CLAIMS

1. Calibration process of a coffee beans roasting apparatus (X), in order to reproduce coffee beans roasting recipes defined with one specific master roasting apparatus (M),

said coffee beans roasting apparatus (X) comprising :

- a chamber (1) to contain coffee beans,
- a heating device (2) configured to supply hot air to the chamber,
- at least one first temperature probe (5) to measure the temperature of air supplied by the heating device, said first temperature probe being positioned outside the chamber,
- a control system (80) configured to control the heating device (2) and configured to reproduce roasting curves, said roasting curves providing at least a set of points ($T_{@ti}$; t_i) representing the temperature to be applied at discrete successive times t_i, respectively, said control of the heating device (2) implementing a feedback loop regulation based on the temperature T_{reg} measured by the at least one first temperature probe (5),

said calibration process comprising the steps of :

a - introducing at least one second temporary temperature probe inside the chamber of the roasting apparatus to be calibrated or replacing said chamber by a temporary calibration chamber, said temporary calibration chamber comprising at least one second temperature probe,

b - controlling the heating device to reproduce a preset curve R_{set}, said preset curve providing a series of points ($T_{set@ti}$; t_i) representing the temperature $T_{set@t1}$, $T_{set@t2}$, … $T_{set@tfinal}$ to be applied at preset corresponding successive times t_1, t_2, …, t_{final} respectively, said control being based on the temperature T_{reg} measured by the at least one first temperature probe (5),

c - during the reproduction of the preset curve R_{set}, measuring the temperature T_{cal} in function of time inside the chamber at the at least one second temperature probe enabling the determination of at least a set of points ($T_{cal@ti}$; t_i),

d - comparing the temperature $T_{cal@ti}$ measured at at least one time t_i with the temperature $T_{ref@ti}$ at said same time t_i of a pre-determined reference curve R_{ref} obtained with the master roasting apparatus (M), said reference curve R_{ref} representing the temperature T_{ref} measured in the chamber of the specific master apparatus (M) while controlling the heating device of the

master apparatus to reproduce said preset curve R_{set},

e - based on this comparison, calibrating the roasting apparatus (X) by applying a correction to the feedback loop regulation, preferably by applying a correction to the temperature T_{reg} measured by the first temperature probe (5) or by applying a correction to the temperatures $T@t_i$ provided by the roasting curves to be reproduced by the roasting apparatus (X).

2. Calibration process according to Claim 1, wherein :

- step d) happens simultaneously to step c), and

- in step c), during the reproduction of the preset curve R_{set}, at predefined times $t_{ref\ i}$, corresponding temperatures $T_{ref@tref\ i}$ and $T_{cal@tref\ i}$ are compared and a correction is immediately applied to the feedback loop regulation, preferably a correction is applied to the temperature T_{reg} regulated by the first temperate probe (5) or a correction is applied to the temperatures $T_{set@ti}$ provided by the preset curve R_{set},

- in step e), based on the last correction in step c), the roasting apparatus (X) is calibrated by applying said last correction to the feedback loop regulation, preferably by applying said last correction to the temperature T_{reg} measured by the first temperature probe (5) or by applying said last correction to the temperatures $T@t_i$ provided by the roasting curves to be reproduced by the roasting apparatus (X).

3. Calibration process according to Claim 1 or 2, wherein between step c) and step d) :

- the value of the temperature $T_{cal@ti}$ measured at the at least one second temperature probe at step c) is adjusted to an adjusted value $T_{cal@ti\text{-}adjusted}$, said adjusted value depending on the second temperature probe introduced inside the chamber of the roasting apparatus to be calibrated or on the temporary calibration chamber replacing the chamber of the roasting apparatus to be calibrated,

and

- in step d) this adjusted value $T_{cal@ti\text{-}adjusted}$ is compared with the temperature $T_{ref@ti}$.

4. Calibration process according to the precedent claim, wherein :

$$T_{cal@ti\text{-}adjusted} = K_{2probe}.(T_{cal@ti})^2 + K_{1probe}.T_{cal@ti} + T_{probe}$$

wherein :

T_{probe} corresponds to a preset temperature offset, said preset temperature offset being specifically pre-determined for the at least one second temporary temperature probe introduced inside the chamber of the roasting apparatus to be calibrated or for the temporary calibration chamber replacing the chamber of the roasting apparatus to be calibrated, or is equal to 0 by default,

$K1_{probe}$ and corresponds to a preset temperature ratio, said preset temperature ratio being specifically pre-determined for the at least one second temporary temperature probe introduced inside the chamber of the roasting apparatus to be calibrated or for the temporary calibration chamber replacing the chamber of the roasting apparatus to be calibrated, or is equal to 1 by default,

$K2_{probe}$ and corresponds to a preset temperature ratio, said preset temperature ratio being specifically pre-determined for the at least one second temporary temperature probe introduced inside the chamber of the roasting apparatus to be calibrated or for the temporary calibration chamber replacing the chamber of the roasting apparatus to be calibrated, or is equal to 0 by default.

5. Calibration process according to Claim 4, wherein, in step c), during the reproduction of the preset curve R_{set}, the value of T_{probe} and/or the value of $K1_{probe}$ and/or the value of $K2_{probe}$ varies with time and/or temperature.

6. Calibration process according to any one of the precedent claims, wherein :

- step d) happens simultaneously to step c), and

- in step c), during the reproduction of the preset curve R_{set}, at predefined times $t_{ref\ i}$, the corresponding ratio $T_{ref@tref\ i}/T_{cal@tref\ i}$ is calculated and a correction is immediately applied :
  . either to the temperatures T_{set} provided by the roasting curves to be reproduced, said correction being a multiplication factor Ki defined as follows :

$$K_i = K_0 \prod_{n=1}^{i} \frac{T_{ref@tref\ n}}{T_{cal@tref\ n}}$$

wherein :

$K0$ is preset, or is equal to 1 by default,

or

. to the temperature T_{reg} measured by the first temperature probe (5), said correction being a multiplication factor $\frac{1}{Ki}$,

- in step e), based on the last defined ratio Ki in step c), the roasting apparatus (X) is calibrated by applying :

. said factor Ki of correction to the temperatures $T_{@ti}$ provided by the roasting curves to be reproduced by the roasting apparatus (X) or

. said factor $\frac{1}{Ki}$ to the temperature T_{reg} measured by the first temperature probe (5).

7. Calibration process according to the precedent claim, wherein, K_0 corresponds to :
- a preset factor specifically pre-determined for a series of similar manufactured apparatuses, or
- a preset factor pre-determined for specific ambient conditions, or
- a combination of said two preset multiplication factors.

8. Calibration process according to Claim 6 or 7, wherein, in step c), if for successive $t_{ref\ i}$ the corresponding calculated ratios $T_{ref@tref\ i}/T_{cal@tref\ i}$ converge to one fixed value, then step c) is stopped and the last calculated factor of correction Ki is used as the last defined ratio in step d).

9. Calibration process according to Claim 6 or 7, wherein, in step c), if for successive $t_{ref\ i}$ the corresponding calculated ratios $T_{ref@tref\ i}/T_{cal@tref\ i}$ do not converge to one fixed value, then the calibration process is stopped.

10. Calibration process according to any one of the precedent claims, wherein :
- the preset curve R_{set} is a curve established with the master roasting apparatus (M) for the roasting of beans of a specific type of coffee beans and a specific quantity of said coffee beans, and
- before step b), coffee beans of said specific type and said specific quantity are introduced inside the chamber of the roasting apparatus (X) or in the temporary calibration chamber, and
- in step b), the heating device is controlled to reproduce said preset curve R_{set} while the chamber of the roasting apparatus (X) comprises said coffee beans.

11. Calibration process according to Claim 1, wherein :

- the preset curve R_{set} is a curve established with the master roasting apparatus (M) for the roasting of beans of coffee of specific type of coffee beans and a specific quantity of said coffee beans, and

- before step b), coffee beans of said specific type and said specific quantity are introduced inside the chamber of the roasting apparatus (X) or in the temporary calibration chamber, and

- in step b), the heating device is controlled to reproduce said preset curve R_{set} while the chamber of the roasting apparatus comprises said coffee beans, and

- in step d), the temperature $T_{cal@ti}$ is compared with the temperature $T_{ref@ti}$ and the ratio $K_{final} = T_{ref@tfinal}/T_{cal@tfinal}$ is calculated at the final time t_{final} of the curves R_{ref} and R_{cal},

- in step e), a factor of correction corresponding to said calculated ratio is applied :

  . either to the temperatures T_{set} provided by the roasting curves to be reproduced, said correction being a multiplication factor K_{final}

or

  . to the temperature T_{reg} measured by the first temperature probe said correction being a multiplication factor $\frac{1}{Kfinal}$

and wherein optionally the steps a) to e) are reproduced at least one time.

12. Calibration process according to any one of Claims 1 to 9, wherein :

- the preset curve R_{set} is a curve established with the master roasting apparatus (M) for the roasting of granular inert objects, said granular inert objects being designed to simulate coffee beans, and

- before step b), said granular inert objects are introduced inside the chamber of the roasting apparatus (X) or in the temporary calibration chamber, and

- in step b), the heating device is controlled to reproduce said preset curve R_{set} while the chamber of the roasting apparatus comprises said granular inert objects.

13. Calibration process according to any one of Claims 1 to 9, wherein :

- the preset curve R_{set} is a curve established with the chamber of the master roasting apparatus (X) void of beans,

- in step b), the heating device is controlled to reproduce said preset curve R_{set} while the chamber of the roasting apparatus is void of beans.

14. Calibration process according to the precedent claim, wherein the preset curve R_{set}, providing set of points ($T_{set@tset\ i}$; $t_{set\ i}$) comprises successively :

- in a first phase, a plateau of the temperature T_{set} at a fixed temperature $T_{set\text{-}stab}$, preferably of about 40°C, then
- in a second phase, an increase of temperature T_{set} from $T_{set\text{-}stab}$ to a higher temperature $T_{set\text{-}high}$, then
- in a third phase, a plateau of the temperature T_{set} at said temperature $T_{set\text{-}high}$.
- optionally the reproduction of the second and third phases at a higher temperature than $T_{set\text{-}high}$.

15. Calibration process according to any one of the precedent claims, wherein after step c) where the preset curve R_{set}, is reproduced, the roasting apparatus is cooled down to a temperature of about 40°C.

16. Coffee beans roasting apparatus comprising :
- a chamber (1) to contain coffee beans,
- a heating device (2) to heat air supplied to the chamber,
- at least one first temperature probe (5) to regulate the temperature supplied by the heating device, said first temperature probe being positioned outside the chamber,
- a control system (80) configured to control the heating device and configured to reproduce roasting curves, said roasting curves providing at least a set of points ($T@t_i$; t_i) representing the temperature to be applied at discrete successive times t_i, respectively, said control of the heating device implementing a feedback loop regulation based on the temperature T_{reg} measured by the at least one first temperature probe (5),

wherein said apparatus comprises means to introduce temporary at least one second temperature probe inside the chamber of the roasting apparatus or is configured to enable the temporary replacement of the chamber by a calibration chamber, said calibration chamber comprising at least one second temperature probe, and

wherein the control system is configured to receive input of measured temperature by said second temperature probe, and

wherein the control system is operable to implement the calibration process of any one of Claims 1 to 15.

17. A computer program comprising instructions which, when executed by a computer, processor or control unit, cause the computer, processor or control unit to perform the calibration process of any one of Claims 1 to 15 in coffee beans roasting apparatus.

18. A computer readable storage medium comprising instructions which, when executed by a computer, processor or control unit cause the computer, processor or control unit to carry out the calibration process of any one of Claims 1 to 15.