeugen eines vorschubsteuersignales, das einem berechneten Wert (ΔH_c) der Wärme entspricht, die in einem der Wärmeträger von dem anderen absorbiert werden soll, um einen Parameter des einen Wärmeträgers aufrechtzuerhalten, welcher den Wärmetauscher auf einem vorbestimmten Niveau verläßt, und

eine Einstelleinrichtung (8) unter Steuerung des Vorschubsignales, um die Wärmeabsorption in dem einen Wärmeträger einzustellen, dadurch gekennzeichnet, daß

ein Regressor (14) so betreibbar ist, daß er die Werte der Koeffizienten (a, b, c, d) in einer nicht linearen Regressionsgleichung mit mehreren Variablen aufgrund der Änderungen von Systemvariablen auffrischt (update) und daß er Signale bereitstellt, die die neuen (aufgefrischten) Koeffizienten anzeigen,

die Erzeugungseinrichtung (21) so betreibbar ist, daß sie ein Sollwertsignal (F_{2c}) für einen Vorschub des Kühlmittelstromes erzeugt, welches auf den aufgefrischten Koeffizienten beruht und dem berechneten Wert (ΔH_c) der Wärme entspricht, die in einem Wärmeträger von dem anderen absorbiert werden soll, um die Enthalpie eines der Wärmeträger aufrechtzuerhalten, welcher den Wärmetauscher (1) bei dem vorbestimmten Niveau verläßt, und

die Einstelleinrichtung (8) auf das Sollwertsignal (F_{2c}) für den Vorschub des Kühlmittelstromes anspricht, um die Wärmeabsorption in dem einen Wärmeträger einzustellen, indem die Strömungsrate (F_{2A}) eines Kühlmittels eingestellt wird, welches die Enthalpie des einen Wärmeträgers verändert.

2. System nach Anspruch 1, einschließlich einer



Einrichtung (27, 31) zum Erzeugen eines Rückmeldesteuersignals (Feedback-Signals), welches dem Unterschied zwischen der Temperatur (T_4) des einen Wärmeträgers, welcher den Wärmetauscher (1) verläßt, und einer vorbestimmten Sollwerttemperatur (29) entspricht, und mit einer Einrichtung (23) unter der Steuerung des Rückmeldesteuersignals zum Verändern des Sollwertsignals (F_{2c}) für den Vorschub des Kühlmittelstromes, der erforderlich ist, um die Temperatur (T_4) des einen Wärmeträgers aufrechtzuerhalten, welcher den Wärmetauscher (1) bei der vorbestimmten Sollwerttemperatur (29) verläßt.

3. System nach Anspruch 1 oder 2 für einen Wärmetauscher (1), welcher ein Konvektionsüberhitzer ist, der von dem Rauchgas eines mit fossilem Brennstoff befeuerten Dampfgenerators geheizt wird, wobei die Einstelleinrichtung (8) so betreibbar ist, daß sie die Strömungsrate (F_{2A}) eines Kühlmittels einstellen kann, welches die Enthalpie des Dampfes verändert, der in den Überhitzer (1) eintritt.

4. System nach Anspruch 1 oder 2 für einen Wärmetauscher (1), der ein Konvektionsüberhitzer ist, welcher von dem Rauchgas eines mit fossilem Brennstoff befeuerten Dampfgenerators geheizt wird, wobei die Einstelleinrichtung (8) so betreibbar ist, daß sie die Strömungsrate eines Kühlmittels in Form von Wasser einstellen kann, welches in den Dampf, welcher in den Überhitzer (1) eintritt, abgegeben wird und dadurch die Enthalpie und die Strömungsrate des Dampfes verändert, welcher in den Überhitzer eintritt.

5. System nach einem der Ansprüche 1 bis 4, wobei die Erzeugungseinrichtung (21) so angeschlossen ist, daß sie die Signale, welche eine Anzeige für die aufgefrischten Koeffizienten sind, empfängt und auf die Strömungsrate (F_4) des einen Wärmeträgers durch den Wärmetauscher (1) anspricht, um ein Ausgangssignal (ΔH_c) zu erzeugen, welches sich in nicht linearem Verhältnis zu der Strömungsrate (F_4) verändert.

6. System nach Anspruch 5, welches eine Bestimmungseinrichtung (14) für einen stationären Zustand einschließt, welcher darauf anspricht, daß die Strömungsrate (F_4) innerhalb ausgewählter Bedingungen für einen stationären Zustand liegen, um ein Signal, das diese Strömungsrate (F_4) repräsentiert, dem Regressor (13) zuzuführen, um zu ermöglichen, daß das Auffrischen stattfindet entsprechend einer Änderung der Wärmeübertragung zwischen den beiden Wärmeträgern.

7. System nach Anspruch 6, einschließlich eines Lastpunktfinders (17), welcher zwischen der Bestimmungseinrichtung (14) für den stationären Zustand und dem Regressor (13) angeschlossen ist, um eine gleichförmige Verteilung von Lastpunktdaten für den Regressor aus anderen als den üblichen Betriebslasten bereitzustellen.

8. System nach einem der Ansprüche 1 bis 4, für einen Wärmetauscher (1), der ein Konvektionsüber-

hitzer ist, welcher von dem Rauchgas aus einem Dampfgenerator erhitzt wird, welcher mit Brennstoff und Luft für die Verbrennung beschickt wird, wobei die Erzeugungseinrichtung (21) so angeschlossen ist, daß die Signale empfängt, welche eine Anzeige für die aufgefrischten Koeffizienten sind, und daß sie auf die Strömungsrate des Dampfes durch und des Rauchgases über den Überhitzer (1) hinweg anspricht.

9. System nach Anspruch 8, wobei die Strömungsrate des Rauchgases durch eine Einrichtung bestimmt wird, welche auf den Unterschied ($F_5 - F_4$) zwischen der Strömungsrate (F_5) der für die Verbrennung zugeführten Luft und der Rate (F_4) der Dampferzeugung anspricht.

Revendications

1. Système de commande pour un échangeur de chaleur (1) dans lequel de la chaleur est échangée entre deux conducteurs de la chaleur, le système de commande comprenant :

un moyen de production (21) pour produire un signal de commande de précompensation correspondant à une valeur calculée (ΔH_c) de la chaleur devant être absorbée dans l'un des conducteurs de la chaleur à partir de l'autre afin de maintenir un paramètre dudit un conducteur de la chaleur quittant l'échangeur de chaleur à une valeur prédéterminée ; et

un moyen de réglage (8) commandé par le signal de précompensation pour ajuster l'absorption de chaleur par ledit un conducteur de la chaleur ; caractérisé en ce que :

un calculateur de régression (13) est mis en oeuvre pour actualiser les valeurs des coefficients (a, b, c, d) dans une équation de régression non linéaire multivariables résultant des variations dans les variables du système et pour fournir des signaux indicatifs desdits coefficients actualisés ; les moyens de production (21) sont mis en oeuvre pour produire un signal de point de consigne de débit de refroidissement de précompensation (F_{2c}) basé sur lesdits coefficients actualisés et correspondant à la quantité calculée de chaleur (ΔH_c) devant être absorbée dans ledit un conducteur de la chaleur à partir de l'autre pour maintenir l'enthalpie dudit un conducteur de la chaleur quittant l'échangeur de chaleur (1) à la valeur prédéterminée ; et

le moyen de réglage (8) est sensible au signal de point de consigne de débit de l'agent de refroidissement de précompensation (F_{2c}) pour régler l'absorption de chaleur dans ledit un conducteur de la chaleur en réglant la vitesse d'écoulement (F_{2A}) d'un agent de refroidissement modifiant l'enthalpie dudit un conducteur de la chaleur.



2. Système selon la revendication 1, comprenant un moyen (27, 31) pour produire un signal de commande de contre réaction correspondant à la différence entre la température (T_4) dudit un conducteur de la chaleur quittant l'échangeur de chaleur (1) et une température de point de consigne prédéterminée (29), et un moyen (23) sous le contrôle dudit signal de commande de contre réaction pour modifier ledit signal de point de consigne de débit de l'agent de refroidissement de précompensation (F_{2c}) comme cela est requis pour maintenir la température (T_4) dudit un conducteur de la chaleur sortant de l'échangeur de chaleur (1) à la température de point de consigne prédéterminée (29).

3. Système selon la revendication 1 ou la revendication 2, pour un échangeur de chaleur (1) qui est un surchauffeur à convection chauffé par des gaz brûlés à partir d'un générateur de vapeur chauffé aux combustibles fossiles, dans lequel le moyen de réglage (8) est mis en oeuvre pour ajuster la vitesse d'écoulement (F_{2A}) d'un agent de refroidissement modifiant l'enthalpie de la vapeur entrant dans le surchauffeur (1).

4. Système selon la revendication 1 ou la revendication 2, pour un échangeur de chaleur (1) qui est un surchauffeur à convection chauffé par des gaz brûlés à partir d'un générateur de vapeur chauffé aux combustibles fossiles, dans lequel le moyen de réglage (8) est mis en oeuvre pour ajuster la vitesse d'écoulement d'un agent de refroidissement sous la forme d'eau injectée dans la vapeur entrant dans le surchauffeur (1) et en modifiant par ce moyen l'enthalpie et la vitesse d'écoulement de la vapeur entrant dans le surchauffeur.

5. Système selon l'une quelconque des revendications 1 à 4, dans lequel le moyen de production (21) est connecté pour recevoir lesdits signaux indicatifs desdits coefficients actualisés et est sensible à la vitesse d'écoulement (F_4) dudit un conducteur de la chaleur à travers l'échangeur de chaleur (1) pour produire un signal de sortie (ΔH_c) variant dans une relation non linéaire par rapport à ladite vitesse d'écoulement (F_4).

6. Système selon la revendication 5, qui comprend un moyen de détermination d'un état stabilisé (14) sensible à ladite vitesse d'écoulement (F_4) se trouvant à l'intérieur de conditions d'état stabilisé présélectionnées pour fournir un signal représentant ladite vitesse d'écoulement (F_4) au calculateur de régression (13) pour permettre à ladite actualisation d'être effectuée en fonction d'une variation dans la vitesse de transfert de la chaleur entre les deux conducteurs de la chaleur.

7. Système selon la revendication 6, comprenant un détecteur de point de charge (17) connecté entre ledit moyen de détermination d'état stabilisé (14) et le calculateur de régression (13) pour fournir une répartition uniforme des données de points de charge au

calculateur de régression pour des charges autres que la charge de fonctionnement normal.

8. Système selon l'une quelconque des revendications 1 à 4, pour un échangeur de chaleur (1) qui est un surchauffeur à convection chauffé par des gaz brûlés issus d'un générateur de vapeur alimenté (5, 7) avec du combustible et de l'air pour la combustion, dans lequel le moyen de production (21) est connecté de façon à recevoir lesdits signaux indicatifs desdits coefficients actualisés et est sensible aux vitesses des écoulements de vapeur et de gaz brûlés dans le surchauffeur (1).

9. Système selon la revendication 8, dans lequel la vitesse d'écoulement des gaz brûlés est déterminé par un moyen sensible à la différence ($F_6 - F_4$) entre la vitesse d'écoulement (F_6) de l'air fourni pour la combustion et la vitesse (F_4) de production de vapeur.

