CHIMNEYS AND THEIR CONSTRUCTION

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THE subject of chimneys and chimney construction is an extremely diversified one, requiring not only a knowledge of the mechanical and mathematical features, but a knowledge of chemistry, thermodynamics, ceramics and subjects dealing not alone with the flow of gases, but also the effects of different gases under various conditions of temperature and moisture content.

The steaming rate of a boiler depends on the rate at which coal can be burned. This in turn depends upon the difference of pressure available to produce flow of air through the fuel bed on the grate to the chimney. This difference in pressure is known as draft and is required to overcome various obstaclees which retard the flow of air. There are two types of draft: natural draft, produced by chimneys, and mechanical draft, produced by fans.

Draft as produced by a chimney is caused by the difference in weight between a column of hot gases inside the chimney and the weight of a column of gases of equal height outside the chimney. Chimney draft varies with climatic conditions and is less when the outside temperature is high. Other influencing factors are the height of the chimney, its diameter and height above sea level.

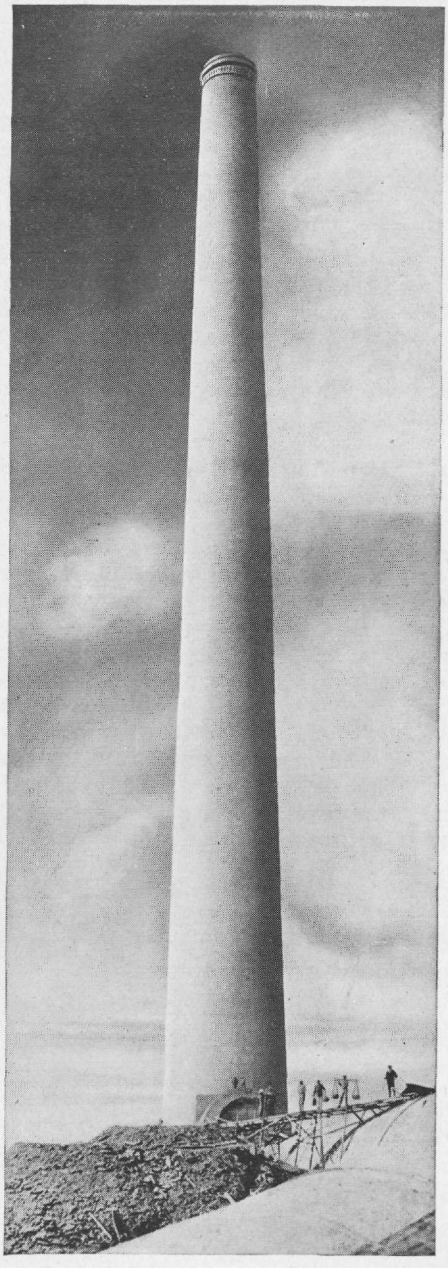
A chimney is called upon to perform various duties in addition to producing draft for steam boilers. It is this multiplicity of duties that presents the many chimney problems. Many chimneys are connected directly to roasting kilns, furnaces used in the production of chemicals, etc.

The material used in chimneys is usually brick, steel or concrete, the former being used most extensively. Brick chimneys consist of an outer and an inner wall with an air space between them. The outer wall is made of hard, well burned brick and varies in thickness by a series of steps from top to bottom, the minimum thickness at the top being usually the length of a single brick. The taper of the outer walls is about one quarter of an inch per foot. The inner wall or lining is made of fire brick, and the inner diameter is usually uniform with the offsets on the outside. At the top of the chimney the outer wall is drawn in over the opening between the two walls. A cast iron cap or grating is usually placed on the top as a protection against the action of weathering. The use of two walls eliminates the trouble that would be caused by the unequal expansion of a single wall of such a thickness. The air chamber is an excellent insulation against loss of heat by radiation. A clean-out door is provided near the base of the stack.

The chimneys used at the Ohio State University power houses are typical examples of brick chimneys. The stack at the new power house furnishes natural draft for seven large steam boilers. It is 230 feet high and has a base approximately 20 feet square. The stack at the old plant has a height of 205 feet.

A chimney to handle acid gases is generally made of brick and must be designed and built not only for adequate capacity and draft but also to resist the destructive effect of the particular acid gas. A damp acid smoke in contact with ordinary mortars of cement, lime and sand produces a swelling and puffing of the joints, the change taking place on the surface. The mortar becomes soft and of the consistency of mud, and as time passes the softening works entirely through the walls, causing the brick work to bulge and crack. If the brick is not highly impervious the exposed surfaces will also soften and flake off. It is therefore necessary to use a highly vitrified brick and an acid-proof mortar for the chimney lining. An acid resisting cap of lead or monel metal is generally used.

Steel chimneys are either self supporting or guyed, and are usually composed of a series of steel cylinders with single riveted lap joints. The steel plate varies from three-sixteenths to one-half of an inch in thickness, depending upon the size of the stack. The cylindrical rings may be of two different diameters in the same chimney, alternating the two, or all the rings may be the same diameter but slightly conical in shape so that the tapered end of one may fit into the next ring. The various rings are fastened together by a single row of rivets. The bottom ring is flared to form a base



The Tallest Chimney in the World

A 570-foot stack of the Saganoseki Copper Co., Saganoseki, Japan. Has withstood several violent earthquakes.

which is held to the foundation by anchor bolts. The steel structure above the boiler is often used to support the stack in order to reduce the ground space required.

This type of chimney depends for its stability upon the anchor bolts and the foundation. It is usually lined to prevent excessive radiation and to protect the steel from the corrosive action of gases. Beginning at the bottom a good portion of this lining is fire brick, but the upper part is common brick.

Steel chimneys are often guyed to insure stability by three steel cables, the upper ends of which are fastened to a band about two-thirds of the way to the chimney top. The bottom ends are securely anchored on the ground at such a position that the cable makes about a 60° angle with the vertical.

Concrete chimneys which have been used only in the last few years can be either straight or tapered. When tapered the thickness of the wall at the top is about four inches and when straight, about six inches. The concrete must be reinforced in order to resist the tensile strains resulting from wind pressure. Concrete chimneys are ordinarily lined to about one-third of their height since acid smoke rapidly disintegrates the cement content.

For all types of stacks a suitable foundation must be provided to prevent the chimney from tipping or settling. It is usually constructed of concrete and distributed over a sufficient area to prevent settling. Bases over a hundred feet square are not uncommon.

The life of brick and concrete is longer than that of steel chimneys, the former types retaining their usefulness for about fifty years and steel chimneys for from five to fifteen years, depending on the care taken to prevent erosion. Because of cracks due to faulty brick laying, a brick stack may have considerable air leakage, which is seldom found in the other two types.

The concrete chimney is comparatively light in weight, requires a smaller space than either the steel or brick chimneys, has great resisting power and can be rapidly constructed. If unlined it is apt to have an excessive loss due to radiation, which will lower the draft produced.

The steel chimney can be constructed at a more rapid rate and has less weight than either brick or concrete. It requires frequent painting to prevent corrosion, which is rapid in air that contains salt water.

The cost of the brick chimney is the highest and that of the steel stack is the lowest. The cost of concrete chimneys varies from about $2,000 for a chimney having an inside diameter of four feet and height of 105 feet, to about $18,000 for a stack with an inside diameter of 16 feet and height of 258 feet. These figures give some idea of the variance of cost in chimney construction.

In order to reduce the necessary height of chimneys and at the same time to maintain a draft which is sufficient regardless of weather conditions, fans and blowers are often used. This is known as mechanical draft, but since its study covers a large field not within the limits of this paper, it will not be discussed here.