

## Production of clay polymers for fertilizer coating

Shafaq Nisar<sup>1</sup>, Muhammad Raffi Shehzad<sup>1\*</sup>, Madiha Rafiq<sup>2</sup>, Sadia Kousar<sup>1</sup> and Hafiz Abdul Qadeer<sup>1</sup>

<sup>1</sup>Department of Chemistry, University of Agriculture, Faisalabad-38040 Pakistant and <sup>2</sup>College of Science, Shantou University, Guangdong, China

### Abstract

The clay polymers are hydrophilic three-dimensional (3D) composites which are used for the coating of fertilizers for environmentally benefits to overcome the problem of waste of nutrients, dehydration, leaching and pollution. There are many methods for coating of fertilizers and one of them is coating of fertilizers with clay polymers. The clay polymers have an extraordinary property of adsorbing water and retain it for long time until water is released on plants demand. There are many types of clay which are used for clay polymer synthesis like montmorillonite, bentonite, double layered hydroxide, vermiculite, kaolinite etc. These silicates layered minerals give specific characters to clay polymers for fertilizers coating like enhance absorbance, mechanical properties etc. Methods used for production of clay minerals are in situ polymerization, melt intercalation, sol gel technology, polymerization from solution, template synthesis, with aid of supercritical CO<sub>2</sub>. Each process has its own benefits and limitation and there are certain factors which determined the production of clay polymers like temperature, pH, ionic concentration between the layers of silicates layers of clay. The techniques used for characterization are X ray diffraction, Cation exchange capacity, nuclear magnetic resonance, ellipsometry, atomic force microscope and transmission electron microscopy. These techniques are employed to investigate the properties and characteristics of prepared clay polymers.

**Key words:** Clay polymers, Fertilizer, Bentonite, Polymerization, Characterization

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### 1. Introduction

Polymer or clay nanocomposites are new class of the composites with polymer matrix. The dispersed phase in this type of composites is silicate which consists of particles having at least one of its dimensions is in the nanometer range. Main objective of applying the fertilizers is to deliver nutrients to the plants to increase crop yield. Therefore, it is important to the producer of fertilizer to improve the fertilizer use efficiency in terms of the nutrient uptake. However, any type of fertilizer, whether in the organic, inorganic or natural form effect the environment if misused. Over use of fertilizers causes environmental pollution [1-2]. Recently, environmentalists consider the usage of fertilizer as a source of environmental pollution such as water, soil and air pollution [3]. The main environmental pollutions due to fertilizer use have been linked to the nitrate leaching into the ground water, soil polluted with the heavy metals, surface runoff of nitrogen and phosphorus and emission of the greenhouse gases. To ensure that the appropriate use of fertilizer is advantageous to both the production of crop and environment. The researchers and the producers of fertilizer have tried to attain the fundamental flaw to apply nitrogen

fertilizer. We don't apply nitrogen as a newly defined goal of the fertilizer usage that may progress the nutrient use efficiency of the applied fertilizers and reduce the environmental pollution. Urea is extensively used as fertilizer due to its higher N content (approximately 46.6 %). Due to its higher water solubility, N from urea leached from the soil before the plants have an opportunity to use it. According to an estimate 75 % of N lost in those areas where high intermittent rain falls. These disadvantages result in increased cost but also contribute to pollute the local water. Though urea losses can be recovered by continuous application of smaller fertilizers, but the cost related with the repeated spreading are also high.

Maximum benefit is achieved form the coated fertilizer is only when the growers synchronizes the duration of nutrients release with the duration of plants uptake of nutrients. Knowing the design of release of nutrients from the coated fertilizers in wide ranging soil and the cropping condition is complex, because various environmental factors are present. For example, numerous coated fertilizers release more quickly with the increased temperature of soil and the moisture. Some products depend on the microbial activity of

the soil for the release of nutrients. An understanding of the pattern of the release of nutrients helps producers to get extreme value from the coated fertilizers [4]. Controlled release fertilizers are water soluble fertilizers that are enclosed within the coating of polymer and form a round prill. Small holes are present on the polymer coating in which the water passes into these prills and solubilize the fertilizer. Then this fertilizer slowly leaches from the prills. Hydrogel, also the product of controlled release fertilizers following the absorption of water and after swelling have the capacity of retaining the water. Urea released from the hydrogels of urea is determined by concentration gradient among the exterior and interior of hydrogels because it responds to the plants nutrient demand [5].

## 2. Types of clay used in production

The use of synthetic and the modified natural clays for designing the polymer nanocomposites is presented here. Natural clays such as hectorite, laponite, montmorillonite, saponite, rectorite, vermiculite, kaolinite, saponite, chlorine and vermiculate are the form of modified clays used for the preparation of composite. Synthetic clays used for the preparation of composite are hectorite, synthetic montmorillonite, double layered hydroxides, etc.

### 2.1. Montmorillonite clay

A soft layered silicate montmorillonite named after Montmorillin in the France. It comprises of plate like particles and an average diameter of about 1 $\mu$ m. Its chemical formula is  $(\text{Na,Ca})_{0.33}(\text{Al,Mg})_2(\text{Si}_4\text{O}_{10})(\text{OH})_2 \cdot n\text{H}_2\text{O}$ . The montmorillonite capacity of cation exchange is around 80-150 mequiv per 100 g. For the preparation of polymer nanocomposite different forms of the cloisites are used in the matrices of polymer. Cloisites are the natural MMTs modified with the quaternary ammonium salt. Montmorillonite, 2:1 is a clay mineral and it is a member of smectic group. It consists of two layered tetrahedral sheets sandwiching with the central octahedral sheet [6].

### 2.2. Sepiolite clay

Sepiolite also known as the hydrated silicates of magnesium [7]. It comprises of two-dimensional sheets of the  $\text{SiO}_5$ , thus keeping it in the family of phyllosilicate [3-8]. Theoretical unit of the sepiolite is  $\text{Si}_{12}\text{O}_{30}\text{Mg}_8(\text{OH})_4(\text{OH}_2)_4 \cdot (\text{H}_2\text{O})_8$ , a pure trioctahedral mineral [9]. Its structure is comparable to the 2:1 structure of montmorillonite, which consist of octahedral sheets of the magnesium oxide or hydroxide between layers of the tetrahedral silica [10].

### 2.3. Hectorite clay

Hectorite, a magnesium-lithium trioctahedral smectite and it is present in the Mojave Desert near Hector, California. It is a rare, greasy, soft, white clay mineral. Its chemical formula is  $\text{Na}_{0.3}(\text{Mg, Li})_3\text{Si}_4\text{O}_{10}(\text{OH})_2$ . Hectorite comprises of only silicates, while the montmorillonite is an aluminosilicate. Hectorite are good choice to prepare the clay polymers for fertilizers coating because of the above

discussed properties. Clay polymers which are made up of hectorite in fertilizers coating are good superabsorbent. Due to its softness and greasy texture hectorite with other polymer absorb large amount of water.

### 2.4. Saponite clay

Saponite is a tri-octahedral mineral of smectite group. It contains layers of negative charged that are neutralized by the counter ions of positive charged ( $\text{Na}^+$  and  $\text{Mg}^{2+}$ ).  $\text{Ca}_{0.25}(\text{Mg, Fe})_3(\text{Si, Al})_4\text{O}_{10}(\text{OH})_2 \cdot n(\text{H}_2\text{O})$  is a chemical formula of saponite clay. It also present in the family of 2:1 smectite group, i.e., the silicate layers are sandwiching between a gibbsite layer in a silicate-gibbsite-silicate. Saponite clay also have crystal structure like montmorillonite clay [11]. It is swelling and sticky clay as all others clays of the smectic group. This is the main property used in clay polymer coated fertilizers to hold the water or fertilizers in dissolved solution form. These are chosen over other minerals clays.

### 2.5. Laponite clay

Laponite belongs to the synthetic silicate layers under the 2:1 smectite group. Its particle size is small as compared to the MMT. Its basic unit consists of hydrous magnesium silicate layers, with a thickness of about 1 nm. The structure of laponite is similar to the montmorillonite, but an interstitial charge deficiency is created by replacing  $\text{Mg}^{2+}$  with  $\text{Li}^+$ . Its capacity of cation exchange is 0.55 mequiv/g.  $\text{Si}_8(\text{Mg}_{5.45}\text{Li}_{0.4})\text{H}_4\text{O}_{24}\text{Na}_{0.75}$  is a chemical formula of laponite [12].

### 2.6. Rectorite

Rectorite is also present in the silicate layers of smectite group. Rectorite clay is a regular interstratified clay mineral with the irregular pairs of di-octahedral mica like layer and di-octahedral smectite type layer in the ratio of 1:1. Length and width of the single layer of rectorite is one or several microns and about 2nm in thickness. The inorganic or the organic cations easily exchanged within the cations of tertiary layer of rectorite clay. Importantly, the pure rectorites hydrophobic lead to the poor affinity with hydrophobic copolymer. Therefore, research on the organic modified rectorite nanocomposites has been broadly carried out [13].

### 2.7. Vermiculite

Vermiculate clay is a hydrous phyllo-silicate mineral. It undergoes substantial expansion when heated and the exfoliation occurred when this mineral is sufficiently heated, and effect is regularly produced in the commercial furnaces. Vermiculite clay is designed by the weathering or hydrothermal of phlogopite or biotite. Mines of vermiculate now exist in the Brazil, China and Russia. Vermiculites are weather-beaten micas in which ions of potassium between molecular sheets are replaced by the ions of iron and magnesium.

### 2.8. Bentonite

Bentonite clay is an absorbent of the aluminum

phyllo-silicates. It is a sedimentary rock consists of large proportion of the clays with a typical 2:1 layered structure and high contents of the calcium and sodium ions are situated between the layers. Quality of the smectite (main mineral for bentonite clay) is vital to improve superiority of the bentonite. Impurities adversely affect the capacity of cation exchange and thermal stability of the bentonites. Common impurities are organic matter, quartz, feldspar and the mica [14-15].

### 2.9. Kaolinite

Kaolinite a clay mineral is a part of group of industrial minerals. Chemical composition of kaolinite is  $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$ . It is a type of silicate layered mineral. Tetrahedral sheet of the silica is linked through the oxygen atoms of the octahedral sheets of alumina octahedra. Rocks rich in kailinite are called as china clay or kaolin. Kailinite has lower capacity of cation exchange (1–15 meq/100 g) and lower shrink well capacity. Kaolinite is usually white, earthy, soft mineral produced by chemical weathering of the aluminium silicate minerals [16]. Kaolinite clay is used to produce clay polymers to enhance the adsorbing and mechanical properties of clay polymers for fertilizers coating.

### 2.10. Modified layered double hydroxide

Double layered hydroxide is significant synthetic clay and its structure is derived from the brucite. Layers of brucite are formed by the in which central  $\text{Mg}^{2+}$  octahedrally surrounded by the hydroxyl groups. Isomorphous substitution of some of the divalent cations by the trivalent gives brucite like layers with positively charged, counter balanced by some of the interlayer anions and the water leads to a neutral double layered structure of hydroxide. For the preparation of polymer nanocomposites with the double layered hydroxide, the chains of polymer are unable to intercalate with the interlayer space of the double layered hydroxide because of its smaller interlayer spaces as compared to the monomer diameter of polymers.

Apart from the above types of clay minerals, other minerals like modified clays used for the preparation of composite. These include natural clays such as hectorite, saponite, sepiolite, montmorillonite, rectorite, laponite, chlorite, bentonite, kaolinite and vermiculite as well as the synthetic clays includes various double layered hydroxides, hectorite, synthetic montmorillonite, etc. Specific types of clays (Figure 1) are used in the specific method to give polymer of certain characteristics.

## 3. Methods of production of clay polymers

There are following methods to introduce clay in to the polymers of fertilizers coating to make them superabsorbent to hold the water for a long term and provide to plants when required.

### 3.1. In situ polymerization

In situ a Latin word which means “in position”. In situ-polymerization was the first method used to produce

clay nano-composites based on the polyamide.

#### 3.1.1. Mechanism

In this process polymerization of the monomer species occur in the presence of layered materials. Firstly, polymer clays are swollen with the monomer solution, which is followed by its polymerization in between intercalated sheets. Polymerization can be started by heat or by the radiation, by diffusion of appropriate initiator or by the organic initiator or the catalyst fixed through the cation exchange inside interlayer and before the inflammation step when required. This process involves the swelling of nano-fillers in the monomer solution. Lower molecular weight solution of monomer can be easily seeps in between the layers that causes swelling [17]. Researchers [18] used this method for the formation of poly( $\epsilon$ -caprolactam)-based nanocomposites. They modified the montmorillonite by using the protonated amino lauric acid and spread the modified montmorillonite liquid  $\epsilon$ -caprolactone before polymerizing at higher temperature [19].

#### 3.1.2. Merits and demerits

Various advantages are attributed to the in-situ polymerization process. Firstly, thermoset based nanocomposites can be produced by this method [20]. Furthermore, it permits grafting of the polymers on the surface of fillers, which commonly improve the properties of final composite. Partly exfoliated structures attained by this process due to good dispersion and the intercalation of fillers in polymer matrix. In-situ polymerization process includes swelling of the layered silicate in solution of monomer so that polymer formation occurs between intercalated sheets. Polymerization is then conducted by the heating or an organic initiator or the catalyst fixed through the cation exchange between the interlayer. In the in-situ polymerization process, monomer is directly used as solubilizing agent for the swelling of silicate layers. Successive polymerization occurs after combining the monomer and silicate layers, thus allowing the formation of chains of polymer between intercalated sheets [21]. The disadvantage of this method is the requirement of specific solvent or the polymer solvent pairs, higher cost associated with solvent, their disposal and harmful effect on the environment. In the in-situ polymerization process, there is a difficulty in the control of inter gallery interaction. This process has very limited application. The other disadvantage of this process is that higher temperature is used for the synthesis which causes decomposition of the polymer.

### 3.2. Melt intercalation

Vaia demonstrated this method in 1993, which inspired by the revival of interest in nano-composite of clay. This process has become conventional for fabrication of the polymer clay nano-composite in recent years. This process is economical, simple and environment friendly.

#### 3.2.1. Mechanism

A chemist [22] discussed the relation between the

conditions of processing and morphologies gained for the CNT (carbon nano tube) nanocomposites. Furthermore, the authors elucidated the process of dispersion in four steps: (i) Wetting of the initial agglomerates by polymer, (ii) Infiltration of the polymer chains in the initial agglomerates to fade them, (iii) dispersion of the agglomerates by erosion and rupture, and (iv) distributions of the customized nanotubes into the matrix. This process consists of blending the layers of silicate with matrix of polymer in the molten state under such conditions, if the surface layers are sufficiently well suited with the chosen polymer, the polymer can creep into interlayer space and forms either an exfoliated or intercalated nanocomposite. Typically, during the extrusion clay is mixed with the molten polymer, whose chains penetrate between the sides of clay layers perceiving its intercalation [23].

### 3.2.2 Merits and demerits

As discussed above, melt intercalation is considered as eco-friendly and much better substitution for mixing of the solution, if permissible. Though, the processing conditions like surface modifications of the filler, and the compatibility of fillers and the polymer matrix. These all play an important role in determining how well the dispersion be achieved. However, melt mixing appears to be only partly effective since the concentration of exfoliated silicates is greater than about 4wt% have not been possible. This method has greater advantages as compared to both the polymer and in-situ intercalation. This is because of two reasons: firstly, this method is good for the environment because no organic solvents are used and secondly this process is more compatible with the industrial processes such as the extrusion and the injection molding. The disadvantage of melt intercalation process is its dependence on processing conditions and the advantageous connection with the polymer and clay. Therefore, in most of the studies only the exfoliated structure of nanocomposite with up to 5 wt% MMT is achieved. To get benefit from potential offered by the nano-particles in areas such as the electrical conductivity, barrier and the reinforcement, and also higher levels of the fully dispersed nano-particles are achieved.

### 3.3. Synthesis with aid of super critical CO<sub>2</sub>

In recent years supercritical fluid method got tremendous attention due to its applications in many areas of life like pharmaceuticals, plastic and food industries. Specially, supercritical carbon dioxide widely used in various applications because it is nontoxic, inflammable, environmentally friendly and relatively lower cost as compared to the other supercritical fluids (SCF). Supercritical fluids have been used in the formation of clay polymer to increase their required properties. This process has many advantages over the other methods.

#### 3.3.1. Mechanism

In general, supercritical fluids have many

advantages over the other organic solvents because of their lower viscosity, surface tension, liquid like density and gas like diffusivity. Particularly, supercritical carbon dioxide appeared as an important SCF because of its several desirable features such as lower cost, lower toxicity, abundance and readily accessible conditions. In the preparation of higher molecular weight polymers high viscosity is usually a main problem. To defeat this problem, supercritical CO<sub>2</sub> can be used as plasticizing agent to lower the viscosity of the various polymers. Under the ambient conditions, carbon dioxide gas makes its exclusion easy. Carbon dioxide behaves like polar and highly volatile solvent, which swells up and plasticizes the polymers when it interacts with them. Montmorillonite contains ions of alkali metals between the sheets of silicate, so it is considered as a swelling mineral. Therefore, this can be swollen in the polar solvents like sc-CO<sub>2</sub> and water [24]. Distance of the silicate sheets broadened in the polar solvents, so the sheets of silicate come to exfoliate into the individual sheet [23-25]. Supercritical carbon dioxide processing technique involves contacting mixtures of polymer clay with the sc-CO<sub>2</sub>. The layered clays or the polymer mixtures are contacted with the CO<sub>2</sub> in higher pressure vessel. A primary hypothesis for this mechanism is: in the soaking step, carbon dioxide or the CO<sub>2</sub> mixture and the polymer diffuses between the layers of clay under optimum conditions for the processing. At places where polymers are present, the lower viscosity and higher diffusivity of CO<sub>2</sub>-philic polymer in the mixture enables the penetration of the clay layer. At places where only the clay and CO<sub>2</sub> are present CO<sub>2</sub> diffuses into CO<sub>2</sub>-philic clay gallery.

#### 3.3.2. Merits and demerits

Proper use of supercritical CO<sub>2</sub> may lead to higher concentrations of the exfoliated nano-clay particles. Nanocomposites of the clay polymers are usually produced through the solution route. Due to this large quantity of the organic solvent is required and this may cause environmental pollution. Thus, the most preferable method is the green synthetic method. Supercritical carbon dioxide (sc-CO<sub>2</sub>) may be an alternative to the conventional processing.

### 3.4. Sol gel technology

Sol-gel is a two-step process, first step is sol and the second one is gel. Sol is suspension of the particles of solid while gel is the interconnected framework that formed between the phases [26].

#### 3.4.1. Mechanism

This method involves the direct crystallization of silicate clays by using hydrothermal treatment of the gel including the polymers. Gel contains the organometallics and organic which includes magnesium hydroxide, silica gel and the lithium fluoride. It has the capability to promote higher dispersion of the layers of silicate in one step process,

without use of an ion as a surfactant. In this method, clay minerals are produced in between the polymer matrix by using an aqueous solution which contains building blocks of the silicate and polymers. As forerunner for clay silica sol, lithium fluoride and the magnesium hydroxide sol are used in this process. Polymers help the growth of inorganic host crystals and nucleation and get stuck between the layers when they grow. Sol is a suspension of the solid nanoparticles in monomer solution. Gel is 3D interlinking network formed between the phases [17]. Sol-gel method by using metal alkoxide is an efficient way for the formation of inorganic-organic polymers.

**3.4.2. Merits and demerits**

This is a simple process, lower processing temperature and higher chemical homogeneity. The main advantage of the sol-gel process is its compatibility with the polymers and the polymerization processes, this allows the formation of nanoparticles in the presence of organic molecules. This method produced high purity product such as polymers of clay. Three dimensional polymers are formed which contain metal-oxide bond, single or multiple matrices. This method is used specifically for the formation of composite material with liquid or with the viscous fluid that derived from the alkoxide. This method has some disadvantages, greater shrinking and the lower amounts of void as compared to the mixing process.

**3.5. Intercalation of polymers or prepolymers from solution**

The solution induced intercalation method applies solvent to swell and disperse the clays into the polymer solution.

**3.5.1. Mechanism**

Intercalation of polymer from the solution is a two-stage process. In this method polymer is exchanged with a

suitable solvent. Two immiscible phases are present, one phase is an aqueous phase and the other phase is non-aqueous which contains the monomer or prepolymer. Natural exchange needs a negative variation in Gibbs free energy. Reduced entropy due to the confinement of polymer is recompense by an increase due to desorption of the intercalated solvent molecules. Polymers or the pre-polymer intercalation from solution is a method of intercalating the polymers or pre-polymers between the layers of inorganic layer substances [27]. Main disadvantage of this process is that, the low or even no polarity intercalated nanocomposites can be produced. However, the approach of solvent is difficult to apply in the industries due to problems associated with the use of higher amount of solvent [28].

**3.5.2. Merits and demerits**

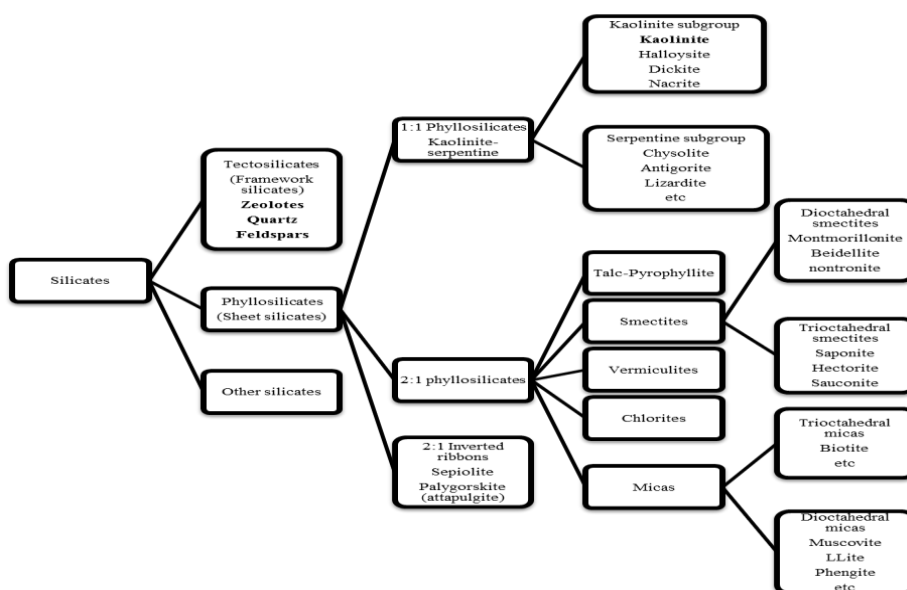
Formation of the intercalated nanocomposites is based on the low or even no polarity polymers. This method involves the industrial use of larger amount of solvent.

**3.6. Template synthesis**

Template synthesis is a method to form polymers of clay to get some certain properties.

**3.6.1 Mechanism**

A template is used in this process to form the nanocomposite material of specific shape, for example hexagonal, layered shape etc. In this process synthesis are often correlated with the sol-gel method. In this method the clay minerals are produced within the matrix of polymers, using an aqueous solution which contains the polymers and the building blocks of silicate. Lithium fluoride and the magnesium hydroxide are used as a precursor for the clay silica sol. This method has been extensively used for the formation of double layered hydroxide nanocomposites, but this method is far less developed for the layered silicates. This process is based upon the self-assembly process.



**Figure.1 Classification of clay which are used in clay polymers production**

**Table.2 Comparison of all clay polymer production methods**

Sr.No.	Methods	Advantages	Limitations
1	In-situ polymerization	Easy procedure based on dispersion of the filler	Difficult control of integrally polymerization.
2	Melt intercalation	Environmentally friendly, well-suited for industrial polymer process	Limited application to the polyolefins
3	Synthesis with aid of sc-CO <sub>2</sub>	Environmentally friendly, higher concentration of the clay polymer	Process conditions are not easy
4	Sol-gel technology	Simple lower processing temperature, higher chemical homogeneity, versatile, formation of three-dimensional polymers, rigorous stoichiometry control, high purity products, Single or multiple matrices. specifically used to produce composite material	Greater shrinkage, based mainly in water soluble polymers, contaminated by side products
5	Intercalation of the polymers from solution	Formation of the clay polymers with low polarity, preparation of the homogeneous dispersion of the filler.	Industrial use of large amount of the solvents
6	Template synthesis	Easy production, large scale production	Limited application based mainly in water soluble polymers. Products may be contaminated by the side products

#### 4. Factors affecting the production

Properties of the nanocomposite are highly affected by the degree of mixing of the two phases and on the size of its phase component. Significant difference in the properties of component achieved depends upon the nature of the components (polymer matrix, capacity of cation exchange and the nanofiber) and also on the preparation methods. There are following main factors which effect the production. Each process has its own conditions but there are some factors that are important to consider while preparation of clay polymers nanocomposites

##### 4.1. pH

Main feature of the clay polymers is dependence of their properties on pH of the medium. pH of the environment has greater effect on swelling behavior of the clay polymer hydrogels. It is observed that the percent swelling changes vigorously with the change of swelling medium [29]. pH change effect the state of ionization and the hydrophobic/hydrophilic balance in these types of clay polymers nano-composite. Weakly basic and acidic hydrogels have been formed, exhibiting the complementary pH sensitivities at its physiological temperature (37 °C). Amines the cationic monomers can be easily copolymerized and incorporated into the matrix to produce the polybasic hydrogels exhibiting pH dependent swelling at 37 °C temperature. Anionic comonomers are somewhat more difficult to incorporate due to the tendency of the clay nano particles to coagulate. The availability of strong pH-sensitive hydrogels is expected to extend the utility of hydrogels in various applications such as drug delivery. The

high solubility of a pH-responsive polymer is advantageous for large-scale production necessary for in-situ engineering applications. pH-responsive polymers may have various conformations as a function of the surrounding fluid chemistry, which could lead to changes in clay polymers properties, so change in pH mainly changes the properties of clay polymer formed due to change in the ionic concentration of the clay polymers layers. pH change depends on ionic charge nature. Three approaches were employed to overcome this problem.

##### 4.2. Temperature

Temperature affects the mechanical properties of the clay polymers. Mechanical response has significant effect on the performance and design of the composite. At higher temperature swelling of the clay decreases slightly. Small increase of absorption capacity has been observed at temperature between 24 °C and 35 °C due to easy movement of the chains of copolymer. At temperature higher than 35 °C a small decrease of the absorption has been observed. This specifies a release of the water-soluble materials. Different production methods have different temperature requirements but a very high temperature can destroy the polymer structure so it must be in optimum range to carry out synthesis.

##### 4.3. Ionic concentration

More polar groups in the polymer improve ionic interaction between the clays and the chains of polymer. This leads to exhibit the greater improvement in the physio-mechanical properties of the composites. Swelling behavior of the clay nanocomposites depends upon the composition

of polymers, specifically when at least one of the constituent monomer contains ionizable groups. Clay particles in the formation include anionic, cationic and neutral sites. The above mentioned is an ion exchange reaction. Inorganic smaller sodium ions are replaced with larger organic cations [30].

### 5. Characterization techniques

The prepared clay polymers were characterized for their crystallinity, surface morphology, surface functional group, cation exchange capacity, specific surface area and water absorbability by chemical and instrumental techniques. Absorbency of water and the water contents of hydrogel could be calculated by weighing of the swollen gels.

### 6. Conclusion

Fertilizers are very important for the plants growth but there are some problems regarding use of fertilizers the plants cannot use fertilizers for long term, the fertilizers used are a big source of environmental challenges like pollution, leeching, etc. to overcome these problems scientists have been working for many years to improve the efficiency of fertilizers. The main idea to do so is to coat the fertilizers with such components which are not harmful to environmental and can provide fertilizers nutrients to plants on need. There are many types of coating but the coating of fertilizers with the clay polymers is most efficient because it has more efficiency than other coating subjects. There are mainly three methods to prepare the clay polymers for many years scientists prepared polymers with template synthesis, in situ polymerization, polymerization from solution intercalation these are traditional methods these methods have benefits as well as limitations among them there are some new methods like synthesis with aid of super critical CO<sub>2</sub> and sol gel technology. There is a need to overcome the limitations of these methods and further modifications should be made to improve the production methods. One of them is the use of these techniques on industrial scale to improve plants yield by providing with nutrients on demand. Researchers and scientists have been working to modify and improve in near future it would be used on large scale.

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