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MATERIALS USED FOR COAGULATION AND FLOCCULATION IN WASTEWATER TREATMENT: A RAVIEW

[1*]A.Nath,
Associate Professor
Department of Chemistry,
B.R.D.P.G.College, Deoria, U.P,
India.

[2] K. Kashaudhan,
Research Scholar,
Department of Chemistry,
&Environmental, Science
MMMUT Gorakhpur, U.P.

[3]P.P.Pande
Professor
Department of Chemistry,
&Environmental, Science
MMMUT Gorakhpur, U.P.

Abstract: Water is one the most important natural resources, which are important for whole living being. The urbanization development increases the unavailability of the pure water for life. For the removal of above problem use the purified wastewater. There are various treatment process used for wastewater treatment. Out of which adsorption and coagulation/flocculation process have been used. In this process have some limitations. In this paper we have described the use of naturally occurring polymeric materials as adsorbent and coagulants which have been utilized to overcome the above limitations

Keywords: Adsorbent, Adsorbates, Polysaccharides, Coagulants.

1. INTRODUCTION:

THERE ARE VARIOUS PROCESSES HAVE BEEN USED INTO WASTEWATER TREATMENT VIZ. SCREENING, CHEMICAL PRE-TREATMENT, COAGULATION/ FLOCCULATION, FILTRATION AND ADSORPTION PROCESS. ONE OR MORE PROCESSES HAVE BEEN USED TOGETHER FOR WASTEWATER TREATMENT. ON THE BASIS OF WATER CHARACTER, A PARTICULAR UNIT PROCESS MAY BE SELECTED FOR THE TREATMENT OF WASTEWATER. THE TREATMENT PROCEDURE MAY BE CLASSIFIED INTO THREE METHODS VIZ. PRIMARY, SECONDARY AND TERTIARY METHODS.

- SCREENING, PRE-SEDIMENTATION, AND CHEMICAL ADDITION WHICH SHOW LOW SPECIFIES ARE USED IN PRIMARY TREATMENT PROCESS.

- THE SECONDARY PROCESS SUCH AS COAGULATION/ FLOCCULATION, FILTRATION AND DISINFECTION PROCESS WHICH HAVE GREATER MAGNITUDE AND MORE SPECIFIES THAN PRIMARY TREATMENT.

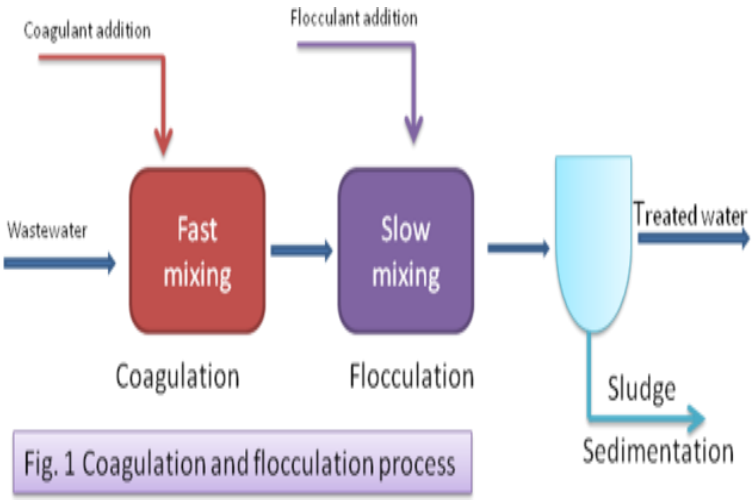

Fig. 1 Coagulation and flocculation process

• ADSORPTION, REVERSE OSMOSIS ETC ARE USED IN TERTIARY PROCESS WHICH HAS GREATER EFFICIENCY FOR TREATMENT OF SPECIFIC POLLUTANT PRESENT IN WATER [1]. ADSORPTION PROCESS REQUIRES A WIDE RANGE OF AREA IN WHICH CHEMICAL POLLUTANTS ARE ADSORBED ON THE LIQUID OR SOLID SURFACE. THIS PROCESS IS EFFECTIVE, RELIABLE WHICH ARE USED FOR THE ELIMINATION OF POLLUTANT PARTICLES FROM WASTEWATER. THE CHEMICAL REMOVAL PROCESS WHICH REMOVED AGGLOMERATE COLLOIDAL AND SUSPENDED POLLUTANT PARTICLES ARE KNOWN AS COAGULATION/FLOCCULATION (CF) PROCESS SHOWN IN FIG 1.

2. PRINCIPLE OF ADSORPTION AND COAGULATION/FLOCCULATION

2.1. Wastewater Treatment by Adsorption

This process is used when the pollutant particles are present in water initially as aqueous phase, these pollutants are removed by the accumulation on interface between aqueous and solid phase. The solid phase have better performance than liquid phase this phase depend on the presence of active and energy rich site on the solid phase [2].

The solid surface is of heterogeneous nature which has various energetically active sites. In the adsorption process the presence of variables are as concentration, temperature, pH and ionic concentration altered the adsorption process is reverse and the adsorbed pollutant particles give up their site and changed into the liquid phase this phenomenon in known as desorption. The solid phase at which adsorption takes place called adsorbent and the substance which adsorbed are called as adsorbates. There are some conventional adsorbent which are used on industrial scale and laboratory practices are given below.

- Activate Carbon: It is carbonaceous substances have large surface. The powder and granular two types of activated carbon are used in adsorption process which have more active free site for adsorption of pollutant particles.
- Silica gel: It tough, granular porous substances which obtained by precipitation sodium silicates in acidic medium.
- Activated alumina: It is produced from activation of aluminium oxide at high temperature and is used in primary process for adsorption of moisture.
- Aluminium silicates of sieves: It is porous synthetic zeolites of substance which are used in separation process.

On the basis of nature of adsorbent and adsorbates the adsorption process are categories in two main groups as

- Physical adsorption or physic-sorption: In this process the adsorbate are held with adsorbent via Vander Waals force of interaction.
- Chemisorptions: In this process the adsorbate are held with adsorbents by chemical bonds as covalent or ionic bond.

Sometimes these two phenomena are found simultaneously into the adsorption process.

During adsorption process at constant temperature equilibrium is generated between the aqueous phase of the solute and solid phase of adsorbent is known as adsorption isotherm. This isotherm plays an important role into the designing of system for adsorption-based wastewater treatment.

In the designing of system for treatment of wastewater used the kinetics of adsorption process which gives valuable information about the reaction pathway and adsorption mechanism. It also the dependence of concentration of solute present in the solution on adsorption rate and also give the information about the effect of rate of reaction on the basis of adsorbent nature[3].Therefore, on the basis of kinetics, the adsorption reaction predicts the easily removal of solute particles present in the water. There are two mode of kinetics are present in adsorption process are ascribed as:

- Rate of adsorption reaction depends on the capacity of adsorbent for a solid-liquid system.
- Rate of adsorption depends on the concentration of solution.

The adsorption kinetics equation which depends on the concentration of solution can be classified [4] as first order [5], second order [6], reversible with first order [7], reversible with second order[8], irreversible ones and pseudo- first order [9], and irreversible second orders [2].

The equation of kinetics which order of reactions depend on the adsorbent capacity are shown [4] Langergren's first order equation [10], Zeldowisch model [11], and Ho's second order expresion [12-15].

2.2. Treatment of Water by Coagulation/flocculation

This process is known as chemical removal process in which chemicals are used as coagulants and flocculants. This process involves the destabilization and agglomerate the pollutant particles dissolved in water. In coagulation process the chemicals such as Alum, Sodium aluminate, Ferric chloride; Ferric sulphate and some organic polymer are used as coagulants in aqueous phase for treatment of wastewater [16]. Inorganic and organic materials which caused impact on taste and order, phosphate and biological pollutant species are removed by the process. The metal based coagulants such as alum, Iron(II), Iron(III)salts, slake lime, or a mixture of chemicals are used before the invention of synthetic organic coagulant in wastewater treatments. These coagulants concentrations are depends on the coagulation mechanism such as at low concentration involved charged neutralization mechanism and while used as sufficient concentration of coagulants required Sweep coagulation mechanism for elimination pollutants particles in wastewater treatment process.

The polymer based coagulants are other types of coagulants which have different mechanism as metal based coagulants. Coagulation/flocculation mechanism of polymer based coagulant is involved destabilization of pollutants particles by bridging and form flocs for removal of pollutants particles present in water. The production of flocs by this method is more stable than the destabilization of particles by simple salts [16-17]. The aggregates produce via polymeric flocculants have more stable which not easily break [18]. This process is very use full that increase settling rate of flocs, economy improved, increases water quality, and sludge produces [16-18].

3. MATERIALS USED IN ADSORPTION AND COAGULATION / FLOCCULATION

3.1. **Adsorption Process**

This process is known as surface phenomenon, in this process there must be choice a materials as absorbent in which surface chemistry are used. It shows the more important facts that determine the interaction means between the adsorbent and adsorbates present in water as pollutants. There are a wide range of chemicals are present which have a variety of surface structure are used as adsorbents and useful for industrial scale and laboratory practices [19]. There are two types of adsorbents are present which are based on their source and compositions are as i. natural and synthetic adsorbent ii.) Inorganic and organic based coagulants. For removal of organic and inorganic pollutant dissolved in water activated carbon are used conventionally. Some other materials such as minerals of clay, carbonaceous polymeric adsorbent, natural and synthetic zeolites, natural polymer and oxides of metals are also used as conventional adsorbents in wastewater treatment.

Polysaccharides their substituted based natural adsorbents are investigated by researcher are also used conventionally as adsorbent. The synthetic polymeric materials have more potential for removal of pollutant dissolved in water and form stable flocs which are easily removed by filtration process [20].

3.2. **Coagulation/Flocculation Process Units**

- In the wastewater treatment primary coagulants such as metal salts and synthetic organic polymers are used in coagulation/flocculation process. All types of coagulants are used in CF process shows following mechanism:
- Compression of electrical double layer.
- Adsorption and bridging of pollutant particles.
- Charge neutralization of ionic pollutant present in wastewater.
- Sweep coagulation of pollutant by used of excess coagulants.
- The mechanism of coagulation depends on the structural feature of coagulants such as inorganic coagulants are shows compression of electrical double layer, charge neutralization and sweep coagulation mechanism, in other hand polymeric coagulants shows the charge neutralization, adsorption and bridging mechanism.

•The functional properties of the coagulants show any one of the mechanism only are-

- Charge density is high: It involves charge neutralization and compression of electrical double layer.
- Macromolecular structural feature: It involved adsorption and bridging mechanism.
- Conversion of insoluble substance: It involved sweep coagulation.

Commercially organic polymers are used about four decade [21]. These polymers are linear soluble in water and have high molecular weight [16]. Their hydroxyl groups are converts into the ionic form easily by hydrolysis and form polyelectrolytes.

4. POLYSACCHARIDE BASED MATERIALS

It is polymeric forms of carbohydrates with long chain of monosaccharide liked together with glycoside bonds which can be easily converted into the monosaccharide or oligosaccharides on hydrolysis. The structure of polysaccharides is linear with multi branches [22, 23]. The starch and glycogen are the examples of storage polysaccharides and chitin and cellulose is the structural polysaccharides.

The polysaccharides show some unique properties as:

- Naturally abundant polymers.
- Low-cost materials
- Renewable resources.
- Stable and hydrophilic polymers
- Can be modified easily for specific application.

This polymer has also some valuable properties such as non- toxic, biocompatible, biodegradable, presence of poly- functional group, chemically high reactive, chiral, chelation and adsorption.

5. USED OF POLYSACCHARIDES IN WASTEWATER TREATMENTS[22,23]

There are following mechanism are involved for treatment of water as

5.1. Adsorption based wastewater treatment

The polysaccharides based adsorbents have as variety of properties for used as conventional adsorbent in wastewater treatment which easily follow the phenomenon of surface chemistry and structural skeleton. The polysaccharides base adsorbents have an enormous surface are with functional

polar groups such as aldehyde, ketone, acidic and phenolic [24, 25] groups which enhance chemical interaction between adsorbent and adsorbates in liquid phase. The polysaccharides based substances are used as adsorbents [26] have following properties as

- Hydroxy groups present in glucose shows the hydrophilic nature of polysaccharides surface,which enhance the interaction between the surface of polymer and pollutant particles present into water.
- The presence of acetamido, primary amino hydroxyl group on the surface shows grater possibilities of interaction between polysaccharides adsorbents and pollutants adsorbates.
- The presence of chemically active functional groups on the surface of polysaccharides are easily coveted into other required derivatives and converted into suitable adsorbent on the basis of adsorbates.
- The polysaccharides have flexible structural chain which promotes the interaction between adsorbent and adsorbates.

5.2.Coagulation/Flocculation Process for Wastewater Treatment

There are following limitations present into the conventionally used minerals, salts, polymeric organic materials [27-29], as-

- High cost unaffordable in most developing and developed countries.
- Primary coagulants generate toxic by-products.
- Large sludge volume production.
- Influence under the pH of treated water.
- Sludge show toxic nature which difficult to discharge.

For overcome of above shortcoming of the conventional adsorbents in the wastewater treatment a new adsorbent is investigated by researcher known as polysaccharide based adsorbent [30-32] which show low-cast, eco-friendly are used as adsorbent in place of conventional adsorbents, the various advantages are present this coagulants [33-35] and effective for dye removal [36], as easily biodegradable, non- toxic, non corrosive nature, low sludge volume are produced and no change the pH of treated water. These adsorbents are easily available and caste effective than conventional coagulants [37].

6. DISPOSAL OF SLUDGE

The disposal of sludge produced by coagulation process is an important step in wastewater treatment. It involved dewatering process because about 90% water present in sludge. The dewatering of the sludge based on the characteristics of coagulants and flocculants are used in wastewater treatment shown in fig.2and 3[38].

Fig. 2. Sludge dewatering of conditioning methods

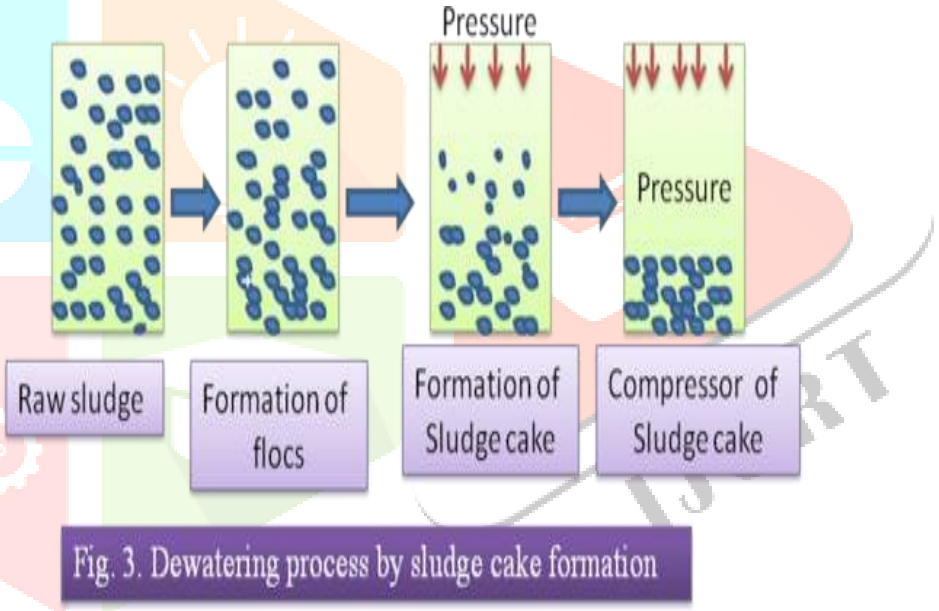

Fig. 3. Dewatering process by sludge cake formation

7. CONCLUSIONS

Wastewater treatment process follows an adsorption based mechanism. The choice of the adsorbent materials is based on the surface chemistry of adsorbent. On other hand in coagulation/ flocculation process the selection of adsorbent material depends on the basic properties of the substances to involve in coagulation/ flocculation. The properties of substances viz. higher density, macromolecular structural skeleton and ability to form insoluble species are frequently used for selecting the suitable adsorbent in wastewater treatment. The naturally occurring polymeric materials polysaccharides are used as adsorbent in place of conventionally used inorganic salts and organic polymeric materials. Polysaccharides are easily involved into both adsorption and coagulation/flocculation process. The unique feature and properties in polysaccharides viz plentiful abundance, cost effective, renewable resources stable and hydrophilic nature and easily modifiable structure make polysaccharides a material of choice for wastewater treatment process.

REFERENCES

[1] Nurudeen A. Oladoja, Emmanuel I. Unuabonah, Omotayo S. Amuda, Olatunji M. Kolawole 2017. Polysaccharides as a Green and Sustainable Resources for water and wastewater treatment. *Biobased Polym.*

[2] C.A. Zaror, 1997. Enhanced oxidation of toxic efflurnts using simultaneous ozonation and activated carbon treatmenm. J. Chem. Biotechnol. 70: 21-28.
[3] N.A. Oladoja, 2015. A critical review of the applicability of A vermin fractional kinetic equation in adsorption-based water treatment studies. Desalin Water Treat., 1-13,
[4] Y-S. Ho, 2006. Review of second order models for adsorption systems".J.Hazar. Mater.. B136, 681-689.
[5] J.E. Saiers, G.M. Hornberger, L. Liang, 2006. Frist- and Second order kinetics approaches for modeling the transport of colloidal particles in porous media. Water Resour. Res. 30: 2499-2506.
[6] M.A. McCoy, A.I. Liapis, 1991. Evaluation of kinetic-models for biospecific adsorption and its implication for finite bath and column performance. J. Chromatogr. A548, 25-60.
[7] S.V. Mohan, N.C. Rao, J. Karthikeyan, 2002. Adsorptive removal of direct azo dye from aqueous phase on to coal based sorbents: a kinetic and mechanistic study. J. Hazard. Mater. 90: 189- 204.
[8] K.Chu, M. Hasim, 2003. Modeling batch equilibrium and kinetics of copper removal by crab shell". Sep. Sci. Technol. 38, 3927- 3950.
[9] D.J. O'Shannessy, D.J. Winzore, 1996. Interpretation of derivatives from pseudo-first-order kinetic-behaviour in the characterization of ligand binding by biosensor technology. Anal. Biochem., 236, 275-283.
[10] S. Lagergren, "Zur theorie der sogenannten adsorption geloster stoffe K. Sevn. Vetenskapsakad". Handlinger, 1898. 24,1-39.
[11] J.Zeldowitsch, 1934. "Uber den mechanismus der katalytischen oxylation von CO and MnO2." Acta Physicochim. URSS. 1, 364-449.
[12] Y.S. Ho, 1995. Adsorption of heavy metals from waste streams, Ph.D. Thesis, University of Birmingham", Brimingham, U.K.
[13] Y.S. Ho, G. McKay, 1998. Sorption of dye from aqueous solution by peat. Chem. Eng. J. 70: 115-124.
[14] Y.S. Ho, G. McKay, 1999. Pseudo-second order model for sorption Processes". Process Biochem. 34, 451-465.
[15] Y.S. Ho, G. McKay, 2000. The kinetics of sorption of divalent metal ions onto sphagnum moss peat. Water Res. 34, 735-742.
[16] R. Sanghi, B. Bhattacharya, V. Dixit, V. Singh, 2006. Ipomoea dasysperma seed gum: an effective natural coagulant for the decolorization of taxti;e dye solutios. J. Environ. Manage., 81: 36-41.
[17] B.A. Bolto, 1995. Soluble polymers in water purification". Prog. Polym. Sci., 20: 987-1041,
[18] M.A. Yukselen, J.Gregory, 2004. The reversibility of floc breakage. Int. J. Min. Proces. 73: 251-259.
[19] D.T. Ray, R. Hogg, 1987. Agglomerate breakage in polymer-floccculated Suspensions. Colloid Inter. Sci, 116, 256- 268,
[20] A. Dabrowski, 2001. Adsorption-from theory to practice. Adv. Colloid Inter. Sci., 93,135-224,
[21] E. Worch, "Adsorption Technology in Water treatment- Fundamental process" (Walter de Gruyter GmH & Co. KG, Berlin/Boston, Goettingen, 2012.
[22] A. Dkhissi, E.Hakmaouli, et.al.,2018. Treatment of vegetal oil refinery wastewater by coagulation-flocculation process using the cactus as a bio-flocculant, J. of Mater. and Environ. Sci., 9(1): 18- 25.
[23] Amar Nath and Poorn Prakash, Pande, 2018. Polysaccharides: A Natural polymers for wastewater treatment. Progre. Res.- An Int. J., 13(Spec.): 600-603.
[24] S. Kawamura, 1991. Effectiveness of natural polyelectrolytes in water Treatment, J.AWWA, 88-91,
[25] Y.S. Ho, W.T. Chiu, C.T. Huang, 2004. Sorption of lead ions from aqueous solution using tree ferns as sorbent", Hydrometallurgy, 73: 55-61.
[26] M. Horsfall Jr. A.A. Abia, A.I. Spiff, 2005. Kinetics studies on the sorption Cd2+, Cu2+ and Zn2+ ion from aqueous solution by cassava (Manihot esculenta Cranz) tuber bark waste, Bioresour. Technol., 96(7), 782-789.
[27] G. Crini, 2005. Recent developments in polysaccharides based materials used as adsorbent in wastewater treatment", Prog. Polym. Sci., 20: 38-70,
[28] C. James, C.R.O'Melia, 1982. Considering sludge production in the selection of coagulants, J. Am. Water Works Assoc. 74, 158- 252.
[29] A. Ndabigengesere, K.S. Narasiah, B.G. Talbot, 1995. Active agents and mechanism of coagulation of turbid water using Moringa oleifera", Water Res., 29(2): 703-710.
[30] A. Ndabigengesere, K.S. Narasiah, 1998. Quality of water treated by coagulation using Moringa oleifera seeds. Water Res., 32: 781-791.
[31] J. Haaroff, J.L. Cleasby, 1988. Comparing aluminium and iron coagulants for in-line filtration of cold waters", J.Am. Water Works Assoc. 80: 168-175.

[32] WHO, "Combating Waterborn Disease at the Household Level" (WHO Press, Geneva, Switzerland, 2007.
[33] Ruen, C. 2004.Acrylamide and cancer risk-expert risk assessments and the public debate", J. Food Chem. Toxico., 42: 335-349.
[34] Sciban, M. Klasnja, M. Antov, Skrbic, M. B. 2009. "Removal of water turbidity by natural coagulants obtained from chestnut and acorn", Bioresour. Technol., 100, 6639-6643.
[35] Sethupathy, 2015. "An experimental investigation of alum and Moringa olrifera seed in water treatment", Int. J. of Adv. Res., 3: 515-518.
[36] A.K. Verma, R.R.,Dash and P.Bhunia, 2012. A review on chemical coagulation technologies for removal of colour from textile wastewaters. J. of Environ.l Manag., 93, 154-168,.
[37] O.N. Abiola, et. al., 2018. Polymer for coagulation and flocculation in water treatment. Polymeric Material for Clean" Water., 77-92,.
[38] H.Wei, B. Gao, J.Ren, A. Li, H. Yang, 2018. Coagulation/flocculation in dewatering of sludge: A review" Water Res., 143; 608- 631.