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METHOD OF DRYING WET MATERIALS

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It is known to dry wet materials in vacuum in such manner that the material is heated by means of direct steam in a drying chamber whereupon the chamber is evacuated by means of a pump, the steam removed being to the greater part condensed in a condenser provided between the drying chamber and the pump.

Said method is generally carried out in the following manner. The drying chamber is charged with the wet goods to be dried and then closed with the exception of an outlet valve which is left open. Then steam of a pressure of for instance 2 to 4 atmospheres is supplied to the chamber, the air contained in the chamber being expelled through the open outlet valve while the goods and the walls of the drying chamber being heated. The heating is, if desired, amplified by indirect heating, for instance by means of steam heated coils provided in the drying chamber. When the goods to be dried has attained the desired temperature, which for wood amounts to about 70 to 95° C., the outlet valve is closed and the supply of heating steam is cut off. Then the vacuum pump is started, so that steam and the remainder of air is removed from the drying chamber, the steam being condensed in the condenser provided between the drying chamber and the pump. The pressure in the drying chamber sinks rapidly and when it has reached a value corresponding to the pressure of saturated steam at the temperature of the goods to be dried, the water content of the goods begins to evaporate. By continuing the evacuation and the condensation, the equilibrium between the temperature of the wet goods and the pressure of the saturated steam in the drying chamber is maintained. The heat stored in the walls of the drying chamber and in the wet goods causes a continued generation of steam which, if desired, is increased by an indirect supply of heat. When the condensation in the condenser has decreased to a slight value which occurs when the temperature of the goods has decreased to about 30 to 40° C. if the cooling water available for the condenser has a temperature of about 15° C. the evacuation is interrupted. Air is

then supplied to the drying chamber so as to restore the atmospheric pressure and the remaining moisture in the interior of the goods is given an opportunity to diffuse towards the surface. Then a renewed heating by direct steam followed by evacuation and restoring of the atmospheric pressure takes place which processes are repeated until the desired dryness has been attained.

Said known method though effective has the drawback that it requires a rather long time and a rather high temperature which in some cases may be detrimental for the goods to be dried.

This invention relates to an improvement of said known drying method according to which a uniform and complete drying may be attained in a shorter time and at a lower temperature than hitherto. The invention consists chiefly in first heating the goods to be dried by means of direct steam at atmospheric pressure in a drying chamber while expelling the air present in said chamber and the goods and then alternately evacuating the drying chamber and supplying steam to it in absence of atmospheric air while maintaining a pressure below the atmospheric pressure until the desired dryness of the goods has been attained.

As an example of carrying out the invention I will herebelow describe its application to the drying of wood. The wood to be treated is charged in a drying chamber, having preferably the form of a cylinder with a loose cover at one end. After the closing of the chamber steam of a pressure of 2 to 4 atmospheres is supplied, the supply of steam being controlled in such manner that the temperature of the wood is slowly raised to about 60° C. although it may at times be carried as high as 90° C., depending upon the character of wood being treated. The maximum temperature varies with the sort of the wood and should for resinous wood such as pine not exceed 55° C. in order to avoid effusions of resin. In addition to the heating by direct steam heat may be supplied during the first period of heating also indirectly for instance by steam heated coils provided in the drying cylinder. Said first

heating is preferably carried out at atmospheric pressure, the air contained in the drying chamber being expelled through an outlet valve by the steam supplied. When the charge has attained the permissible maximum temperature, the outlet valve is closed and the supply of steam is cut off. The drying chamber is then evacuated by means of a pump, the steam sucked off from the drying chamber being to the greater part condensed in a condenser provided in the conduit between the drying chamber and the pump. When the condensing in the condenser has decreased to a low value which is the case when the temperature of the wood has decreased to about 20° to 40° C. if the temperature of the cooling water available for use in the condenser is about 15° C., the evacuation is interrupted. A renewed heating of the wood is now immediately effected by supplying steam to the drying chamber while any supply of air to the drying chamber being avoided and the supply of steam being so controlled that a rather high vacuum is maintained in the chamber. By said supply of steam the temperature of the goods treated and of the walls of the drying chamber is again increased to the permissible maximum value. The pressure in the drying cylinder should at least during a part of the heating period not exceed 200 m. m. Hg and throughout the heating period is preferably maintained below atmospheric. During the heating period the steam supplied delivers part of its heat to the wood. The condensate formed collects partly as drops or bodies of water on the wood and the walls of the drying chamber but a considerable part thereof remains suspended as a mist in the cylinder and will be removed in said state in the subsequent evacuation without requiring any supply of heat for its evaporation. The process is repeated with alternate supply of steam while maintaining a desired vacuum and evacuation to a low pressure until the desired degree of dryness has been attained.

The process can be modified in such manner that a moderate supply of steam is maintained also during the evacuation periods, if desired in connection with indirect heating, the temperature and pressure in the cylinder being thus maintained approximately constant and at desired values by controlling the temperature and superheating of the steam supplied.

Besides the advantages of a shortened time of treatment and a reduced maximum temperature in comparison with known steam heating methods, my invention has also the advantage that the heating steam may be supplied at a higher pressure than hitherto and be superheated, if desired, in as much as the heating is interrupted each time at such an early stage that the material

treated cannot be injured by superheating. In drying wood according to this invention the method has further the advantage that cracks, discolouring and effusions of resin are avoided.

The method according to the invention is applicable to all kinds of drying goods which can be subjected to heating by direct steam, such as for instance wood, corn, fish, flesh and other albumin substances, bricks, pottery etc.

What I claim is:—

1. Method of drying wet materials, which comprises first heating the material in a drying chamber by means of direct steam substantially at atmospheric pressure while removing the atmospheric air from said chamber, and then alternately evacuating the drying chamber to a low pressure and supplying steam to reheat the material treated substantially in absence of atmospheric air until the desired degree of dryness has been attained, the reheating taking place at a pressure below the atmospheric pressure.

2. Method of drying wet materials, which comprises first heating the material in a drying chamber by means of direct steam substantially at atmospheric pressure while removing the atmospheric air from said chamber, and then alternately evacuating the drying chamber to a low pressure and supplying steam to reheat the material substantially in absence of atmospheric air until the desired degree of dryness has been attained, the reheating being started when the temperature of the material treated has fallen to about 35 to 40° C. and being interrupted when the temperature of the material has been raised to at most 60° C.

3. Method of drying wet materials, which comprises first heating the material in a drying chamber by means of superheated direct steam at atmospheric pressure while removing the atmospheric air from the drying chamber, and then alternately evacuating the drying chamber to a pressure below 200 m. m. Hg and supplying superheated steam to reheat the material treated substantially in absence of atmospheric air, until the desired dryness has been attained, the reheating being each time interrupted before the pressure in the heating chamber has reached the atmospheric pressure.

4. The method of drying wet material which comprises introducing the same into a drying chamber, withdrawing atmospheric air from said chamber, heating the material by means of direct steam while maintaining the pressure below atmospheric, and then alternately evacuating the chamber to a low sub-atmospheric pressure and supplying steam to reheat the material while maintaining at substantially all times pressure below atmospheric until the desired degree of dryness has been attained.

5. The method of drying wet material which comprises introducing the same into a drying chamber, withdrawing atmospheric air from said chamber, heating the material by means of direct steam, and then alternately evacuating the chamber to a low pressure and supplying steam to reheat the material treated, while excluding atmospheric air and maintaining at substantially all times pressure below atmospheric until the desired degree of dryness has been attained.

6. The method of drying wood which comprises introducing the wood into a drying chamber, removing atmospheric air from the chamber, heating the wood in the chamber by means of direct steam and alternately evacuating the chamber to a sub-atmospheric pressure and supplying steam to reheat the material in the absence of atmospheric air while excluding atmospheric air and maintaining the pressure in the heating and evacuation below atmospheric, the reheating being started when the temperature of the material has fallen not lower than 20° C. and being interrupted when the temperature of the material has been raised to a desired maximum.

7. The method of drying material which comprises introducing the same into a drying chamber, heating the material by means of direct steam, evacuating the drying chamber and then alternately introducing steam and evacuating while maintaining substantially throughout the treatment less than atmospheric pressure.

8. The method of drying material which comprises introducing the same into a drying chamber, heating the material by means of direct steam, evacuating the drying chamber and then alternately introducing steam and evacuating while excluding atmospheric air and maintaining substantially throughout the treatment less than atmospheric pressure.

9. The method of drying material which comprises introducing the same into a drying chamber, withdrawing atmospheric air and heating the material by means of direct steam, evacuating the chamber and then alternately introducing steam and evacuating, the reheating being started when the temperature of the material has fallen to not less than 20° C. and being interrupted before the pressure substantially exceeds atmospheric.

10. The method of drying material which comprises introducing the same into a drying chamber, withdrawing atmospheric air and heating the material by means of direct steam, evacuating the drying chamber and then alternately introducing steam and evacuating, the reheating being each time interrupted before the pressure in the heating chamber substantially exceeds atmospheric pressure.

11. The method of drying material which comprises introducing the same into a drying chamber, withdrawing atmospheric air from said chamber, heating the material by means of direct steam and then alternately evacuating the chamber and introducing direct steam, the pressure in the evacuating steps and throughout the greater portion of the individual heating steps being maintained below atmospheric.

12. The method of drying material which comprises introducing the same into a drying chamber, withdrawing atmospheric air from said chamber, heating the material by means of direct steam and then alternately evacuating the chamber and introducing direct steam, the pressure in the evacuating steps and throughout the greater portion of the individual heating steps being maintained below atmospheric, and air being excluded throughout.

13. The method of drying material which comprises introducing the same into a drying chamber, withdrawing atmospheric air from said chamber, heating the material by means of direct steam and then alternately evacuating the chamber and introducing direct steam substantially in the absence of atmospheric air, the pressure in the evacuating steps and throughout the greater portion of the individual heating steps being maintained below atmospheric.

14. The method of drying material which comprises introducing the same into a drying chamber, withdrawing atmospheric air from said chamber, heating the material by means of direct steam and then alternately evacuating the chamber and introducing direct steam substantially in the absence of atmospheric air, the pressure in the evacuating steps and throughout the greater portion of the individual heating steps being maintained below atmospheric, and air being excluded throughout.

15. The method of drying wood which comprises introducing the same into a drying chamber, withdrawing atmospheric air from said chamber, heating the wood by means of direct steam and then alternately evacuating the chamber and introducing direct steam, the pressure in the evacuating steps and throughout the greater portion of the individual heating steps being maintained below atmospheric, each time resuming the heating when the temperature falls to not less than 20° C., and interrupting the same below a temperature which would cause effusions of rosin or similar wood content.

16. The process of drying substances which consists in altering the temperature thereof by subjecting the same to direct steam, maintaining sub-atmospheric pressure substantially throughout the steam treatment, and then drying by evacuation.

17. The process of drying substances which

consists in altering the temperature thereof by subjecting the same to direct steam, maintaining sub-atmospheric pressure substantially through the steam treatment, and also substantially excluding atmospheric air and then drying by evacuation.

18. The process of drying substances which consists in subjecting the same first to steam under atmospheric pressure and then alternately (a) drying by evacuation and (b) supplying additional heat by subjecting the substances to direct steam while maintaining sub-atmospheric pressure substantially through the steam treatment.

19. The process of drying substances which consists in subjecting the same first to steam under atmospheric pressure and then alternately (a) drying by evacuation and (b) supplying additional heat by subjecting the substances to direct steam while maintaining sub-atmospheric pressure substantially throughout the steam treatment and also substantially excluding atmospheric air.

In testimony whereof I have signed my name.

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