ABSTRACT

A recirculating dryer system is disclosed wherein combustion gases from a waste wood-fired furnace are circulated through a wood veneer dryer or lumber dry kiln and returned to a mixing chamber for exposure to the hot gases leaving the furnace, causing incineration of volatile hydrocarbons and wood fiber picked up by the gas stream in its passage over the veneer or lumber. A novel form of damper construction is employed to provide a damper in elevated position between the fuel cell of the furnace and said mixing chamber. The damper comprises an apertured block of refractory material having an inverted pendulum support provided by a pair of pivotal columns.

3 Claims, 5 Drawing Figures
REFRACTORY DAMPER FOR HIGH TEMPERATURE OR CORROSIVE GASES

CROSS REFERENCES TO RELATED APPLICATIONS


BACKGROUND OF THE INVENTION

This invention relates to an improved refractory damper for high temperature or corrosive gases, the damper being illustrated by way of example in connection with the recirculating dryer system in said application Ser. No. 108,527, now U.S. Pat. No. 3,675,600.

Veneer dryers operate at a relatively high temperature, causing a distillation of various volatile hydrocarbons from the wood. Some of these hydrocarbons are non-condensable in the sense that they remain in a vapor or gaseous state when cooled down to outside temperature and are invisible when discharged from the veneer dryer. A major portion of the hydrocarbons extracted along with the moisture in the wood, however, are condensable at outside temperatures and create a plume of blue haze above the exhaust stacks. This haze is referred to as veneer dryer emission and constitutes an objectionable pollutant in the atmosphere. The haze consists mainly of coalesced liquid droplets and also includes a small amount of particulates in the form of wood fiber.

Conventional veneer dryers are heated by steam coils or direct fired gas burners. The veneer is carried through the dryer in a plurality of vertically spaced layers, each referred to as a line or deck. In each deck the veneer travels between pairs of upper and lower driven rollers. The heated air is caused to flow in contact with the surfaces of the veneers between the decks. The moisture laden air is discharged to atmosphere through exhaust stacks which may number from one to as many as seventeen, depending on the type of dryer. As the veneer passes through the dryer, the heated air is circulated and recirculated through the dryer by large fans with a portion of the circulated air being vented through the exhaust stacks.

As the green (wet) veneer enters the dryer, it is heated and any surface water is rapidly evaporated. Then, as the veneer is heated further, the water within the sheets begins to move toward the surface. As the water is continuously evaporated from the surface, some of the hydrocarbons which are present in the wood are removed in a process similar to steam distillation. Thus, even though the surface temperature of the veneer may be below the boiling point of the hydrocarbons, they are vaporized from the veneer and released into the air stream. As long as the air is circulating within the dryer at high temperature, the distilled hydrocarbons remain in a gaseous state but, as soon as they are released to the atmosphere, they cool and some of them condense.

In the outside atmosphere, the condensable hydrocarbons form very fine droplets of sub-micron size. The temperature of the air leaving the stack is in the range between 225°F. to 325°F. or higher. The condensable hydrocarbons condense slightly below 300°F. and coalesce into a viscous, sticky liquid. The fine droplets of this liquid form the blue haze visible emission which is found objectionable.

Also, the non-condensable hydrocarbons are photo-chemically reactive and are capable of later producing smog-like conditions. The total emissions of many veneer dryers already exceed allowable amounts permitted in certain smog-prone regions of the United States. Therefore, no practical way has been found to eliminate this source of pollution.

The elimination of such pollution has presented a serious problem in the industry because the character of the pollutants is not fully understood and because of the cost of installing and operating auxiliary equipment to eliminate the pollutants, particularly in dryers having a plurality of exhaust stacks. It is necessary to significantly reduce or eliminate the pollution in an efficient manner and at low cost because pollution control equipment does nothing to enhance the value of the product of the dryer. The criteria for conformity to pollution regulations generally relate to the opacity of the emissions and the acceptable limits of hydrocarbons discharged into the atmosphere.

Another problem in the forest products industries, which may also be characterized as a pollution problem, is the disposal of enormous quantities of various waste products such as plywood trim, knots, bark, sawdust and sand dust. Although these various materials are combustible, it has been extremely difficult for the industry to conform to air quality standards governing stack emissions from bark and wood combustion systems.

Objects of the invention are, therefore, to provide a substantially pollution-free dryer system for wood veneer, lumber and other materials, to provide an improved recirculating dryer system, to provide a veneer dryer in which volatile hydrocarbons and wood fiber entrained in the air stream are incinerated, to provide a furnace for such a dryer system capable of utilizing various forms of waste wood products, and to provide an improved damper for the furnace disclosed herein and for other purposes.

SUMMARY OF THE INVENTION

In the present dryer system the source of heat is a specially constructed furnace for utilizing the various wood waste materials mentioned hereinabove. A preheated forced draft source of primary air permits the use of damp or even wet fuel. The combustion gases are drawn through a mixing chamber by a fan which then circulates the hot gases through the dryer. No gas, water vapor or emissions are discharged directly from the dryer; they are returned to the mixing chamber where the hydrocarbons and wood fiber picked up from the veneer are incinerated in the hot combustion gases leaving the furnace.

The only discharge point in the system is on the pressure side of the fan following the incineration step just described. A portion of the incinerated gas flow leaving the fan is discharged to atmosphere and the rest is cir-
culated through the dryer as above mentioned. The gases circulated through the dryer are partly combus-
tion gases directly from the furnace and partly recircu-
lated and incinerated gases returned from a previous
circulation through the dryer.

The invention will be better understood and addi-
tional objects and advantages will become apparent
from the following description of the preferred embodi-
ments illustrated in the accompanying drawings. Vari-
ous changes may be made in the details of construction
and arrangement of parts and certain features may be
used without others. All such modifications within the
scope of the appended claims are included in the inven-
tion. The improved damper disclosed herein is of
general application and is not limited to the present
dryer system.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation view, with parts broken
away, showing a first embodiment of recirculating
dryer system incorporating the principles of the inven-
tion;

FIG. 2 is a view on the line 2—2 in FIG. 1, with parts
broken away;

FIG. 3 is an enlarged view of a portion of FIG. 2, with
parts broken away;

FIG. 4 is a view on the line 4—4 in FIG. 3; and

FIG. 5 is a view similar to FIG. 1 showing a modifica-
tion.

DESCRIPTION OF THE PREFERRED
EMBODIMENTS

Referring first to FIG. 1, a fuel cell 10 having refrac-

tory walls is arranged to receive solid fuel from suitable
feed means, not shown. This fuel cell is designed to
burn waste wood products such as plywood trim, knots,
bark, sawdust and sander dust which may be either wet
or dry or mixed and dry. In order to burn wet fuel, the

wall of the fuel cell is provided with tuyeres 11 and the
grate 12 is provided with openings 13 to admit pre-

heated primary air. Gate 12 is preferably a water
cooled, roll out grate for convenient cleaning and re-

pair as disclosed in my application Ser. No. 87,806.

In order to control the combustion in the fuel cell,
the preheated primary air is supplied to tuyeres 11 and
grate openings 13 from a plurality of air pressure cham-

bers 14, 15, 16 and 17 under the control of dampers 18,
19, 20 and 21. This primary air supply indicated by ar-

rows 24 in duct 23 is blown into these chambers by pri-

mary air fan 25, the air being heated in a heat exchanger 26 as will presently be explained.

The hot combustion gases 30 generated by the fuel in
fuel cell 10 pass through a primary combustion chan-

nel 31, a secondary combustion chamber 32, a ternary combustion chamber 33 and a mixing and in-


cinerating chamber 34. Chambers 31, 32 and 33 may
also be regarded as a single reflight chamber having pri-

mary, secondary and tertiary combustion zones
 therein. Chambers 31 and 32 are separated by a verti-
cal wall 35 and chambers 32 and 33 are separated by a
vertical wall 36. Mixing and incinerating chamber 34 is
separated from tertiary combustion chamber 33 by a
refractory damper 40 which is a modification of the
damper shown in my prior application Ser. No. 25,974,
now U.S. Pat. No. 3,598,067. The outside walls 41 of
combustion chambers 31, 32 and 33 preferably com-
prise refractory panels as disclosed in my application
Ser. No. 56,447. The construction of the roof 42 of
chambers 31 and 32 is also illustrated in the last men-
tioned prior application.

The top of wall 35 is spaced below roof 42, allowing
a stream of combustion gases 30 to pass over the top of
this wall from primary combustion chamber 31 into the
top of secondary combustion chamber 32. These gases
pass downward through secondary combustion

chamber 32 and flow through openings 45 in a lower
portion of wall 36 to enter the bottom of tertiary com-
bustion chamber 33. The combustion gases 30 pass up-
ward through chamber 33 and leave through openings
46 in a refractory panel 47 at the top of chamber 33.

This additional travel through chamber 33 allow time
for the efficient combustion of burning cinders which
are carried along in the gas stream and may not be
completely burned in the primary and secondary com-
bustion chambers. The flow through openings 46 is
controlled by movements of the damper 40 which has
openings 50 movable into and out of registry with the
openings 46.

In order to assist in the thorough combustion of all
combustible substances in chambers 32 and 33, the
former is supplied with additional preheated primary
air 24 controlled by a damper 51 in a duct 52 supplied
by primary air fan 25. Duct 52 discharges into seconda-
ry combustion chamber 32 at 53.

Mixing and incinerating chamber 34 forms part of an
inlet duct conveying a mixed flow of gases 60 to in-
duced draft fan 61. The suction of this fan and the
throttling effect of damper 60 produce the lowest pres-
sure in the system in chamber 34 which thus becomes a
suction chamber at a pressure below atmospheric pres-
ure.

Duct 62 conveys a major portion of the discharge
from fan 61 to the dryer, a minor portion of the fan
discharge passing through heat exchanger 26 and being

discharged to atmosphere through exhaust stack 63. The
ration of the two flows is controlled by a pair of in-
terconnected dampers 65. The portion of gas stream 60
passing through heat exchanger 26 provides the heat
source for preheating the primary combustion air 24.
Air 24 and gas stream 60 are conducted through
separate passageways in the heat exchanger so that
there is no intermixing of gas stream 60 with the incom-


ing air 24.

There are no exhaust stacks in the dryer (not shown).
Except for unavoidable leakage, the whole
amount of gas stream 60 supplied to the dryer, plus
volatile hydrocarbons distilled from the wood and air-
borne wood fibers released from the wood, are

returned from the dryer in a gas stream 70 through
return flow conduit 71. This return flow of gases and
particulate matter, which is maintained at a tempera-
ture above the condensation point of the condensible
hydrocarbons distilled from the wood in the dryer, is
heated to a higher temperature by passage through a
shroud or jacket 72 surrounding the walls 41 and ceil-
ing 42 of the combustion chambers of the furnace.

Either stationary baffles or adjustable damper-type
baffles may be provided in jacket 72 for directing the
air flow over the walls 41 and ceiling 42 in a uniform
flow pattern to avoid hot and cold spots in different
areas.
3,716,004

Jacket 72 extends down to a lower end 73 which is closed to confine the flow of gases 70 in heat exchange relation to the walls of the combustion chambers. An extension 74 of the jacket 72 surrounds the upper portion of incinerating chamber 34 and directs the return flow of gases 70 into the incinerating chamber through a port 75 controlled by a damper 76. Thus, hydrocarbons and wood fibers released from the wood in the dryer are incinerated in chamber 34 upon contact with the hot furnace gases 30. Thorough incineration is promoted by an inlet opening 80 which admits a stream of outside air 81 under the control of damper 82.

The adjustment of damper 82 is coordinated with the adjustments of dampers 76 and 65 to control the pressure and temperature in chamber 34 and dryer duct 62. The stream of combustion gases 30 is too hot to be fed directly into the dryer and the air inflow 81 dilutes and cools these gases as well as supplying the oxygen necessary for incineration. Notwithstanding the diluting and cooling effect of air 81, the temperature in chamber 34 remains high enough to perform its incinerating function. The preheating of return gases 70 in jacket 72, 74 reduces the cooling of the incinerating chamber by these gases. Since stack 63 is the only point of discharge for water vapor from the dryer, and carbon dioxide from the furnace and incinerating chamber 34, these components of the gas stream also affect the regulation of the dampers.

A portion of the return flow 70 from the dryer may be diverted into the primary combustion air 24 on the intake side of fan 25, if desired, thereby causing the distilled hydrocarbons from the dryer to pass through the combustion chambers of the furnace.

The construction of damper 40 is illustrated in FIGS. 2 to 4. The movable damper is cast as a perforate block of refractory material which is supported on edge on a horizontal beam 85. Each end of beam 85 is supported by a pair of pivot bolts 86, each having a washer 87 resting on an accurate bearing plate 88 on yoke 89. Each yoke 89 is mounted on the upper end of a column 90 having a pivotal knife-edge support 91 at its lower end.

This provides an inverted pendulum support which may be shifted laterally through a small range of movement as indicated at 92 to move the openings 50 in damper 40 into and out of register with the openings 46 in stationary refractory panel 47. Modulating movement is produced by a piston rod 93 in a fluid pressure control cylinder 94. The damper is stabilized in the direction of air flow by pairs of rollers 95 engaging opposite side faces of the yokes 89. The ends of beam 85 extend out of opposite sides of the furnace for the application of air or water cooling means to passageways 96 in the beam.

In lieu of the heat exchanger 26 in FIG. 1, the primary combustion air 24 may be preheated by a modified form of shroud or jacket 72a as shown in FIG. 5. In this arrangement the lower edge 73a of the jacket is open and spaced away from the combustion chamber walls 41 to provide an updraft air intake opening for the primary air 24. The primary air is heated in passing over the hot walls 41 and ceiling 42.

The slot-like inlet opening 73a may be equipped with a series of dampers, referred to as segmental dampers, and stationary baffles may be provided within jacket 72a, to control the pattern of air flow over walls 41 and ceiling 42 so as to prevent hot spots.

In FIG. 5 the jacket 72a is separate and independent from the jacket 74a. Jacket 74a then heats the return gas flow 70 from the dryer by passing this gas flow across the top and around the upper side walls of tertiary combustion chamber 33 and incinerating chamber 34 independently of the jacket 72a.

In this FIG. 5 modification there is somewhat more loss of heat from the system by discharging the stack gases at a higher temperature but there is the advantage of saving the first cost and maintenance of the rather expensive separate heat exchanger 26 in FIG. 1. In installations where wood waste products may be obtained for fuel at very little cost, the saving in the cost of equipment may outweigh the loss resulting from a lower thermal efficiency.

Having now described my invention and in what manner the same may be used, what I claim as new and desire to protect by Letters Patent is:

1. A damper comprising a block of refractory material having openings therethrough; a horizontal beam supporting said block; and an inverted pendulum support for said beam comprising a pair of columns at opposite ends of said beam, pivotal connections between said beam and the upper ends of said columns, and pivotal supports for the lower ends of said columns; and means for moving the damper horizontally in the vertical plane of said beam and columns.

2. A damper as defined in claim 1, said pivotal connections between said beam and the upper ends of said columns each comprising an upstanding yoke on the upper end of the column encircling said beam, arcuate bearing plates on top of said yoke, vertical bolts in said beam projecting upward through the top of said yoke and said arcuate bearing plates, and bearing members on the upper ends of said bolts resting on said arcuate bearing plates and supporting said beam.

3. A damper as defined in claim 1, said pivotal supports for the lower ends of said columns comprising knife edge members on the ends of the columns.

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