

SANITARY ENGINEERING.

INTRODUCTION.

SANITARY Engineering may be defined as the art of removing from the neighbourhood of dwellings and finally disposing of the solid and liquid refuse of human beings, animals, and manufacturing processes.

If the human body is to be maintained in health and vigour, it is essential to dispose of all those matters eliminated from the animal system, whether in health or disease, as well as all other animal and vegetable refuse in the vicinity of inhabited buildings, as speedily as possible before decay begins, as in putrefaction the matters evolved are highly injurious to health and dangerous to life.

This is more particularly the case wherever human beings congregate in any numbers, as in villages, and still more so in towns. History records many instances of the evil effects in all ages of large bodies of troops being encamped for any length of time, or repeatedly on the same spot.

The causes of zymotic disease are external to the human body, and each type is found to possess its own specific germ from which it is generated, and which must thus be introduced into the human system in order to produce the disease.

These germs appear to be world-wide in their range, though some descriptions more particularly affect certain localities, and only await favourable conditions of environment to develop their latent dangerous characters.

There are three channels by which such poison can be introduced into the body, viz., by air, water, or food ; and it is therefore very necessary to guard all three from any possibility of contamination, notwithstanding the fact that a variable amount of such poison may be, and often is, taken with impunity ; this is due to the provision of nature which enables the human body to protect itself to some extent from the deleterious matter thus introduced, to throw it off from the system by those channels provided for the secretions and waste products, and if

unsuccessful in so doing, it is due either to the existence of conditions in the body itself which defeat this action, or to the virulence of the poison to be combated.

The germ may be very small in the first instance, but it is impossible to say how rapidly it may develop with a suitable environment.

Spores of typhoid bacilli can be blown about in dust, and in this way get into milk or water and be directly swallowed.

Where soil is saturated with rainwater, the bacilli perish, and however salubrious in other respects gravels and sands may be found, yet typhoid fever is more prevalent with such sites than where stiff and cold clays prevail. The latter are unfavourable to the bacilli, whereas they have a happy hunting-ground in loose sand and well-aërated gravels; the action of strong winds upon the latter favours the growth of the microbes; a high barometric pressure and temperature also favour the growth of the bacilli.

A heavy rainfall in summer has in many instances been found to lessen the amount of disease, not only in that season, but in the following winter, and this is apparently due to the rain interfering with the germination of the bacilli.

The site for habitations being chosen, for a variety of reasons the science of Sanitary Engineering is called in to prevent a condition of things arising which would be hostile to the health of the community, and to do this the surroundings as well as the subsoil must be kept pure and uncontaminated.

The ventilation, warming, and lighting of inhabited buildings, although important branches of sanitary engineering, are not touched on in this work.

Very great strides have been made of recent years in sanitary science, due to the fact that serious outbreaks of zymotic disease at various times have necessitated careful investigation of their causes, the result being traced, as a rule, to inattention to sanitary principles, involving defects either in the system adopted, or in the apparatus employed.

Constant improvements are being effected, so that a great deal that found favour some few years ago would not be tolerated for a moment now that further light has been let in on the subject.

As the size of a community increases, so does the difficulty of getting rid of the refuse already referred to as dangerous to health, and this more especially applies to the liquid refuse which contains foul matter in suspension as well as in solution.

Dry animal and vegetable refuse may be collected in ash-bins and be carted away, but liquid matter requires more elaborate arrangements.

The liquid refuse, termed sewage, is defined by the Rivers Pollution Commissioners to be "water mixed with any refuse that may affect public

health," and according to another definition, "By sewage is meant the liquid contents of a sewer."

The West Riding of Yorkshire Rivers Act, 1894, defines ordinary sewage as follows :

"Liquid sewage includes unpurified urine, excrementitious matter, and liquid refuse of any house or premises, blood and the washings of a slaughter house containing blood or urinary or fæcal matter, but does not include any liquid rendered poisonous, noxious, or polluting in the course of some manufacturing process."

Sewage is an extremely complex liquid and varies both in quantity and quality not only in different towns apparently similarly situated but also in the same town during different hours of the day and different days of the week.

In manufacturing towns, where trade refuse is admitted to the sewers, the variation is even more acutely marked.

To give an idea of the average composition of domestic sewage the following table from the first report of the Rivers Pollution Commissioners, 1868, may be quoted :—

TABLE 1.—AVERAGE COMPOSITION OF SEWAGE OF ENGLISH TOWNS.
(Parts per 100,000.)

Classes of Towns.	Total Solids in Solution.	Organic Carbon.	Organic Nitrogen.	Ammonia.	Total Combined Nitrogen.	Chlorine.	Suspended Matter.		
							Mineral.	Organic.	Total.
Privy midden towns	82.4	4.181	1.975	5.435	6.451	11.54	17.81	21.30	39.11
Water closet towns	72.2	4.696	2.205	6.703	7.728	10.66	24.18	20.51	44.69

In districts where textile, dyeing, and chemical trades are carried on the trade wastes contain sulphuric, hypochloric, and nitric acids, alkalies, soap lees, solutions of iron, zinc, tin, alum, copper, chrome, antimony, and arsenic, waste dye liquors, spent dye wares, glue, size, fibres of wool, mohair, &c. Where hardware, iron, wire, and kindred trades prevail, the sewage contains iron in solution to considerable amount from the pickling processes, and salts of iron as ferrous chloride. Other trades producing liquid refuse are tanneries, breweries, paper making, fellmongering, and gas residual works.

The effect of these trade refuses on the problem of sewage purification will be dealt with in subsequent chapters.

The systems of collecting, removing, and dealing with sewage and other refuse may be summarised thus :—

I.—CONSERVANCY SYSTEMS.

- (a) Cesspits.
- (b) Soakpits.
- (c) Middens.
- (d) Pails and Tubs.
- (e) Earth Closets.

II.—SEWERAGE (WATER-CARRIAGE).

(f) **The Combined System.**—By which all sewage, surface water, subsoil water, and manufacturer's refuse are carried into the same sewer.

(g) **Modification Excluding Subsoil Water.**—The next system is a modification of the preceding, in so far as that the subsoil water is carefully excluded from the sewers.

(h) **Absolutely Separate System.**—The absolutely separate system involves the use of three sets of drains, one for foul water or sewage, one for surface water, and another for subsoil water.

(i) **Partially Separate System.**—Then we have the partially separate system, which is a combination of the “combined” and “absolutely separate” systems.