strong that by splitting the flow of water to the reaction chamber, overtreating with lime the major portion at the inlet end of the reaction chamber, and, some time after the application of the soda ash, introducing the minor portion of the raw water, the undesirable factor of residual causticity, true of all water-softening processes, would in a large measure be overcome.

In general, therefore, it may be said that the concentrated action of the total amount of lime on the major portion but not on the total amount of water serves to speed up and to render possible a more complete lime reaction, not only as relates to the removal of magnesium but also to the removal of the calcium.

Elimination of Residual Causticity.—In all processes of softening hard water in which lime or caustic soda are used as softening agents, there is a possibility that the softened product will at times contain an excess of free caustic alkali, owing to the frequent changes in the character of the raw water, or to carelessness or accident in the operation of the plant, or to the method of application of the softening chemicals to the raw water. Another condition instrumental in the production of a caustic effluent is the retarding effect caused by low temperature on the rapidity and completeness of the softening reaction. In systems of water softening where the period allowed for the softening reactions to take place is comparatively short, particularly where such plants are designed to furnish water for drinking, rigid precautions are demanded to overcome the occasional inevitable residual causticity. In some plants the matter is controlled by installing carbonating devices for the purpose of subjecting the softened water to the action of carbon dioxide. If properly distributed in adequate amounts through a water possessing causticity, this gas is effective in overcoming this inadmissible condition.

This process is known as "carbonating," the principle involved being the same in all devices designed to accomplish this end. The features essential to successful carbonating are the uniform rate of application of the gas, and the thoroughness with which it is disseminated through the water. Although the process is without doubt practicable for small water-softening plants, its use in large plants would probably entail too great an expense to justify its installation. Further, aside from the cost, which perhaps might be reduced, it appears that the application of the gas to large volumes of water would cause great uncertainties in this feature of the plant, which must be under perfect control at all times.

Causticity that the raw water can neutralize is obviously equal to the amount of caustic lime (or caustic soda) required to soften the water. As a substitute for the carbonating devices in use in small water-softening plants, the application to the softened water of a small percentage of raw water may be practiced. It is apparent that the percentage of raw water required for each part of free causticity which may remain in the softened water will be one hundred times the reciprocal of the number of parts of lime (CaO), required to soften the water. In other words, all unchanged caustic alkalinity which the softened water may contain will be neutralized by the addition of a small percentage of raw water, the caustic neutralizing power of which is at a maximum.

Sedimentation of Softened Water Prior to Filtration.—Where river waters are to be softened, filtration usually follows the softening process. The necessity for the sedimentation of the softened water after the reaction period and prior to its filtration refers to the removal of an economical percentage of the precipitated salts of lime and magnesium, together with the suspended mud, silt, and clay carried by the water at flood seasons. It is clear that it would not be practicable or economical to apply to filters the softened water as it leaves the reaction chamber. As the precipitating salts are purposely held in suspension during the reaction period, the major portion of them passes out with the water as it leaves this chamber. The volume of this precipitate will be so great as probably to preclude the direct application to the filter of the water as it leaves the reaction chamber. Furthermore, at times when the river water carries high amounts of sediment, economy in filter operation demands that a period of sedimentation be allowed to intervene before such water is applied to the filter in order that a substantial removal of the mud, silt, and clay may take place in the settling basins.

For still other reasons it appears advisable to provide for several hours' subsidence as a means for compensating irregularities in the operation of a softening plant, namely, to guard against incomplete softening in the reaction period; to overcome uncertain factors introduced by winter weather, producing retardation of the softening action; to avoid the undesirable effect produced by possible after-reactions, which cause deposition of slow-forming precipitates on valves, boiler-water condensers, and the like, and to remove the esthetic objection introduced by the presence in the water, as delivered to the consumer, of small particles of precipitated lime and magnesium compounds.

RATING REFRIGERATING MACHINES.

In this country there are two generally accepted units for rating a refrigerating machine. These are commonly called the ice-melting or refrigerating capacity and the ice-making capacity. Both are expressed in tons of 2,000 lb. per day of 24 hour. When a machine is rated at one ton ice-melting or refrigerating capacity, it would mean that under an assumed range of operating temperature it would remove from the refrigerator the number of heat units equivalent to that required to melt one ton of ice at 32 deg. F. into water at 32 deg. F. The latent heat of ice has been variously taken as 142, 143, 143.7 and 144 B.t.u., but 144 B.t.u. is now the figure generally accepted. Then

$$2{,}000 \times 144 = 288{,}000 \; B.t.u.$$

is the equivalent of a ton of refrigeration per day of 24 hr. This would give 12,000 B.t.u. per ton per hour and 200 B.t.u. per ton per minute, all convenient figures to work with. The machine is supposed to work between a condenser temperature of 90 deg F., and a temperature of zero in the expansion coils.

The ice-making capacity is a measure of the actual weight of ice made by a machine, designed for the purpose, in tons per 24 hr. For a machine not designed for ice making this unit would appear of little value, but for the sake of comparison it is approximately six-tenths the ice-melting or refrigerating capacity.

The Board of Railway Commissioners for Canada has issued to the railways a circular calling attention to the advisability of warning employees about the absolute necessity of keeping away from all electric light or power lines, and also to the advisability of becoming familiar with the recently revised rules for "Resuscitation from Apparent Death from Electric Shock."