

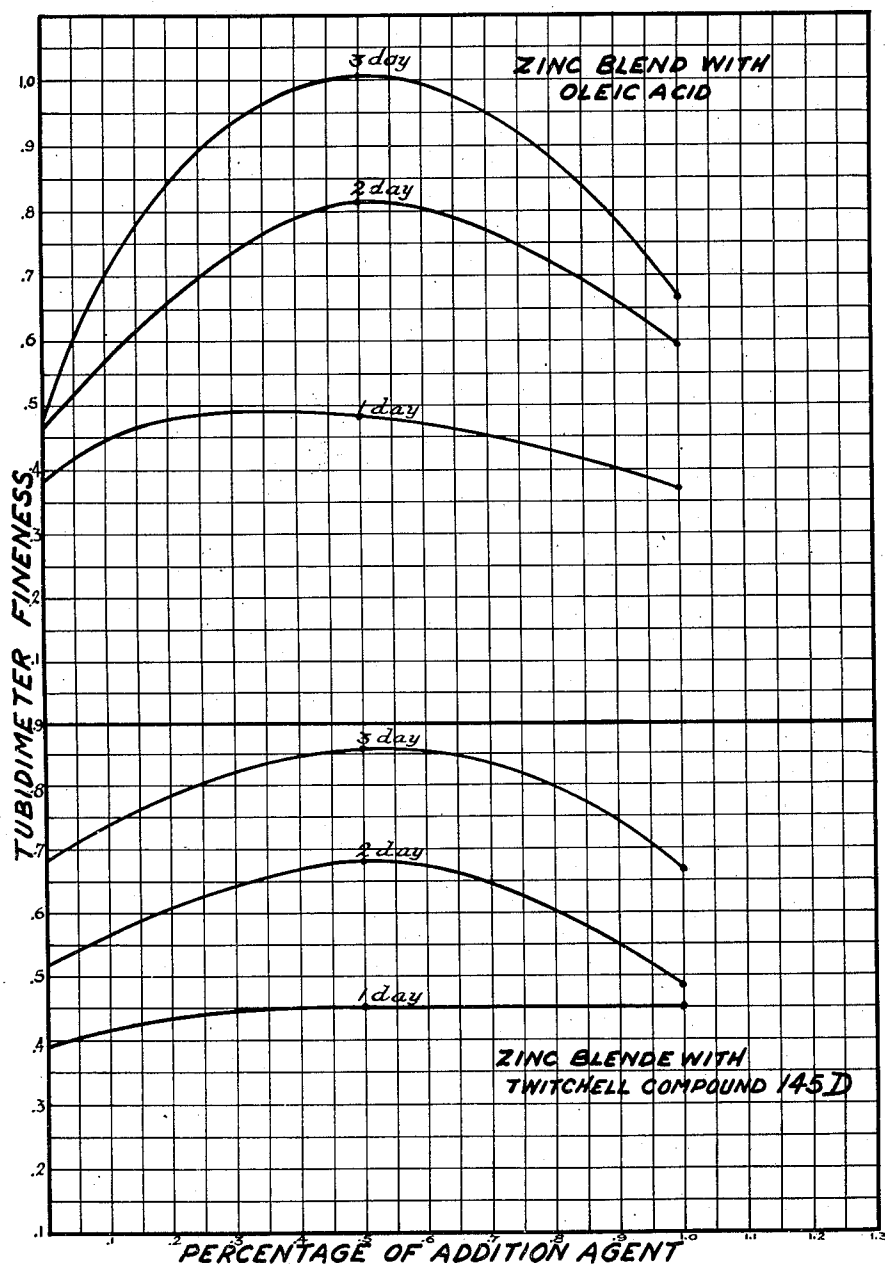
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FINE DRY GRINDING

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FINE DRY GRINDING

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The present invention relates to dry grinding and has for an object to provide an improved process of this character, wherein a greater ultimate fineness of the particles, or a higher efficiency for a given fineness, may be secured.

The invention has been developed in connection with the grinding of pumice, zinc blende, pigments, cement and similar materials in a ball mill and for convenience of description such an embodiment of the invention will be more particularly described for the purpose of illustrating the principles of the invention, but it is to be understood that the application of the invention is not limited to the particular illustration, but extends to all fields of fine dry grinding.

In the dry grinding of particles to a fine powder in which for example 90% or more of the particles are reduced to the fineness of a 200 mesh screen, it has been found that further fine grinding is extremely difficult and the energy input is out of all proportion to the further production of fine particles. When during the grinding process as usually conducted in a ball mill, the bulk of the material reaches this certain degree of fineness, the efficiency of the grinding action is materially reduced and although the mill continues to rotate the larger particles remaining unbroken resist the grinding action of the balls. This seems to be due to the fact that the fine particles tend to adhere to each other and bunch or flocculate and tend also to adhere to the balls and to the larger particles in such manner as to have a cushioning effect on the action of the balls, so that the energy of the balls is absorbed in spreading or deforming these floccules, whereby the larger particles are not broken by the impact of the balls.

The present invention provides an improved method of dry grinding, whereby a more complete grinding of the material is obtained with a more uniform product. This result is obtained by adding to the material to be ground a material which has the property of reducing adherence of the small particles to each other and to the large particles and grinding balls or other impact devices. In one embodiment of the invention a combination of low temperature and the addition of a suitable material to reduce adherence is used.

It is my belief that the adherence or flocculation as above noted is due to the presence of a slight film of moisture or gases which gathers on the surface of the fine particles and that the deflocculating agents act to prevent the formation of these very thin moisture films and prevent

cohesion between fine particles. All my experiments have been conducted on this theory and it has been noted that the more effective materials added for the purpose of promoting fine grinding are of a water and gas repellent character and have the property of forming a slight film over the surface of the fine particles and of the grinding elements. This artificial film is extremely attenuated, and must be thin enough not to act as a flocculating agent itself. In fact, the best results have been obtained by the use of less than 1% of the deflocculating agent per weight of the material being ground. While this theory of action appears to be borne out by the results of my process, it is to be understood that my invention is not based on the theory but on the practical results of the process.

The selection of the material used as a deflocculating agent is influenced by the character of the material to be ground, and the uses for which the material is intended after grinding, and the additive material may therefore embrace a varied class of substances, in general however the additive material should possess the characteristic of smearing or spreading over the surfaces of the particles being ground. The deflocculating agent may advantageously be so selected as to have such affinity for the material to be ground that a surface film will be readily formed and spread on the particles of such material, but it should be of a harmless character in the uses for which the ground material is intended.

The quantity of the deflocculating agent added depends upon several factors such as the mobility of the deflocculating agent, the chemical nature of both the agent and the ground material and the affinity therebetween, the fineness of the resultant ground material and the rate at which the grinding progresses, that is to say the rate at which fresh surfaces are formed.

The proportion of the agent to be added reaches an optimum amount for each individual agent and for each of the different materials to be ground and the efficiency either remains constant or decreases as more than this optimum amount is added. This optimum amount differs for different agents and the amount of the different agents necessary to obtain the same effect varies. For example, when grinding pumice with oleic acid as an additive agent, the optimum amount of oleic acid is between $\frac{1}{8}$ and $\frac{1}{4}$ of 1%, but when grinding zinc blende, the optimum amount of oleic acid is $\frac{1}{2}$ %. Again, for example, the addition of 1/100% of oleic acid, castor oil or Turkey

red oil added to cement being ground will have approximately the same effect in improving the grinding operation as the addition of from 5/100% to 10/100% of hardwood pitch or stearic acid. The more efficient agents such as oleic acid and the like generally attain their maximum efficacy at or below 1/2%. In greater amounts they may show substantially the same or considerable less efficiency. In general there is a marked decrease in efficiency if substantially more than 1% of the more efficient agents is added. The percentages indicated above and throughout the specification and claims are by weight.

Apparently the agents of a mildly acidic nature and particularly the more mobile of such compounds which have the effect of spreading a thin film over the particles of the material provide the best results. Bituminous coal may be used to advantage as a deflocculating agent but it must be used in relatively larger quantities, because of the relatively low amount of smeary content, as for example, to obtain substantially equivalent results fifty times as much bituminous coal will be required as oleic acid.

It has been found also that better efficiency is obtained if a portion of the additive agent, perhaps half of the total amount to be used, is added for the preliminary grinding and the rest for the final grinding, that is to say if enough additive agent is introduced for the early stages of grinding to coat the surfaces then exposed and after more surface is exposed by the continued grinding correspondingly more of the agent is added in order that a sufficient proportion of the agent may be present at all times for the amount of surface then exposed.

Ordinarily it is sufficient if half of the additive agent is introduced at the beginning of the grinding and the other half is added when the grinding approaches the final stage but under some conditions it may prove desirable to add the agent more gradually in smaller increments during the progress of the grinding operation.

My theory in explanation of the facts noted is that the additive agent coats the surfaces of the ground particles with a water repellent film and that the formation of a film of moisture on the surfaces of the ground particles is thereby prevented, and as long as the film of the additive agent remains thin flocculation is reduced or prevented, but when an excess of the deflocculating agent is applied and a thicker film forms on the ground particles that film has the effect in itself of causing adherence of the ground particles to each other and to the balls, and therefore cushions the impact of the balls and retards or prevents further grinding. In other words that the excess of the deflocculating agent will cause an adherence of the ground particles together.

The operation of the process may be illustrated by the following examples:

Pumice was ground for three days in the presence of 1/4% of oleic acid with the result that in a given small sample quantity under a microscope about ten particles were of a size greater than five microns in diameter and most of the particles were smaller than two microns in diameter as compared with the result of pumice similarly ground without an additive agent, wherein forty particles in a similar sample quantity were found about five microns in diameter and most of the particles were between zero and five microns in diameter. The best results were secured using 1/2 of 1% of oleic acid. The tabulated results of

the use of 0, 1/8, 1/4, and 2% of oleic acid are as follows:

Percent oleic acid		Observation on the screen
Percent		
1/8	Finest	Only 5 particles above 5 microns. Most under 2.
1/4	Fine	About 10 particles above 5 microns. Most under 2.
0	Coarse	About 40 particles above 5 microns. Most between 0-5 microns.
2	Coarse	About same as the straight pumice.

Zinc blende ground with 0, 1/8, 1/4, 1/2, and 1% of oleic acid showed the results indicated in the accompanying drawing after 1, 2 and 3 days of grinding with different amounts of the additive agents, and likewise showed similar results when ground with corresponding amounts of Twitchell Compound #145d ("Mahogany or green acid" a by-product of indeterminate composition resulting from the treatment of mineral oil by the Twitchell process).

In this drawing, it will be noted that as different amounts of the additive agent were added to the zinc blende up to 1/2 of 1%, the efficiency of the grinding increased, whereas amounts of more than 1/2 of 1% caused a decrease of grinding efficiency which became more pronounced as the grinding was continued.

In certain embodiments of my invention where the materials being ground give off moisture under the elevated temperature of the grinding mill, it is desirable to artificially cool the mill by blowing air or spraying currents of water thereon to prevent the giving off of moisture which condenses on the surface of the particles and retards the efficiency of the additive material used.

In the fine grinding of pigments, it is possible to take advantage of the film of additive agent coating, the particles of the pigment to promote mixing of the pigment with oil or other carriers.

The foregoing particular applications are illustrative merely and are not intended as defining the limits of the invention as it will be readily understood that various additive agents may be used in the fine grinding of various materials, all within the scope of my invention.

I claim:

1. The method of grinding material to a fine dry powder which comprises cooling the material during the grinding operation to prevent adherence of the finely ground particles and adding an agent having the quality of forming a moisture repellent coating on the particles being ground.

2. The method of grinding zinc blend to a fine dry powder which comprises adding to the zinc blend while dry oleic acid in the proportion of approximately 0.5% of the zinc blend and grinding said material while still dry by repeated blows of impact devices for a period of 2 to 3 days.

3. The method of grinding pumice to a fine dry powder which comprises adding to the pumice while dry oleic acid in a proportion of approximately 1/8th of 1% of the pumice and grinding the material while still dry between grinding elements for a period of 2 to 3 days.

4. The method of dry grinding fine material consisting of particles of oriented crystalline structure 90% of which will pass a 200 mesh screen which comprises adding to the material at different times during the grinding operation increments of a deflocculating agent of water repellent character which coats the particles during grinding with a film to prevent the particles adhering

to each other and to the grinding elements, said deflocculating agent being added in a total quantity of less than 1% of the weight of the material and grinding said material by impact elements to rupture said particles.

5. The method of grinding fine crystalline material consisting of fragments of oriented crystalline structure 90% of which will pass a 200 mesh screen which comprises adding to the material a deflocculating agent of oily character which coats the particles during grinding with a film to prevent the particles adhering to each other in a proportion to prevent flocculation of finely ground particles but insufficient to cause adherence and fracturing the crystal fragments between grinding elements.

6. The method of dry grinding fine crystalline material 90% of which will pass a 200 mesh screen which comprises adding to such crystalline material in dry form a moisture repellent deflocculating agent of smearing or spreading character in a proportion approximating 0.5% of the weight of the material and grinding said material while still dry between grinding elements to fracture the crystal fragments.

7. The method of dry grinding fine crystalline material 90% of which will pass a 200 mesh screen which comprises adding to such crystalline material in dry form a moisture repellent deflocculating agent of smearing or spreading character which coats the particles during grinding with a film to prevent the particles adhering to each other and to the grinding elements in a proportion of less than 1% of the weight of the material and grinding said material while still dry be-

tween grinding elements to fracture the crystalline particles.

8. The method of dry grinding fine material 90% of the particles of which will pass a 200 mesh screen to reduce the average size of the ultimate particles which comprises adding to such material in dry form a moisture repellent deflocculating agent of smearing or spreading character which coats the particles during grinding with a film to prevent the particles adhering to each other and to the grinding elements in a proportion of less than 1% of the weight of the material and grinding said material while still dry between grinding elements to fracture the particles.

9. The method of grinding to reduce the average size of the ultimate particles of fine dry powder 90% of which will pass a 200 mesh screen by fracturing the particles which comprises adding to the material while dry approximately 0.5% of its weight of oleic acid and grinding the material while still dry between grinding elements to fracture the particles and thereby reduce the average particle size.

10. The method of grinding to reduce the average size of the ultimate particles of fine dry powder 90% of which will pass a 200 mesh screen by fracturing the particles which comprises adding to the material while dry approximately 0.5% of its weight of a deflocculating agent which coats the particles to prevent adhering to each other and grinding the material while still dry between grinding elements to fracture the particles and thereby reduce the average particle size.

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