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GRINDING OF ORGANIC MATERIALS

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This invention relates to processes for grinding organic materials and more specifically to the production of combustible materials in finely divided form by procedures in which all danger of explosion, burning, decomposition of deterioration of the product due to oxidation or other causes is avoided.

Highly efficient grinding mills and processes have been developed for pulverizing inorganic materials but these cannot without modification be applied to wood, shells and other organic materials because the heat developed and the oxygen in the surrounding atmosphere tend to cause and have caused serious fires and explosions. The expedient of cooling during the grinding of inorganic material by means of a large volume of air circulated through the mill cannot be used in the grinding of organic material because of the hazards arising from the presence of the oxygen.

In an effort to overcome these fire hazards, many safety devices and cut-out systems have been installed on grinding machinery to prevent fires or their spreading and to localize explosions. Grinding systems and processes have been designed wherein the avoidance of oxygen in the mill is attempted by the introduction of inert gases such as carbon dioxide, nitrogen and steam. Since most ground organic materials however, have limited commercial value, the use of carbon dioxide, nitrogen, or other inert gas, even when the same is recirculated through the system has been found to be unsuitable or too expensive for industrial acceptance. To a limited extent wood flour has been ground on mill stones at temperatures below the boiling point of water where there is no fire hazard and also limited amounts of of water and sometimes steam have been applied to the stones to cool the same. This process is employed where ample water power is available but is not satisfactory for general use.

At the present time, various organic materials are ground on corrugated and spiked differential rolls, in various attrition mills and in ball mills, but in spite of magnetic and other separating devices for removing tramp metal, of various safety devices and of various cut-out systems, such are not 100% efficient. In spite of all precautions taken, serious explosions have occurred on many occasions and because of inability to completely eliminate the explosion hazard, some manufacturers have been forced to discontinue operation of their plants.

It is an object of the present invention to provide a method of grinding combustible materials

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in such a way as to prevent fires and explosions or injury to the material being ground.

Broadly considered, the present invention involves the grinding of heat and oxygen sensitive organic material in a normally hot operating grinding mill under a superatmospheric pressure of steam generated by vaporization of a small amount of water introduced in the grinding mill. The water may be introduced into the mill along with the organic material to be ground or may be introduced through a separate inlet into contact with the organic material or the hot grinding elements. The vaporization of the water in the mill takes up or dissipates the excess heat generated by the grinding operation and the vaporizing water or steam positively excludes oxygen from contact with the material being ground or the ground material.

The grinding operation of the present invention is not limited to any particular type of mill, for the grinding may be accomplished in conventional dry grinding hammer mills, attrition mills, mill stones, disk mills, roller mills or in disintegrators now used for or capable of grinding any of the many types of combustible materials contemplated by the present invention. The mill employed, however, must be totally enclosed in order that the superatmospheric pressure required may be developed and maintained. Sealed feed and discharge devices, such as rotary valves and interrupted or plug seal screw conveyors, must also be employed. For the release of any excess steam generated in the mill, the mill or conveying system may be provided with an asperating pipe fitted with an adjustable damper so adjusted at all times as to keep the mill atmosphere under pressure.

The process of the invention applies primarily to the production of fine particle size powders and industrial flours from various combustible organic materials and particularly to very fine particle sizes such as those which will pass a 100 mesh screen, a 200 mesh screen, a 325 mesh screen or still smaller sizes. It is not generally applicable to the grinding of such materials to particles of coarse sizes in excess of 60 mesh, for ordinarily high temperatures or other deteriorative conditions are not encountered when coarse mesh material is produced. The process is applicable only to grinding in hot operating, dry-grinding mills, i. e. mills in which the motivating energy and internal friction loss in the mill are high and where a considerable amount of heat is generated in the mill which unless dissipated in some way will cause the above described organic material

being ground to burn, explode, decompose, or otherwise be damaged by oxygen or other conditions.

The process of the invention is applicable to the treatment of a great variety of natural vegetable materials such as to wood for producing wood flour, to nut shells for producing nut shell flour and also to pits, seeds, roots, tubers, stems, fibers, barks, grains and hulls for the production of fillers, extenders, adhesives, agricultural dusting powders and the like. The process is also applicable to the grinding of many synthetic combustible materials such as resins, organic pigments and other organic materials in general which do not appreciably soften at temperatures below 300° C.

In the grinding of natural vegetable materials by the processes of the present invention, the conversion of pentosans to furfural and organic acids such as acetic, formic, and gallic acids is avoided. Also the oxidation of the resin and wax content of such materials to undesirable end products is inhibited.

The grinding operation of the present invention may be efficiently carried out in an attrition mill. A suitable mill is one equipped with 36 inch disks powered with 75 horse power motors on the respective disks which run in opposite directions. The heat dissipation factor of the present invention can be appreciated from the knowledge that the 150 horse power connected load on this mill converted to heat energy represents approximately 380,000 B. t. u. per hour. In the grinding of a material to a fine particle size it is reasonable to assume that at least 60% of the energy input is converted to heat by friction and with respect to the 36 inch attrition mill the heat developed would amount to about 230,000 B. t. u. per hour. In the operation of the process of the present invention an amount of water is continuously introduced into the mill which dissipates sufficient heat to maintain the temperature below that at which fires, explosions or product decomposition will result, which amount of water, of course, must not be sufficient to take the temperature of the mill below the required 212° F. for otherwise a superatmosphere of steam would not be maintained.

As hereinbefore indicated, the water removes or dissipates the excess heat through the latent heat of evaporation and the water is continuously introduced into the mill at a predetermined and controlled rate. In commercial installations for operation of the present invention, the rate of flow of water into the mill may be controlled automatically by means of a thermostat in the mill wall connected to a needle valve in a water feed line leading to the mill, the control instrument being set at a given temperature above the boiling point of water. Through this arrangement, mill temperatures may be held within ±10° F. of the setting of the instrument. During the grinding operation under the temperature conditions stated, steam is constantly generated in the mill, thereby creating a positive pressure above atmospheric within the enclosed mill (1 to 3 pounds excess being a safe amount) thus excluding oxygen from the grinding atmosphere. Under these conditions explosions and fires can not take place. Furthermore, no deterioration due to oxidation is possible in the mill.

In the above-described 36 inch attrition mill with 150 horse power, the process of the present invention is capable of producing 800 pounds per hour of a 325 mesh nut shell flour operating at a temperature of 275° F. In maintaining such temperature, from .1 to .5 gallon of water per minute are fed into the raw material going into the mill or into the mill itself. The amount of water introduced into the mill in any specific operation to obtain the required temperature is determined by the amount of water in the raw shell material fed to the mill, the atmospheric conditions and radiation losses, the clearance settings of the mill, the fineness of the finished product, the amount of recirculating load to the mill and the resistance of the raw material to grinding. The amount of moisture in the raw shell material ordinarily will vary between 8 and 10% and is generally reduced during the grinding operation to 2 to 4% in the hot, dry ground product obtained. In view of this moisture variation, the automatic control of the water supply added by means of a thermostat on the mill provides an extremely simple but positive method of controlling the temperature while simultaneously effecting exclusion of oxygen.

The process of the invention not only has the advantage of grinding in a non-explosive and non-oxidizing atmosphere but it also, by automatic control of the temperature in the mill, permits the mill to operate at its maximum capacity without danger of explosion.

An apparatus for carrying out the process of the instant application is described and claimed in the copending application, Serial Number 683,226, now Patent No. 2,561,043. A related invention concerned with the classification of the ground products of the present invention and claiming such operations either alone or in combination with grinding operations is set forth in application, Serial Number 683,227, now Patent No. 2,554,450.

It should be understood that the present invention is not limited to the specific details of procedures and conditions herein disclosed except as set forth in the appended claims and that it extends to all equivalents which will occur to those skilled in the art upon consideration of the said claims.

I claim:

1. A process for grinding to a finely divided condition heat and oxygen sensitive organic material in a normally hot-operating, dry-grinding mill which comprises, dry-grinding such material in said mill, introducing water into the grinding mill and vaporizing the same by means of heat developed by the grinding operation, creating a superatmospheric pressure of steam in the mill, dissipating excess heat developed by the grinding operation by means of said evaporation, and positively excluding oxygen from the mill by means of such steam.

2. The process of grinding vegetable shell material to a size at least as small as 60 mesh which comprises dry-grinding such material at a temperature above 212° F. in an enclosed mill, introducing water into the grinding mill and vaporizing the same by means of heat developed by the grinding operation, creating a superatmospheric pressure of steam in the mill, dissipating excess heat developed by the grinding operation by means of said evaporation, and positively excluding oxygen from the mill by means of such steam.

3. The process of producing walnut shell flour to a size not greater than 60 mesh which comprises, dry-grinding the said shells at a temperature above 212° F. in an enclosed mill, continuously introducing water into the mill, vaporizing

the said water in the grinding mill by means of heat developed by the grinding operation, creating a superatmospheric pressure of steam in the mill, dissipating excess heat developed by the grinding operation by means of said evaporation, and positively excluding oxygen from the mill by means of such steam.

4. The process of producing walnut shell flour of a size not greater than 60 mesh which comprises, continuously introducing such shells and a small amount of water into the mill, continuously dry-grinding such material in said mill, vaporizing the said water in the grinding mill by means of the heat developed by the grinding operation, creating a superatmospheric pressure of steam in the mill, regulating the amount of water introduced in direct relation to the temperature in the mill, dissipating excess heat developed by the grinding operation by means of said evaporation, positively excluding oxygen from the mill by means of such steam, and removing the ground nut shell flour from the mill in a substantially dry form.

5. The process of grinding heat and oxygen sensitive organic material into a finely divided form of less than 60 mesh size which comprises dry-grinding such material in said mill under frictional heat producing conditions which in the absence of cooling would cause overheating the material introducing water into the mill and vaporizing the same by means of the frictional heat developed by the grinding operation, creating a superatmospheric pressure of steam in said mill, dissipating excess heat developed by the grinding operation by means of said evaporation and positively excluding oxygen from the mill by means of said steam.

6. The process of finely grinding combustible heat and oxygen sensitive organic materials which do not appreciably soften at temperatures below 300° F. which comprises, dry-grinding such material in an enclosed mill under frictional heat producing conditions which in the absence of cooling would cause overheating of the material, continuously introducing a small amount of water into the mill, vaporizing such water in the mill by means of the said frictionally developed heat, creating a superatmospheric pressure of steam in the mill, dissipating excess heat developed by the grinding operation by means of said evaporation, and positively excluding oxygen from the mill by means of such steam.

7. A process for reducing to a finely divided condition heat and oxygen sensitive organic material in a normally hot-operating, dry-grinding mill which comprises, continuously introducing such material and a small amount of water into the mill, dry-grinding such material in said mill, vaporizing the said water in the grinding mill by means of the heat developed by the grinding operation, creating a superatmospheric pressure, automatically increasing and decreasing the amount of water introduced into the mill in response to increases and decreases in the temperature of the mill, dissipating excess heat developed by the grinding operation by means of said evaporation, and positively excluding oxygen from the mill by means of such steam.

8. A process for grinding heat and oxygen sensitive organic materials which do not appreciably soften at temperatures below 300° F. into a finely divided form of less than 60 mesh size which comprises continuously introducing such material and a small amount of water into an enclosed grinding mill, dry-grinding such material at a temperature above 212° F. in said mill, vaporizing the said water in the grinding mill by means of heat developed by the grinding operation, creating a superatmospheric pressure of steam in the mill, regulating the amount of water added to the material in the mill automatically in response to changes in the temperature in the mill, dissipating excess heat developed by the grinding operation by means of said evaporation, positively excluding oxygen from the mill by means of such steam, and finally discharging the substantially dry ground material from the mill.

9. A process for reducing to a finely divided condition heat and oxygen sensitive organic combustible materials which do not appreciably soften at temperatures below 300° F. by grinding in a normally hot-operating, enclosed mill which comprises dry-grinding such material in said mill at a temperature in excess of 212° F. at a superatmospheric pressure of at least one atmosphere, continuously introducing a small amount of water and vaporizing the same in the mill by means of heat developed by the grinding operation, creating the superatmospheric pressure by means of steam in the mill, dissipating excess heat developed by the grinding operation by means of said evaporation, positively excluding oxygen from the mill by means of such steam, whereby the temperature of the material being ground is prevented from rising to a point at which heat deterioration of the material being ground will occur and any deterioration effect from oxygen is avoided.

10. A process for dry-grinding heat and oxygen sensitive organic materials which do not appreciably soften at temperatures below 300° F. in a normally hot-operating enclosed mill which comprises, continuously introducing such material into such grinding mill, dry-grinding such material at a rate creating a temperature above 210° F. but which in the absence of cooling would overheat the material, continuously introducing water into the mill in a quantity which through its evaporation maintains the material at a temperature below that at which deterioration thereof occurs, continuously vaporizing such water by means of the heat developed by the grinding operation, creating a superatmospheric pressure of steam in the mill through such evaporation, regulating the amount of water added in the mill automatically in response to changes in the temperature in the mill, dissipating excess heat developed by the grinding operation by means of said evaporation, positively excluding oxygen from the mill by means of such steam and removing from the mill a substantially dry ground material undeteriorated by the action of oxygen and heat.

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