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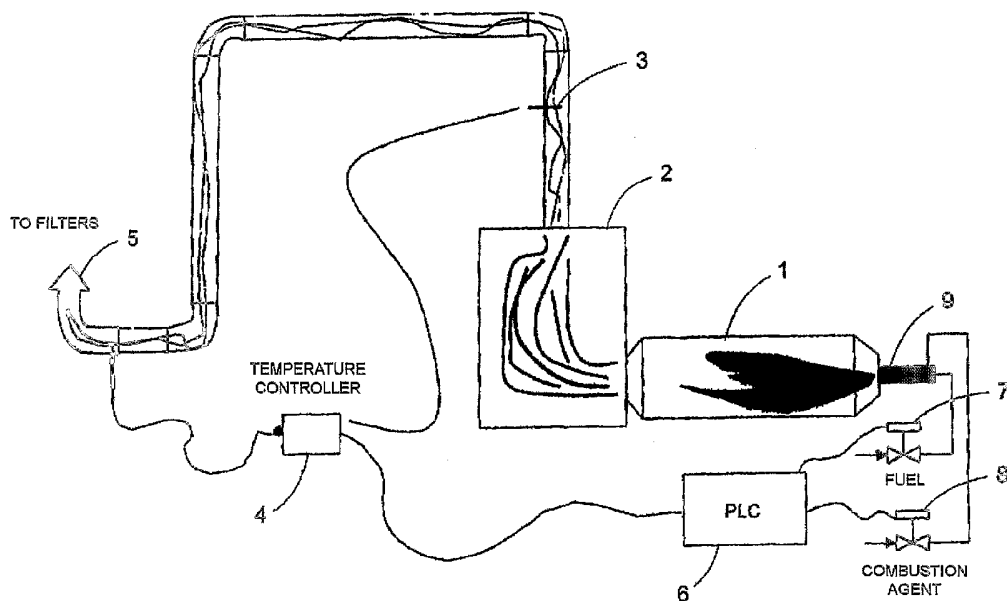
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(54) Title: PROCESS FOR MELTING AN ALUMINUM CHARGE CONTAINING ORGANIC MATERIAL



(57) Abstract: In a process for the melting of an aluminum charge in a melting furnace, the A1 charge contains organic materials or an organic charge is provided into the furnace. The combustion of the organic charge is carried out with an oxyfuel burner wherein the oxygen/fuel ratio in the burner is such that there is an excess of oxygen which provides an oxidizing atmosphere in the melting furnace. The heat content of the organic loading is used for melting A1 and the furnace yield is increased.

PROCESS FOR MELTING AN ALUMINIUM CHARGE CONTAINING ORGANIC MATERIAL

This invention relates to a process for melting an aluminum charge that comprises melting said aluminum charge in a furnace by supplying fuel and oxygen at least through a burner.

Various types of aluminum melting furnaces, whose energy supply method is qualitatively determined as a function of the type of furnace used, are known.

Thus, for example, an electric induction furnace carries out the melting of an aluminum charge by current induced and governed by an electrical system. This induced current deposits energy on the aluminum charge in order to melt it, and thus the "characteristic source" of energy in this case is electrical energy.

In addition, there are aluminum melting furnaces that use combustion as their "characteristic source" of energy. These can be of many types, each of which is adapted to the requirements of production.

Reverberatory furnaces, dry hearth furnaces, and rotary furnaces are among the most common melting furnaces.

In reverberatory furnaces, one or more burners reverberates its flame over the aluminum charge to be melted, producing a change in the state of the aluminum and heating it to the process temperature for ensuing degasification or alloying, as appropriate. These furnaces can tilt in order to take off the aluminum.

In addition, dry hearth furnaces are characterized by having one or more burners that change the state of the aluminum from solid to liquid over a hearth from which the aluminum flows to a principal hearth, where the liquid aluminum is heated to its process temperature, alloyed, and degasified.

Finally, rotary furnaces are characterized by having a burner and a system for rotating the horizontal axis of the furnace. They are normally melting furnaces that

decant the molten aluminum to another furnace where its temperature is raised up to the process temperature and it is degasified and/or alloyed.

The "characteristic energy" in the aforementioned combustion furnaces is supplied by a burner that burns a fossil fuel with air, oxygen-enriched air, or pure oxygen; it is therefore of chemical origin.

However, it should be pointed out that in all the cases mentioned, aluminum melting is carried out at an oxygen deficit in order to minimize aluminum losses due to oxidation.

In recent years, aluminum foundries have improved their production yields out of concern for the environment. Combustion with oxygen-enriched air and combustion with pure oxygen have substantially reduced the pollution rates of the furnaces, both in the level of gas emissions and in their quality. Solid particles have been reduced as a result of offgas filtration systems and also the use of oxycombustion.

The secondary melting of aluminum is normally carried out in combustion furnaces whose burners use a hydrocarbon burned in air, enriched air, or oxygen as "characteristic energy". It must be taken into account that aluminum charges are usually composed of aluminum scrap and aluminum slag that can be quite rich in free metal.

Aluminum scrap usually comes from the aluminum shop sector and normally carries adhered organic material, such as lacquers, varnish, paint, oil, plastic, emulsions, and other compounds of organic origin that contain significant energy ranging from 4,000 to 12,000 kcal/kg depending on the type and that, when loaded in a furnace that cannot completely burn them, will produce a large quantity of uncombusted substances such as CO, H₂, and C that upon passing through the flue put the offgas filtration and purification equipment to the test.

The oxidation of aluminum, like that of all metals, basically depends on the following factors:

- Partial pressure of the oxidants in the “medium”.
- Temperature of the aluminum.
- The time the aluminum is exposed to the medium.

Aluminum oxide is not reducible to metallic aluminum by pyrolysis processes because it leaves the furnace with the ash with a concomitant reduction in the metal yield of the melt.

Thus, for example, for a furnace charge made up of 100% aluminum scrap, analysis of the offgas leaving the furnace has shown it to contain up to 20% carbon monoxide and up to 6% hydrogen, in addition to a quantity of carbon in the form of nonquantified soot.

However, the prior art methods used to prevent the release of volatiles are based on improving filtration and offgas purification equipment at the outlet from the flue of the melting furnace.

It is therefore evident that there does not yet exist a process for the melting of aluminum that enables a reduction in carbon monoxide and hydrogen emissions to values significantly lower than those of the prior art. More specifically, to date no process for the melting of an aluminum charge has been found that enables a reduction in carbon monoxide and hydrogen emissions and, at the same time, enables a reduction in the formation of aluminum oxide during the melting of aluminum in a combustion furnace.

In this invention, “aluminum charge” means aluminum that is placed in a combustion furnace for the purpose of melting the aluminum. Generally, this aluminum comes from aluminum scrap that may or may not be contaminated with organic products comprising primarily lacquer, varnish, paint, oil, and plastics, to cite the most usual.

In this invention, "organic charge" means organic product that can be used as fuel due to its high energy content. Generally, the organic charge is composed of lacquer, varnish, paint, oil, and plastics and can be present in the aluminum charge or can be added separately to said aluminum charge.

5 In this invention, "oxygen/fuel ratio at the burner" denotes the ratio that exists between the oxygen and the fuel at the burner, regardless of whether the oxygen is supplied together with the fuel at the entrance to the burner or is supplied by a circuit independent of the burner in such a way that the ratio of the fuel leaving the burner and the oxygen supplied at this point together provide an oxidizing atmosphere.

10 The object of this invention is to resolve the problems in the prior art by developing a process that makes it possible to take advantage of the energy from the organic charge whether or not said organic charge is inherent to the aluminum charge, while at the same time minimizing the losses of aluminum oxide that can occur during the melting of the aluminum charge.

15 In keeping with this object, the process of the invention for the melting of an aluminum charge is characterized by the fact that an organic charge is included and by the fact that the combustion of said organic charge is carried out using an oxygen/fuel ratio at the burner that creates an oxidizing atmosphere in the melting furnace.

Unexpectedly, despite introducing an excess of oxygen into the aluminum melting
20 furnace and increasing the oxidizing power of the medium, the inventive process makes it possible to obtain better aluminum yields than in the conventional process due to the fact that, by increasing the energy efficiency of the furnace and therefore the speed of aluminum melting, the time that the aluminum is exposed to the medium is less than in the conventional process.

25 It is known that aluminum oxide formation depends on the temperature of the aluminum, the partial pressure of the oxidizing agents in the medium, and the time that

the aluminum is exposed to the medium, with the lattermost being the variable that most directly influences aluminum oxide formation.

The process of the invention advantageously increases the thermal yield and reduces aluminum losses due to oxidation by reducing the aluminum/medium contact time.

The reduction in the aluminum/medium contact time is achieved by using the organic charge that is inherent in the aluminum charge or is added to the aluminum charge as fuel, which when burned adequately with oxygen supplies available energy to the aluminum charge.

The process of the invention therefore enables a substantial reduction in the release of volatiles at the flue outlet, resulting from an environmental point of view in a much cleaner process than the conventional processes used to date.

It is known that when aluminum scrap is loaded into the furnace, the organic material begins to release combustible volatiles that exit the furnace through the flue toward the offgas purifier along with the other gases resulting from combustion at the burner. Combustible gases such as carbon monoxide and hydrogen and carbon in the form of soot travel with the total mass of combustion gases during extraction of offgas from the furnace, and along their path encounter oxygen molecules that have not yet combined with molecules that react to generate temperature in the flue.

According to tests done during the investigation, a proportional correlation exists between the quantity of reducers at a point in the flue and the temperature at said point such that when there is a higher concentration of CO, H₂, and C, the temperature is higher, and vice versa.

For this reason, the invention proposes a process for the melting of aluminum in which combustion of the organic charge inherent in or added to the aluminum charge takes place using an oxygen/fuel ratio at the burner that provides an oxidizing atmosphere in the melting furnace.

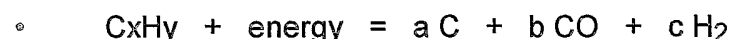
In this way, an increase in the oxygen partial pressure in the furnace is obtained with the result that combustion of the organic charge takes place within the furnace rather than in the offgas outlet flue. Combustion of the organic material in the furnace supplies available energy to the aluminum charge and in so doing results in an increase in the speed of aluminum melting and at the same time in a reduction in the time that the aluminum is exposed to the medium and as a consequence in a substantial reduction in aluminum losses due to oxidation.

Once the organic charge has been burned in the furnace, the combustion system is controlled in such a way that the oxygen/fuel ratio at the burner creates a reducing atmosphere in the melting furnace, that is, aluminum melting continues by the conventional process.

However, in continuous melting processes in which organic charge can be introduced in a continuous or intermittent manner depending on the requirements of the system, the oxygen/fuel ratio at the burner will vary proportionally at each instant according to a reference temperature in the circuit for extraction of offgas from the furnace since the atmosphere in the melting furnace will be oxidizing at times and reducing at other times.

The process of the invention can therefore be successfully applied when the aluminum charge to the furnace is continuous as well as discontinuous and also when the organic charge is inherent to the aluminum charge or is added continuously or intermittently.

In the absence of the excess oxygen supplied according to the invention, molecules of organic compounds decompose according to the following equation:



In the presence of excess oxygen that continuously controls the process of the invention, the equation that takes place is the following:



The process produces a surprising and unanticipated effect since by increasing the oxygen ratio, excess oxygen combines with the uncombusted products CO, H₂, and C from organic material, burning them completely inside the furnace and preventing them from entering the flue. In this way the temperature at the selected
5 checkpoint decreases, re-establishing the normal ratios at the burner.

For a better understanding of what has been presented, a figure is attached that illustrates, schematically and only as a non-limiting example, a practical case of implementation.

10 Said figure shows a melting furnace control system that conforms to the process of the invention.

An aluminum charge that contains an inherent organic charge is placed in the melting furnace 1. The burner 9, which is supplied with fuel through valve 7 and with oxygen as combustion agent through valve 8, is ignited. The temperature of the
15 combustion gases 2 is detected by a temperature sensor 3 installed in the flue of the melting furnace. This temperature sensor 3 transmits a signal to a temperature controller 4 in which a set point has been pre-set based on the distance from the point to the offgas exit from the furnace 5. Said controller 4 has an output of 4 - 20 mA across an automatic PLC 6 that can effect the progressive closure of the globe valve 7
20 that supplies fuel or the progressive opening of the globe valve 8 that supplies oxygen. This configuration serves to increase the oxygen partial pressure in the furnace, which makes it possible to complete all the combustion of the organic charge within the furnace, which leads to a substantial reduction in the specific consumption of
"characteristic energy" by the system.

25 Notwithstanding the fact that a specific embodiment of this invention has been described and represented, it is evident that an expert in this field will be able to

introduce variants and modifications or substitute other technical equivalents for the details, without departing from the scope of protection defined by the attached claims.

For example, although a system has been schematically represented for the discontinuous supply of the aluminum charge, it is clear that the supply of an aluminum charge and an organic charge in a continuous regime to a melting furnace is also part of the subject matter of this invention. In the same way, it is clear that the subject matter of this invention includes the substitution of air or oxygen-enriched air for oxygen.

10 EXPERIMENTAL TESTS

In the process of the invention, an aluminum charge is melted, in a known manner, while supplying fuel and also supplying oxygen as a combustion agent at a maximum ratio, for example, of 2.3 for oxygen/natural gas, 5.3 for oxygen/propane, or 2.4 for oxygen/fuel. The process is characterized by the existence of an inherent organic charge or one that is added to the aluminum charge for the furnace and as a result by combustion of the characteristic fuel at ratios higher than those cited. Thus, for example, the following oxygen/fuel ratios can be used: 1.8 - 5 for oxygen/natural gas, 4 - 10 for oxygen/propane, and 1.9 - 4.5 for oxygen/fuel oil.

The process of the invention has been tested in a rotary furnace (capacity = 17 Tm) equipped with an oxy-natural gas burner. The combustion system was automated and had globe supply valves and all the safety devices inherent to this type of equipment.

The strategy of conservation of the characteristic fuel was used during the tests, that is, "excess temperature in the flue, natural gas valve with progressive closure until re-establishment of the temperature according to the set point".

The final results are reported in the following table:

PARAMETERS	CONVENTIONA L	INVENTION	DIFFERENCE
BURNER TIME	3.25 HOURS	2.5 HOURS	-23%
NATURAL GAS CONSUMPTION	58 m ³ /Tm Al	37 m ³ /Tm Al	-13.50%
OXYGEN CONSUMPTION	95 m ³ /Tm Al	95 m ³ /Tm Al	0
MELTING RATE	5.23 Tm/hr	6.8 Tm/hr	30%
OFFGAS TEMPERATURE	515°C	352°C	-32%

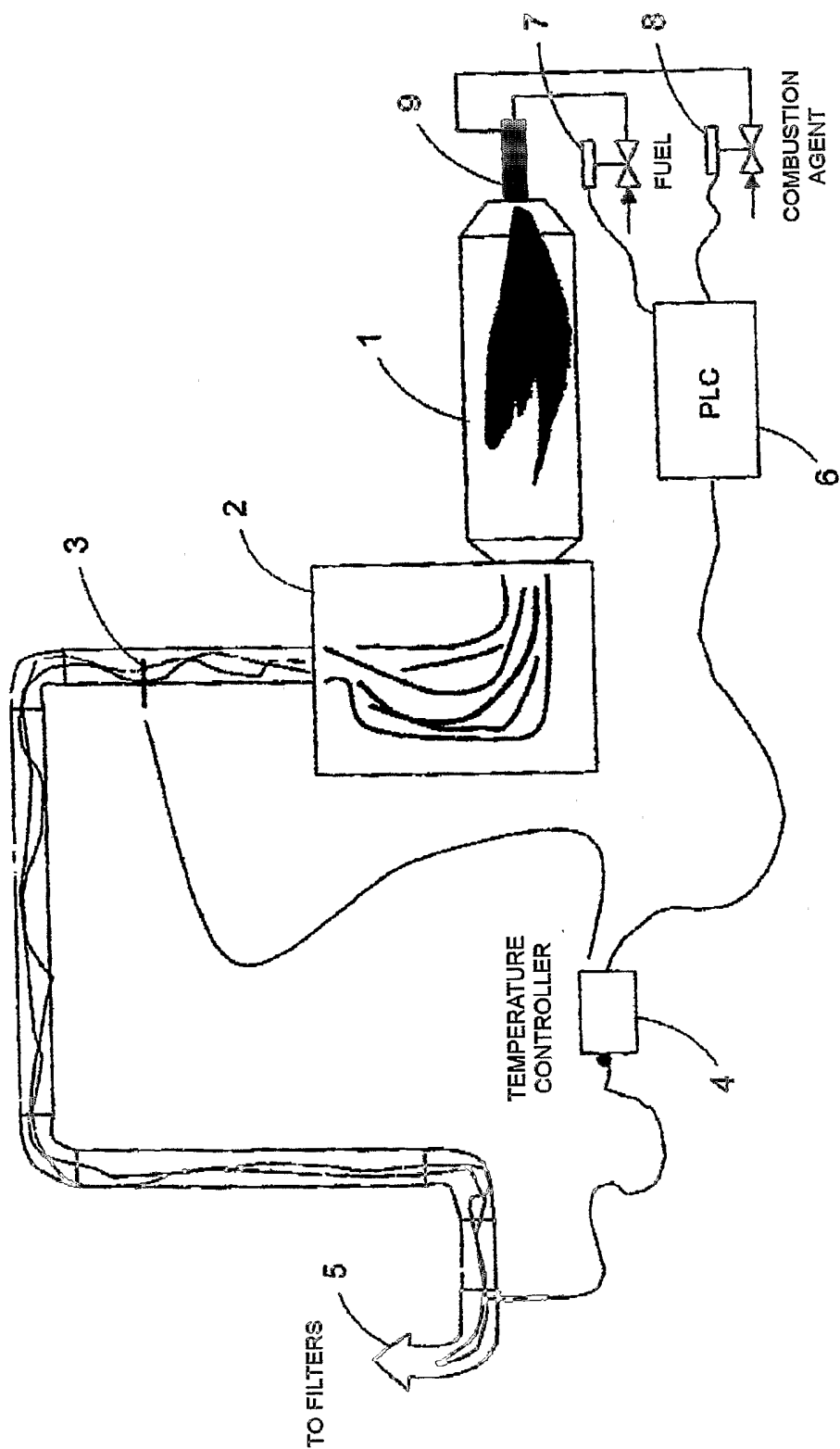
The first column in the preceding table shows the parameters that have been taken into consideration. The second column shows the values obtained according to a conventional process in a melting furnace. The third column shows the values obtained according to the inventive process. The fourth column reports the difference between the values afforded by the inventive process and the values from the literature or from the prior art.

Based on the values in the preceding table, it can be observed that the inventive process has resulted in an increase in the melting rate by 30%, a decline in the specific consumption of natural gas by 13.5%, and a decline in the exit temperature of the offgas at the flue of more than 30%.

The process of this invention therefore clearly solves the problems associated with the prior art in addition to providing additional advantages such as a reduction in the melting time, a reduction in fuel consumption, an increase in the aluminum melting speed, and a significant reduction in the temperature of the offgas at the flue exit and as a result in the release of volatiles.

CLAIMS

1. Process for the melting of an aluminum charge in a melting furnace, characterized by the fact that an organic charge is included and by the fact that the combustion
5 of the organic charge is carried out using an oxygen/fuel ratio at the burner that provides an oxidizing atmosphere in the melting furnace.
2. Process according to claim 1, characterized by the fact that the organic charge is inherent to the aluminum charge.
- 10 3. Process according to claim 1, characterized by the fact that the organic charge is added to the aluminum charge.
4. Process according to claim 1, characterized by the fact that the organic charge is
15 introduced into the furnace by a process of continuous charging.
5. Process according to claim 1, characterized by the fact that the oxygen/fuel ratio at the burner is proportional at each instant to a reference temperature in the offgas take-off circuit of the furnace.
- 20 6. Use of an oxygen/fuel ratio at the burner of a furnace for aluminum melting that provides an oxidizing atmosphere in the melting furnace.
7. Use in a process for the melting of an aluminum charge of an excess of oxygen in
25 order to burn the organic charge inherent in or added to said aluminum charge in order to increase the energy yield and reduce the emission of reducers to the flue



INTERNATIONAL SEARCH REPORT

International Application No

PCT/IB 03/01053

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C22B21/00 C22B9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C22B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 245 122 B1 (MEYERS FREDERICK N) 12 June 2001 (2001-06-12)	1-4,6,7
Y	column 1, line 30 -column 2, line 32; claims 1-10	5
Y	----- PATENT ABSTRACTS OF JAPAN vol. 017, no. 146 (C-1039), 24 March 1993 (1993-03-24) & JP 04 314835 A (DAIDO STEEL CO LTD), 6 November 1992 (1992-11-06) abstract	5
A	----- US 3 759 702 A (HORAK E) 18 September 1973 (1973-09-18) column 1, line 42 -column 2, line 19 ----- -/--	1



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

° Special categories of cited documents :

A document defining the general state of the art which is not considered to be of particular relevance

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P document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

* & * document member of the same patent family

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/IB 03/01053

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 009, no. 271 (C-311), 29 October 1985 (1985-10-29) & JP 60 121235 A (FURUKAWA DENKI KOGYO KK), 28 June 1985 (1985-06-28) abstract ----	6
A	PATENT ABSTRACTS OF JAPAN vol. 017, no. 108 (C-1032), 5 March 1993 (1993-03-05) & JP 04 293740 A (DAIDO STEEL CO LTD), 19 October 1992 (1992-10-19) abstract -----	1,2,6,7

INTERNATIONAL SEARCH REPORT

International Application No

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JP 04314835	A	06-11-1992	NONE	
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JP 60121235	A	28-06-1985	NONE	
JP 04293740	A	19-10-1992	NONE	