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The swimming pool, being really a sort of common bath, rapidly departs from a sanitary condition, unless prompt and adequate measures are taken to maintain a reasonable degree of purity in the water. Moreover, since various types of intestinal infections, infections of the respiratory system, eye and ear infections, gonorrheal infections and skin infections have been traced to the waters of swimming pools, the protection of the bathers by means of proper treatment of the water and rigid inspection of all entrants into the pool is essential to safety.

The supervision of preliminary soap shower baths is a factor capable of greatly reducing the burden on the water purification apparatus and also capable of reducing the amount of chemical treatment necessary. If the pool is carelessly supervised it is possible for the bathers to make it an unpleasant and perhaps an unsafe place.

The construction of the pool room and the tank are features of importance, of course, since they make cleaning easy or difficult and to a certain extent determine the habits of the patrons. Convenient toilet facilities, convenient showers in good repair and furnished with an ample supply of warm water and a clean pathway will aid the bathers in entering the pool in reasonably clean condition. Provision of a visitor's gallery which allows the exclusion of persons wearing street shoes is highly desirable.

The manner in which suits and towels are handled is of considerable importance. Washing is not always sufficient to kill the organisms causing skin diseases, a fact which may require steam sterilization to be practiced. To be sure, careless handling of the cleaned suits and towels may undo the work of sterilization and leave them in as bad a state as ever.

However, the matters which are of greatest interest have to do with the pool water itself. Proper construction makes it easier to maintain the pool in a clean condition and proper supervision tends to reduce the contamination of the water, especially the more dangerous contamination from bathers carrying pathogenic organisms.

The State University of Iowa has two pools; one of 61,200

gallons capacity at the Women's Gymnasium, the other of 89,100 gallons capacity at the Armory. Both are lined with white tile and located in light rooms. The women's pool has a scum gutter entirely around the pool, while at the men's pool the gutter is on the two sides and not on the ends. The water of both pools is continuously purified by passage through a filter. At the women's pool the filter is a single-unit, open, gravity installation with a capacity of 138,240 gallons per 24 hours; at the men's the apparatus is a two-unit, enclosed pressure filter of a capacity of 116,000 gallons per day. Both plants employ aluminum sulphate as a coagulant. Filtered water is treated with 0.34 to 1.0 parts per million copper sulphate and 0.3 to 2.0 parts per million calcium hypochlorite. The dosage is varied according to the condition of the water in the pools. When the plants were installed it was intended to use liquid chlorine for disinfection, but the apparatus secured did not give good results and finally had to be discarded on account of the difficulty of keeping it in repair. The men's pool is kept at a temperature of 76° F., while the women's pool runs up to 84° F.

From the foregoing brief statement some idea of the operation of the pools may be obtained. More complete descriptions of the chemical equipment have been given elsewhere.[1]

Since the commencement of operations in January, 1916, samples have been taken every day that the pools have been in use. Sundays and holidays have been omitted as the pools have been closed at such times.

Table No. 1, which summarizes the results from January 27, 1916, to March 31, 1920, is the longest series of consecutive swimming pool results with which the writer is familiar. Table No. 2 gives the periods varying from 12 to 136 days elapsing between the times of filling and emptying. While some of these periods have been terminated by the failure of the water to respond to treatment, most of them have been determined by external factors, such as vacations, shortage of coal, need for the pool room for an S. A. T. C. dormitory and so on.

Table No. 1 is a sort of frequency chart showing the number of days on which the bacterial counts fell within certain limits, and also showing the number of times gas-forming organisms were found in lactose broth and acid colonies on lactose agar.

1 Hinman, Engineering and Contracting **46**, 135 (Aug. 9, 1916).
Hinman, Journal of the American Water Works Association, **4**, 86 (March 1917).
Hinman, American City (City Edition) **16**, No. 4, 305 (April, 1918).
Hinman, American Physical Education Review, December, 1920.

TABLE NO. 1. THE STATE UNIVERSITY OF IOWA — SWIMMING POOLS

January 27, 1916 — March 31, 1920

		Litmus Lactose Agar at 37°C. 24 hrs.								Plain Agar at 20°C. 48 hrs.								Gas Formers Lactose Broth				Acid Colony L. L. Agar	
		Days None In 1 c.c.	1-10	11-50	51-100	101-500	501-1000	>1000	No. Platings	1-100	101-500	501-1000	1001-10,000	10,001 — 20,000	20,001 — 30,000	>30,000	No. Platings	Gas in 1 c.c.	No. Plantings	Gas in 10 c.c.	No. Plantings	Acid Colonies 1 c.c.	No. Platings
Women	Filters alone	1	17	5	0	1	0	0	24	3	7	5	7	3	1	0	26	3	26	....	....	1	24
Women	" & Chlorine	7	20	9	1	5	0	0	42	0	3	1	24	10	7	0	45	0	45	....	....	0	42
Women	" & $CuSO_4$	0	2	11	5	61	0	0	79	1	0	0	34	27	20	0	82	0	82	....	....	0	79
Women	" & $CuSO_4$+Cl	5	48	36	22	49	0	0	160	12	23	13	74	25	11	1	159	1	46	5	70	1	160
Women	" $CuSO_4$+hypo	107	227	77	38	83	24	39	595	84	93	67	258	44	14	31	591	4	591	39	591	6	591
Women	Totals	120	314	138	66	199	24	39	900	100	126	86	397	109	53	32	903	8	790	44	659	8	896
Men	Filters alone	1	23	2	0	0	0	0	26	0	4	4	13	6	2	0	29	7	29	....	....	2	26
Men	" & Chlorine	16	19	5	4	1	0	0	45	0	0	4	30	11	10	0	45	0	45	....	....	0	45
Men	" & $CuSO_4$	2	11	8	10	47	0	0	78	0	0	1	49	23	11	0	84	0	84	....	....	0	78
Men	" $CuSO_4$+hypo	130	299	150	54	83	15	18	749	86	115	80	373	68	17	13	752	18	634	114	632	19	750
Men	Totals	149	352	165	68	131	15	18	898	86	119	89	455	108	40	13	910	25	792	114	632	21	899
Totals of all Exam.		269	666	303	134	330	39	57	1798	186	245	175	852	217	93	45	1813	33	1582	158	1291	29	1795

Grand Total: 8279 Examinations.

TABLE NO. 2. S. U. I. — SWIMMING POOLS

January 27, 1916 — March 31, 1920

Women			Men		
Filled	Emptied	Days	Filled	Emptied	Days
1-21-16	5-19-16	119	1-21-16	5-27-16	127
5-21-16	8-24-16	95	5-28-16	8-24-16	88
9-21-16	12-21-16	91	9-25-16	12-21-16	87
1-6-17	4-4-17	88	1-5-17	4-4-17	89
4-9-17	6-12-17	64	4-9-17	6-9-17	61
6-19-17	8-25-17	67	6-21-17	8-26-17	66
9-28-17	12-22-17	85	9-25-17	12-22-17	88
1-6-18	1-19-18	13	1-7-18	1-19-18	12
2-22-18	6-5-18	103	2-22-18	3-28-18	36
6-17-18	8-31-18	75	4-3-18	6-7-18	65
1-28-19	6-13-19	136	6-21-18	8-30-18	70
6-18-19	8-30-19	73	1-22-19	3-21-19	58
10-9-19	11-28-19	51	3-25-19	6-13-19	80
1-11-20	3-25-20	74	6-18-19	7-25-19	37
			7-30-19	8-30-19	31
			10-6-19	11-28-19	53
			1-7-20	2-12-20	36
			2-17-20	3-26-20	38
			3-31-20		

Since the condition of the pool water is dependent upon the contamination introduced by the bathers and the natural multiplication of bacteria as well as upon the amount of purified water returned to the tank and the degree of purification, it has been thought best to take all samples after the pool has been used for the day so as to have samples representing the worst condition of the pool. It is obviously undesirable to take the effluent from the filters as a representative sample because that represents the purified water rather than the pool water itself. A small quantity of practically sterile water is naturally not able to improve the quality of the pool water to the same extent as a large volume of water not quite so thoroughly treated.

There is no agreement upon the degree of purity necessary in the water of swimming tanks, although it would be generally accepted that the more nearly the water approached the purity of drinking water, the better. But there is no very general agreement as to the degree of purity which a water must have to pass into the classification of drinking water. Perhaps the United States Treasury Department Standard of 1914, for water supplied to passengers by common carriers in interstate traffic, is the most generally recognized standard. It requires that the water shall show less than one hundred bacteria per c.c. on agar at 37° C. after 24 hours incubation and also that it shall show not more than one positive confirmed test for *B. coli* out of five 10 c.c. plantings

of the water. It would seem that 500 bacteria at 37° C. is a more reasonable requirement for pool water and that the colon bacilli should be absent in one cubic centemeter.

The environmental conditions in the pool are such that the growth of the ordinary water bacteria is much stimulated. Temperature and food conditions enable the few organisms remaining after disinfections to multiply rapidly and give aftergrowth represented by large numbers. There is no special reason to regard these bacteria as pathogenic, and unless the bacterial count at 37° C. is high and colon type organisms are present, there is probably no reason to think that a high 20° C. count has any particular significance. Some workers have entirely omitted the enumeration at 20° and neglected the information which the 20° C. count may give at times.

We have found the 20° count subject to sharp fluctuations, although likely to show up in the worst manner within the first few days after the pool is filled. From the operation standpoint we have not paid great attention to this first aftergrowth. When the pool shows a high 20° C. count after having been in use some time and we find it difficult to reduce it promptly we take it as evidence that the food conditions are too advantageous. We may then advise that the pool be emptied.

We watch the 37° C. count more zealously than we do the 20° C. ones. While about 20 per cent of the latter have passed the limits which we have arbitrarily set as desirable, only about 5 per cent of the former have passed the limits.

The presence of gas-formers and acid colonies is regarded as most significant of all. If these are persistent, even in 10 c.c. quantities of water, the advice is given to empty the pool. The gas-forming organisms have not all received the confirmatory test for *B. coli.* Of those that have been specially tested about one-fourth have proven to be *B. coli.* It should always be kept in mind that these figures give the results on samples taken after use, not on the pool as it is after having received purified water all night. Fresh contaminations are considered to be more dangerous than older ones.

In the table given the figures for purification by filters alone may be misleading. They appear to show superior results. As a matter of fact only the instructors were using the pools at that time and the bathing load was only about 1 per cent of the normal load. Attention is called to the high percentage of positive tests for gas- and acid-forming bacteria found. Our experience has

been that, while the filters are running, the use of copper sulphate has apparently given the least satisfactory results. Personally I am inclined to think that copper sulphate plus chlorine is most satisfactory. We have obtained good results with copper sulphate plus calcium hypochlorite, however.

As has been noted by others in other localities we find that the numbers of bacteria in the women's pool tend to be higher than in men's pool. This is probably due in part at least to the suits worn. The fact that the women's pool is kept at a temperature about six degrees higher than the men's pool may also be a factor in favoring the tendency to higher 37° C. bacterial counts. Here, however, the bathing load at the men's pool is greater than at the women's pool and the occurence of gas-forming organisms is more frequent.

In conclusion, the writer wishes to acknowledge the work of Mr. Deloss H. Barber, Mr. Frank Kennan, Mr. Cecil E. Ewen, and Mr. Roy M. Mayne, who have operated the filter plants and made most of the examinations of the pool waters. He also wishes to acknowledge the work of Miss Zelma Zentmire, who supervised the operation of the pools during the period he spent in the Army.

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