

creased to about the same amount.

In order to equalize the draft on the wells and furnish storage capacity on which to draw in times of heavy consumption, a 6,000,000 gal. reservoir has just been completed. The water is raised from the wells by pumps of 15,000,000 gal. capacity, and is delivered to the city by a 5,000,000-gal. triple-expansion pump and an electrically-driven centrifugal pump of the same capacity.

The water is very hard and is softened before it is distributed. The artesian well water supplied to Winnipeg contains, in its natural state, the following elements, in round numbers, in the amounts stated: Carbonate of lime, 16 grains per imp. gal.; carbonate of magnesium, 8.5 grains; sulphate of magnesium, 12 grains; sulphate of sodium, 5.5 grains; carbonate of sodium, 3.0 grains; chloride of sodium, 27.5 grains. Other compounds are present in minute amounts and are of no significance in this connection. The constituents mentioned have remained almost constant in kind and in quantity for over five years.

Of the constituents mentioned, only the first three cause the water to be hard. Of these three com-

pounds, the softening process removes only the first two, the carbonates of lime and magnesium. Sulphate of magnesium, while acting to some extent on soap, does not form any scale in boilers. In order to remove it from the water it would be necessary to add soda ash as well as lime. This would involve expense and other objections out of proportion to the benefit gained. The removal of the carbonates of lime and magnesium eliminates rather over two thirds of the hardening substances from the water.

The carbonates in the water are held in solution by carbonic acid gas which the water dissolved from the air or soil before it was able to dissolve the carbonates of lime or magnesium from the rock. Any means which will abstract this carbonic acid from the water will soften it, because the carbonates of lime and magnesium will at once separate from the water. Boiling softens the water for this reason, but it would be impracticable and undesirable to soften a public water supply in this manner. It is possible, however, to accomplish the same thing without the use of heat. If any substance having a strong affinity for carbonic acid is added to hard water, it combines with the

acid and sets free the carbonates of lime and magnesium, which thereupon separate and settle out as a white powder, leaving the water soft.

Such a substance is found in the builders' lime of the trade, the best grade being the cheapest to use. For convenience it is slaked and converted into lime water. When the lime water is mixed with hard water, flakes and crystalline matter are observed to separate at once. These consist of carbonate of lime, formed by the union of the lime, which was used with the carbonic acid in the water, also the carbonate of lime which was in the hard water, and lastly, hydrate of magnesium, produced by the action of the lime on the magnesium carbonate in the hard water. It is thus apparent that all of the lime which is used for softening is converted in the process into carbonate of lime, which separates immediately from the water, bringing with it the carbonates which were in the hard water.

The apparatus for preparing and pumping up the lime cream consist of a slaking bed, a mixing well and a ball valve pump. The speed of the pump is regulated from the operating platform. The lime water

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