

[54] **METHOD AND APPARATUS FOR INJECTING OIL INTO THE TUYERES OF A BLAST FURNACE**

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[51] Int. Cl..... **C21b 5/00**

[58] **Field of Search**..... 266/41, 29, 30; 239/425, 239/426, 430, 431; 431/4, 8, 187; 75/41, 42, 11 S

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[57] **ABSTRACT**

A method and an apparatus for injecting oil into the tuyeres of a blast furnace preferably if the substitution ratio is above 50 to 100 kg oil/ton of pig iron. The oil is injected into the blast current with a speed at which it is not atomized when leaving the nozzle but injected as coherent jets, preferably in radial direction, maintaining their coherence a substantial distance in front of the nozzle. In this way the combustion of the oil is improved and its utilization can be increased to far greater amounts of oil which can be economically injected into the blast furnace in substitution of coke.

9 Claims, 3 Drawing Figures

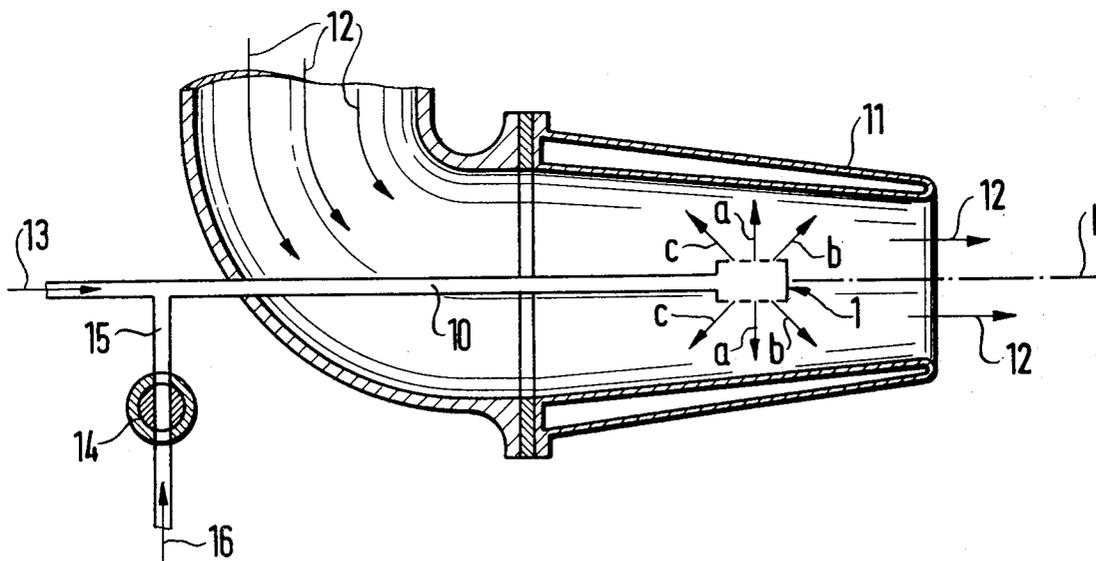


Fig. 1

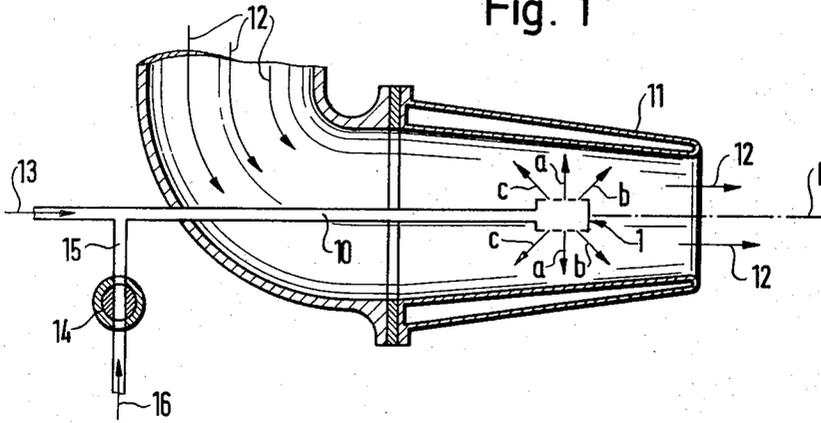


Fig. 2

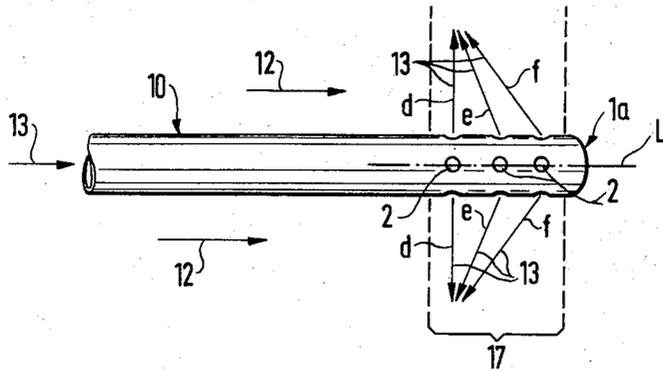
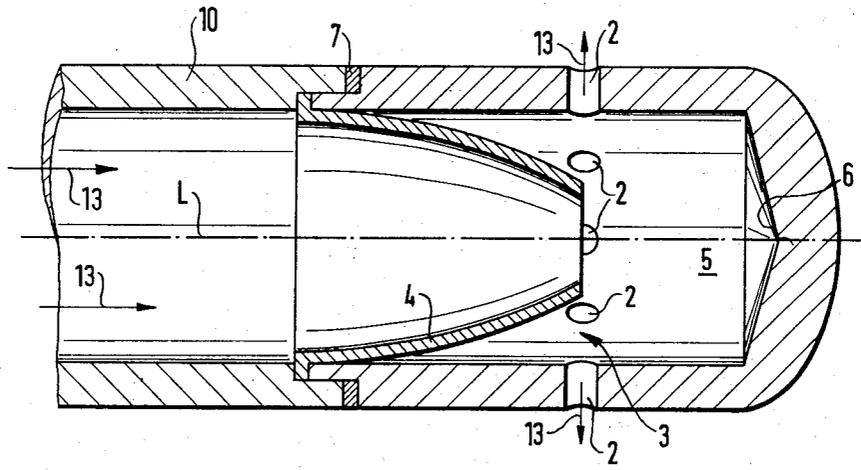


Fig. 3

METHOD AND APPARATUS FOR INJECTING OIL INTO THE TUYERES OF A BLAST FURNACE

BACKGROUND OF THE INVENTION

The invention relates to a method of adding fuel oil to a blast furnace, in which fuel oil is added to the stream of combustion air supplied by a tuyere, and to a device for carrying out this method.

It is known that the introduction of fuel oil instead of coke into the blast furnace is effected by spraying the fuel oil into the furnace blast, i.e. the combustion air supplied to the blast furnace, and this takes place inside the tuyeres.

However, the economics of adding fuel oil are considerably limited, because above a certain amount of oil, generally above 50 to 100 kg oil/ton of pig iron, the substitution ratio, i.e. the amount of coke effectively replaced by the addition of oil falls from 1.5 to under 1.0 and below, and at the same time a thick black smoke occurs, which causes the undesirable settlement of soot coming from the fuel oil in the flue dust collector. This flue dust means wasted fuel.

Attempts have already been made to increase the amount of oil which can be added economically, by the addition to the fuel oil of additives, but this has had only limited success. Also a better atomization of the oil supply jets, which previously blew practically solely as a spray into the blast current, did not have the desired success. However, on the other hand, a spraying of this type, i.e. the addition of fuel oil to the furnace blast in the form of an oil spray of fine little droplets, which forms immediately before the oil jet, was not successful even if the oil supply jets had a radial direction component when being sprayed into the blast current. This is because the blast current has a comparatively high viscosity which is nearly the viscosity of the oil and the oil spray cannot be homogeneously distributed over a broad portion of the cross-section of the tuyeres ready to be completely burned just in the mouth of the tuyere. In the prior art method of injecting the oil as a spray the oil spray is compressed within the central area of the tuyeres and cannot be completely burned on its way out of the tuyere within about 500 microseconds between the moment of injection until passing the mouth area of the tuyere. Thus, only a fractional burning is achieved which is not complete and reduces the oil only to soot without heating effect, assuming more than 50 to 100 kg oil per ton of pig iron are added to the blast.

SUMMARY OF THE INVENTION

Despite an addition of fuel oil of up to about 100 kg oil/ton of pig iron or more, it is the object of the invention to obtain a favourable substitution ratio and thus to avoid the formation of thick black smoke, i.e. unnecessary losses by way of soot.

It is also an object of the invention to achieve a broad and improved homogeneous distribution of the substituted oil over the cross-section of the blast current within the tuyeres.

It is a further object of the invention to improve the injection of oil into the blast current by changing the manner of the injection of the oil and finding an advantageous ratio of the injecting speed of the oil in relation to the speed of the blast current.

Moreover it is an object of the invention to improve the construction of the nozzles injecting the oil into the blast current.

Surprisingly, according to the invention it has been found that this can be achieved if the oil is injected into the tuyere blast from the longitudinal centre of the tuyere in radial direction to the tuyere or at about right angles to the flow of the tuyere blast by means of at least one oil jet. There results an optimum economy, if up to 15 percent by weight, preferably up to 10 percent by weight of water or of water vapour is added to or injected with the oil.

In this case, the injection of the oil in radial direction should be understood to mean that the oil is injected and distributed over a considerably wider cross-section across the blast current than in the known methods. Moreover, by injection of the oil jet it is meant that the oil jet leaving the oil nozzle is not atomized into an oil spray or disintegrated into fine droplets by the blast immediately in front of the nozzle (as it is the case if the speed of the oil when leaving the nozzle is to low in comparison with the speed of the blast current), but the coherency of each oil jet is largely maintained to a greater distance in front of the nozzle, in order to achieve a maximum distribution of fuel oil across the blast current. Only in this way is it possible to distribute the fuel oil as widely as possible across the furnace blast, which at approximately 1,250° - 1,300° C has a comparatively high viscosity. On the basis of the wide distribution of the fuel oil according to the invention the disadvantage of the need of excessively more fuel is avoided which can result due to lowering the hearth temperature of the blast furnace. This considerably improved distribution of fuel oil is assured with the method according to the invention especially inside the tuyere or shortly in front of its orifice, since the possibility of any mixing occurring deeper in the hearth is limited on account of the relatively high viscosity of the flue gases in the blast furnace. In order to keep the oil jets compact to as far as possible in front of the oil nozzle, it is essential that the injection of the fuel oil takes place at a comparatively high injection speed of at least 20 m/sec compared with the ten times as great (200 m/sec) speed of the furnace blast. In this way the oil jets atomise only when there is an additional increase in their speed due to the blast speed, so that their reaction with oxygen occurs after a true mixing reaction, which is increased widely over the cross-section of the blast current.

The value of 20 m/sec for the injection speed of the oil depends, however, on the individual operation conditions of the furnace. Thus, the scope of the invention includes all such normal variations.

Despite the cooling as a result of cracking or cleavaging of the fuel oil caused initially with this fuel oil injection according to the invention, which cooling is also shifted in radial direction, if the temperature increase of the tuyere walls is too high under certain circumstances it can be further reduced by the addition of water vapour or preferably of water to the fuel oil. Thus, in addition to the effect of the water vapour or superheated steam as a combustion accelerator, there is also the cooling effect which occurs when it is added to fuel oil distributed in a considerably uniform manner over the entire cross-section of the tuyere.

Since the method according to the invention is based substantially on a better radial distribution of the fuel

oil injection, the advantages obtained therewith can also be obtained if the oil is injected radially and diagonally against the blast flow.

Similarly, with a different construction of the tuyeres an oil injection distributed uniformly over the tuyere cross-section by means of an injection undertaken from the periphery of the tuyere and occurring radially inwardly, can have advantages, although injecting the oil in radially outwardly direction is much more preferred.

A preferred, advantageous execution of the method is achieved with a device or an oil injection nozzle lance, whose nozzle tip is located in the vicinity of the longitudinal centre of a tuyere and which is characterised according to the invention in that the nozzle tip has several nozzles distributed over its periphery and directed in radial direction to the tuyere or in a direction with a considerable radial component or at a steep angle to the tuyere flow.

Thus, the individual oil nozzles preferably having a certain length in jetting direction can start from a central distribution chamber, in which there is located an oil-flow nozzle directed in axial direction, in front of which an eddy chamber is provided so that inside the distribution chamber a turbulence of the oil/water or steam mixture occurs.

Such a cooling of the oil injection lance is essential for the operation, because the high temperature of the furnace blast formerly led within a few seconds to a decomposition of the fuel oil within the lance and thus to a clogging of the oil nozzle.

With an axially elongated distribution chamber, the individual nozzles can be distributed over a greater axial length, whereby instead of only a relatively flat, radial injection plane, an axially extended injection zone can be formed, in which the individual nozzles can additionally inject with varying injection angles. Thus the longitudinal axes of the individual nozzles or their injection directions can intersect, so that the turbulence and atomization of the fuel oil, when having reached the radially outward area of the cross-section of the tuyere, is increased by mutual kinetic interference of the oil outlet jets. With axially distributed nozzles the lance tip is longer, so that no additional obstruction of the free cross-section of flow in the tuyere occurs. With the distribution of the nozzles axially over the lance head the individual nozzles can also be arranged offset in their angle relationship.

An additional cooling of the front end of the oil injection lance is achieved if the oil flow leaving an oil flow nozzle into the eddy chamber is directed against the inner surface of the front end of the distribution chamber in the blast direction.

Moreover the simple construction of the oil injection lance according to the invention allows a construction with which it can be exchanged easily and quickly in the tuyere.

The features according to the invention are moreover not limited to blast furnaces, but may be applied for all similar purposes.

The invention is described in detail in the following in various embodiments with reference to the drawings.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a schematic longitudinal sectional view of the oil injection according to the invention inside the tuyere of a blast furnace.

FIG. 2 is an enlarged longitudinal sectional view of a nozzle tip according to the invention; and

FIG. 3 is a schematic view of a modified nozzle tip having nozzles located in three different angular positions.

DETAILED DESCRIPTION OF INVENTION

According to FIG. 1 a nozzle lance 10, having an internal diameter of, for example, approximately 6 – 8 mm, projects, for example, into a water-cooled tuyere 11, through which there is injected into the hearth of a blast furnace the furnace blast 12 pre-heated, for example, to 1,000° C or more, having a speed, for instance, of 200–320 m/sec. The supply of oil 13 is effected by means of the nozzle lance 10. Supply pipe 15 admits measured amounts of water or steam 16 passing from needle valve 14 to lance 10. The amounts of water or steam 16 varying according to the method of operation of the blast furnace, which is already available for the indispensable pre-heating of oil having, for example, a pressure of 6 atmospheres. The added amount of water or steam can always be regulated in a different manner according to the method of operation of the blast furnace.

Generally, up to 15 per cent by weight of water or water vapour is sufficient relative to the amount of oil. However, in normal conditions, optimum efficiency lies in the addition of up to 10 per cent by weight of water or steam, whereby the increase in temperature, which is normally involved with the addition of oil can be stabilized.

The fuel oil 13 is injected through the nozzle tip, into the blast stream transverse to the direction of the flow at approximately 90° (arrow *a*). The oil injection direction according to the arrows shown schematically in FIG. 1 can also deviate a certain amount from the 90°-radial direction, either forwards (arrow *b*) or backwards (arrow *c*). The nozzle lance 10 or the nozzle tip 1 do not have to be located exactly co-axial the longitudinal central axis L, but can lie off-centre corresponding to the optimum direction of flow of the furnace blast. Moreover there can also be provided several nozzle tips 1 distributed radially.

The nozzle tip illustrated on an enlarged scale in FIG. 2 is releasably connected at 7 to the lance 10 and has a number, for example 6, 8 up to 12, of individual nozzles 2 directed radially outwardly, having a diameter, for example, of 3 mm and a noticeable length of bore. Through each tuyere and nozzle tip approximately 260 kg of fuel oil can be injected, at approximately 3 atmospheres excess pressure in the nozzle lance 10 with respect to the blast pressure, and a viscosity of 15 cSt having an outlet speed of approximately 20 – 25 m/sec. The distance of the nozzle tip 10 from the front tuyere aperture amounts to, 250 mm for example, with an average diameter of the tuyere of 200 – 300 mm.

The nozzle tip 1 has a central distribution chamber 3, from which the nozzles 2 start and into which an oil flow nozzle 4 can project, which supplies the oil 13 to the front end 6 of the distribution chamber 3 so that this end can be cooled. In front of the oil flow nozzle 4 there is thus set up simultaneously an eddy chamber

5, from which the oil 13 is injected out through the nozzles 2.

An axially extended nozzle tip 1a, according to FIG. 3 can also be used in which the fuel oil reaches the furnace blast 12 by means of an injection region 17 extending in axial direction of the tuyere. With this, the injection angle of the individual nozzles can also be directed obliquely according to the arrows *d*, *e* and *f* in FIG. 3, in particular obliquely or inclined to each other, so that at the same time as the more regular distribution of the oil supply over the tuyere crosssection the atomization followed subsequently to the distribution is improved. Moreover the front set of nozzles respectively can have an injection direction which can be directed backwards, in order to compensate for the effect in the speed of the blast. At any rate, every injected jet of oil first has a radial path which on the way radially outward is similar to a parabolic curve which is changed at about two-thirds of the inner radius of the tuyere outward to the axial direction. The initial speed of the oil is calculated such that the oil jets do not contact the inner walls of the tuyeres. The desintegration or atomization of the jet beams starts approximately in the area at which their direction is turned to the axial direction.

The oil supply can be regulated by changing the supply pressure, but a better way is to replace the nozzle tips 1. Nozzle tips for different total amounts of oil to be injected can be kept available for 50 kg oil/h or 60 kg oil/h etc, so that the optimum injection characteristics are attained at the time of changing the total of the oil supply.

A further possibility for improving the uniformity of the fuel oil injection, lies in forming the diameter of the individual nozzles in a different manner systematically so that, for example, one set of nozzles covers a narrow injection area and another set of nozzles covers an outer injection area.

Finally, the uniformity of the fuel oil injection can be attained by the angularly staggered arrangement along the periphery of the nozzle tip 1 of two axially spaced sets of nozzles.

With the method and apparatus according to the invention it is possible to achieve a comparatively high specific heat capacity for each tuyere, which capacity considerably exceeds the value of 1 Gcal/liter space of the tuyere, which value in the known art up to now was regarded as a maximum limit. This is achieved without having additional amounts of soot.

What is claimed is:

1. A method for injecting more than 50-100 kg fuel oil/ton of pig iron into a blast furnace or the like comprising the steps of passing combustion air at a temperature of about 1,000°C through a tuyere having a longitudinal axis and a smooth continuous inner wall having a frusto-conical shape becoming smaller in cross section in the direction of the combustion air flow; positioning at least the nozzle of an oil lance along the axis of said tuyere, which oil lance has a plurality of nozzles about the circumference of the lance, the axis of each nozzle being generally directed radially outwardly introducing up to 15 percent by weight of water to the

fuel oil; then injecting a stream of liquid oil and water through the nozzles generally radially outwardly towards the inner wall of the tuyere at an exit speed relative to the speed of the combustion air passing through the tuyere of approximately a ratio of 1:10 such that the injected oil and water remains a coherent stream until it has traveled the majority of the distance to the inner tuyere wall at which time it atomizes thereby achieving a greater distribution of oil in the combustion air of a tuyere.

2. The method as claimed in claim 1 wherein the exit speed of the fuel oil is at least 20 m/sec.

3. The method as claimed in claim 2 wherein the exit speed is 25 m/sec.

4. The method as claimed in claim 1 wherein the nozzle is positioned from the exit of the tuyere along the longitudinal axis of the tuyere a distance approximately equal to the diameter of the tuyere.

5. The method as claimed in claim 1 wherein the water is in the form of steam, 10 percent by weight is introduced, and the steam condenses to liquid after it is introduced into said fuel oil.

6. The method as claimed in claim 1 wherein some of the radial nozzle axes being at a 90° angle to the longitudinal axis and other of the radial nozzle axes, spaced downstream said 90° angle axes being inclined towards the direction of flow of the combustion air so that the coherent streams of oil injected through the nozzles impinge at a radial distance from the lance which augments the atomization.

7. The method as claimed in claim 1 wherein the oil stream remains coherent following a parabolic curve until about two-thirds of the radial distance from the nozzle exit to the inner wall of the tuyere has been traversed at which time the stream is atomized.

8. Apparatus for injecting fuel oil into a blast furnace or the like comprising a tuyere having a longitudinal axis and a smooth continuous inner wall; an oil lance positioned along the axis of said tuyere; a cap on the end of the oil lance and an oil flow nozzle of gradually decreasing cross-section axially upstream said end so as to form an eddy chamber between the end of the cap and the oil flow nozzle; and at least one nozzle in the wall of the eddy chamber which nozzle has an axis directed radially outwardly so that the oil flows through the oil flow nozzle directly impinging against the end of the cap to cool same, changes direction in the eddy chamber and exits from the nozzle in a coherent stream.

9. Apparatus as claimed in claim 8 wherein there are a plurality of nozzles in the wall defining the eddy chamber; a first set of nozzles are arranged about the circumference, their axes being 90° to the longitudinal axis; a second set of nozzles arranged about the circumference intermediate said first set and the end of the cap, the axes of said second set being inclined upstream the gas flow in the tuyere so that the coherent streams of oil issuing from the second set of nozzles impinges the coherent streams of oil issuing from the first set at a radial distance from the nozzle exits to augment the atomization of the oil.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

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Inventor(s) Friedrich August Karl Lüth

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

[30] Foreign Priority Data:

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[75] Inventor:

Friedrich August Karl Lüth

Signed and sealed this 21st day of January 1975.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents