A REVIEW - HOT AIR NOZZLE SYSTEM OF TEXTILE DRYER

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ABSTRACT

Hot air nozzle system is a used for thermally treatment on a textile fabric. The fabric in open width condition is passed through the system. During the passage of the fabric through the Nozzle system, hot air steam is directed onto the fabric from above and below by an assembly of Blowers, radiators, nozzle etc. arranged above and below the fabric. The assembly are known as chamber and suitable insulated to ensure minimum heat loss provided structure and corresponding drying oven for fabric. There are different types of drying technique for different fabrics, Hot air is used for dry the fabric so fabric dry quality is directly depending on Air mass flow rate. More evenly air is flow over the fabric there is higher quality of fabric drying can be achieved. Here study and review of Hot air flowing Nozzle system used in Textile Dryer.

Keywords: - *Textile Dryer, Heat Transfer, Air flow distribution*

1. INTRODUCTION

Drying is done by effecting vaporization of the liquid by supplying heat to wet feedstock. Heat may be applied by various way like it may be supplied by convention, by conduction, radiation or volumetrically by placing the wet material in microwave or radio frequency electromagnetic field. There are most industrial dryers are of convective type with hot air or direct combustion gases as the drying medium. Textile Dryer is widely used for stretching of fabrics, and drying, heat setting and finishing. Woven and knit fabrics of polyester and nylon fibers and their blends are normally heat-set on pin-stenter in hot air. Two types of variant main is clip machine and pin machine and now also combine of pin and clip machines are also available. Each and every product, there is a represented curve that describes the drying characteristics for that product at specific temperature, Velocity and pressure conditions. Basic Principal of Drying Fabric is Drying cloth involves two processes. Energy is provided to change the water from liquid to vapour and air stream is needed to remove the vapour. According to kinetic theory, temperature is expression of the average energy of molecular motion. Rate of evaporation will be lower, giving time for heat to migrate into wet cloth from surrounding air. Temperature s stable at some value below ambient which depends on the balance between the rate at which the water molecules merge from the surface and rate at which heat can reach the cloth.The First Phase, or initial period, is where sensible heat is transferred to the product and the contained moisture. This is the heating up of the product from the inlet condition to the process condition, which enables process to take place. The rate of evaporation increase during this period with mostly free moisture removed. The Second Phase, or constant rate period, is when the free moisture persists on the surfaces and the rate of evaporation alters very alters very little as the moisture content reduces. There is a gradual and relatively small increase in the product temperature during this period. In this period drying rates are high, Higher inlet air temperatures than in subsequent drying stages can be used without detrimental effect to the product. The third phase, is the phase during which migration of moisture from the inner interstices of each particle to the outer surface becomes the limiting factor that reduces the drying rate. Heat-setting can be carried out at three different stages in a processing sequence. The stage of Heat setting is depending on extent of contaminations and types of fibers or yarns present in the fabric.

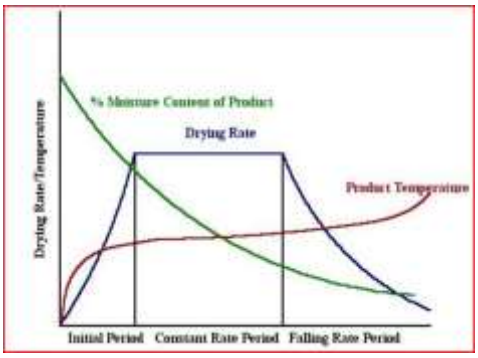

Fig. 1 Drying Curve [1]

2. METHODS OF HEAT-SETTING

There are various methods is used to remove the water from fabric by evaporation based on fabric types and availability of machine.

A. Contact Method: - The fabric is run in contact with a heated metal surface. Some machine is composed of metal rollers having gas fired cores and are filled with a liquid known as diathermy to uniformly distribute the heat. Two or more enclosed rollers are heated with high temperature steam. It is mainly used for polyester/cotton blended fabrics.

B. Steam-Setting Method: - Steaming is carried out in a steam sterilization with vacuum pump. For material stabilizing it is used 107°C steam on ring spinners tube for most effective means and soft dyeing packages under minimum tension.

C. Hydro-Setting Method: - This method is done with hot water in a high temperature liquid circulating in machine at 130°C. Water and steam cum out from fabric and may cause some hydrolysis in chain and it partially destruct intermolecular bonds and depolymerization of fiber with loss in tenacity.

D. Heat-setting Method: - Fabric is hold by pin or chain and Hot air is supply by using Fan blower system to impact on moving fabric that is remove water particles placed between yarn and Dry the fabric. Mostly stenter machine is used for Heat-setting Method.

3. DRYING PROCESS

Temperature and water content of Air stream changes as per it passed through the cloth. Here the diagram of portion of vapour pressure diagram for water. Here the air is passes through cloth with various condition, when air is passes from freely suspended cloth it transfer heat to cloth and reduce its temperature and gain water from fabric. Air has properties like when it leaving the fabric it is at 100% RH it is not depends on speed of air so it shows that saturation vapour pressure line is not change with changed of air velocity. There for psychrometric is simple and reliable way to measuring relative humidity. As it shown in Figure 100% relative humidity line position is not affected by air pressure, because there is no interaction between air and molecules of water vapour. The air passing over the fabric moves along the blue arrow to set point A with heat for evaporation coming only from the air. Point B is describing as, the fabric which is provided conductive heat from one side, cloth is laid on metal plate. For air at C the metal support was held exactly at ambient temperature, so at C will be more effective at removing moisture because it can entrain water molecules at a concentration.

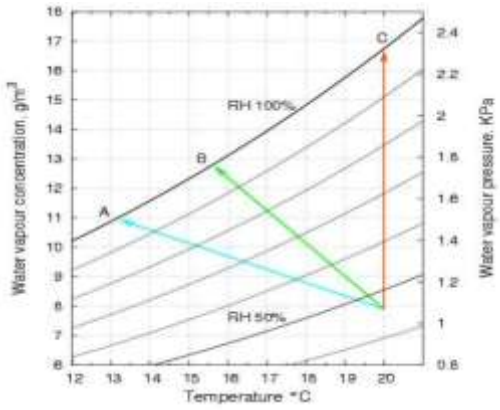

Figure 2 psychrometric chart [2]

It would expect that air flow rate is directly proportional to drying rate. It has a very strong reason because the air leaving the surface is always at 100%Rh, so more rapid air flow it removes much more water vapour. There is temperature is also play role in that temperature is not change with air speed but evaporation rate is changed so the heat brought to fabric by air is alone sufficient to evaporate of enough molecules to saturate the space above the fabric. The fabric to dry quickly nut there is also requirements is dry moisture content never to fall below the value in equilibrium with the ambient air, which means about 9% water content for cotton. If fabric loss water more than that value lower, the cotton fibers will shrink. It also slides past one another in process, permeant shrinkage or warping occur. For that to be sure the cloth cannot over dry is to ensure that it never gets warmer than the ambient air so evaporating surface is remain at ambient temperature.

4. HOT-AIR NOZZLE SYSTEM

The system is called as the Hot-air nozzle system because of it blow the heated air on the fabric by using number of nozzles are arrange in system. Various dryers are used this system to dry the fabric by evaporating the water from the fabric yarn Stenter is widely used for stretching, drying, heat-setting and finishing of fabrics. Stenter which is use for setting only that have a light pin chains and if it is used for drying and setting both than it provided with a heavy combined pin and clip chain. Suitable to drying and heat-setting purposes, the stenter machine is divided into three sections and can be removed about centerline. The entry section is consisting system with feeding in fabric with padding mangle, uncurled, selvedge feeler for automatic correction of width. Section length is very as per fabric types as woven usually about 5m and for knits it is 7m.

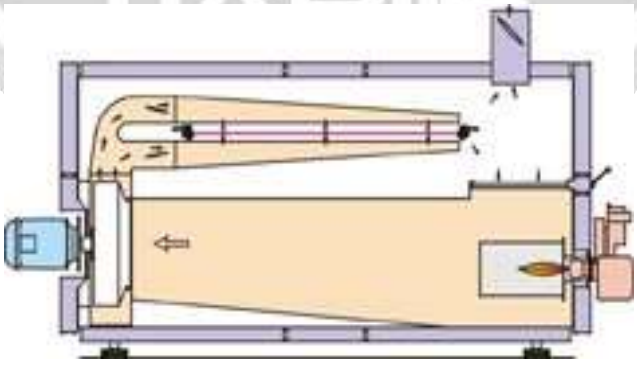

Figure 3 Hot-air Nozzle system [2]

The center section is contained nozzle system as shown in figure there is arrangement is shown in figure. One machine has 3 to 8 heating chambers and each chamber is 3m long. The delivery section is 4 to 5m long to give permit sufficient cooling take place before fabric is pinned and either rolled or plaited. Speed of fabric through chamber is depends on material, temperature ranging, moisture content, and thickness of material. This chamber is totally insulated from all sides and rest on pedestals. Different types of heating system can be used direct gas, indirect steam or oil heating or electrical heating depends on the customer's requirements. Air is used as transport

medium for Nozzle system thus the air velocity decreases, available energy in the form of heat also decreases. As in system fresh air is fed separately to each compartment in stenter, and exhaust air is similarly remove from each section. The Overfed and adjustment of the width is provided to overcome shrinkage in length and width is taken into consideration. Most of machines is make provision for overfeed if the entry rollers feed the fabric at slow speed; the fabric will be pulled by the travelling chains, so that increase in length it respectively loses the width. The main processing problem are inadequate to eliminate shrinkage, skew and bow distortion; and poor productivity and impairment of look of the fabric. Air nozzle system produces supporting effect and uniform floating of fabric providing air cushions, endless belt or other supports.

5. LITERATURE SURVEY

In use of the Nozzle system there is somehow problem arrives dur to uneven air flow volume over the system due to that product quality is changed and same as productivity is decrees. Some survey has to done is listed below.

Xuan Thao Thrinh, he is investigated in an impinging jet, it is efficient way to improve heat transfer. It is widely used in industry for cooling, heating and Drying purpose. Tested various nozzle hole shapes and compare the heat transfer rate with change in Nusselt number and Reynolds number. For all same jet to plate distance round orifice has higher Nusselt number that indicate higher heat transfer rate compare to other nozzle hole shapes. [3]

M.Fenot, this study is related to heat transfer and flow structure of an impinging jet flow. He considers five different parameters for flow distribution and heat transfer measurements. Jet is impact on flat plate is divided into three zones the free jet, the stagnation zone, and wall jet. Studied upstream flow and axisymmetric flow. The highest average velocity values are observed in the lower part and on the side of the injection forming a shape. Heat transfer rate is lower than classically recorded for with different jets. Most important parameters that affect the heat transfer rate is injection Reynolds number and injection to plate spacing. [4]

Vadiraj Katti, Investigation is related to study experimental and theoretical analysis for local heat transfer distribution between smooth flat surface and impinging air jet by using circular straight pipe nozzle. A single jet straight nozzle of circular shape length to diameter ratio is tested. As per Jet exit to plate distance Reynolds number is based on nozzle exit condition is varied. [5]

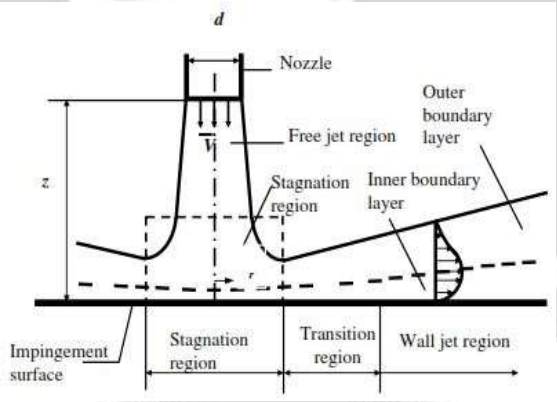

Figure 4 Air Jet [5]

Studied about local heat distribution of heat transfer coefficients between the orthogonally jet from square edge long pipe circular nozzle. Based on the flow characteristics of impinging jet three regions on the impingement surface are identified. With increase of Reynolds number is directly increase the heat transfer rate at all location. Highest heat transfer rate is achieved at stagnation region away from that heat transfer rate is decrease. By varying z/d value it gives distance between jet to plate varying, the peak value in the radial direction may occur due to flow transition in jet transferred from laminar to turbulent.

Various Approach to energy saving in Hot Air Dryer/ Stenters

High temperature 200°C to 80°C varying air is used in Stenters. A Cylinder dryer is used same heat treating air requirement except that there is an additional consumption towards heating the fresh air, which has to be drawn in matching quantities with exhaust.

In Hot air dryer rate of drying is increased by: [6]
1) High temperature Thermic fluid in heaters or High steam pressure in heaters with high temperature of air jets
2) Heater capacity and cleanliness of heaters and fins.
3) In case of steam heaters proper removal of condensate, air and incase of Thermic Fluid heating proper circulation of non-deteriorated thermic fluid.
4) Air jet velocity Operate generally at 30 to 40m/s and avoiding drop in air velocity due to choking of filters, damaged fan blades or belt slippage in fan drives, opening or leaks in air ducts.
5) Try to avoiding high humidity and maintain optimum air humidity.
6) Steam leaks and stoppages must be avoided.

In modern Design of Stenter/Dryer following features are incorporated.
1) Steam leakage loss and condensate losses are avoided because heating medium is circulating thermic fluid. Use if possible, Direct gas fired burners are avoiding heat transmission loss and heaters.
2) Air to water and air to air heat exchanger is used. Also, pollution due to fumes is avoided and any lubricating oil vapors in exhaust are reconsented.
3) Blower, Machine motors, and exhaust fans are sync with main drive so that when machine stops they also stop.
4)Control systems are provided to monitor productivity and also to measure and control the moisture on the fabric leaving the stenter. To adjust the speed as per the pre-set dwell time required in drying chamber there is systems also available.
5) Recirculating fan and exhaust are provided with variable speed drives to regulate air circulation rates and pressures.
6) Exhaust is minimized by adopting super-heated steam drying in some of the latest design.
So, there is some of problem is there for air flow distribution uniformity over the fabric width as well length. It requires to study the fluid flow analysis to improve flow distribution uniformly over the all section of nozzle air-system to improve quality of product as well as productivity improve.

6. CONCLUSION

Simple experiments are shows that to drying and heating just to ambient temperature will greatly increase the speed of drying fabric. The most of water is present as capillary water held between the yarn, in directed by the long straight section of the drying curves. There is no any chemical reaction between air and water particle. The air is acting as transport agent it brings heat to the cloth through transfer of vibrational molecular energy and mechanically water particle away from the space immediately above fabric. So, higher Hot Air mass flow in specific time higher Drying rate can be achieved and more uniform air flow over the width and length of fabric more product quality will be achieve.

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