condition which is later apt to restrict the normal shrinkage of the interior and cause internal rupture and distortion.

Raising the temperature of air increases its capacity to hold moisture and correspondingly lowers its relative humidity and increases its drying power. The moisture holding capacity of the air at atmospheric pressure and representative temperatures is given below:

TABLE 1. APPROXIMATE AMOUNT OF MOISTURE IN SATURATED AIR (AT NORMAL ATMOSPHERIC PRESSURE OF 29.9 IN. MERCURY)

Temperature Deg. Fahr.	Grains Moisture per Cu. Ft.	Temperature Deg. Fahr.	Grains Moisture per Cu. Ft.
40	2.86	140	57
60	5.8	160	91
80	11.1	180	140
100	20.0	200	208
120	34.0	212	261

It is seen from the table that if saturated outdoor air on a rainy day, containing 5.8 grains of moisture per cubic foot at a temperature of 60 deg. fahr., is heated to 180 deg. fahr., its moisture holding capacity per cubic foot will be increased approximately 24 times and its relative humidity will be reduced from 100 per cent to 4 per cent. The result at 180 deg. fahr., would have been practically the same, no matter what the humidity of the outdoor air happened to be, and it is for this reason that outdoor humidities are of comparatively small importance in designing air processing equipment in which temperatures of 140 deg. or higher are to be used. In such dryers, *any* outside air is potentially very dry when heated to the temperature at which it is to be used.

For many exacting materials, the increased capacity of the air at higher temperatures must be offset, to a large extent, by the increased humidity required to prevent rapid surface drying. In order to maintain this increased humidity and counteract the effect of outside air entering the dryer, it is often necessary to *add* moisture to the air in the dryer to supplement what evaporates from the material. This is usually done with steam sprays although in some cases, evaporating pans, water sprays or atomizers are used.

Circulation of Air Currents

The velocity of circulating air currents must be fast enough to transfer to the surface of the material all of the heat required for evaporation. At the same time, it must also be sufficient to carry away the water vapor. The volume necessary for this purpose will correspond roughly to the volume needed for heat transfer. A third requirement is that the velocity should be sufficient to carry away the film or layer of nearly saturated air that is apt to hug the evaporating surface, and whose high vapor pressure retards further evaporation.

Circulation is expressed either by the rate of air flow over the material per minute or by the number of air changes in the dryer per minute or per hour. The former is the logical method as it expresses positive drying

power while the latter may be misleading, because of short-circuiting of some of the moving air without coming in contact with the material.

When air is saturated (at any temperature), the water vapor which it contains weighs 0.623 times as much as the air it has displaced. It follows, then, that the higher the relative humidity (that is, the greater the proportion of air that has been displaced by water vapor) the lighter will be the mixture of air and vapor.

Natural Draft

Circulation by convection, due to the rising tendency of heated air and the falling tendency of cooled air, is the only means of circulation in many of the older and simpler types of dryers. Dryers of this kind give best results with fairly high temperatures and low humidities and are adapted to drying material which will stand a considerable variation in temperature and humidity conditions without injury.

In natural draft dryers the moisture evaporated is usually allowed to escape through ventilators, to be replaced by fresh air. This means that a large amount of only partially saturated warm air is allowed to escape giving this type of equipment a low thermal efficiency. Where cold-water coils or sprays are used for moisture removal, a somewhat higher efficiency is obtained. Natural draft dryers are sensitive to changes in outside wind and weather and the temperature and humidity conditions within the dryer usually vary within a wide range since such variation is necessary in order to obtain enough difference in specific gravity to produce a vigorous circulation.

The direction of natural air currents is difficult to control; they often short-circuit from one part of the dryer to another, leaving portions of the material surrounded by stagnant air of low drying power. In some designs, this is partly overcome by the use of baffles and ducts for guiding the air and by the use of water sprays or steam jets placed at certain points for the double purpose of increasing the velocity of the air as well as adding to its humidity. Tunnel dryers are better adapted to a natural draft circulation than are compartment or charge type dryers. The desirability of maintaining higher temperature and lower humidities at one end of the tunnel than at the other creates a rising circulation at one end and a falling circulation at the other which produces a general endwise circulation of air through the dryer. The higher the temperature and the longer the tunnel, the greater will be the volume and velocity of air movement.

In most dryers of the tunnel type the flow of air is opposite to the flow of material, or *counter-current.* The freshly-heated air, at maximum temperature, comes in contact with material in the final stage of drying at the discharge end where high heat is needed and can be safely used. This air then works its way back through the dryer to the charging end, losing heat and picking up evaporated moisture, thus giving a graduated range of conditions suited to the different stages of drying. Such dryers are often designed to create a sidewise as well as endwise movement of the air for more uniform drying. The internal circulation is usually aided by placing ventilating chimneys at the charging end of the dryer, to draw the moist air in that direction.