ADVANCED METHODS FOR POTABLE WATER REATMENT UNDER THE EGYPTIAN CIRCUMSTANCES Y USING CLAYS TO INCREASE THE EFFICIENCY OF SEDIMENTATION TANKS

A THESIS SUBMITTED
TO

DEPARTMENT OF PUBLIC WORKS
THE FACULTY OF ENGINEERING
AIN SHAMS UNIVERSITY

BY

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B. Sc. CIVIL ENGINEERING

UNDER THE SUPERVISION OF

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IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR

THE M. SC. DEGREE IN CIVIL ENGINEERING

(SANITARY ENGINEERING)

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ABSTRACT

This study investigates the feasibility of reducing the dosage requirement of coagulants for the removal of colloidal particles from waters containing small amount of suspended solids **(i.e. Nile water).**

To accomplish this purpose, two kinds of clay namely caolinite and bentonite are used as coagulant aids. Metallic salts such as aluminum sulfate, ferric chloride and ferrous sulfate are used as coagulants.

Procedures are as follows:

- Using coagulants with and without coagulant aids.
- Determination of the optimum dose of each coagulant when used alone and when used with various amounts of each kind of clay.
- Calculating the percent of coagulant saved in each case.
- Using the returned sludge with the two cases and detemrining the optimum dose for both coagulant and coagulant aid.

The results of laboratory experiments indicate that adding amounts of clay within certain limits, achieves a valuable saving of coagulants. Also, the use of returned sludge techniques achieves a high efficiency for turbidity removal and gives the ability for decreasing both of coagulant and coagulant aid dosages.

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CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

1.1 INTRODUCTION:

Production of potable water from a water supply contaminated by naturally or man-made pollutants needs a series of unit processes. One of the most important processes is that of coagulation and flocculation which will be discussed in this investigation.

In water treatment the object of coagulation process is to destabilize and to increase the particle size of the colloids. Coagulation is widely the most used process to remove the substances producing turbidity in water. These substances consist largely of clay minerals and microscopic organisms with widely varying sizes. Abroad distribution of clay particle sizes is much easier to coagulate than a suspension containing a single or narrow range of particle sizes.

With very high turbidities relatively smaller coagulant doses are required because of high collision propabilities. for the same reason the very low turbidities are frequently more difficult to coagulate. Particulary, as the numbers of particles increased, the rate of flocculation increased because of the increased density of flocs and hence increased sttling velocities.

In low turbidity waters, the small numbers of particles contribute to the low rate of floc formation and to the poor settling velocities of the floc.

After building the High Dam, the nature of Nile water had been changed. Quantities and sizes of suspended and colloidal particles had been minimized because of the lack of silt and clay. This change affected coagulation process directly as mentioned before.

This study investigates optimizing coagulation process for savings of water, energy, chemicals and time. The operation will be performed by adding different kinds of clay with different quantities to the water before coagulation. Then, coagulation is performed by adding different quantities of different kinds of coagulant. Results must be compared to choose the best.

1.2 LITERATURE REVIEW:

Many investigators tried different methods to achieve an optimizing coagulation process in order to save chemicals, water, energy and time. Most of these methods are dependent on controlling one or more of the factors governed the coagulation process. These factors are the pH-value, Zeta potential, temperature, mobility, molecular weight, flow rate, coagulant dose and chemical aids [1]. Most of the used methods for optimization of coagulation process are as follows:

1. pH-control technique.
2. Zeta potential controlling.
3. Electrophoretic mobility changes.
4. Tube settlers.
5. Chemical aids.

1.2.1 pH Control Technique:

La Mer et al. [2], [3], [4] proposed a bridging theory to explain the formation of settleable flocs. They proposed that polymers have chemical groups which can interact with certain portions on the surface of colloidal particles due to specific chemical reactions. When the polymer added to an aqueous suspension, it can thus attach itself to several sorption sites on the surface of a colloid. The remaining portion of the polymer extends out in the solution and can be sorbed by another colloids. Therefore, it forms bridges among the colloids to form large settleable flocs. This is termed **"Bridging Theory"** of destabilization.

To ensure that the final pH is in the optimum range, **Stumm** and **Morgan [5]** suggested a control method using an automatic titrator. The coagulation process is performed by adjusting the pH of the sample to a pre-selected level with acid or base. The coagulant is then slowly added to the sample. At the same time, an automatic titrator is employed to dose automatically the base solution to maintain the solution pH constant.

A number of alternatives for maintaining a constant solution pH have been practices by other investigators. **Black and William [6]** recommended that a pre-determined quantity of acid or base must be added with the coagulant to verify a desired constant solution pH in the coagulated sample. All alternatives were designed to maintain a constant solution pH at the optimum level when metallic coagulants are added. These methods are refered to as the **"Constant pH Method"** for coagulation.

With the constant pH method some of the polymers are sorbed by the adjacent solids before being homogenously distributed in the bulk of solution. This is because the time necessary for the formation of hydroxopolymers from the applied metalic coagulant is very short. Therefore, the coagulant qpplied, is not evenly sorbed by the suspended solids to be destabilized. Some solids may be overloaded with polymers while some others may sorb a quantity that is not adequate for destabilization. In both situations, extra amount of coagulant is needed to achieve effective agglomeration of the solids.

The **"two-step pH control method"** allows the solution pH to drop to lower values when the coagulant is applied. Thus, the applied coagulant exists in the solution as soluble species. They are effectively adsorbed homogenously by the suspended colloids and may partially destabilize the colloids **Chao [7].**

After the dropped solution pH is adjusted to the optimum level, the soluble species polymerize to form insoluble bridging material. The resulting insoluble bridging materials are uniformly sorbed anto the colloidal surface at more sites as shown in **Figure[1/1]** resulting in a lower dosage