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# Sodium Polyacrylate as a Super Absorbent

Umarfarooq A Halyal

Assistant Professor, Department of Chemistry M. G. V. C.Arts, Commerce and Science College, Muddebihal, Vijayapur, Karnataka

**Abstract:** This work is devoted to the study of synthesis, properties and practical Applications of class of acrylic-based sodium Polyacrylate superabsorbent polymers. The techniques of solution, emulsion/gel polymerization were used for synthesis. Each absorbent was mainly characterized by its equilibrium capacity of water absorption and by the rate of absorption. The swelling characteristics of the polymers were evaluated in terms of change in polymerization variables which include, type and amount of cross linker, monomer composition, and process of polymerization, temperature, initiator concentration, monomer concentration, Rate of agitation and particle size of the product. The swelling dependency on salinity, ionic strength and PH was also examined. The rapid growing nanotechnology has led to more explorations of SAPs and SAPCs for applications in biomedical, biotechnology and advanced technologies. Examples of research work of SAPs and SAPCs published in refereed, reviewed articles are referred.

**Keywords**: Superabsorbent polymers; swelling properties of SAP. Superabsorbent Poly composites; Water absorption capacity; Cross linking reaction;

#### I. INTRODUCTION

#### 1.1 Definition

In our daily life, cotton, paper and sponges are commonly used to absorb water. These materials absorb only a few times their weight of water and have rather poor properties with respect to water retention. However, some types of polymers and copolymers do function as high water absorbents, having very good water retention properties and high affinity towards water. These polymers are termed as Super Absorbent Polymers As mentioned above superabsorbent polymer can absorb water up to several thousand times of its own weight and keep this water under pressure. The absorbed water can be released slowly when the SAP is put in dry air to maintain the moisture of the environment.

Superabsorbent polymers (SAPs) are materials that have the ability to absorb and retain large volumes of water and aqueous solutions. This makes them ideal for use in water absorbing applications such as baby nappies and adults incontinence pads to absorbent medical dressings and controlled release medium.

#### 1.2 Brief History

Until the 1980s, water absorbing materials were cellulosic or fiber-based products. Choices were tissue paper, cotton, sponge, and fluff pulp. The water absorbent capacity of these types of materials is only up to 11 times their weight, but most of it is lost under moderate pressure.

In the early 1960s, the United States Department of Agriculture (USDA) was conducting work on materials to improve water conservation in soils. They developed a resin based on the grafting of acrylonitrile polymer onto the backbone of starch molecules (i.e. starch-grafting). The hydrolyzed product of the hydrolysis of this starch-acrylonitrile co-polymer gave water absorption greater than 400 times its weight. Also, the gel did not release liquid water the way that fiber-based absorbents do.

The polymer came to be known as "Super Slurper". The USDA gave the technical know-how to several USA companies for further development of the basic technology. A wide range of grafting combinations were attempted including work with acrylic acid, acryl amide and poly vinyl alcohol (PVA). Polyacrylate/polyacrylamide copolymers were originally designed for use in conditions with high electrolyte/mineral content and a need for long term stability including numerous wet/dry cycles.

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#### 1.3 Superabsorbent Polymer Classification

The SAPs can be classified with different methods. From a morphological point of view they can be divided into particle, powder, spherical, fiber, membrane and emulsion types etc. The morphology of SAP is designed to respond the different requirements of the applications.

For example, the powder product can be put in the multilayer's sheet to form sanitary napkins and diapers, the particle and spherical product can be used as deodorant, fiber product can be used as Antistatic electric fiber, membrane product can be used as antifost sheet and emulsion product can be used in soaking and painting. From a material resources point of view, SAP can also be divided into natural macromolecules, semi-synthesized polymer, and synthesized polymers. From a preparation method point of view, it can be classified as graft polymerization, cross-linking polymerization, networks formation of water-soluble polymer and radiation cross-linking etc. There are many types of SAPs in the present market. Mostly, they are cross linked copolymer of acrylates and acrylic acid, and grafted starch-acrylic acid polymer that are prepared by reverse suspension and emulsion polymerization, aqueous solution polymerization, and starch graft polymerization. Water absorption capacity (WAC) is the most important characteristic of SAP. There are two primary types of superabsorbent polymers:

Starch-graft polymers and those based on cross-linked polyacrylates. Although starch-graft polymers were the first developed, these polymers suffer from the disadvantage of salt instability. Polyacrylate polymers initially had difficulty achieving high absorption under load (AUL) characteristics at moderate pressures, as the materials would dissolve partially. However, this problem was solved by partly cross-linking the polyacrylate to provide a networked structure. The sodium acrylate and starch-graft polymers account for virtually all of the commercial volume of super absorbent polymers. Although other chemistries, such as polyacrylamide, poly (ethylene oxide), poly (vinyl alcohol), polysuccinimides, and hydrolyzed polyacrylonitrile polymers have been explored, they have to gain widespread commercial acceptance. Thus, sodium acrylates are expected to remain the commercially preferred SAP material. While significantly lower cost is attained by the starch-graft SAPs, they are not preferred by end-users due to inferior performance characteristics.

# 1.4 Structural Design of Superabsorbent Polymers

Macromolecules exhibiting solubility in aqueous solutions represent a diverse class of polymers ranging from biopolymers that direct life processes to synthetic systems with enormous commercial utility. This class of materials can be regarded a base to produces upper absorbing polymers. Therefore, to design a desired superabsorbent Polymer, a deep knowledge on hydrophilic polymers is fundamental. Solution properties and ultimate performance of water-soluble polymers are determined by specific structural characteristics of the solvated macromolecular backbone which can be explained as follows

Acryl ate polymers – in a dry state – resemble curled up curly-Qs or pigs tails.



When these molecules are placed in water, hydrogen bonding with the HOH surrounding them causes them to unfold and straighten out (like strands of spaghetti).



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When the molecules straighten out, they increase the viscosity of the surrounding liquid. That is why several types of acrylates are used as thickeners. Super absorbent chemistry requires two things: the addition of small cross-linking molecules between the polymer strands and the partial neutralization of the carboxyl acid groups (- COOH) along the polymer backbone (- COO- Na+).

# **1.5 Cross Linking**

In bulk Cross linking of polymer chains is basically carried out in two ways . The first involves free-radical copolymerization with small amounts of polyvinyl co monomers. The use of polyunsaturated co monomers is by far the most common method for obtaining cross linked poly( acrylates). In this case, cross linking takes place simultaneously with chain growth. Diacrylates or bisacrylamides are the most frequently used polyunsaturated cross linkers, although tri-functional employed. Spontaneous thermal cross linking or auto-cross linking without using cross linker molecules occurs through hydrogen abstraction from the polymer backbone followed by radical combinations or involves intermolecular reactions between chemical functionalities already present in the polymer chains as pendant groups such as carboxyl's and hydroxyls. These types of cross linking reactions render covalent crosslink's. Another way to produce crosslink's is treatment of polymerization mixtures with polyvalent metallic cat ion solutions. Multivalent metal ions can function as ionic bridges between carboxyl ate groups of two or more different poly (acrylates) chains. Zinc, calcium. strontium or barium acetates are used for this purpose at the end of(after) polymerization. As in thermoplastic elastomers, , saline domains (hard segments) act as crosslinks. Block copolymers of an acrylic monomer

# 1.6 Cross linking at surface

In fact when a water-absorbent resin which crosses linked by any method described above is contacted with water, swelling first occurs at the surface of the particles and further penetration of water into the core, or toward the central parts of the articles, is retarded. The particles become sticky and form agglomerates (lumps). Which block the diffusion of water toward particles into the agglomerates? As a result a low absorption rate is achieved. The phenomenon is sometimes rendered as "fish-eyes"formation or "gel-blocking". A method of obviating these inconveniences is to render the gel surface structure more rigid; hence the effectiveness of surface cross linking was found valuable.

# 1.7 Swelling

# 1.7.1 Non-ionic gels

When such a polymer is contacted with water or an aqueous solution, free energy of mixing comes to play because of polymer- solvent interaction which renders the polymer soluble in water. The infinite solubility can be prevented by the elasticli' response of the network which is provided by some cross linking. Balancing these two forces determine the swelling capacity of non-charged networks.

#### 1.7.2. Ionic gels

Most synthetic SAPs are polyelectrolyte gels, i.e. gels which bear ionic or ionizable moieties and active sites for cross linking. When immersed in a high dielectric constant medium, such as aqueous fluids, these ionic moieties will dissociate and create an overall charge density along the chains as well as a high concentration of mobile ions in the gel.

# 1.8 Mechanism of Swelling in Super Absorbent Polymers

Before discussing the synthesis of superabsorbent polymers it is first necessary to understand the reasons why they swell. There are several mechanisms to the process of swelling, all of which contribute to the final swelling capacity (or centrifuge retention capacity CRC – which is the amount of 0.9 wt% saline solution that a SAP can retain under free swelling conditions when surface water has been removed in a centrifuge) These effects decrease the energy snd increase the entropy of the system due to the hydrophilic nature of SAP the polymer chains have a tendency to disperse in a given amount of water (i.e they are trying to dissolve in the water ).

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This is the interaction of ions of a solute with molecules of a solvent i.e. COO and Na ions attract the polar water molecules .

#### **1.9 Applications and Benefits**

The commercially important superabsorbent polymers are sodium .salts of cross linked poly(acrylic acid) and graft copolymers cellulose or acrylo nitrile. Superabsorbent polymer technology has been available since the early 1970's, but the market potential superabsorbent polymers was not realized until the Japanese used them extensively for personal care products. Commercial production started in Japan in1978. In the United States, until a few years ago, these materials were only used in some adult incontinence products. These absorbing polymers were reintroduced to the United States after Procter & Gamble test marketed its "Ultra Pampers" disposable baby diapering 1985. Superabsorbent polymers are used ill non-woven presentations in three particular segments of personal care products: infant disposable diapers, adult inconstancy nice briefs and feminine pads. In disposable baby diapers, the superabsorbent is used at the rate of 5 to 6g per diaper, whereas in the adult incontin~neediapers of superabsorbent is used per pad. In the external feminine hygiene products, only about 1.0-I.Sg of superabsorbent is used per p.1d. Personal hygiene products accounts for more than 950/0 of the market for superabsorbent manufactured Other uses of superabsorbent polymers are in civil engineering, e.g. mud conditiol1~rs,lubricants, sealing material, wall covering to prevent drops of condensation from forming. and in agriculture/ gardening, e.g. water retention material artificial culture soil, etc. A tiny fraction or the total superabsorbent can be used

- Artificial snow
- Water scavenger pouches to absorb water from hydrocarbon fuel and oil
- Artificial soils for hydroponics
- Drilling fluid additive usable in wellbores
- Sealing underground formations, joints in water-supply pipes, building constructions.
- Fibre optic cables.
- Polymer concrete compositions.
- Static demolition agent for destroying rock structures.
- Thickening sewage,
- Absorbing moisture from powder of coking coal.
- Biomass support and carrier,
- Antifouling coating for watercraft.
- Thermal energy storage.
- A dew-preventing coating.
- Preventing electrolyte leakage and electrode drowning.
- Artificial\_Snow

Uses: Movies, snow parties, indoor\_ski\_slopes\_etc 10gms of dry snow powder Expands to 60 times its volume

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Mechanism: Dry powder expands in volume upon Absorbing water and resembles snow

Super absorbing Baby Diapers



Use: Baby diapers, nappy pads

**Mechanism:** Layered construction which allows the transfer and distribution of urine to an absorbent core structure where it is locked in.

# **II. EXPERIMENTAL STUDY**

# 2.1 Introduction

Today superabsorbent polymers are made using one of three primary methods; gel polymerization, suspension polymerization or solution polymerization. Each of the processes have their respective advantages but all yield a consistent quality of product.

#### 2.2 Gel Polymerization

A mixture of frozen acrylic acid, water, cross-linking agents and UV initiator chemicals are blended and placed either on a moving belt or in large tubs. The liquid mixture then goes into a "reactor" which is a long chamber with a series of strong UV lights. The UV radiation drives the polymerization and cross-linking reactions. The resulting "logs" are sticky gels containing 60-70% water. The logs are shredded or ground and placed in various sorts of driers. Additional cross-linking agent may be sprayed on the particles' surface; this "surface cross-linking" increases the product's ability to swell under pressure -- a property measured as Absorbency Under Load (AUL) or Absorbency Against Pressure (AAP). The dried polymer particles are then screened for proper particle size distribution and packaging. The gel polymerization (GP) method is currently the most popular method for making the sodium polyacrylate superabsorbent polymers now used in baby diapers and other disposable hygienic articles.<sup>[5]</sup>

#### 2.3 Solution Polymerization

Solution polymers offer the absorbency of a granular polymer supplied in solution form. Solutions and can be diluted with water prior to application. Can coat most substrates or used to saturated. After drying at a specific temperature for a specific time, the result is a coated substrate with superabsorbent functionality. For example, this chemistry can be

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applied directly onto wires & cables, though it is especially optimized for use on components such as rolled goods or sheeted substrates.

Solution based polymerization is commonly used today for SAP manufacture of co-polymers particularly those with the toxic acryl amide monomer. This process is efficient and generally has a lower capital cost base. The solution process uses a water based monomer solution to produce a mass of reactant polymerized gel. The polymerizations own reaction energy (exothermic) is used to drive much of the process, helping reduce manufacturing cost. The reactant polymer gel is then chopped, dried and ground to its final granule size. Any treatments to enhance performance characteristics of the SAP are usually accomplished after the final granule size is created.

# 2.7 Preparation of Reagent Solutions

# A. Monomer Solution

Glacial acrylic acid was diluted with the prescribed amount of doubly-distilled water at' room temperature with mild magnetic agitation. The same procedure was applied to prepare acryl amide solutions. The acrylic acid and the acryl amide are liquid and solid respectively at room temperature, thus the latter needs longer time to pass into solution. These two clear solutions were stored in tightly-stopper bottles at room temperature until required. Solutions were left for a maximum of a couple of hours before starting the reactions.

# **B.** Initiator Solution

To a prescribed amount of dourly-distilled water contain in a 100 ml beaker, a defined amount of re crystallized initiator was added at room temperature while shaking, until clear solution was obtained and the solution stored in cool place (0 °C) a\\ ay from light.

# **C. Cross Linker Solution**

To a magnetically-stirred prescribed amount of doubly-distilled water contained into 3100mi beaker, a defamed amount of cross linker was introduced at room term  $\sim$  rapture and stirred until it passed into solution, as indicated by a clear appearance. The solution  $\sim$ stored in cool place (0-5 °C) from light.

# **D.** Neutralizer Solution

To a pre-determined amount of doubly-distilled water~ the required amounts of sodium hydroxide or potassium hydroxide pellets were added over an ice-war bath to suppressant exothermicity. The mixture was agitated magnetically until a clear cold solution was obtained. The solution was stored at room temperature until required.

# E. Surfactant Solution

To a defined amount of an aromatic hydrocarbon. an appropriate amount of a water in oil surfactant was added and heated under stirring up to 80°C while bubbling nitrogen through the solution over a period of 15 min.

# F. Cross Linker Solution

To a certain part of an organic hydrocarbon. the oil-soluble cross linker was incorporated at room temperature while stirring magnetically.

# G. Sequence of addition

The sequence of addition and treatment to prepare aqueous dispersion phase was conducted as follows,

The acrylic acid solution, prepared as in [a] was treated with the neutralizer solution, prepared as in [d]. The latter was added drop wise through a dropping funnel to the former under mild magnetic stirring over: m ice-water bath to attain a prescribed, partial degree of neutralization. The treatment was completed short!), after a clear solution was obtained.-To the acryl amide solution, prepared as in [a], the cross linker solution of [c], was introduced. This step is essential to avoid any cross linker noncom nonentity.-The next step was to combine the two above solutions, i.e. [a]

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plus [d] with [a] plus[c].-The initiator solution [b] was left aside starting the reaction in order to prevent any premature polymerization.-To prepare a continual~: organic phase, the cross linker solution, as prepared in [t]. was introduced to the surfactant solution, as prepared in [e].

# 2.8 Methodology

Step 1: Take a solution of 1.07 gm of sodium hydroxide in 10 ml of water in a 250 ml conical flask

**Step 2:** Make a crushed ice bath in 500 ml beaker and insert the conical flask with NaOH inside the beaker allow the solution to attain 0°C.

**Step 3:** Keep the beaker with the conical flask on magnetic stirrer and gently place a magnetic palate in NaOH solution. **Step 4:** While stirring vigorously; slowly add 2.57 gm of acrylic acid drop wise using a dropper

**Step 5:** Remove the conical flask from ice bath and place it directly on stirrer and continue stirring allowing the solution to reach room temperature.

Step 6: To this solution, add 5.2 mg of methylene bis acryl amide and 0.1 gm ammonium or potassium per sulphate

**Step 7:** An exothermic polymerization reaction will occur which can be held by touching conical flask which will be slightly warmer and by observing the formation of viscous layer. Stirring is continued for 15 to 20 minutes. So that the reaction completes. Cool the solution and transfer it to a crucible.

# 2.9 Materials and Equipments

Acrylic acid, NaOH, acryl amide, toluene. Doubly distilled water Magnetic stirrer conductivity bridge and stirring bars, ice bath, conical flask, beaker, porcelain crucible etc

# 2.10 Experiments

According to the voluminous research on the acrylic anionic SAP literature, the most important reaction variables affecting the final properties are as follows,

- (a) Cross-linker type and concentration
- (b) Initiator type and concentration
- (c) Monomer(s) type and concentration
- (d) Type, size, and amount of inorganic particles Incorporated (if any)
- (e) Polymerization method
- (f) Polymerization temperature
- (g) Amount and type of the surfactant used
- (h) Stirrer/reactor geometry and rate of stirring
- (i) Porosity generating method or the amount and type of the porogen (if used)
- (j) Drying; its method, temperature, and time
- (k) Post-treatments such as surface cross-linking to enhance the swollen gel strength

Each of the above mentioned variables has its own individual effects on the SAP properties. However, to optimize a process, a set of variables having the most special effects on the desired SAP product should betaken into consideration Based on the above

**Reaction Variable** factors synthesis of super absorbent polymer either sodium or potassium Polyacrylate can be studied performing the following series of experiments

Experiment No 1: First exp is performed as per the above steps with the following amount of chemicals,

- 1. Acrylic acid 2.75 ml
- 2. NaOH 1.07gm
- 3. Acryl amide- 5.2mg
- 4. Potassium persulphat -0.1 gm

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**Experiment** No 2: Repeatation of exp no 1, except that of changing the amount of sodium hydroxide and acryl amide. The polymer obtained was of stickey-gel, water-swollen property.

**Experiment** No 3: Repeatation of experiment 2, except changing the amount of acryl amide, acrylic acid The polymer obtained was of sticky-gel of high degree water-swollen property.

**Experiment** No 4: Reputation of exp 3, except by changing the nature of neutralizer that is KOH in place of NaOH The polymer was obtained as an amorphous, water-soluble gel.

**Experiment No 5**: Repetition of exp 4, except changing the nature of cross linker that is in place of acryl amide in toluene The polymer was obtained as simile of expt 3

**Experiment** No 6: Repetition of exp 5, except changing the nature of initiator polyacrylic acid in place of acrylic acid The polymer obtained was of sticky-gel of high degree water-swollen property.

**Experiment** No 7: Repetition of exp 6, except changing the temperature The polymer obtained was of sticky-gel of high degree water-swollen property.

Swelling Measurements



SAP-Sodium Polyacrylate Sample- Gel-state 2.5

A sieved sample of the polymer ( $1.Og \pm O.OOlg$ , 50-60 mesh) was dispersed into 2L of doubly distilled water or accordingly saline solution, and allowed to swell with mild agitation. The steady state, or equilibrium swelling was determined by allowing overnight for absorption. The swollen samples were filtered through a 100 -mesh wire gauze and surface water dried carefully using a piece of a soft open-cell poly urethane foam until they no longer slipped from the sieve when it was held vertical. For measuring swelling kinetics or rate of absorption, the water-absorbed samples were taken from the solution at prescribed periods and then exposed to swelling measurements through the above procedure. To obtain a reliable value for swelling at any time, five values were averaged, although the value of standard deviation for this method is  $\pm 2.1$  g of water absorbed per g of dry superabsorbent. The quantitative figures of swelling were calculated as shown in following Equation.

$$Q_t = [q_{ss} - q_{ds}] I$$

where:  $Q_t$  is Swelling Degree at time t.

 $q_{ss}$  is Weight of the swollen or water-absorbed polymer at time t.

 $q_{ds}$  is Weight of the original dry superabsorbent

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#### **III. RESULTS AND DISCUSSIONS**

# 3.1 Presentation of Experimental Results

Based on the Experimental data, the Results can be presented as follows

- Experiment No 2: Repetition of exp no1 expect that of changing the amount of sodium hydroxide and acryl amide
- Experiment No 3: Repetition of experiment 2 expect changing the amount of acryl amide, acrylic acid
- **Experiment No 4:** Repetition of exp 3 expect by changing the nature of neutralizer that is KOH in place of NaOH
- Experiment No 5: Repetition of exp 4 expect changing the nature of cross linker that is in place of acryl amide in toluene
- Experiment No 6: Repetition of exp 5 expect changing the nature of initiator polyacrylic acid in place of acrylic acid
- Experiment No 7: Repetition of exp 6 expect changing the temperature

To obtain the desired, degree of partial neutralization of acrylic acid, i.e. the required acid/salt ratio, the required amount of sodium hydroxide was estimated by the following table To draw the latter, dilute acrylic acid (30g in 7.5g double distilled water) was titrated with 25.4 wlw % NaOH solution. According to the table 750/0neutralisation degree (acid/salt molar ratio of 1/3) is obtained when the pH is low

The amount of water sorption is quantified by the degree of swelling, i. e.the ratio of the swollen polymer volume or mass to that of the dry polymer 4. The volume degree of swelling of cross linked polymers is simply the inverse of the polymer volume fractions the former can be readily predicted as a function of polymer-solvent interaction parameter, crosslink density and polymer ionic content, neglecting the electrostatic.

A brief summary of the effect of reaction variable on swelling properties of SAP								
	Exp	Monomer	Cross linker	Neutralizer				

Exp	Monomer		Cross linker		Neutralizer			Degree of
NO					Temperature			swelling
1	Acrylic	2.57	Acryl	5.2 mg	NaOH	1.07	50 C	Low
	acid	ml	amide			gm		
2		7.7 ml		15.6mg		3.21	65 C	
	دد		دد		"	gm		Moderate
3		15.42		31.2mg	KOH	6.42	80 C	High
	دد	ml	دد			gm		

Swelling Capacity of SAP - Effects of Cross Linking and Netralisation

# Part-1

Effect of cross-linking on swelling capacity

For a fixed degree of neutralisation (Dn) the capacity of a superabsorbent polymer decreases with increasing ratio of cross-linker (when swollen in saline solution).



When the Dn is changed the curves show similar trends but the slopes change. The higher the Dn the steeper the curve. When the polymers are in deionised water there is a large difference in the CRC from 0% to 20% Dnbut this difference is less pronounced as Dn increases.

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Figure below is a Representative curve for swelling kinetics of a hybrid SAP sample in distilled water weight of wet paper plus swollen polymer is determined(A), and the absorbency of the sample in g/g is then calculated after correcting for the weight of dry paper and the amount of water absorbed under identical conditions by the paper alone in the absence of sample (eqn 5). Each test is preferred to be repeated3-5 times and the results are averaged.



WC = (A-B-W1)/W1 (5) where, B is wet paper without polymer. Assuming a monotonous absorption for the duration of 60 s, an estimation of wicking rate (g/g.s) of the SAP may be obtained by dividing the WC value by 60.

#### **IV. CONCLUSION AND FUTURE PROSPECTUS**

SAPs have created a very attractive area in the viewpoint of super-swelling behavior, chemistry, and designing the variety of final applications. When working in this field, we always deal with water, aqueous media and bio-related systems. Thus, we increasingly walk in a green area becoming greener via replacing the synthetics with the bio-based materials, e.g., polysaccharides and polypeptides. This, however, is a long-term perspective. More or less, the acrylic kingdom will extend its domination in the future markets. The presence of water in soil is essential to vegetation. Liquid water ensures the feeding of plants with nutritive elements, which makes it possible for the plants to obtain a better growth rate. It seems to be interesting to exploit the existing water potential by reducing the losses of water and also ensuring better living conditions for vegetation. Taking into account the water imbibing characteristics of SAP materials, the possibilities of its application in the agricultural field has increasingly been investigated to alleviate certain agricultural problems. Saps have been successfully used as soil amendments in the horticulture industry to improve the physical properties of soil in view of increasing their water-holding capacity and/or nutrient retention of sandy soils to be comparable to salty clay or loam.

SAP hydro gels potentially influence soil permeability, density, structure, and texture, evaporation, and infiltration rates of water through the soils. Particularly, the hydro gels reduce irrigation frequency and compaction tendency, stop erosion and water run off, and increase the soil aeration and microbial activity [116]. In arid areas, the use of SAP in the sandy soil(macro porous medium), to increase its water-holding capacity seems to be one of the most significant means to improve the quality of plants. The SAP particles may be taken as "miniature water reservoirs "in soil. Water will be removed from these reservoirs upon the root demand through osmotic pressure difference. The hydro gels also act as a controlled release system by favoring the uptake of some nutrient elements, holding them tightly, and delaying their dissolution. Consequently, the plant can still access some of the fertilizers, resulting in improved growth and performance rates.

On the other hand, SAPs in agriculture can be used as retaining materials in the form of seed additives to aid in germination and seedling establishment), seed coatings, root dips, and for immobilizing plant growth regulator or protecting agents for controlled release.

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