chloride of lime and from personal observation, the amount of chloride of lime that will give a taste to water may be estimated at from 7 to 20 lb. per million gal., the average figure being from 10 to 12.

(9) Liquid chlorine does not change the character or the water by the introduction of lime salts. The lime salts will usually amount to not over one part per million.

(10) Liquid chlorine necessitates no labor cost while chloride of lime does. This is true, but a liquid chlorine requires skilled supervision to be operated properly and is not fool-proof.

(11) Liquid chlorine leaves no sludge.

(12) Liquid chlorine will reduce the amount of alum needed for bacterial removal. There can be no question but that in cases where the water is comparatively clear and where alum is used chiefly for bacteria removal if liquid chlorine is used before filtration it will make a marked saving in the cost of alum and in many cases will not only pay for itself but will decrease the general cost of the plant.

A saving of ½ grain per gal. of alum at 1c. per lb. by the use of 1 lb. liquid chlorine per million gal. at 10c. means a saving of 61c. per million gal.

(13) The feed of liquid chlorine is regular from hour to hour while the feed of chloride of lime varies constantly.

Objections to Use of Liquid Chlorine.—The chief objection to the use of liquid chlorine lies in the concentrated energy of the material itself. If liquid chlorine is set free in small enclosures it will cause nausea. With ordinary common sense and judgment on the part of the operator this is not likely to happen. The greatest danger lies in faulty cylinders and faulty valves. If the cylinder valve will not turn off or if the cylinder leaks it must be gotten out to the open air and the chlorine allowed to escape. Careful inspections of cylinders and valves must be made.

When it comes in contact with moisture, liquid chlorine has a very corrosive action, but this has been overcome by the use of hard rubber pipes and towers.

Comparative Costs.—The following estimated comparative figures are submitted:

Chloride of lime costs us from $1.22 to $1.70 per 100 lb.; the usual quotation was $1.34 and the average figure $1.40. We used during 1913 an average of a little over 1,200 lb. a day, or $16.80 a day for powder. Two laborers at 25c. per hour were employed for eight haurs, making a total cost of $20.80 per day, exclusive of repairs, sample collecting, or laboratory analyses.

180 lb. of liquid chlorine would cost, at 10c. per lb., $18 per day. We have now passed the worst conditions of the year, February and March, when we used 234 lb. a day or $23.40 cost. It is expected that we will be able to reduce the amount of liquid chlorine to at least ¾ lb. per million, or 120 lb. a day.

Some supervision and handling of cylinders is required. At present the work is done by a $3 a day mechanic, who also keeps the pre-filters in repair. His wages is charged against the pre-filters. A charge of $1 per day would be fair for this service. This is partly balanced by the discontinuance of laboratory analyses.

The labor cost during 1913 of $4 per day at Torresdale, with its output of 180,000,000 gal., amounted to but 2.2c. per million gal. At Belmont and at Queen Lane the labor cost of about $1.50 per day amounted to 3.8c and 3c. respectively. At Roxborough plants the labor cost averaged over $1 per day for mixing, that at Lower Roxborough cost 10c. per million, and at Upper Roxborough 6.7c. per million. The cost per million gallons at these plants during 1913 amounted to from 16 to 18c. At 1 lb. per million gal. for liquid chlorine the cost would be 10c., or a saving of 6.8c. per million gal. On April 14th the quantity used was reduced to ½ lb. per million gal., or a cost of 5c., a saving of from 11 to 13c.

Belmont and Queen Lane are saving a labor cost of 3.8 and 3c. Belmont is operating at a rate of ½ lb. and Queen Lane at ¾ lb., or about 5 and 7.5c.

In general, the cost of the two processes should be about equal, but liquid chlorine should prove the cheaper of the two.

With the use of liquid chlorine it is necessary to have an accurate determination of the flow of gas; it must be kept in a condition that it will not corrode the apparatus, and a proper absorption of the gas must be obtained. This has been accomplished by the use of absorption towers, which require from 50 to 100 gal. of water per 1 lb. of chlorine used.

While in some instances liquid chlorine may prove more costly than chloride of lime, the regularity with which it can be applied, the more effective the action on pathogenic bacteria, the small compact apparatus and the absence of the odor of chlorine around the plant recommends it as a satisfactory substitute for hypochlorite, possessing as it does all the advantages of the latter and only some of the faults.

It has been shown from experiments conducted in Belgium with a view to discovering the effect of foreign metals on the rolling of zinc, that ingots weighing 40 lb. were prepared by casting together zinc alloys of various metals, with spelter containing lead 1.05 to 1.25, cadmium 0.076 to 0.11, and iron 0.03 to 0.039 per cent. It was found that cadmium is harmful above 0.25 per cent., while with 0.5 per cent. rolling is impossible. In regard to arsenic, 0.02 per cent. markedly increases the hardness, and with 0.03 per cent. the metal is too brittle for practical purposes. Antimony is less objectionable than arsenic as regards hardness, as 0.07 per cent. does not increase the hardness; but 0.02 per cent. is enough to produce a striated surface on the rolled sheet, which makes it unsaleable. Tin is objectionable when above 0.01, and prohibitive at 0.03 per cent. Copper has no hardening effect until it reaches 0.08, and with 0.19 per cent. the zinc is unworkable. A permissible maximum of iron is 0.12 per cent., but this is easily reduced in refining. Though 1 to 1.25 per cent. of lead does not interfere with the rolling, a slight increase not only seriously affects malleability, but the excess of lead remains unalloyed and forms patches on the sheet. The presence of two or more impurities together results in a combination of the injurious effects of each.

"Le Genie Civil" reports the results of tests made at the Ecole Centrale, Paris, to show that when holes are drilled and then reamed in soft-steel bars the metal materially increases in strength, the average limit of elasticity improving 12.3 per cent. and the average tensile strength 9.2 per cent. This phenomenon is explained thus:—In putting together the parts of a test piece broken under tension, it is found that the two ends do not coincide; and that, while the edges make a good contact, the central parts do not, thus indicating that the rupture begins at the centre, and that the edges have a higher tensile resistance than there is along the axis of the bar. Therefore, if several holes are drilled so as not to injure the material too much, as might be the case with punching, the average tensile strength of the section across the holes, per unit of metal, will be higher than before the holes were drilled, since each hole creates, so to speak, additional edges.