

THE ARSENIC CONTENT OF FILTER ALUM USED
BY ILLINOIS WATER PURIFICATION PLANTS

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INTRODUCTION

Specifications requiring arsenic free alum for water treatment by several European¹ purification plants suggested to us that it would be advisable to make determinations of the arsenic content of the filter alum used in the State of Illinois.

It is well known that products which are manufactured with the aid of commercial sulfuric acid quite generally contain more or less arsenic, depending upon the purity of the acid used. The poisonous character of arsenic compounds, even when present in small amounts, makes it of general interest and importance to have definite knowledge of the presence or absence of arsenic in any substance which enters directly or indirectly into foods or drinks. Sulfuric acid is used in the manufacture of filter alum and it is thus quite essential, particularly to those who are in public health work, to know whether arsenic in any considerable amounts is being added to drinking water in the process of purification with alum.

We have not been able to learn that anything has been done in this country to regulate the amount of arsenic in filter alum. The purification plants (at least in this State) have made no effort to obtain an arsenic free article. The manufacturers of alum keep more or less accurate records of the arsenic content of their product, but we have found no published records. We have found only one producer who advertises "arsenic free alum." Neither the government nor any of the States have promulgated legislation regulating this product, although there is a regulation concerning arsenic in other substances entering into foods. The government has set a limit for arsenic in coal tar dyes and in baking powder of one part in 700,000. This very low limit, particularly when it is considered that only relatively small amounts of these substances are used in food preparation, shows that considerable importance is attached to the presence of arsenic and its compounds.

Samples: In order that our results might be of greatest value by showing the condition of the alums as they are actually used, we obtained as many samples as possible directly from the various purification plants in the state. Twenty-six plants use alum in treating the water. The purpose of our investiga-

1. Jour. f. Gasbel: 1913 (Sept.)

tion was explained to the managers of each plant. They were asked to co-operate with us by furnishing a sample of the alum used, together with the name of the manufacturer or dealer supplying the same. Twenty-one of the plants very promptly complied with our request, and in nearly every case, expressed decided interest in the subject with a wish to know the results of our investigation. The specimens of alum were carefully sampled, ground and analyzed in duplicate by the following methods:

Methods of Analysis: The method used in obtaining most of the data given is a modified Gutzeit Method, developed by Claude R. Smith¹ in his work on coal tar dyes and other food constituents. The results obtained by this method were in several cases checked by the Marsh-Bezelius Method² and were found to agree. The Gutzeit Method has been investigated by others for quantitative work, and, when proper care is taken in the manipulation, has been found to give satisfactory results. The chief modification proposed by Smith is the use of paper sensitized with mercuric bromide in the place of mercuric chloride, which had previously been generally used. The bromide gives more permanent stains and the standards can be kept longer. The method depends upon the formation of a dark orange stain when the generated arsine is brought in contact with the sensitized paper. Under uniform conditions, the length of the stain varies with the amount of arsenic present. A series of standard stains prepared from known amounts of arsenic are used for comparison. A convenient series is made from 2, 5, 7.5, 10, and 15 micro milligrams. The amount of arsenic in the weight of alum taken is determined by matching the stain it produces with the standards; it is then a matter of simple calculation to determine the percentage arsenic content or the parts per million of arsenic. A one gram sample will contain as many parts per million of arsenic as there are micro milligrams of stain obtained. For example, if one gram of alum produces a stain which matches the 5 micro milligram standard stain, then that alum contains 5 parts per million. One part per million is equivalent to .0001 of one per cent. A stain representing between five and twenty-five milligrams gives the most satisfactory results. A stain between these limits can be obtained by varying the weight of alum used.

Experiments: Preliminary qualitative tests were run on several samples of alum that were in the laboratory. All were

1. U. S. Dept. Agr. Bur. of Chem., Circular No. 102.
2. U. S. Dept. Agr., Bur. of Chem., Circular No. 99.

found to contain arsenic, but apparently in rather small amounts.

The results from the samples obtained from the purification plants are given in a table. In all cases the arsenic is recorded as arsenic trioxide, As_2O_3 . Five gram samples of the alum were used, as this amount gave stains best suited for comparison with the standards. Quincy and the Rock Island Arsenal each submitted samples from two different manufacturers, therefore twenty-three samples from twenty-one places were examined.

TABLE I.
ARSENIC AS As_2O_3 IN FILTER ALUMS USED IN ILLINOIS

City	Arsenic as As_2O_3		Gallons*
	Pts. per mil	Percent	
Cairo	1.6	.00016	3213
Carlinville	1.8	.00018	2856
Charleston	1.2	.00012	4283
Chicago and Rogers Park.....	1.4	.00014	3671
E. St. Louis and Granite City....	.8	.00008	6425
Decatur	1.4	.00014	3671
Elgin	1.6	.00016	3213
Ft. Sheridan	1.2	.00012	4283
Hamilton	1.4	.00014	3671
Kankakee8	.00008	6425
Kenilworth	1.4	.00014	3671
Lawrenceville	3.0	.00030	1713
Macomb	1.6	.00016	3213
Moline	1.0	.00010	5140
Mt. Carmel	2.0	.00020	2570
Mt. Vernon	1.2	.00012	4283
Pana	1.2	.00012	4283
Quincy	1.0	.00010	5140
Quincy	4.0	.00040	1285
Rock Island	2.0	.00020	2570
Rock Island Arsenal	1.6	.00016	3213
Rock Island Arsenal	1.0	.00010	5140
Streator	3.4	.00034	1512

*Gallons of water containing a minimum medicinal dose of 2 mg. when the water is treated with 6 grains of alum per gallon, provided that all the arsenic remains in solution.

The results obtained by analyzing alum used in Illinois clearly show that arsenic in exceedingly small amounts is always present in filter alums. We find a minimum of 0.8 parts per million (.00008 per cent) and a maximum of 4.0 parts per million (.0004 per cent) of arsenic as As_2O_3 in the alum used by Illinois water purification plants. If a water were treated with alum containing the maximum amount of arsenic found at a rate of 6 grains of alum per gallon, an amount which is very seldom exceeded, and if all the arsenic were soluble and remained in the filtered water, since arsenic is not an accumulative poison, a person must drink 1285 gallons of the treated

water at one time to obtain a medicinal dose of 2 milligrams. From this it is readily seen that the arsenic content of filter alums used in Illinois is of no significance.

All alums used in this State are supplied by western manufacturers. Several samples have been obtained from the East. In some of these the arsenic content is much higher than that of the Illinois alums. This matter is being investigated further and will be reported later.
