## WATER PURIFICATION BY EXCESS LIME.

R. A. C. HOUSTON, the Director of Water Examination to the Metropolitan Water Board of London, Eng., issued recently his eleventh report on research work, in which he deals further with his investigations into the purification of raw water by the excess lime method. In his eighth report, reviewed in these columns in 1912, some results were given that tended to demonstrate the utility of this purification process, but his recent findings, under more nearly service conditions, indicate its effectiveness to a decidedly interesting extent. The "Engineer" of London publishes the following review of Dr. Houston's most recent work, beginning with a brief explanation of the principles involved in the experiments.

The hardness of water, as is well recognized, is of two kinds, "temporary" and "permanent." It is chiefly due to bicarbonate of lime (temporary) and sulphate of lime (permanent). When water is boiled carbonic acid is driven off, the comparatively insoluble carbonate of lime is precipitated, and the temporary hardness of the Water is removed. In like manner, when lime is added to water it combines with the free and semi-combined carbonic acid and thus effects the same results. What takes place is represented in the following equation:-Bicarbonate of lime Quicklime Carbonate of lime  $CaCO_3$ ,  $H_2CO_3$  + CaO =  $2 CaCO_3$  + Water H<sub>2</sub>O +

If only the exact quantity of lime be added to bring about this reaction the water remains non-bactericidal in character, though it has lost its temporary hardness and many of its impurities may also have been mechanically removed during the precipitation of the relatively insoluble carbonate of lime.

If, on the other hand, more than enough lime be added the water is rendered caustically alkaline owing to the presence of an excess of calcium hydrate Ca(OH)<sub>2</sub>. Such a liquid is actively bactericidal. In the absence of Carbon a liquid is actively bactericidal. carbonation from the air, and allowing for several days' contact, the excess of lime—CaO—required is exceedingly small—less than one part per 100,000, or 1 lb. per 10,000 sallons. With soft waters the process is cheap, but with those possessing a high degree of temporary hardness it is a good deal more expensive, as such waters cannot be storighted by the large sterilized until the lime has combined with the large amount of bicarbonates present in them. Moreover, it is necessary in such cases to have a greater excess of lime than . than is actually required for sterilization purposes, as a very very small increase in the amount of temporary hardness Would at once rob the water of the excess of lime on which sterilization depends.

Having satisfied himself that water could be sterilized by the lime method under laboratory conditions, Dr. Houston then went on to try the process on much larger volumes of water than were employed in his original experiments. Before describing what he himself did in this direct: direction, Dr. Houston explains the results obtained on a large large scale with Aberdeen water. It appears that the water water used in that city is very soft and that the total <sup>supply</sup> is about  $63_4$  million gallons per day. It is ab-stracted c stracted from the River Dee at Cairnton and first passes through an aqueduct one mile long into Invercannie reservoir, which contains 9 million gallons. The lime was made into milk of lime and continuously added to the water into milk of lime and continuously added to the water just before it entered the reservoir. From the latter to the second secon latter the water is conveyed by an aqueduct  $18\frac{1}{2}$  miles long to two service reservoirs at Mannofield, which con-tain to two service reservoirs at three small reservoirs tain 18 million gallons, and also to three small reservoirs for Supel for supplying the higher parts of the town. Excluding

these small reservoirs, the duration of contact was nominally between four and five days, but actually it was found that some of the water was delivered to consumers within twenty-four hours.

The amount of lime added on the recommendation of Dr. Houston was equivalent to three parts of CaO per 100,000 parts, or 3 lb. per 10,000 gallons. The treatment was begun on February 26th, 1913, at 7 a.m. and finished on March 19th following at 10.30 p.m. The bacterial condition of the water as delivered from the Mannofield service reservoirs before, during, and after the treatment is set out in the following table :-

Date.	Typical B. coli found in
January 10th	50 c.c.
February 17th	·· 5 c.c.
February 19th	·· 5 c.c.
February 21st	IO C.C.
February 24th	IOO C.C.
Treatment commenced Febru	1ary 26th, 7 a.m.
February 26th	IO C.C.
February 27th	IO C.C.
February 28th	50 c.c.
March 1st to March 18th (inclusiv	ve) Not in 100 c.c.
March 19th	50 not in 100 c.c.
Treatment stopped March 19th, 10.30 p.m.	
March 20th	Not in 100 c.c.
March 21st	Not in 100 c.c.
March 22nd	·· 5 c.c.
March 23rd	I C.C.
March 24th	I C.C.
March 25th	IO C.C.

It will be observed that both before and after the treatment the water contained B. coli in 100, 50, 10, 5, or even 1 c.c., but that during the treatment the bacillus



Fig. 1.-Diagram of Sunbury Experimental Plant for Treatment of Thames Water.

was practically always absent from 100 c.c. of water, which, as Dr. Houston says, is a remarkably good result.

It was calculated that of the total amount of lime-3 parts per 100,000-added to the water, the consumer received 72 per cent., or 2.17 parts, as caustic alkali, and 15 per cent., or 0.45 parts, as carbonate of lime, the remaining 13 per cent .- 0.39 part-of carbonate of lime having settled in the reservoirs. The presence of the carbonate of lime in suspension was, it is pointed out, of no importance from a health point of view, though it imparted a slight, milkiness to the water, and had the treatment been continued might have resulted in the deposition of a gradually increasing coating in the pipes. Whether or not the caustic alkalinity would be injurious to health is another matter, and is open, as Dr. Houston remarks, to argument, though he himself does not think it would do any harm. He adds that the lime water of the British Pharmacopœia contains about half a grain of caustic alkalinity to the fluid ounce. The treated Aberdeen water