

Operation of Slow Sand Filters at Toronto

Ten Thousand Samples Tested During Year 1918 Show 99.7% Average Reduction in B. Coli, 99.1% in Total Bacteria, and 99% in Excremental Bacteria—Pollution of Raw Water Increased 61.9% in Five Years Judged by B. Coli Tests

By NORMAN J. HOWARD

Bacteriologist-in-Charge, Filtration Plant Laboratory, Toronto

THE water supply for the city of Toronto is drawn out of Lake Ontario, the intakes being situated a little more than 2,000 feet due south of the plant. Filtration is effected by means of two modern installations, one being a mechanical plant of the drifting sand type, and the other a slow sand system. As the mechanical plant is being made the subject of a special report, it is proposed to deal only with the slow sand system for the period of twelve months ending December, 1918.

Out of 15,880 samples examined in the laboratory, either chemically, physically, microscopically or bacteriologically, some 10,000 were from the slow sand system.

Bacteriological Results

Tests for the enumeration of bacteria growing on agar and rebielagar at blood temperature, and for the isolation of the colon bacillus were made on the raw and filtered water throughout the year. The average number of bacteria per c.c. growing on nutrient agar for twenty-four hours at blood temperature was 356.3 in the raw water and 2.2 in the filtered water, a reduction of 99.1 per cent. Excremental bacteria growing under the same conditions showed that the raw water contained 26.5 and the filtered water 0.25 per c.c., respectively, giving a reduction of 99 per cent. The media used in test was neutral red, lactose bile-salt, peptone agar,

Physical examination of the water was made daily, and showed that, whilst the turbidity varied considerably in the raw water, ranging between 1 to 160 parts per million, the filtered water was at all times free from turbidity, the effluent being clear, bright and sparkling. The microscopical examination was not carried out as frequently or as thoroughly as in previous years, due to the extra laboratory work involved by the new mechanical plant. Nevertheless, the observations made at the different seasons of the year were extremely valuable, and often threw light on the fluctuation in the loss of head of the filters, which otherwise would have been difficult to understand.

Amongst the many types noted were the diatoms cymbella, coconeis, navicula gracilis, stauroneis, epithemia,

TABLE B

Bacteria growing on Agar at 37-39 degs. C., 24 hours incubation, showing monthly maximum, minimum, and average number per c.c. in raw and filtered water; yearly average number per c.c. in raw and filtered water, and the total percentage reduction in the filtered water for the year.

Month.	Raw Water			Filtered Water		
	Maximum	Minimum	Average	Maximum	Minimum	Average
Jan.	550	0	50.4	5	0	.96
Feb.	280	0	27.6	3	0	.87
Mar.	320	1	37.8	6	0	.32
Apr.	970	0	139.0	6	0	.76
May	1,800	1	114.0	6	0	1.36
June	1,340	0	195.46	14	0	1.83
July	620	0	110.23	5	0	.96
Aug.	3,800	16	654.27	46	0	2.96
Sept.	2,200	1	564.2	25	0	3.5
Oct.	17,200	8	1,466.6	30	0	5.6
Nov.	3,825	2	309.2	12	0	3.5
Dec.	1,850	2	573.35	7	0	2.4
Average for year			356.3			2.2

Total reduction for the year, 99.1 per cent.

TABLE A

Number of Examinations Made During the Year

Month	Bacteriological	Physical and Microscopical	Chemical
January	660	447	169
February	579	374	124
March	614	425	143
April	704	510	162
May	699	426	136
June	638	532	135
July	735	451	155
August	686	549	187
September	661	545	160
October	644	664	201
November	678	581	167
December	590	533	167
Total	7,888	6,037	1,906
Total			15,831

Special Examinations

Aluminium Sulphate	26
Boiler Incrustations	3
Boiler Compounds	2
Trap Rock	3
Copper and Brass	12
Cement	3
Total	49

Grand Total

Examinations made in 1912	8,096
" " " 1913	9,382
" " " 1914	9,848
" " " 1915	10,292
" " " 1916	12,076
" " " 1917	15,041

himantidium, asterionella, synedra, fragilaria, diatoma, tabellaria, nitzschia sigmoidea and longissima, melosira, cyclotella, stephanodiscus, the cyanophyceae microcystis, coelosphaerium, anabaena, the chlorophyceae palmella, tetraspora, scenedsmus, hydrodicton, sorastrum, volvox, ulothrix, the protozoa actinophrys, uroglena, dinobryon, ceratium, vorticella, codonella, coleps, and several types of rotifera, crustacea, and infusoria. There were many other varieties which were not identified. Many of the above mentioned when present are known to be objectionable on account of their imparting a taste or smell to the water. During the summer months, when the water was warm, particularly during August and September, a faint taste appeared to be present in the raw water. The filtered water was practically free from organisms; occasionally there was a trace of amorphous matter, but the taste previously mentioned, whilst considerably lessened, was not completely eliminated. It is doubtful if the taste was noticed by the consumer.

Chemical Examination

Considerable time was devoted to the chemical examination of the raw and filtered water. The test for the determination of ammoniacal nitrogen is practically the only known test for ascertaining rapidly the condition of the raw water. On many occasions this information was most useful in the operation of the filters. The general reduction of the organic matter in the filtered water was satisfactory, the free and albuminoid nitrogen and the oxygen consumed showing substantial reductions. The nitrates increased, pointing to oxidation caused by nitrifying bacteria on the surface of the filters. A further increase in the chlorides cannot be regarded as satisfactory, and is another indication of the degree of pollution that is yearly increasing.

as used by Dr. A. C. Houston, of the Metropolitan Water Board, London, Eng. For the isolation of the colon bacillus, lactose ox gall was used. The raw water showed the colon bacillus to be present in one cubic centimetre on 121 days (39.9 per cent.). The average indicated number of B. Coli present in the raw water was 11.36 per c.c., whilst the filtered water contained .027 per c.c. The total percentage removal of the colon bacillus in the filtered water was 99.7. Reference to table D will show the complete figures covering the colon tests for the past six years.