HUMIDIFICATION, ITS RELATION TO THE VENTILATION OF TEXTILE MILLS.

Now add to the losses, from waste and material spoiled, the decrease in the production of the mill because of the frequent stoppages of machines to repair broken threads and to patch up defects, stoppages due to imperfect action or jamming of parts of the machines, faulty action from the parts being warped or shrunk out of shape, belts drying out and slipping or breaking: does it not seem a necessity to overcome these conditions if we expect to operate the mill with any profit at all? Then there is the question of extra cost of power to be considered, it being a well-known fact that the spinning frames or the looms will require a great deal more power when they are working in a hot, dry atmosphere than when operating under favorable conditions of moisture and temperature. Artificial conditioning of the air, therefore, is seen to be an absolute necessity.

The answer to the second question is this:—that there is no mill in the whole United States that can depend upon uniform conditions of climate or weather from one day to another. Our climate is about the most variable in the world, temperature and atmospheric conditions are seldom the same for consecutive hours, let alone days. It is a physical impossibility to maintain uniform conditions in a mill if depending on climate alone, some means must be employed to counteract the differences between the heat of summer and the cold of winter. Then there must be considered the differences in the humidity of almost every day, not to mention at all the difference between that of day and of night. Unless some means are taken to counteract it, the effect of the machinery in operation will alone cause great variations in atmospheric conditions, as before referred to.

There is but one answer to the third question, unless the natural atmospheric conditions of our mills be modified by artificial means they cannot operate upon any but the coarsest yarns and fabrics. We cannot compete with the mills of England or Continental countries in the production of fine goods, neither can we manufacture as good qualities of the coarser grades. For self-preservation, we must use artificial means for obtaining the favorable conditions that our foreign competitors have naturally, our changeable climate is a handicap that can only be overcome by the employment of mechanical devices to secure the conditions that they have by Nature's bounty. Furthermore, our mills would be practically unfit for occupation during part of the year if nothing was done to modify the effects of our climate; no employees could work in them. The practical confinement of mills in our Southern States to the manufacture of coarser grades of yarns, because of climatic conditions, until artificial conditioning was adopted, shows conclusively the futility of trying to spin yarn without providing means to counteract our natural climatic conditions.

The answer to the last question, the comparison of the cost of operating a system for artificially conditioning the air of a mill with the value of the increase in the quantity and the quality of the mill's production, depends largely upon the system itself. Is it really efficient or is it only a makeshift? Does it actually modify the natural conditions of the air or does it only seem to do so? Does it do its work regardless of outside atmospheric conditions or is it dependent upon certain favorable conditions of wind or weather or on the perfect action of complicated devices? Does it work automatically and uniformly or does it require constant attention or manipulation? If a system or method or device does not comply with all the conditions stated and does not do its work efficiently under all conditions of weather, climate and mill operation, it is not worth its first cost, let alone the cost of its operation.

Many of the devices and systems that are claimed to modify the atmospheric conditions of a textile mill are dependent upon certain favorable conditions of weather or temperature or methods of operation for their success, and consequently they cannot possibly maintain uniformity of either temperature or humidity. There are other devices that attempt to operate in direct variance with natural laws, which sometimes work well when everything is just right, but oftener fail under stress when most needed, these need not be given serious attention. It is a waste of time and money to install any system that does not work efficiently and positively at all times and under all conditions, no matter how cheap it be in first cost and operation. The only basis for our comparison is a system that works right at all times and under all conditions and that maintains the desired temperature and relative humidity; let us see what the comparison is.

An efficient system that will maintain uniform and favorable conditions of temperature and humidity will pay for its cost of operation in the saving of the one item of waste alone. Take the spinning room for example, if there is 20% of waste in a hot, dry spinning room, and if this can be cut down to only 5% by properly conditioning the air, the bigger the mill and its output, the greater will be the saving in actual money value. Then take the question of operating the machinery of the mill. If the spinning frames can be run smoothly and evenly and without frequent stoppages on account of broken ends, thin places, kinks, knots, etc., will not this give a much greater output and will not this be worth money? If the machines be run smoothly, will not they turn out a better quality of yarns and fabrics and will not this better quality be worth more money than poor, or even moderately good, yarns or cloth? And so the comparison can be carried on through all the departments of the mill—there will be a saving of waste and losses from materials spoiled, a saving in the time and labor otherwise lost from stoppages of machinery, etc., lessened cost of repairs, etc., etc. Then there will be the added profit from an increase in the quantity and the quality of the goods manufactured in all operations and in all departments of the mill, and in the better prices that can be obtained for them. Still further, there will be a considerable saving in the amount of power needed to operate the machinery, because the machines will work with less power if the atmospheric conditions be favorable than if they are subjected to hot, dry air. There will be, consequently, a saving in the cost of power transmission, shafting, belting, pulleys, etc., on a lessened cost for the power itself, in fact, there will be a saving all through the mechanical department of the mill.

The effect upon the mill help of good ventilation and a proper degree of humidity has not been touched on yet, although this is an important consideration by itself alone. It has been too well proven to admit of contradiction that a person can do more work and better work in a place that is kept at a moderate temperature and is well ventilated than in a close, hot, ill-ventilated one. From the standpoint of getting more work and better work from the employees, it is a paying proposition to provide them with workrooms kept at a proper atmospheric condition, even if there be no consideration given to this question as affecting their health and welfare. It pays well in their better spirits and contentment and work cheerfully done is generally work well done.

The question of what constitutes an efficient system for conditioning the air inside a textile mill having been answered, *i. e.,* it must be a system that does the work it is required to do under all conditions, regardless of anything short of an actual breakdown, effectually and cheaply, the next question will be, "What must be the mechanical construction and operation of such a system?" Omitting for the present any detailed description of the mechanical parts, we would answer that the system must be one that will deliver air of the requisite degree of humidity in sufficient volume to replace the air that is continuously being heated by the machinery, and that this heated air must also be removed at an equal rate to the fresh air supply, so that practically uniform conditions of temperature and humidity will be maintained in all parts of the mill.

There is only one system that will, or can, meet these requirements, and this is a system of artificial ventilation by which the air is taken from outside, filtered, warmed or cooled, and saturated with the required amount of moisture, then delivered, by means of ducts, and distributed to the various parts of the mill, this system working in conjunction with a secondary system that removes the heated air from the rooms in proportion as the fresh air is supplied. The movement of the fresh air through the air-ducts and the discharge of heated air from the rooms are secured by the use of fans or blowers, one set working positively, the other set working negatively, the size of the fans being proportioned according to the volumes of air to be moved rather than using excessively rapid revolutions of small fans to produce the same results.

Long and exhaustive tests have proven that the only satisfactory way of handling the problems of ventilation and humidification in places where large amounts of heat are generated by machinery or processes, is to provide some means for removing the heat as fast as it is given off to the air, as well as to supply tempered fresh air. It has been demonstrated by tests made that neither the "plenum" system nor the "exhaust" system alone will give satisfactory results under the foregoing conditions. The plenum system by itself will work very well when it is simply a question of supplying fresh air in places where there is little or no heat generated, but it fails of its purpose where heat is a factor, because the fresh air must become more or less mixed with the heated air, and both will escape in about the same volume unless special care is taken in locating both inlets and outlets.

Lest some may not understand the terms "plenum" and "exhaust," as applied to ventilation, the following explanation is given. The "plenum" system of ventilation is a system in which air is forced into a room, or other space, by means of fans or blowers, this causing the air in the room to be under a certain amount of pressure, as compared with the outside air, which forces the vitiated air out of the room through natural or artificial openings. The "exhaust" system is just the reverse of this, the vitiated air is drawn out of the room or space by means of suction fans, and the fresh air enters through the openings, because the outside air is at a greater pressure than the air inside. This system can never be made to work with full efficiency, because the air is supplied by a negative, or indirect, process instead of by a positive, or direct, process; there is no control over either the quantity or the quality of the air supplied and it cannot be regulated, either as to temperature or humidity. In the plenum system, there is a positive control of both the volume of the air supply and of its temperature and humidity, and there is no probability of the air in the room becoming contaminated from outside because there is always an excess of air pressure inside. However, there is this defect in the plenum system, there is no way to regulate the rate of discharge of the heated air except by forcing in more or less fresh air, and even then there is no way to prevent the fresh air from escaping as well as the heated air. To insure positive displacement of the heated air as fast as it is formed, it is necessary to force in the fresh air at considerable pressure, and this will cause objectionable air currents at and around the openings of the air ducts.

There is only one system, therefore, by which the air in a textile mill can be maintained at the proper conditions of temperature and humidity, and that is a system that combines both supply and exhaust ventilation, a system by which the heated air can be removed as fast as it is formed and the supply of fresh air can be regulated both as to its volume and condition, so that it will continuously replace the vitiated air by an equal amount of air of suitable temperature and degree of humidity. The supply system alone should not be made to do all the work, because, if it is so forced, much more power will be required to operate the fans and strong air currents will result, whereas, if the heated air be removed by another set of fans, the fresh air will distribute itself naturally and less pressure will be required. This method will be referred to hereafter as the "combination system."

This combination system of ventilation and humidification is absolutely certain in its action and effects, if it be properly designed to meet the requirements of the mill and is erected in accordance with correct mechanical principles. With it, the air in the mill may be kept at a fixed and constant temperature and degree of humidity, within narrow limits of variation. There is no waste of power, time or labor in trying to keep a body of air that is continuously being heated and reheated supplied with the moisture needed to keep it at the required relative humidity—in other words, trying to do an impossibility—the problem of conditioning the air is solved in the simple way of removing the heated and dry air bodily, as fast as it is heated, and supplying fresh air of the proper temperature and humidity in its place. Neither is it necessary, with the combination system, to saturate the air supplied with an excess of moisture, to allow for its being heated after entering the room, as must be done with the plenum system used alone, because with it there is no way for the heated air to get out of the room except by diffusion, and the incoming air will soon be heated and will then need more moisture to preserve its relative humidity.

The air in the mill is conditioned actually and positively, at whatever degree of temperature and humidity is desired, by the combination system—the air supply can be cooled in summer and heated in winter, can be dried or more moisture be added, just as may be needed, and with proper regulation, the incoming fresh air need never mix with the hot air in the upper part of the room. Thus, the machines will always work in the atmosphere best suited to them and their heat will be taken care of effectually.

The problems of maintaining a suitable degree of relative humidity in the mill are much simplified by the employment of this combination system of ventilation, because the air can be kept at a comparatively regular temperature with only small variations in winter and summer; *i. e.,* the air can be heated in winter and cooled in summer by appropriate means. Therefore, if the air be kept at about the same temperature, the same amount of moisture added to it will keep it at the same degree of relative humidity. In practice, however, the air must be brought to within the allowable range of temperature before attempt is made to humidify it. The success of this system of humidification depends largely upon the effectiveness of the exhaust fan in removing the hot air from the room as fast as it becomes heated by the machinery, otherwise it will be difficult to prevent the air supply from being itself heated, and thus lowered in relative humidity, by the downward diffusion of the hot air in the upper part of the room.

In operating the system referred to, any practical method of heating or cooling the air can be used, similarly, any practical method of humidifying the air supply may be employed, the only requirement is that they should work economically and efficiently. A discussion of these different methods or devices more properly belongs to the engineering of ventilation, for which there is not the space available in this article. However, it is expected that in an early issue of this JOURNAL the subject of ventilation from an engineering point of view will be taken up and its application to the textile mill discussed. From the data given, it will be possible to compare some of the humidifying devices in use in regard to their efficiency and value for use in the mill.

(To be continued)