# DISCUSSIONS

## THE REMOVAL OF CLAY AND SILICA FROM WATER

The paper in the May JOURNAL by Otto M. Smith, on "The Removal of Clay and Silica from Water," is an interesting and instructive contribution. The behavior of colloidal matter in natural waters, when its removal is attempted with the usual coagulants at our disposal, is of prime interest to every operator of a water purification plant.

The practical application of the principles of colloidal and physical chemistry to these problems is much needed and has been urged by the writer for many years. The author brings out clearly by his illustrations and his charts the influence of protective colloids and electrolytes on coagulation of clay suspensions. This phase of the subject is an extremely important one, and needs more elucidation in actual practice.

The writer only wishes that the author had found some method of measuring the degree of what might be called "effective coagulation;" that is, for example, the least quantity of sulphate of aluminum and the time necessary for this amount of coagulant to act that would have enabled the water to be filtered. This is of practical importance in the operation of filter plants. Unfortunately, no numerical expression of the degree of coagulation has, as yet, to the writer's knowledge, been proposed. There may be a considerable difference of opinion, especially on the border line, as to whether a water is well or poorly coagulated, and some measure of this aggregation of colloidal particles is much needed.

The writer hopes that more papers along this same line may be presented in the future.

J. W. ELLMS.[1]

Last year and this year with a beginning of a flood coagulation at the Grand Rapids filtration plant has been extremely simple;

[1] Consulting Engineer, Cleveland, Ohio.

the turbidity is heavy and as the flood is heavy the alkalinity drops to 90 p.m. The entire turbidity changes as the alkalinity changes. The application of the alum has been reversed. Formerly the alum was added after the lime addition, but now alum is added first so that it works all the way along the mixing chamber. Then the lime is added and this procedure cleared the whole situation.

WALTER A. SPERRY.[2]

The paper on the removal of clay and silica from water brings out very clearly the difference between the presence of colloids and suspended matter in water, and indicates that the treatment of water for the removal of colloids should be along different lines from those ordinarily followed. The chemist at any water plant is familiar with the difficulties which arise at the time these colloidal matters are present. The method suggested, it would seem, might readily be adapted to those periods when the turbidity of the water is not lessened by the settling basin and the method should be tried out on plants where this condition exists.

H. F. SALMONDE.[3]

The author's illuminating paper defines clearly the fundamental principles of the physics of colloids, as well as gives some results of experiments with coagulation, which go far in explaining the difficulties in chemically treating a coagulating water containing silicic acid and finely divided clay. The writer gathers from the article that the author advises as the best treatment for clayey waters containing colloidal silica, the addition of enough lime to slightly more than neutralize the carbonic acid, followed by the addition of iron or aluminum sulphate until coagulation is produced,—the lime increasing the concentration of OH ions and decreasing that of H ions, thereby preventing dispersion of the silica.

While this practice is proper and efficient for clayey waters, it is not the one which governs the coagulation of soft, slightly alkaline waters containing colloidal silica and color. The Metropolitan water of Boston, which has the composition given on the next page, is a good example of this kind of water:

[2] Chemist, Filtration Plant, Grand Rapids, Mich.
[3] Chemist, Filtration Plant, Springfield, Mass.

| *Substance* | *p.p.m.* |
|---|---|
| Color | 20.0 |
| Turbidity | 1.0 |
| Alkalinity | 11.5 |
| Hardness | 19.9 |
| Silica, $SiO_2$ | 2.1 |
| Aluminum and iron oxides | 0.6 |
| Calcium oxide | 9.1 |

For the coagulation of this water, between 0.19 and 0.28 milligram equivalents of sulphate of alumina are required, the former amount producing no appreciable coagulation even after 72 hours standing, and the latter acting in less than 24 hours.

Now, if lime be added to the untreated water until it reacts red to phenolphthalein, the coagulation is retarded, while if half equivalent amounts of sodium carbonate be added, coagulation is accelerated, and 0.19 milligram equivalents of sulphate of alumina suffice to coagulate the water after 72 hours. If equivalent instead of half equivalent amounts of soda be added, the colloidal precipitate is apparently dispersed.

The sample to which 0.28 milligram equivalents of sulphate of alumina were added was analyzed before treatment, and after treatment and filtration, respectively, with the following results:

*Results of partial mineral analysis of Metropolitan water before and after treatment with sulphate of alumina*

| SUBSTANCE | PARTS PER MILLION | |
|---|---|---|
| | Untreated water | Treated water |
| Silica | 2.1 | 1.8 |
| Aluminum and iron oxides | 0.6 | 0.5 |
| Calcium oxide | 9.1 | 9.0 |
| Alkalinity, by erythrosine | 11.5 | 8.1 |
| Color | 20.0 | 3.0 |
| Turbidity | 1.0 | 0.0 |

It will be noted that the amount of silica is appreciably reduced by coagulation, and if soda be added, this amount is still further reduced.

In repeated cases in practice, where brown, slightly alkaline waters have to be purified, and the addition of an alkali is necessary, the writer has found that apart from its convenience, sodium car-

bonate is a more efficient reagent than calcium hydrate. On the other hand, if the sodium carbonate be added in equivalent quantities, coagulation is frequently prevented, or, in other words, the "floc" reverts to the colloidal state. Frequently these waters can be overtreated with sulphate of alumina, and coagulation produced. Then, if too much soda be added, the reversion of coagulation takes place before filtration.

The writer believes that the author could have thrown a great deal of light upon the problem, had he determined the hydrogen ion concentration of the various solutions experimented with. It should be borne in mind in considering this question that recent research work has shown that a water may be alkaline to the usual indicators and still contain free carbon dioxide; therefore, the importance of determining the reaction of the water by measuring the H ion concentration electrolytically rather than by titration with the different indicators.

A condition analogous to that of coagulation is the prevention of the corrosive action of lead by the addition of lime to produce a coagulation of the lead carbonate on the surface of the lead service pipe, thereby preventing corrosion of the metal. In a recent paper, Liverseege and Knapp[4] have shown that the best conditions for the protection of service pipes are those which the author suggests to be best for the treatment of clayey waters, namely the addition of enough calcium carbonate or hydrate to remove the free $CO_2$ and produce the maximum amount of bi-carbonates. The writer wishes to praise Mr. Smith's important contribution to our knowledge of water purification, and his very interesting and useful diagrams which accompany the paper. The application of physical chemistry to the problems of water purification has only begun, and it is the writer's belief that to this branch of chemistry we must look for important advances in the future.

ROBERT SPURR WESTON.[5]

Before commenting on the preceding discussions of his paper, the author desires to express his gratitude to Professor W. F. Monfort and Dr. Edward Bartow, under whose direction this investigation was made, for their interest and many helpful suggestions during the progress of this work.

[4] *Jour. Soc. Chem. Ind.*, **39**, 32T.

[5] Consulting Engineer, Boston, Mass.

The author heartily agrees with Mr. Ellms that a numerical method of expressing the "degree of what might be called effective coagulation" is much needed for both practical and scientific purposes. He attempted to establish some similar unit for use in this paper, but failed because of irregularity in the number, size, form, gravity and absorptive power of the coagulated and uncoagulated suspended particles and the difficulty of evaluating these different factors.

In connection with Mr. Sperry's note, it is worth noting that in coagulating water from the Red River at Shreveport, La., it was found economical to apply the alum first and follow with lime. In treating flood water on the Arkansas River it was found that as the turbidity decreased after the crest of the flood had passed the coefficient of fineness of the suspended material decreased and the alum consumption increased. This "colloidal water" showed a characteristic milky white appearance.

In regard to Mr. Weston's comments, it may be said that the action of lime is twofold, that of supplying a sufficient concentration of OH ions and at the same time furnishing bivalent cations which have greater coagulating effect on silicic acid and colloidal clay than the monovalent. The Metropolitan water of Boston has considerable amount of color which is probably colloidal and which reacts with the lime. It is conceivable that this combination of color, lime, and color and lime may disperse or protect the small amount of silicic acid and clay. The action of alum and $Na_2CO_3$ is shown in the following table:

*Effect of* $Na_2CO_3$ *on the coagulation of a clay suspension by* $Al_2(SO_4)_3$*

| MILLIEQUIVALENT OF ALUMINUM | MILLIEQUIVALENTS OF $Na_2CO_3$ ADDED | |
|---|---|---|
| | 0.5 | 1.0 |
| 0.00 | 400 | 400 |
| 0.30 | 125 | 400 |
| 0.45 | 125 | 125 |
| 0.60 | 175 | 65 |
| 0.75 | 400 | 125 |
| 0.90 | 400 | 100 |

* Results expressed as turbidities at the end of 1½ hours.

A similar effect is shown in figure 6 in the paper,[6] in which

0.09 milliequiv. Al. coagulates with 0.00 added NaOH
0.12 milliequiv. Al. coagulates with 0.09 milliequiv. added NaOH
0.18 milliequiv. Al. coagulates with 0.18 milliequiv. added NaOH
0.55 milliequiv. Al. coagulates with 0.36 milliequiv. added NaOH

In both examples it is clear that as the carbonate or hydroxide is increased the amount of alum required is likewise increased and that increasing the alum or the carbonate or hydroxide does not always insure coagulation. A suspension containing 0.09 to 0.18 milliequivalents of NaOH is coagulated by 0.12 to 0.18 milliequivalents of aluminum but not coagulated (dispersed) when about 0.55 milliequivalents is used. There must be a proper proportioning of the reagents in order to obtain coagulation.

Some H ion concentrations were made by the colorimetric method, but the results showed so little difference between coagulation and dispersion that no further work was done. The author agrees that by using the electrolytic method some valuable information may be obtained.

OTTO M. SMITH.[7]

## MEETING THE SHORTAGE OF UNSKILLED LABOR

The writer has just returned from an extensive trip covering the entire West, where he found from the time he left Chicago until he reached the Pacific Coast, thence from the Mexican to the Canadian borders, that the main topic of conversation, whether it was banker, farmer, merchant or engineer with whom he conversed, was the shortage of unskilled labor. This because the same was not only affecting the production of their farms and their industries but because it was also seriously handicapping many large engineering projects whose furtherance was being stunted on account of the lack of economical labor as represented by "The pick and shovel and wheelbarrow man."

The writer also found that some of the thinking people of the West were endeavoring to solve the question and have started active work in sounding sentiment as regards the modifying of the

[6] JOURNAL, May, 1920, p. 309.

[7] Chemist, Proctor & Gamble Company, Ivorydale, Ohio.

Exclusion Act, so as to permit the importation of a limited number of Chinese laborers to do the menial and rough work which our white labor will no longer do. Such labor to be admitted under the direct supervision of a commission representative of our different governmental departments, the farming, labor and business interests of the country. This commission would supervise their employment so that they would not compete with our American labor nor reduce their standard of living. The importance of the question involved and of the movement impressed the writer so much that he concluded, on his return to Chicago, that he would endeavor to learn how the members of our profession feel about this all-important question.

As an engineer, the writer is certain that engineers realize that it is up to them to assist in solving this vital problem of securing a source of supply of common labor, which would be both economical and efficient, if they wish to see the many engineering projects, in which they are directly or indirectly interested, completed. Unless they do interest themselves more than passively many of the large projects under consideration will be held in abeyance, because there is no question but that one of the greatest items of cost of construction today is labor.

As city engineer of Chicago for 22 years, the writer's experiences have been many as to how the increased labor costs have affected construction. Realizing what the securing of economical labor means to the future of the engineering profession, because of the effect the present abnormal labor conditions is having on capital seeking new development projects, the writer concluded that it is timely to make a survey and is desirous of securing opinions relative to the importation of Chinese labor under the above-mentioned conditions.

The eyes of the world are upon America. Europe has been drained of its manhood. Continental industry has been crippled beyond hope of immediate reparation and the foodless populations of devastated countries now look to us for salvation. Shall we sit idly by and permit antiquated and perverted notions of "economic necessity" to stultify our efforts? Or shall we assert the cause of righteousness and, recognizing the needs of the hour, pronounce to the world that America is prepared to continue the pace in the race for progress already set by tireless workers of reconstruction?

As the law of supply and demand governs at all times and with the demand here and not sufficient supply available, the writer believes it is up to engineers to do something.

JOHN ERICSON.[8]

## THE SECTIONS[9]

Our Association must depend for future growth upon the development of its Sections. There must be strength in our Sections in order that the Association as a whole may develop. I do not believe that we can, with one meeting a year, develop as a truly national organization. There cannot be enough vitality, enough mutual interest and mutual understanding, when the only personal contact among our members is a single annual meeting attended by a small percentage of our membership.

Coöperation is the basis of active Association work, and coöperation exclusively by correspondence is likely to lack force and unity of purpose. Men must get together personally, learn to know each other and to talk to each other, before they can work together to the best advantage of each and all. The Sections give this opportunity for mutual acquaintance and the interchange of useful information. Every month, at least, each of us has some problem we will be glad to talk over with some one having experience which will help us. Attendance at Section meetings will give us the wide circle of acquaintance which enables us to go to the right man for advice on our problem. Without such acquaintance we must work out our salvation without the benefit of the experience of those who have already worked it out, which is a most wasteful procedure.

We are meeting today under unexpected difficulties due to an outlaw strike of railway men. They, like many others, seem like the Mock Turtle, who told Alice when she was in Wonderland that

[8] Consulting Engineer, Chicago. As this communication goes to the printer, Mr. Ericson reports 608 engineers have written to him favoring importation of Chinese labor, 74 are somewhat inclined toward that opinion, 86 favor other immigration, 10 advocate use of labor-saving machinery, 95 are neutral, 101 are against any more immigration and 28 have asked for further information. The general results have been so favorable that a National Immigration Council has been formed, with Mr. Ericson as chairman.—Editor.

[9] Informal discussion at a meeting of the 4-States Section, Philadelphia, April 16, 1920.

he was studying mathematics—ambition, distraction, uglification and derision. This seems to be the study of many men throughout our far-reaching country, and it is something that we, managers of the most vital of urban utilities, must combat. It is up to us to set an example of efficient and loyal service to the public which depends upon us. We can do this best if we have behind us a strong and forceful national association. The lack of such an organization was evidenced during the World War, when the water works alone among the public utilities was without an official representative at Washington to look after their interests. That experience showed how far the American Water Works Association must go before it can be completely representative of the water supply business. The Association can become completely representative, but not until the water works of each geographical section are more closely united than they are today, a union best accomplished by building up strong Sections.

CARLETON E. DAVIS.[10]

What our President has said about Sections is exactly right. There is a feeling that men interested in any industry, particularly a quasi-public industry, can get together in some way in a national organization that will give them a lot of importance at home. This is an idle dream. Reputations that carry influence at home are not made in that way. They are made right at home, where everybody has a chance and a right to criticize and to praise.

Take our business of supplying water. It is the most important public utility business in a city. It is one of the biggest enterprises, public or private, in a city. It calls for technical knowledge, business ability and a lot of tact. It is a business to be proud of; a well-run water department is something every citizen should be ready to praise when he talks about his city. Usually the citizen has no knowledge of the water department except that it furnishes something he needs daily at a price he usually considers too high. He may see occasionally an annual report full of such exciting information as pounds of coal burned in the pumping station, gallons of water pumped one foot high, valves set and pipe laid. No attempt is made to show him what a big business is conducted by the water

[10] Chief, Bureau of Water Supply, Philadelphia; President, American Water Works Association.

department in which he is a stockholder. What little he sees in print about the work is as interesting as the unlettered side of a flour sack. It is not his fault that he lacks interest in the water works, for there has been no proper attempt to make him acquainted with this big business. The water supply business is shoved into the background because there is nobody to put it into the prominent place it deserves and then keep it there. When the appeal of the water department for needed extensions is turned down, we go home and work off our disappointment by kicking the dog or otherwise misbehaving privately, but do we ever go out among our acquaintances and tell them how necessary these extensions are and why they ought to be made now, and work up a public demand for them which must be satisfied? Better, do we create this public demand before we ask for the extensions officially? Very, very rarely, and therein is the reason that water departments are underestimated by the public. Everything must be sold these days; the person who thinks the public is hunting for meritorious objects upon which to spend public funds, searching for them with the patience of an astronomer seeking new stars, is deceiving himself. It is necessary to use publicity to reach the public in these days.

What all this has to do with Sections may seem remote, but there is a connection worth your consideration. It has seemed to me that the engineering center of the United States, if the influence of engineers on public affairs is considered, is neither New York nor Chicago, despite the loud claims of each for this honor. Nashville, Tenn., is the center of engineering influence in this country, for the little group of engineers in its vicinity exercises a truly powerful influence on all engineering aspects of public affairs. It is not merely a local city matter. A governor of the state once found this influence greater than his own when he thought he should place political pull above engineering ability in filling a technical place. The local politicians dislike to go to this little association for advice in filling places requiring technical knowledge, but they always do so, having learned that it is better to get the credit of a good appointment than to be licked in trying to force a bad one. No public engineering question is settled down there until the local engineering association has talked it over. Nobody there thinks of passing an opinion on engineering matters until engineers have been consulted, Nashville being about the only place in the country of which this can be said.

Here, then, we have a busy, prosperous community where the technical men have standing and influence just because they are specialists and not because they belong to some national organization. It has all come about through intelligent team work at home, through the recognition of the fact that the average citizen wishes to have the public works well run and likes to know about them if somebody will only tell the story to him in plain English, without technical jargon, ponderous tables or mathematical fireworks, all right enough for an engineering fiesta but out of place elsewhere.

This little Nashville technical organization meets frequently, beginning its sessions with an informal, sociable lunch or dinner, at which every engineer visiting the city is welcome and to which each local newspaper is invited to send a reporter. It might be added that the reporters look upon assignments to these meetings as prizes and the newspapers see that their best available men are sent to them. At these gatherings, in addition to occasional formal papers, there are dicussions of all local engineering subjects, usually brought up as soon as they occur to somebody and kept alive at subsequent meetings as they develop in importance. When the time comes to talk to the public about one of these subjects, the reporters not only know about it but know where to go for further reliable information. The members know about the importance of the subject, even if it is one in which they are not personally concerned, and they make it their business to talk about it to all their acquaintances. This last thing is the big achievement of the Nashville technical men. They know how to convince their friends that technical advice should be followed on technical subjects, and they realize that their obligation to their professions as well as their duty as citizens requires them to talk to their acquaintances about these things and gain support for them.

It has long seemed to me that our own local Sections should follow some such plan. Our Iowa Section has already begun to take an active part in molding water works legislation in its state. Great progress in influence can be made by every Section by following the methods of the engineering association of Nashville. There is nothing undignified in insisting among acquaintances that water works affairs should be handled by men who understand them. There is nothing immodest in telling a citizen about the interesting features of the local water works just because one is connected with it. Chambers of Commerce and other influential local organiza-

tions should be educated to an appreciation of what a good water supply means and what is necessary to furnish it. Our Sections should not be little mutual-admiration affairs, wholly self-centered, but local institutions respected for their intelligent, active interest in all aspects of water supply in their districts. With such Sections exerting a real influence, just as the Nashville association exercises a real influence, the future of the American Water Works Association as an important national society is assured. It is a mere dream, a forlorn hope, to expect to accomplish much by building up the Association except on the foundation of strong local Sections. The country is too big, local interests are too diverse, the opportunities for personal acquaintance are too few, for a very large national water works association which does not rest in some way on local bodies. On the other hand, the local Sections can by no possibility accomplish alone so much as they can as parts of a national organization.

JOHN M. GOODELL.[11]

[11] Editor, American Water Works Association.