ABSTRACT

This invention is a dust collecting system for gases containing dust produced in the case of charging coke ovens with coal wherein a plurality of divided subducts are arranged on coke ovens and a main duct connected with them is connected with a dust removing apparatus so that a discharged gas having passed through a dust collecting and removing apparatus for gases containing dust as provided in a coal charging car may be completely introduced into the duct, may have dust well removed with the dust removing apparatus connected with the main duct and may be discharged into the atmosphere as a very clean gas.

5 Claims, 5 Drawing Figures
DUST COLLECTING SYSTEM IN A COAL CHARGING OPERATION FOR COKE OVENS

This invention relates to a dust collecting system for gases containing a large amount of dust and discharged into the atmosphere through a charging port.

For this kind of system, there are already known Japanese patent publications Nos. 16,669 and 30,101/1971.

The above mentioned two publications relate to a dust collecting and cleaning system wherein a coal dust flowing duct in a coal charging car is made free to connect with a gas and dust collecting pipe fixed on an oven and a dust removing apparatus is connected with the pipe at one end or an atmosphere pollution preventing apparatus wherein a guide car and/or coal charging car is provided with a mechanism for introducing dust gases produced in a coke producing process outside a coke oven so that a dust gas may be introduced to connect and collect dust. They show a system wherein, by using an introducing mechanism fitted to a charging car, a dust-containing gas produced in the case of charging coke ovens with coal is introduced into a duct arranged on or outside coke ovens and are led to the end part of the duct to remove dust.

However, when an introducing mechanism fitted to a charging car as in the above mentioned patent publications is connected with a duct arranged on a coke oven, the atmosphere from many other connecting ports (though closed with valves, needless to say) provided in said duct will leak in. Therefore, even if the leakage through one suction port is slight, in a coke oven having more than a hundred connecting ports, the total leakage will be so large that it will be very difficult to completely introduce dust gases into the duct arranged on the oven.

An object of the present invention is to provide a system for completely introducing such dust-containing gases into a duct provided on a coke oven wherein a plurality of divided sub-ducts are arranged on coke ovens which are connected with a main duct through respective valves and a dust remover is provided in the end part of the main duct so that only the sub-duct into which a dust-containing gas is being introduced may be connected with the main duct but the other sub-ducts may be interrupted from the main duct by closing the valves, therefore the atmosphere leaking the through the connecting port may be reduced to be a fraction and the dust-containing gas may be introduced into the sub-duct very easily and completely.

Further, in the above mentioned patent publications, by using a dust-containing gas introducing mechanism fitted to a charging car, a dust-containing gas produced at the time of charging a coke oven with coal is introduced and sucked into a duct arranged on or outside the oven, is led into a dust remover provided in the end part of the duct and is cleaned. However, such large amount of coal gas is present as mixed in the dust-containing gas produced at the time of charging the oven with coal that a flame inside or outside the coke oven has a great danger of causing on explosion of the gas in the course from the dust-containing gas introducing mechanism fitted to the charging car to the dust remover through the duct as often experienced also by the inventors.

According to the present invention, in the case of introducing a dust-containing gas into a duct arranged on an oven by using a dust-containing gas introducing mechanism fitted to a coal charging car, the dust-containing gas in which coal gas is present as mixed is burned in advance so as to be converted to an inert gas and at the same time the dust is pre-washed and the gas is cooled so that the gas explosion may be positively prevented and the discharge of the gas and removal of the dust may be easy.

In a coke oven, in the case of a coal charging operation by using a coal charging car, when coal is dropped into a coke oven chamber through a charging port at the oven top in order to charge the coke oven with the coal, hot air on the coal within the oven chamber will be quickly driven out of the coke and at the same time coal gas will be severely produced from a part of the coal quickly subjected to the heat influence of the oven chamber wall kept at a high temperature of about 1,000°C.

Such hot air and coal gas are accompanied with such large amount of coal dust of the coal charge that they will diffuse around as a black or brown jetted smoke through the top of an open rising pipe or the charging port during the charging with the coal to remarkably pollute not only the working environment but also the general environment.

As regards such gas accompanied with dust as is jetted out through the rising pipe, there is carried out a means of sucking and introducing into a gas collecting main pipe a part of a dust-containing gas produced within an oven chamber by a sucking action caused byjetting a high pressure steam or high pressure water in the bent part of the rising pipe for the connection with the gas collecting main pipe by coping the top of the rising pipe and opening a valve between the rising pipe and the gas collecting main pipe at the time of charging with coal. However, the volume of the gas which can be sucked and introduced into the gas collecting main pipe is about 30 to 20 percent of the dust-containing gas produced within the oven chamber and the greater part of the gas is jetted and diffused into the atmosphere through the charging port at the top of the coke oven.

There is worked a method for collecting a dust-containing gas jetted out through a charging port and diffused into the atmosphere and removing the dust wherein a coal charging car is provided with a dust collecting apparatus and the coal charging port through which the dust-containing gas is jetted out during the coal charging operation is covered with a dust collecting hood so that the dust-containing gas may be led into the dust collector to remove the dust. However, the dust content in the collected dust-containing gas is so high as to be 15 to 30 g./Nm³ that, even if the dust is removed at an efficiency of 90 percent with the dust collector, 2 to 3 g./Nm³ of the dust will still remain in the exhaust gas after the dust is removed and the exhaust gas after the dust is removed as discharged into the atmosphere of the dust collector fitted to the coal charging car is still a black or brown exhaust smoke. Thus, the dust collector set in the coal charging car is restricted in the capacity and performance by the dimensions or weight in the installation, it is unreasonable to expect a great improvement in the dust removing and collecting efficiency and it is very difficult to completely collect the dust. Through the dust collecting hood covering the charging port, a large volume of the dust-containing gas not yet collected in the dust-
collecting apparatus leaks out and is dissipated into the atmosphere.

Further, in this dust-containing gas, unrefined coal gas produced by the thermodecomposition of coal is present as mixed and the gas composition concentration always varies in a wide range. Therefore, such gas will be ignited from the fire source within the coke oven chamber and the explosion of the gas will frequently occur within the dust collecting apparatus. This is a grave problem in the safety of the operation. A perfect dust collecting apparatus having no gas explosion and high in the efficiency of collecting and removing dust has been hoped for.

An object of the present invention is to provide a dust collecting system for dust-containing gases jetted out through a coal charging port at the top of a coke oven chamber in a coal charging operation by using a coal charging car in a coke oven so that the danger of the explosion of the gas within the dust collecting apparatus may be positively prevented and the dust-containing gas may be substantially completely collected and efficiently removed. That is to say, while the dust-containing gas jetted out through the coal charging port is being ignited and burned with an igniting and burning device provided near a dust collecting hood provided in the lower part of a coal hopper of the coal charging car or near a duct following the dust collecting hood, it is sucked into the dust collecting hood together with a comparatively large volume of air with an exhaust device provided in the coal charging car, is thus made an inert gas composition very stable against explosion, is then cooled and has coarser particles of the dust separated with a pre-cleaner provided with a water jetting device and a rotating metal screen in the course of the pipe line from the dust collecting hood to the exhaust, and is then passed through the exhaust. In such case, an exhaust of a type which is also a dust remover may well be used.

The dust-containing gas having left the exhaust is led to a sub-duct arranged on the oven through an exhaust duct.

On the other hand, a plurality of divided sub-ducts are arranged as sectioned respectively for a battery of about 10 to 30 oven chambers. Each sub-duct is provided with a corresponding suction port for each oven chamber. Each suction port is provided with a value. The sub-duct is connected with the main duct through the valve. A dust collector having a sufficient capacity and dust removing performance and an exhaust are connected with the main duct in the end part. A connector is fitted in the end part of an exhaust duct connected with the outlet of the exhaust provided in the coal charging car so as to be connected with the suction port of the sub-duct corresponding to the oven chamber which is being charged with coal to open the value of the suction port. Therefore, the dust-containing exhaust gas is sucked into the sub-duct from the exhaust duct of the coal charging car, is further led into the dust remover through the main duct, has the dust removed and is discharged into the atmosphere through the exhaust.

According to the dust collecting system of this invention, not only the explosion of the gas within the dust collecting apparatus often experienced in the case of collecting dust in the coal charging operation can be positively prevented but also the dust-containing gas can have dust collected and removed substantially completely and far better than with the dust collecting apparatus set in the coal charging car. Further, the exhaust gas can be discharged into the atmosphere as a clean gas in which no tarry substance is recognized at all and therefore the environment pollution problem caused by the dust-containing gas produced in the coal charging operation can be substantially solved.

In the drawings:

FIG. 1 is a general elevation of a dust collecting system according to the present invention showing a coke oven in section;

FIG. 2 is an elevation of a dust collection hood provided in a coal charging car, pre-cleaner, exhaust and arrangement of connecting them showing a sub-duct and main duct in section;

FIG. 3 is a plan view of a dust collecting exhaust duct of the coal charging car, sub-duct arranged on the oven and main duct;

FIG. 4 is an elevation of a device for connecting the sub-duct with the dust collecting exhaust duct provided in the coal charging car;

FIG. 5 is a block diagram of the operation of the value interposed between the sub-duct and main duct.

The numeral 1 is a coke oven battery consisting of 106 ovens, each oven chamber being of a length of 5,560 mm. height of 6,000 mm. and width of 450 mm. and about 27 tons of coal being put into each oven through four charging ports 2. A coal charging car 4 is arranged at the oven top 3 so as to be movable on the oven top. Said coal charging car 4 is provided with as many as 4 coal hoppers 5 as the charging ports. In the lower part of the coal hopper 5 are a coal feeder to drop coal into the charging port 2 and a dust collecting hood 6 to cover a coal feeding port 7 and charging port 2. The dust collecting hood 6 is of a size sufficient to cover the charging port 2 and has an igniting device 8 provided with an electric igniter and oil burner to expand a flame within the dust collecting hood. A duct 9 extends from the dust collecting hood 6 so as to be connected with a pre-cleaner 10 which is of a diameter of about 1000 mm. and within which a metal screen 11 of comparatively large meshes rotates so that water may be jetted onto this metal screen through a nozzle 12. The outlet of the pre-cleaner is connected with an exhaust pipe 14 through a duct. This exhaust has a wind volume of 500 m.³/min. and can perfectly prevent dust-containing gases from escaping into the atmosphere through the charging port and dust collecting cover.

The exhaust 15 is also a dust remover.

An exhaust duct 16 is connected with the outlet of the exhaust 14 and has a connector 16 at the end. This connector 16 advances or retreats by sliding at the end of the exhaust duct 15 by the operation of a fluid cylinder 17. When the coal charging car 4 moves, the connector 16 will retreat to be separated from a suction port 19 of a sub-duct 18 provided to correspond to each oven chamber of the coke oven and having a valve 20. Said sub-duct 18 is arranged along the oven battery on the coke oven and is usually divided into a plurality by being sectioned for 10 to 30 suction ports. This is very important to effectively sucking the dust collecting exhaust of the coal charging car.

In charging the coke oven with coal, when the connector 16 is advanced to be pushed against the suction port 19, a projecting metal piece 21 of the connector 16 will push the valve 20 open. The cross-sectional area of the sub-duct 18 is 1.0 m.² Each of the plurality of the
divided sub-ducts is connected with a main duct 23 through a valve 22. The main duct 23 is connected at the end with a dust remover 24 set on the ground. The outlet of the dust remover 24 is opened to the atmosphere through an exhauster 25 which has a wind volume of 1,500 m.3/min.

The operation shall be explained in the following. When the coal charging car loaded with coal moves to be above the coke oven chamber to be charged with coal, the exhauster 14 and pre-cleaner 10 of the coal charging car will be started the metal screen 11 will rotate and a pump 26 will jet water in a water tank 27 onto the metal screen 11 through the nozzle 12. Then the dust collecting hood 6 will be lowered to cover the coal charging port 2. The burner of the igniting device 8 will be ignited and a flame will be blown into the dust collecting hood.

On the other hand, the exhauster 25 will be started in advance. When the fluid cylinder 17 is operated to advance the connector 16 into contact with the suction port 19, the projecting metal piece 21 will push the valve 20 open so that the exhaust duct 15 and sub-duct 18 may communicate with each other.

At the same time, a pushing plate 36 will push a switch L, fitted to the suction port belonging to the sub-duct 18 to close its electric contact, therefore an electric current will pass through a relay R1 in FIG. 5, thereby electric contacts R1-0 and R1-1 will close, R1-2 and R1-3 will open, therefore the electric current will be interrupted in relays R3 and contacts R3-0 and R3-1 to feed electric currents to electromagnetic valves 31 and 32 will open. Therefore, when the electric contact R3-0 closes, an electromagnetic valve 30 will operate to push down the valve body and a fluid cylinder 33 to be fed with a pressure fluid (for example, compressed air) 37 will operate in the direction of opening the valve 22 interposed between the sub-duct 18 and main duct 23 so that the sub-duct 18 and main duct 23 may communicate with each other. When the electric contacts R3-0 and R3-0 are open, the valves bodies of the electromagnetic valves 31 and 32 will be pushed up by springs and fluid cylinders 34 and 35 to be fed with the pressure fluid 37 will operate in the direction of closing valves 22 and 22”, respectively, interposed between sub-ducts 18’ and 18”’ and the main duct 23 so that the communication between the sub-ducts 18’ and 18”’ and main duct 23 may be interrupted.

Therefore, as the valves 22’ and 22”’ interrupt the communication with the main duct 23, the other sub-ducts 18’ and 18”’ than the sub-duct to which belongs the suction port with which the exhaust duct of the coal charging car is in contact will not impede the suction of exhaust by the coal charging car with the leakage of air through many suction ports belonging to the sub-ducts 18’ and 18”’. Further, even if there is any leakage of air through the other suction ports provided in the sub-duct 18 to which belongs the suction port with which the exhaust duct of the coal charging car is in contact, as the number of the other suction ports is such as will not impede the suction of the dust collecting exhaust by the coal charging car, there will be no problem, needless to say.

For example, when an undivided continuous duct is arranged on the coke oven consisting of 100 ovens, suction ports corresponding to the respective oven chambers are made in this duct, the duct is connected for suction at one end with an exhauster of a wind volume of 1,500 m.3/min. and the size of the suction port is 1 m. X 1 m. = 1 m.2, the valve of the suction port will be required to be easy to open and close and very simple in the structure. Therefore, in such valve, a clearance will be necessarily produced between the valve body and the pipe wall in making the valve. If there is a clearance of 5 mm. and air leaks in through it at a velocity of 10 m/sec., the volume of air flowing into this duct will be

\[ 1 \times 4 \text{ sides} \times 0.005 \times 10 \text{ m.} / \text{sec} \times 60 \text{ sec} \times 100 \div 1,200 = 240 \text{ m.}^3/\text{min}. \]

It will be impossible to suck and introduce 500 m.3/min. of the dust collecting exhaust of the coal charging car into the duct.

On the other hand, if a continuous sub-duct is provided with 20 suction ports and consists of five sub-ducts, the volume of air leaking into the sub-duct will be

\[ 1 \times 4 \text{ sides} \times 0.005 \times 10 \text{ m.} / \text{sec} \times 60 \text{ sec} \times (20 + 4) = 240 \text{ m.}^3/\text{min}. \]

Thus the dust collecting exhaust of the coal charging car will be able to be completely sucked and introduced into the duct.

When the preparation for collecting dust is made as in the above, the coal feeder of the coal hopper in the coal charging car will be operated so that coal may be put into the oven chamber through the four charging ports 2 at the top of the coke oven chamber. Thus the dust-containing gas jetted out through the charging ports will be caught by the dust collecting hood 6, will be burned by the flame of the burner 8 so that the tarry substance and other combustible compositions may be substantially burned, will be led to the pre-cleaner 10 through the duct 9 and will be cooled therein with water jetted out through the nozzle 12. Coarser particles of dust will be caught by the mesh screen 11. The dust will be shaken around by the rotation of the mesh screen, will collect together with washing water in the lower part of the casing and will accumulate in a dirty water tank 28. The water containing dust in the dirty water tank will be discharged with a separate automatic device while the coal hopper in the coal charging car is being loaded with coal when the coal charging operation is finished and, at the same time, a water tank 27 will be fed with fresh water. In the pre-cleaner, about 80 percent of the dust accompanying the gas will be removed.

Table 1 is of the results of measuring the dust removing exhaust gas of the coal charging car equipped with the pre-cleaner wherein the volume of sucked wind was then 250 m.3/min. but was improved later to be 500 m.3/min.

<table>
<thead>
<tr>
<th>October</th>
<th>15, 1969</th>
<th>1969</th>
<th>The</th>
<th>Dust</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>At the inlet of the duct collector in g/Nm.3/pdf. in m.3/Min.</td>
<td>At the outlet of the pre-cleaner in g/Nm.3/pdf. in m.3/Min.</td>
<td>Dust removing rate in</td>
<td>Volume of sucked wind in m.3/min.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| October | 15, 1969 | 13, 1969 | 15, 1969 | of |%
| October | 30.1 | 18.6 | 21.9 | 5.4 | 2.8 | 4.4 | | 82 | 85 | 80 | 250 | 250 | 250 |
The gas having left the pre-cleaner will come out to the exhaust duct 15 through the exhauster 14. As the coarser particles of the dust have been mostly removed in the pre-cleaner, it will be very little to damage the blades of the exhauster. And yet the gas having left the pre-cleaner can not be discharged as it is into the atmosphere, because a small amount of dust will still remain in the gas.

The exhaust gas having left the exhaust duct 15 will enter the sub-duct 18 as it is, will be led into the main duct 23 through the valve 22, will have dust removed in the wet-type dust remover 24, will become a clean gas and will be discharged into the atmosphere through the exhauster 25.

Table 2 is of the results of measuring the dust removing exhaust gas of the dust remover 24 wherein, as the dust content is less than 0.1 g./Nm.³ and the tarry substance in the gas has been already burnt out, the dust removing exhaust gas is so clean as to have substantially no influence on the pollution of the atmosphere.

<table>
<thead>
<tr>
<th>TABLE 2.—DUST CONTENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>At the inlet of the dust collector in g./m.³</td>
</tr>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td>August 24, 1970.....</td>
</tr>
<tr>
<td>August 28, 1970.....</td>
</tr>
<tr>
<td>August 30, 1970.....</td>
</tr>
</tbody>
</table>

When the coal charging car has finished the coal charging operation and the connector 16 is retreated to be separated from the suction port 19 by operating the fluid cylinder 17, the exhauster of the dust collecting apparatus, pre-cleaner and flame of the igniting device in the coal charging car will be stopped and the car will move to be loaded with coal for the next charging.

As in the above, as it is impossible from the structure and object of a coal charging car to provide the coal charging car with a gigantic apparatus high in the dust collecting and removing efficiency, it has been considered a very difficult problem to completely collect and remove dust at the time of charging with coal. Further, even if a duct is arranged on the oven so as to suck the dust collecting exhaust gas at the time of charging with coal, the suction ports will be so many that the total amount of the leakage will be very large and the suction will not be effective. However, as shown in the present invention, if the dust collecting system in the coal charging car is provided with an igniting and burning device, the tarry substance and other combustible compositions in the dust-containing gas are burned therein and the gas is thus converted to an inert gas, has the dust removed in advance in the pre-cleaner, is completely introduced and sucked into a plurality of divided sub-ducts arranged on the oven, is led into a large dust remover high in the performance and fixed on the ground and has dust removed therein, no dust-containing gas will leak out around the coal charging car, the danger of the explosion of the gas will be perfectly prevented, the brown color of the gas will be eliminated and the dust will be able to be substantially completely removed. Therefore, the present invention is very useful to the improvement of the environment and the prevention of the pollution of the atmosphere.

**We claim:**

1. In a coke oven system comprising a battery of coke ovens arranged in a longitudinal direction, each oven having at least one coal charging port, and a coke charging car adapted to travel along a path in said longitudinal direction to a plurality of stations above said battery and to selectively stop at any one of said stations and deliver coal to one of said ovens, said car including hopper means and at least one coal feeding duct for feeding coal from said hopper means to any one of said coal charging ports, the improvement comprising:
   a. at least one hood having ignition means therein on said car for collecting and burning dust laden gas passing through a port from an oven while being charged with coal through said feeding duct,
   b. initial dust filter means on said car,
   c. suction means on said car,
   d. duct means for directing said dust laden gas from said hood, through said initial filter means and suc-
said connecting duct valves, and a pressurized fluid system controlled by said solenoid activated valves for opening and closing said connecting duct valves.

4. The combination of claim 1 wherein said gas filter means on said car comprises a rotatably mounted screen through which said dust laden air is collected, water storage means, means for spraying water from said storage means on said screen, and means for storing the dirty water from said screen.

5. The combination of claim 1 wherein said exhaust port includes means for connecting said exhaust port to any one of said inlet ports and means for simultaneously opening the valve means at the one inlet port.

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