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COMPOSITION FOR ELIMINATING SLAG, SOOT, AND FLY ASH

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The present invention relates to compositions for the removal of carbon (soot) deposits, slag, and fly ash from boiler-tubes, flues, chimneys, walls, superheater banks, etc. of boiler and furnace installations.

It is well known that in the operation of heating systems, the boilers, furnaces and the like, in which fuel, such as coal, coke, oil or gas is burned, gradually become fouled with deposits of soot and scale. The scale usually consists of mineral deposits, such as ashes of the coal or coke, while the soot is primarily a mixture of large amounts of carbon and smaller amounts of heavy hydrocarbons. The soot is usually quite combustible, and, particularly in chimneys, presents a definite fire hazard, for, when once ignited, it burns with great intensity, and such a fire, particularly in case of a defective chimney or flue, may lead to ignition of the building. The scale or slag is mainly composed of silica in combination with iron, aluminum, calcium and magnesium oxides.

Many preparations have been described in the past, which were intended for the removal of these deposits of soot and slag. Most of these were predicated upon the use of common salt (sodium chloride), as this is volatile at high temperatures, and when thrown onto a fire will form fumes of sodium chloride.

It is one of the objects of the present invention to prepare a combustion chamber, a flue and chimney cleaning composition of greatly improved characteristics, and one which not only tends to loosen and disintegrate adherent slag and soot but which will also lower the ignition point of carbon.

It is a further object to provide a method for the cleaning of combustion chambers, flues, chimneys, etc., by treating them with the volatilized constituents of the said compositions.

In order to provide the proper characteristics in a composition for the elimination of slag, soot or fly ash it is essential that, for efficient operation, it have the following characteristics:

1. Extremely high volatility in the combustion chamber of a boiler.

2. It must be a very light fluffy powder which is easily air borne.

3. It preferably should have a bulk density of less than 0.4.

4. It should be composed of a material which, when subjected to heat, will produce a chemical reaction which will render all of the constituents of the mixture volatile so that the resultant gas or vapor will be capable of passing through and acting upon slag, carbon, soot, fly ash, and other by-products of the combustion of coal and fuel oil, not only in the combustion chamber, but also in the back passes of the boiler as well.

5. By reason of its light and fluffy property it must be capable of application to any desired spot or area in the combustion chamber or back passes of a boiler, primarily by reason of the fact that it is air borne. The natural draft existing in the boiler should be sufficient to carry

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the composition along with it so that none of it will be wasted by falling to the grate or lower areas of the combustion chamber or other back passes without reaching the soot, slag or fly ash deposits.

6. By reason of its low specific gravity and dispersibility in the draft of air, it should be capable of being applied to the rear areas of a path of the combustion gases where in spite of the lower temperatures there prevailing it will substantially completely volatilize and become gaseous by reason of its high volatility at low temperatures.

7. Its characteristics of low density, extreme volatility with heat, fluffiness, dispersibility in air currents, and chemical action under heat to form volatile products out of the constituents of the composition which themselves are not inherently volatile, are novel features which hitherto have not been attained in a mixture such as that forming the subject matter of the present invention.

8. In addition to the mixture of chemicals contained in the composition it will also act in the combustion chamber as a catalyst serving to assist in the burning of soot and carbon deposits, primarily by reason of the lowering of the temperature of ignition of carbon by several hundred degrees Fahrenheit.

The compositions of the present invention comprise mixtures of a volatile ammonium salt, a copper salt, and a combustible carrier material, with or without an inert coloring material.

Among the ammonium compounds, the one most suitable, mainly because of its cost, is ammonium chloride, but other halides of ammonium may be used, such as the fluoride, bromide or iodide. Copper sulfate or acetate may be used, as these salts in the presence of heat and the ammonium halide will yield fumes of a copper halide. Copper chloride may also be used. The materials are preferably in powdered form, so that the mixture will be free running and capable of being readily distributed upon a fire burning in the fire-box of a boiler or other furnace. One of the important ingredients is wood flour, or its equivalent, such as comminuted corn-cobs, etc., of about the same degree of comminution as the inorganic ingredients, and not only acts as a carrier but also as a "spacer" for the potentially reacting constituents.

Example I

A suitable mixture may consist of the following:

	Percent by weight
Ammonium chloride.....	40-50
Copper sulfate.....	5-10
Wood flour.....	30-40

Cupric chloride may be substituted for the copper sulfate. The wood flour is preferably about 100 mesh in size, as is the copper sulfate, while the ammonium may be about 20 mesh. From about 0 to 5% of finely ground red iron oxide (Fe_2O_3) may be added as a coloring agent.

A preferred form of the composition comprises the following constituents:

	Percent by weight
100 mesh wood flour.....	39
100 mesh copper sulfate monohydrate.....	7.0
20 mesh ammonium chloride.....	49
100 mesh iron oxide (Fe_2O_3).....	5

These materials are preferably ground together, or at least very thoroughly mixed, and during such mixing have added thereto from a few to about 6% by weight of the mixture of a hydrocarbon such as gas oil, light lubricating oil, kerosene etc., to prevent dusting, but there is not enough of this material used to keep it from being in the form of a free running powder.

Instead of cupric chloride, cuprous chloride, copper

3 oxychloride, copper nitrate, copper acetate or copper formate, etc., may be used. The wood flour may, if desired, be replaced by fine sawdust, starch, cornmeal or the like. These organic, combustible materials also act as spacing agents to avoid too intimate contact between the ammonium halide and the copper compound, for if this were permitted to take place, the mixture might cake and harden up. If the reddish color of the iron oxide should not be deemed desirable, other minerals such as chromium oxide (green), chromates (yellow), ochre (brown), or a blue pigment, or any suitable color lake may be used.

The compositions of the present invention may be employed in a number of different ways. They may be sprinkled on top of the fire in a coal-fired furnace or boiler. They may be blown into the space above or behind the fire, such as into the firebox, flues or passages which the combustion gases traverse on their way to the chimney. They may be introduced at definite intervals, say every four, six, eight, twelve, or twenty-four hours, or small quantities may be introduced at shorter intervals. The introduction may be at several points in the boiler setting at the same time. The amount used depends entirely upon the size of the installation which is to be treated.

After the composition has been introduced, preferably during a period when the draft in the furnace is somewhat diminished, the draft should be increased so that sufficient oxygen may be available to burn up the carbon (soot) deposits which have accumulated on the flues, walls, on the water-tubes of a boiler, or in the fire tubes thereof. If required some of the composition can be introduced into the back reaches of a boiler setting, so as to treat that portion and perhaps also some of the chimney surfaces themselves.

It appears quite probable that both the NH_3 and HCl components of the ammonium chloride, as well as the copper compounds contribute to the disintegrating action of the composition on the slag and soot deposits. Experience has shown that even very tightly adhering slag deposits become, as it were, rotted, porous and weakened by the action of the constituents of the composition, and hence either drop off under their own weight or are readily dislodged by suitable tools, by tube cleaners or blowers, and the like.

For the cleaning of a 500 H. P. steam boiler, it suffices to throw about 3 to 4 pounds of one of the above mixtures onto the fire. The volatilization of the constituents and the burning of the carrier furnish a vapor or fume that serves to carry them into the flues and tubes containing the soot and scale deposits, where they act as catalysts to facilitate the combustion of the carbon or soot, lowering its ignition temperature about by 300 to 400° F.

The composition comprises a volatile and easily dissociated material in the form of ammonium chloride, which very readily dissociates, at high temperatures, into free hydrochloric acid gas (HCl) and free ammonia gas (NH_3). The copper sulfate, probably by reaction with the halogen component of the ammonium salt, forms a volatile copper compound which attacks the mineral constituents of the ash and scale, thereby assisting in loosening it from its adherence to the metallic and brick surfaces of the flues, walls, tubes and chimneys.

When used in furnace or boiler installations fired by means of oil or gas, the mixture may advantageously be injected at or close to the point of combustion. The combustible ingredient of the composition, such as the wood flour, will furnish additional heat as the result of its own combustion; also acting as a physical carrier for the inorganic constituents until they attain a temperature sufficiently high to cause them to react and/or volatilize. As the vapors liberated from the composition reach the cooler portions of the boiler, flues, etc., they tend to disintegrate the slag and eliminate the fly ash. The slag becomes disintegrated while the ignition temperature of the carbonaceous material in the soot is lowered so that

it will ignite and burn up. The local areas of heat thus produced will further aid in the loosening and breaking up of the slag.

A composition which will start to volatilize at the temperature of boiling water, for instance 212° F., or 100° C., is particularly useful, as such volatility is of extreme importance. Thus when applied to or at any designated area the material will instantly volatilize and commence its action upon the surface of which it is applied almost immediately. It has been found that compounds containing sodium chloride, such as have been used in the prior art, cannot be applied in this manner. In the first place they have a density of over 1 so that when injected into the furnace or combustion chamber they immediately fall onto the floor or upon the grate. Moreover, such volatility as they do possess is a rather slow process making their application at specific areas substantially impossible; in fact all of such types of compounds hitherto used for the present purpose have been thrown upon the grate where the temperature is hottest so as to effect volatilization of the sodium chloride contents thereof which then was intended to be carried to different places and regions of the boiler and boiler setting by the natural draft of the furnace.

Thus, however, treatment of specific areas in the boiler was impossible under these conditions. Such compounds of the prior art, because of their low volatility, can reach only a very small area, and while some good may be accomplished an over-all treatment of the entire area is impossible.

According to the present invention, however, a composition is used which is of such a physical structure that the treatment of any specific spots or areas in a boiler will be under the absolute control of the operator.

In the operation of a boiler plant using coal or oil as a fuel a number of problems arise, namely as the result of the deposition of the by-products of combustion in the combustion chamber, the superheater bank tubes and the back passes of the boiler.

The particular problems which are likely to be encountered, and which require elimination because of their deleterious effect upon the efficiency of the boiler, are as follows:

Fly ash.—Fly ash is a fine powdered ash which is carried through the different passes of a boiler, becoming deposited in all of the passages as a result of the decrease in the velocity of the air and combustion gases in their passage through the combustion zone and the back passes of the boiler. It is particularly liable to deposit in the breech of the stack and also on the economizer; in fact it often deposits so heavily upon the latter as to make it temporarily useless. By using the compound of the present invention the fly ash will be broken up into such a fine dust that it will remain suspended and thus pass through all the passes of the boiler to be eliminated out of the top of the stack. As a result of this, both the breeching and economizer remain free of fly ash so that the passage of the air and combustion gases will be unimpeded.

This is a very important feature of the action of the compound of the present invention, and so far as the inventor is aware, no other compound has ever approached the present compound in its efficiency for this type of treatment. As a result of its use the fly ash is reduced to a minimum, the passage of air through the boiler is unimpeded so that the boiler may remain in active operation two, three or even four times as long as the usual time without the necessity of shutting it down and cleaning it.

Induced draft fan.—In many modern boiler installations there is a fan which produces an induced draft, this being used in all cases where good combustion and forced draft are applicable. It is quite important that such a fan be carefully balanced so that it will not vibrate or get out of alignment, because it is evident that when the fan once

gets out of balance it can become useless and even cause severe damage.

It is one of the faults of prior art compounds which are based primarily upon sodium chloride, that the latter, due to its lack of volatility, will, even after having been volatilized on the grate, subsequently condense upon and adhere to the fan blades, with the result that the fan gets out of balance. This, however, cannot occur when using the compounds of the present invention, because the material is entirely volatile and will pass completely through all of the passes as well as the fan without leaving a harmful deposit.

Slag deposits.—Depending upon the type of coal burned, more or less slag becomes deposited on the tubes, walls, super-heater banks and other parts of the combustion chamber. This is common in all types of boilers, the quality of the coal being a primary factor. The slag or fusion point of the coal ash is variable; some coals have an ash which is readily fusible while other coals have an ash which fuses at a comparatively high temperature. However, no furnace or combustion chamber will long remain free of slag, as slagging will take place to a greater or less degree. The accumulation of slag is a serious matter; it leads to the spalling of the bricks; it hangs on the tubes, putting a great strain on them by the sheer weight of the deposits which hang in the form of stalactites in the combustion chamber. If such a mass should break off it will sometimes even break the grates of the boiler. The formation of slag on the superheater bank lowers the efficiency of the superheater so that the steam temperature may drop as much as several hundred degrees if the accumulation of slag is heavy.

The use of the compounds of the prior art containing sodium chloride instead of being helpful actually increases the amount of slag deposit by reason of the fact that the compound formed, which now will contain sodium, will have a greater degree of fusibility; moreover compounds containing sodium chloride are not efficient in disintegrating slag deposits. As a matter of fact they tend to make them denser and therefore hasten the time when the boiler has to be shut down for repairs. On the other hand the use of a compound which contains materials which are practically 100% volatile eliminates the danger of accumulating slag deposits and has proven to be so efficient that the boiler can be operated almost indefinitely without a shutdown. Moreover it has been found that when hard slag deposits are treated by the products produced by the composition of the present invention, they will be attacked, rendered porous, and will become loose and friable so that they may easily be brushed off or blown off by means of an air jet or steam jet. It has been definitely demonstrated that even hard dense slag is attacked and rendered soft, loose and friable by use of the compound of the present invention; no matter how long the deposit may have accumulated or how dense it may have become, it will become loose and porous by this treatment.

This leads to an important consideration, namely how long can a boiler carrying soot and carbon deposits as well as slag be left in service? Most engineers do not care to keep a boiler in service for more than three months at a time, for experience has taught them that this is about the time that scale, slag and fly ash deposits have accumulated to such an extent that the boiler will be no longer operating at an efficient rate. It therefore at that time becomes necessary to draw the fires, cool down the boiler and open it up for inspection. This will take the better part of a week while quite frequently another week or two is spent in chiseling off the accumulated slag deposits from the walls and tubes. Often the old brick work has been so badly damaged that it has to be replaced by new fire brick, particularly at the points where spalling has taken place or where the fire brick has been attacked.

The superheater banks and the economizer also have to be cleaned, and the fly ash deposits removed. All of

these operations are expensive and cumbersome. Therefore the continuous operation of the boiler is highly to be desired, and several thousands of dollars a year can be saved in operating expenses if the boiler can be allowed to operate throughout the year without a shutdown. This therefore is an important factor because money is saved by reason of the greater efficiency attained in the operation of a clean boiler which is free from slag, fly ash, soot and other deposits. Depending upon the amount of water evaporated per day, as much as \$20.00 per day can be saved when the superheater temperatures are kept at their predetermined point. All these desirable effects can be attained by the use of the compound of the present invention. Moreover, the amount of compound used is also important. It has been found that under average operating conditions the use of as little as 1 pound of the compound per 100 H. P. per day will keep the boiler clean and the operation efficient.

It is to be understood that the application of the compound is not limited to just the areas close to the fire box or grate for it may be used in any part of the boiler where conditions indicate that a deposit exists or is forming and should be removed. Once efficient conditions are attained the amount of material used may be diminished materially, this being of course at the discretion of the operator.

Soot and carbon.—Soot and carbon deposits are formed on certain areas in all boilers, even those operating on oil. Ordinarily this is eliminated by the use of so-called soot blowers. This procedure is usually done at night because of the fact that the clouds of black sooty carbonaceous material blown out of the boiler cannot be seen, but it nevertheless escapes from the boiler and settles upon the adjacent area. The use of the compound of the present invention will get rid of all soot and carbon deposits by reason of the catalytic action of the vapors produced by the volatilization of the material in the present compound which cause the carbon and soot to ignite at a fairly low temperature and thus to burn away to form carbon dioxide which freely escapes in the form of a gas. The substantially complete volatilization of the present compound allows this action to go on and therefore serves to eliminate soot and carbon residues; as a result, therefore, boilers using this material do not have to be cleaned with soot blowers, so that they will now no longer be a nuisance in the neighborhood.

From the further description hereinbelow the nature of the present compound and the reason for its efficiency will be more adequately disclosed.

During the latter stages of the action of the composition, sufficient draft should be available to supply the oxygen required for the effective combustion of the soot. As an indication of what is intended, it may be stated that for a 500 H. P. boiler setting and flues, the draft should be on the order of 23,000 cubic feet.

The combustible carrier, by being very finely divided, will of course also be air borne and by its own combustion will generate heat which serves further to increase the volatilization of the volatile constituents of the mixture. Inasmuch as the carrier has little ash of its own, such as in the case of wood flour, or ground corn cobs, or starches, it will of course in no way cause any deposits of its own. In other words, the entire mixture introduced into the furnace eventually passes out through the stack, together with the material which it is desired to eliminate, thus leaving the furnace walls, tubes, superheater and the various reaches of the boiler in clean and serviceable condition, so as to obtain the best possible heat transfer between the heat of the combustion gases and the heat absorbing metal parts of the boiler.

This is even advantageous so far as the walls of the boiler setting are concerned, because it is well known that a bright clean surface will reflect heat better so that a

better effect of radiation from the walls of the heat absorbing surfaces it attained.

It will be obvious that modifications in the proportions of the composition may be made, and it is the intention to include such modifications within the purview and scope of the present invention.

I claim:

A fly ash, slag, soot and carbon eliminator which is extremely light, has a density of not over 0.40, is capable of being air borne and which is extremely volatile in the combustion chamber and back passes of a boiler, comprising from about 40% to 50% by weight of ammonium chloride, about 5% to 10% of copper sulfate, about 30% to 40% of wood flour, and enough mineral coloring matter to make 100%.

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