ROBOTIC SYSTEM AND METHOD FOR THE CLEANING OF CASTING LADLES IN ELECTRIC ARC FURNACES

In the smelting process, the electric furnace is intended to treat the slag from other furnaces. The slag loading of the electric furnace is carried out using a ladle which cools down after unloading the slag which is adhered to the ladle making it difficult to reload the furnace. For this reason, the ladle must be cleaned on a regular basis. Due to the above, a robot system and method have been developed to clean the electric furnace ladle, which is capable of carrying out such activity automatically through the use of a robotic manipulator.

The robotic system is composed mainly of an anthropomorphic robotic manipulator of at least 6 degrees of freedom (1), and one cleaning tool (2) which allows to clean the ladle (3) each time the furnace is loaded (4).
FIG 2
ROBOTIC SYSTEM AND METHOD FOR THE CLEANING OF CASTING LADLES IN ELECTRIC ARC FURNACES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of provisional patent application Ser. No. 60/734,980 filed 2005 Nov 10 by the present inventor.

FEDERAL SPONSORED RESEARCH

Not Applicable

SEQUENCE LISTING OR PROGRAM

Not Applicable

BACKGROUND

1. Field of Invention

This invention relates to the use of robotic technology in mining industry, specifically in the electric arc furnaces.

2. Prior Art

In the metal smelting processes, the smelting furnaces are used and are intended to smelt metals and/or concentrates of metals for purifying and extracting it. These furnaces use the heat generated by the oxidation reactions at high temperatures, obtaining 2 stages: a stage rich in valuable metal, called matte and other stage which is poor in valuable metal called slag. In general terms, the smelting furnaces operate on a continuous basis, while the matte and the slag is unloaded to bins through batch processes through opening and closing the corresponding bin.

The slag generated from this smelting process feeds an electric furnace which is intended to treat the slag from the fusion and conversion furnaces. For these purposes, the slag from these other furnaces is constantly loaded through a reception ladle. When the slag cools off, it solidifies and adheres to the reception ladle which decreases the effective area through which the furnace is fed. This means that the furnace cannot be loaded on a constant basis if the ladle is not cleaned which means the furnace production is reduced.

One of the main disadvantages of the tasks associated to the cleaning of ladles is the exposure of the personnel to harsh environmental conditions. This, in the medium and long term could generate serious occupational diseases to the operators in charge of carrying out this task.

SUMMARY

A robotic system and method have been developed for cleaning the ladle of the electric furnace, capable of carrying out such activity in an automated way.

DRAWINGS—FIGURES

In the drawings, closely related figures share the same numbers, with different alphabetic suffixes.

FIG. 1. General view of a robot system for cleaning the ladle in the electric furnace

FIG. 2. General view of a robot system for cleaning the ladle in the electric furnace

FIG. 3. General layout of a robotic system for cleaning procedures of the ladle in the electric furnace

DRAWINGS—REFERENCE NUMERALS

1. Robotic manipulator

2. Gripping mechanism

3. Cleaning Tool

4. Ladle

DETAILED DESCRIPTION

This invention relates to a new robot system as well as a robotic method for cleaning procedures of the ladle in the electric furnace, which are carried out automatically through anthropomorphous robotic arms of at least 6 degrees of freedom for the cleaning of the ladle after each discharge of the bin.

With reference to FIG. 1, FIG. 2, and FIG. 3, the robot system for the cleaning of the ladle in the electric furnace is composed mainly of one robotic manipulator of at least 6 degrees of freedom (1), provided with a communication, acquisition and control system and a gripping mechanism (2) to allow to take, manipulate, and release a tool (3), which is used for cleaning processes of all the ladle surface (4), after each discharge of the bin.

I claim:

1. A robot system for cleaning the ladle in the electric furnace, comprising an anthropomorphic robotic arm of at least 5 degrees of freedom, one control, communication and programming unit, one gripper adapter, one pneumatic gripper mechanism, one pneumatic gripper driving system, one electric supply system, one fixed or mobile tool holder, one device or tool for cleaning the reception ladles wherein the anthropomorphic robotic arm of at least 5 degrees of freedom is provided with a gripping mechanism which allows in a sequential and programmed way to take the cleaning device or tool which are placed at the fixed and/or mobile tool holder located near the robotic manipulator and which will used for the cleaning of all the surface of the reception ladle after each discharge of the pot at the smelting furnace.

2. A robot system for cleaning the ladle in the electric furnace according to claim 1, wherein the system has the capacity to take, manipulate and release the cleaning device or tool in different paths within the work volume of the robotic manipulator.

3. A robot system for cleaning the ladle in the electric furnace according to claim 1, wherein the robotic manipulator is mounted on a fixed and/or mobile system which allows in a sequential and programmed way to approach or move away from the reception ladle of the slag cleaning furnace in order to carry out the cleaning process of the reception ladle.

4. A robot system for cleaning the ladle in the electric furnace according to claim 1, wherein the anthropomorphic robotic manipulator could communicate by itself or through a PLC interface with the control system.

5. A robot system for cleaning the ladle in the electric furnace according to claim 1, wherein the anthropomor-
phous robotic manipulator has the capacity to obtain and interpret the information from installed analogue and/or digital sensors.

6. A robotic system for cleaning the ladle in the electric furnace according to claim 1, wherein the anthropomorphic robotic manipulator has the capacity to generate analogue and/or digital signals to control analogue and/or digital input devices.

7. A robotic system for cleaning the ladle in the electric furnace according to claim 1, wherein the robotic manipulator has a gripping mechanism, whether pneumatic, electrical and/or hydraulic, so such device allows in a sequential and programmed way to take, manipulate and release the device or tool for cleaning the reception ladle.

8. A robotic system for cleaning the ladle in the electric furnace according to claim 1, wherein it uses a fixed and/or mobile tool holder from which the manipulator takes in a sequential and programmed way the device and tool to be used in the cleaning of reception ladles.

9. A robotic system for cleaning the ladle in the electric furnace according to claim 1, wherein it uses a device or tool located in the tool holder in such a way that the robotic manipulator takes it in a sequential and programmed way, for cleaning the reception ladles so as once this task is ended, it is deposited again in the tool holder.

10. A robotic system for cleaning the ladle in the electric furnace according to claim 1, wherein the anthropomorphic robotic manipulator has an electrical and/or hydraulic system driven by three-stage induction motors, with vectorial and/or scalar control.

11. A robotic system for cleaning the ladle in the electric furnace according to claim 1, wherein it could be integrated to the cleaning process of any type of ladles for slag smelting, conversion and cleaning processes both copper and other metals such as iron, zinc, nickel, silver, gold, tin, lead, etc.

12. A robotic system for cleaning the ladle in the electric furnace according to claim 1, wherein the system may operate automatically, or semi-automatically, and also allows solutions scalability.

13. A robotic method for cleaning the ladle in the electric furnace using the robot System of claim 1 to 12, wherein the anthropomorphic robotic manipulator of at least 5 degrees of freedom is provided with a gripping mechanism so as to take in a sequential and programmed way the cleaning device or tool which is placed on the fixed and/or mobile tool holder located near the robotic manipulator to be used for carrying out the cleaning process of all the surface of the reception ladle after each discharge of bin in the smelting furnace.

14. A robotic method for cleaning the ladle in the electric furnace using the robot System of claim 1 to 12, wherein the robotic manipulator has the capacity to take, manipulate and release the cleaning device or tool in different paths within the work volume of the robotic manipulator.

15. A robotic method for cleaning the ladle in the electric furnace using the robot System of claim 1 to 12, wherein the anthropomorphic robotic manipulator could communicate by itself or through a PLC interface with the control system.

16. A robotic method for cleaning the ladle in the electric furnace using the robot System of claim 1 to 12, wherein the anthropomorphic robotic manipulator has the capacity to obtain and interpret the information from installed analogue and/or digital sensors.

17. A robotic method for cleaning the ladle in the electric furnace using the robot System of claim 1 to 12, wherein the anthropomorphic robotic manipulator could communicate by itself or through a PLC interface with the control system.

18. A robotic method for cleaning the ladle in the electric furnace using the robot System of claim 1 to 12, wherein the robotic manipulator is mounted on a fixed and/or mobile system which allows in a sequential and programmed way to approach and/or move away the reception ladle of the slag cleaning furnace to clean the reception ladle.

19. A robotic method for cleaning the ladle in the electric furnace using the robot System of claim 1 to 12, wherein the robotic manipulator may use a gripping mechanism, whether pneumatic, electric and/or hydraulic, in such a way that such device allows in a sequential and programmed way to take, manipulate and release the cleaning device or tool to be used in the cleaning process of the reception ladle.

20. A robotic method for cleaning the ladle in the electric furnace using the robot System of claim 1 to 12, wherein it uses a fixed and/or mobile tool holder from which the robotic manipulator takes in a sequential and programmed way the device or tool to be used in the cleaning process of the reception ladle.

21. A robotic method for cleaning the ladle in the electric furnace using the robot System of claim 1 to 12, wherein it uses a device or tool which is located in the tool holder so as the robotic manipulator takes it in a sequential and programmed way to carry out the cleaning processes of the reception ladles so as once such task has ended, it is deposited back into the tool holder.

22. A robotic method for cleaning the ladle in the electric furnace using the robot System of claim 1 to 12, wherein it could be integrated to the cleaning of any type of ladles in the slag smelting, conversion and cleaning processes both of copper and other metals such as iron, zinc, nickel, silver, gold, tin, lead, etc.

23. A robotic method for cleaning the ladle in the electric furnace using the robot System of claim 1 to 12, wherein the system may operate automatically or semi-automatically, and also allows solution scalability.

24. Device or tool for cleaning the ladle in an electric furnace using the robot System of claim 1 to 12, wherein it has a geometry which fits the feeding ladle and it is located in the tool holder so as the robotic manipulator takes it in a sequential and programmed way to carry out the cleaning process of the ladle in the electrical furnace, so as once such task has ended it is deposited back into the tool holder.

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