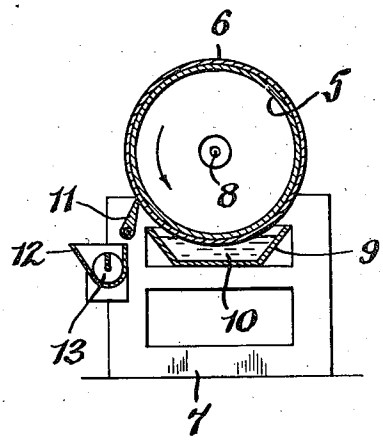
March 17, 1936. D. J. VAN MARLE 2,034,599

METHOD OF DRYING INORGANIC SALTS AND SLUDGES

Filed July 10, 1933

Fig. 1.



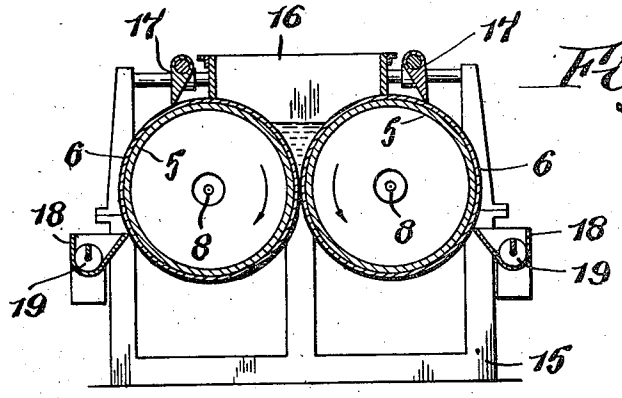


Fig. 2.

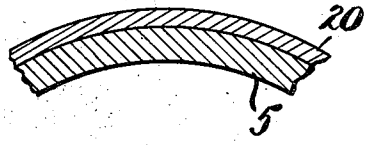


Fig. 4.

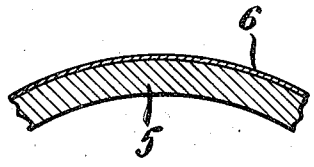


Fig. 3.

Dirk J. Van Marle INVENTOR

BY Popp and Powers ATTORNEYS

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2,034,599

METHOD OF DRYING INORGANIC SALTS AND SLUDGES

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Application July 10, 1933, Serial No. 679,627

1 Claim. (Cl. 159—7)

This invention relates to a process for drying inorganic salts, such as sodium sulfate, sodium sulfite, ammonium phosphate, sodium phosphate, sodium carbonate, sodium chloride, potassium salts, calcium chloride, magnesium chloride and sludges and more particularly to a continuous drying process in which the inorganic salts to be dried are fed in the form of a solution or sludge to a heated revolving drum from which the dried product is scraped by a knife.

Various materials are now being dried, flaked or cooled on bronze, steel or cast iron drums. The drying drums are usually heated by steam and the cooling drums cooled by water, brine or direct expansion. The materials in a liquid or semi-liquid state are applied to the rotating drum or drums and carried around to a fixed point where a scraper or doctor blade removes the material from the drums, and deposits it in a suitable conveyor.

The drum dryers as heretofore constructed are not entirely satisfactory and in fact they are unsuitable for drying many inorganic salts and sludges. However, the short period of drying and the continuous feature of this type of dryer make it very desirable to use for drying such inorganic salts.

The difficulty encountered with steel and cast iron drums is the proper removal of the dried or cooled substance by the knives or doctor blades from the drum surfaces. It appears that cast iron and steel have a great affinity for and retentive power of inorganic salts that are being dried on such surfaces, the inorganic products adhering so tenaciously that it is impossible to completely remove the dried product by the use of any type of knife known at present. The dried product on the drum or drums is therefore only partly removed by the knives, part of it remains as a residual film clinging tightly to the drum surface, and passes between the knife and the drum surface. As the drying proceeds, the continuous abrasion by the film of material dulls the knife very quickly and the residual film which the knife does not remove increases rapidly in thickness, thereby greatly obstructing the flow of heat required for the drying,—this in turn reduced the capacity of the dryer and increases the moisture content of that part of the dry product which the knife is still capable of removing. On products such as sodium sulphate, etc., the conditions as outlined will continue to grow worse until shortly a point is reached at which the drying has to be discontinued.

On some inorganic salts, the residual film builds up to a certain thickness, then, on account of the excessive pressure of the knife and possibly increased expansion of the drum, caused by the insulating qualities of the residual film which results in a slight increase in steam pressure and temperature within the drum, and on account of the continuous exposure of the residual film to this high temperature, such film at intervals will lose its grip on the drum surface and will be removed entirely or irregularly in spots. Should the material be sensitive to heat, the residual film periodically removed would, of course, be overheated and inferior in quality. Moreover, regardless of whether the material is sensitive to heat or not, the texture of the dry product would not be uniform and would vary from a fine powder to large flakes or hard scales which would require a special grinding operation. The capacity and moisture content of the dry product would vary as the residual film would be in process of building up or be removed. The power requirements for the removal of the product from the drums will be excessive and the results as a whole far from satisfactory. If a heavier or stiffer knife blade is selected or the knife placed at a steeper angle in relation to the drum surface in an effort to cut into the residual film, this may result in the scoring of the drum surface or deep gouging of the metal which may be sufficiently serious to render the drum unfit for further use.

In the type of dryers known as double drum dryers, the drums are set close together, with an end board at each end of the drums forming a reservoir on top of and between the drums, for holding and pre-concentrating the liquid to be dried. The drums revolve in a downward direction through this reservoir, the clearance between the two drums determining the thickness of the film on the surface. On this type of dryer any residual film, whether covering the drum surface entirely and uniformly or irregularly in spots, will seriously interfere with the application of a liquid film of uniform thickness on the drum surface. The original clearance between the drums generally is between .030" and .040". The residual layer on the drums soon builds up to a point where this clearance will be closed altogether as a result of which pressure will be exerted on the residual films at a point where they meet between the drums. This pressure becomes greater as the residual film increases in thickness and tends to crush and crack the hard film which makes it possible for the knife to remove all or part of this heavy coating, resulting in an

increased clearance and leakage between the drums in places where the coating has been removed. The excessive pressure between the drums caused by the residual film remaining on the drum surfaces, will in a very short time distort this surface to such an extent that the drums become useless for further service. The double drum dryer is therefore unsuitable for drying solutions of inorganic salts, due to the failure of properly removing the dry substance from the cast iron or steel surfaces used heretofore.

The above objections are found in all kinds of iron or steel drums which have heretofore been employed in drum dryers whether open grained or close grained, or whether large grained or small grained. The reason for the tenacity of iron or steel does not appear to depend entirely upon the size of the grain but it appears that the tenacity with which the metal retains a film of inorganic salt or sludge is due to the chemical composition of the metal, its internal grain structure and possibly the oxidation of the surface, which alone or in combination form a perfect anchorage for inorganic salts.

I have found that if inorganic salts or sludges are dried upon drums having a grain structure which provides a smooth metallic surface, these difficulties do not occur. The film of dry material no longer tenaciously adheres to the drum surface and can be removed by the doctor blade without applying excessive pressure. Consequently, heat transfer is improved, the drum speed can be increased, a high capacity is obtained, moisture content of the dried product becomes uniform, there is no injury to the quality of the product, and no contamination of the product. Moreover, since the knife pressure can be relieved, the wear of the knives is greatly reduced, power consumption is greatly decreased, and the danger of the knives damaging the drums is removed.

It is therefore the object of this invention to provide a process of drying inorganic salts and sludges which consists in drying these materials upon a smooth metallic surface from which they can be readily scraped, thereby avoiding the difficulties encountered in drying these materials on steel or cast iron drums.

In the accompanying drawing:

Fig. 1 is a vertical transverse section through a simple form of single drum atmospheric dryer adapted for use in carrying out my improved process, and showing, in a simplified manner the manner in which the material is applied to the drum and scraped therefrom and showing the drum made of steel or cast iron and plated with chromium.

Fig. 2 is a similar section through a simple form of atmospheric double drum dryer and showing the two drums also made of cast iron and plated with chromium.

Fig. 3 is an enlarged fragmentary cross section of a steel or cast iron drum plated with chromium.

Fig. 4 is a similar fragmentary cross section of a steel or cast iron drum having a stainless steel sleeve applied thereto.

The apparatus shown for carrying out the present process is shown as embodied in a single and a double drum atmospheric dryer, although it will be understood that the invention is also applicable to vacuum drum dryers. In the atmospheric single drum dryer illustrated in a simplified manner in Fig. 1, the drum 5 is made of welded, seamless drawn or cast steel or cast iron in the usual manner, and has its cylindrical face plated with chromium 6. This drum is suitably journaled in end standards 7 and is provided with a steam inlet 8 and also with suitable manner (not shown) for removing the condensate. The liquid or pasty inorganic salt or sludge to be dried can be applied to the chromium plated surface 6 of the drum 5 in any one of a number of different ways but as shown the drum is arranged to dip into a pan 9 which is kept filled with a bath 10 of the material to be dried. The drum is rotated in the direction of the arrow and as it rotates the film of liquid picked up from the pan 9 dries and is scraped off by a longitudinal knife or doctor blade 11 which is preferably provided with means (not shown) for adjusting its pressure against the chromium plated surface of the drum 5. The dried material scraped from the drum by the knife 11 falls into a trough 12 from which it is conveyed by means of a screw conveyor 13. When the inorganic salts are to be dried, the same are fed to the heated drying drum in the form of a solution, slurry or sludge. When the inorganic salts are to be cooled or flaked the salts are fused and may or may not contain water and the drum is cooled.

In the double drum dryer shown in Fig. 2 two parallel drums 5 are provided and each is composed of a welded seamless drawn or cast steel or cast iron body having its outer cylindrical face plated with chromium 6. As in the form shown in Fig. 1 each drum is provided with a steam inlet 8 and suitable means for removing the condensate. The drums are supported for continuous rotation in the direction of the arrows on a frame 15 which also supports an end plate 16 at opposite ends of the drums 5. These end plates enclose the valley between the closely spaced drums, and the material to be dried is held in a valley or trough formed between the drums and between the end plates 16. As the drums rotate they pick up a film of this material and when this film is dried it is scraped off by doctor blades or scrapers 17 which preferably also have means (not shown) for the adjustment of their pressure upon the surface of the drum. The dried material falls into troughs 18 from which it is conveyed away by means of screw conveyors 19.

Instead of plating the drums 5 with chromium, as shown in Figs. 1, 2 and 3 a sleeve of stainless steel 20 can be applied to the body 5 of the drum, as shown in Fig. 4. Stainless steel has an austenitic grain structure as compared with chromium which in plated construction is generally considered to be amorphous. Drums made completely of stainless steel have been found satisfactory but for reasons of economy it is preferable to make the drums of steel or iron and place the stainless steel sleeve around these drums. However, for general purposes, plating the drums 5 with chromium has been found to be the most satisfactory as hereinafter more fully pointed out.

Until recently only steel, cast iron and bronze were available for commercial drums for atmospheric or vacuum dryers. Although bronze offers a considerably better surface than steel or iron it is subject to the same difficulties to a lesser degree and has the additional disadvantage of comparative softness and of being easily damaged by the knives. Nickel, Monel metal and aluminum are also comparatively soft and offer difficulties in making sound castings of the required size. Stainless steel and chromium plated welded, seamless drawn or cast steel or iron drums have proved to give satisfactory results. Stainless steel

can be used in the form of a homogeneous drum of this metal or can be applied as a sleeve over a steel or cast iron drum. To be entirely satisfactory this metal must be of the proper hardness, otherwise it will be readily scored by the knives on account of its ductility. Even then chromium plated steel or cast iron drums are to be preferred because of their better heat transfer, reduced tension on the knives and because of the unequal expansion between the stainless steel sleeve and the cast iron drums. Moreover, if soft knives are used in connection with a stainless steel drum surface to prevent scoring the wear of these knives again becomes excessive. Cast iron and steel alloys of an austenitic grain structure such as nickel-iron and nickel-copper-iron alloy, known commercially as Ni-resist, have been found to be an improvement but at present suffer from the same disability of comparative softness. Both of these alloys and stainless steel form a homogeneous solid solution in the solid state. Nickel plating does not offer much promise because of the softness of the nickel and the danger of breaking or peeling of this plating. However, improved knives which require less tension and a better electro-deposit of nickel may render a nickel plated drum entirely satisfactory.

The chromium plating of welded, seamless drawn or cast steel or iron drums has proved entirely satisfactory as it forms a hard, smooth coating which is harder than the steel or iron surface and is not subject to atmospheric corrosion. Special steel, iron, nickel or bronze alloys of suitable hardness, internal grain structure and surface condition also offer a possibility.

With chromium plated drums drying sodium sulfate it has been possible to increase the speed from 2 R. P. M. with cast iron drums to 10 R. P. M. obtaining an increase in capacity of 60% over that obtained on cast iron drums. Moreover the moisture content of the dried product was reduced from 1.6–1.8% on the cast iron drums to from 0.2–0.3% on stainless steel or chromium plated drums.

Sodium sulfite shows an increase in capacity of 75% in favor of the chromium plated drum, at approximately the same drum speed. However, it is possible with the chromium plated drum to double the speed and obtain an increase in capacity of 170%.

Sodium phosphate shows the same increase in capacity and a reduction in power consumption from 26 horse power for the cast iron drums to less than 15 horse power for the chromium plated drums. This result was obtained in a commercial drying installation of much larger size than the experimental dryer on which the other tests were made.

Tests have indicated that it is apparently more satisfactory to chromium plate steel drums than cast iron drums. Due to the lack of sufficient hardness of steel which can be used in making drying drums, the use of chromium plated steel drums appears to be particularly applicable to single drum atmospheric and vacuum dryers for drying inorganic salts and sludges.

The smooth surfaced drums forming the subject of this invention can also be advantageously used as flaking or cooling drums in flaking inorganic salts and sludges which materials adhere very tenaciously to cast iron drums and can only be removed from the drum surface by using great pressure on the knife. By providing a smooth metallic surface, as by chromium plating the flaking or cooling drums, the same advantageous results are obtained in flaking these materials.

The present invention therefore provides a process for drying inorganic salts or sludges on a smooth surface to which the material will not adhere tenaciously and can be readily scraped off by knives which are adjusted to bear with only relatively slight pressure against the drying surface. This avoids all of the difficulties referred to with reference to iron or steel drums on which, unless excessive knife pressure is used, a film of the dried material will adhere to the drum surface, build up in the form of a residual film or layer of dried material, reduce the efficiency of the dryer, slow up the drying process, require greater heat and result in a product which is liable to be contaminated.

I claim as my invention:

The method of drying a solution of an inorganic salt selected from a group comprising sodium sulfate, sodium sulfite, ammonium phosphate, sodium phosphate, sodium carbonate, sodium chloride and potassium salts, which consists in applying a coating of a solution of the inorganic salt to a smooth surface of a metal selected from a group composed of chromium and a ferrous nickel alloy of austenitic grain structure and of a temperature higher than the boiling point of said inorganic salt solution and continuously scraping the entire hardened coating of inorganic salt therefrom.

DIRK J. VAN MARLE.