

graphic films, lumber, paper and macaroni. The importance of exact control of moisture in the finished product is notable in artificial silk, which is manufactured annually to the value of hundreds of millions of dollars. A variation of but one per cent in the moisture content of this silk would mean a very wide range in the sale price of the product. Although such variation in moisture might not affect the intrinsic value of the silk a regulated moisture content definitely is preferred by the purchasers. The same is true to a less extent with cotton yarns, where an increased moisture content is desirable not only from the sales standpoint but also from the manufacturing standpoint.

Wheat flour is another product which requires careful moisture standardization; and considerable attention is being given to this field at the present time.

Air conditioning is important in certain branches of the chemical industry in controlling the temperature of reaction and in facilitating or retarding evaporation.

The control of the moisture content of air supplied to blast furnaces in the manufacture of pig iron is advantageous, and with present improved methods of moisture removal from the air, this field may become prominent.

AIR CONDITIONING FOR EFFICIENCY OF EMPLOYEES

Air conditioning combined with ventilation is commercially desirable from the standpoint of efficiency of employees. In many industries the output is affected, and in some cases the output is limited, by the physical endurance of the workers. The output of a factory, therefore, is greatly increased by the proper control of temperature and humidity conditions, if these conditions are normally unfavorable without control. This is particularly true in the cotton mill industry, in steel rolling mills, in hot climates such as that of India, in deep mines, particularly in Brazil, India and South Africa, and in the manufacture of glazed iron ware and similar processes.

In some industries, such as the lithographic industry, the quality of the product and the personal comfort of the employees assume almost equal importance. In order that the proper register may be obtained for the application of the different colors which may be applied, one at a time on different days, a very exact humidity control is necessary, and in hot, moist weather perfect registry can be secured only by dehumidification and by artificial refrigeration, or, if employees comfort is to be ignored, by heating to such a degree as to be almost unbearable for human beings.

In other industries, the product is affected both by relative humidity and temperature, as in the manufacture of chocolates, chewing gum, cigarettes and machine-made cigars. In these industries it is necessary to humidify during some parts of the year, and to dehumidify and refrigerate at other seasons, in order to maintain a uniform condition within the limits permissible by the product.

In many instances, of course, the atmospheric conditions best suited to the products and process are ideal for the health, comfort and efficiency of the workers.

AIR CONDITIONING FOR HUMAN COMFORT

Air conditioning systems are being used more extensively for controlling conditions for personal comfort. Buildings in which air conditioning is used for this purpose include auditoriums, theaters, department stores, hotels, restaurants, banks and office buildings.

Ventilation with cooling and dehumidification have been proved to offer high economic returns for buildings in which human comfort is the sole objective.

In large department stores air conditioning with refrigeration has been found to be a very satisfactory method of securing the desired degree of comfort during days of special summer sales, when large numbers of people are present. The investment for refrigerating equipment of such installations often represents approximately one third of the cost of the entire installation.

Large air cooling installations cost nearly \$200 per ton of refrigeration to install for the refrigerating equipment alone, yet it is evident that the investment is economically sound, from the rapidly increasing number of installations which are being made.

FUNDAMENTAL PRINCIPLES

The art of air conditioning is based upon very definite physical principles. The phenomena involved have been given intensive study, both from the theoretical and experimental standpoint. As a result, the various relationships have been quantitatively expressed, either rationally or empirically.

The usual requirement in air conditioning as applied to processing hygroscopic materials is to maintain a definite moisture content of the product. In some cases, however, it is desired to control merely a definite moisture content of the air. In problems involving human comfort, it is necessary to maintain certain limiting or desirable effective temperatures which depends upon the experimentally-determined relationships of wet and dry bulb temperatures and air motion.

It should be noted that the moisture content in a given space is independent of the maximum quantity of air or other gases present. In other words, the properties of saturated water vapor are assumed to be in no way affected by the presence of other gases. The quantity of moisture present in a given space may then be determined directly from the data available involving the physical properties of water vapor.

As is well known, the vapor pressure of water, and consequently the weight per unit of volume of that vapor, depends upon its temperature. Vapor pressure and density curves and tables are available for all the ranges of atmospheric temperature, and the accuracy of these generally can be relied upon.

Where the vapor pressure of the water vapor present is known, it is evident that the proportionate weight of water vapor to other gases in the mixture obeys Dalton's law; assuming, of course, that the gases have no chemical affinity. This may be expressed by the relationship:

$$W = \frac{Se}{P-e} \quad (1)$$