

Preparation and application of a new type of water absorption and expansion rubber; Literature Review

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Abstract: To look at the preparation and apply of superabsorbent resin (SAR) in preventing water evaporation in soil, hydroxymethyl cellulose sodium-g-poly (acrylic acid-co-2- acrylamide-2-methyl-1-propane sulfonic acid)/laterite (NaHMC-g-P (AA-co-AMPS)/ laterite) turned into organized through radical polymerization. Also there is another important side we look for SAR such as Coal mine fires pose a danger to the lives of underground employees and motive incalculable losses to the country-wide economic system. When a fire happens, the temperature within the underground wells will rise, which will become a massive hidden danger that desires to be controlled to save you failures. To solve this problem we use sodium carboxymethyl cellulose as a matrix and thru graft copolymerization of acrylic acid and a pair of- acrylamide-2-methyl propane sulfonic acid, a unique fire-extinguishing gel with excessive water absorption and excessive resistance has been prepared. In each of those cases, we want a high water absorption ratio as well as tremendous fire prevention effect and water evaporation in the soil. The composition and morphology of SAR were distinguished by FTIR, SEM, and TGA. The circumstances affecting the water absorbency of SAR were analyzed and the water absorption of the mastic below the excellent synthetic situations reached the balance of 15 min in purified water, and the optimum water absorption of SAR was 1329 g/g, 269 g/g, and 140 g/g in purified water, tap water, and 0.9 wt% NaCl solution, sequentially. The swelling dynamic mechanism of the SAR was described by the false-second-order swelling kinetics model. We will talk a little bit about water-swallowable rubber was prepared by way of mixing polychloroprene (CR) with crosslinked sodium polyacrylate (CSP), brought about silica, poly(ethylene oxide) (PEO), and vulcanizing retailers. Superabsorbent water resin does not disperse properly in hydrophobic rubber, with very low interfaces between them, so the hydrophilic part can effortlessly wreck off from rubber networks and the swelling potential is in the end lost.

Keywords: superabsorbent, evaporation, water-swallowable, crosslinked, carboxymethyl cellulose

Date of Submission: 20-06-2021

Date of Acceptance: 05-07-2021

I. Introduction

Superabsorbent resin (SAR) is a type of functional polymer material with sturdy hydrophilic companies and a three-dimensional network shape [1-3]. It not only has a great water absorption appearance but also has excellent water maintenance performance. Hence, it is generally used in medicine and health [4]. And drug sustained-release, chemical industry, and other fields. However, its utility in preventing water evaporation in soil has been suggested hardly ever. Water evaporation in the soil is a system wherein water is transferred from liquid to gaseous to the environment. It is associated with outside meteorological situations, consisting of temperature, humidity, wind speed, and rainfall. Excessive or insufficient water in soil has a sure effects on vegetation and microorganisms [4-6]. The abnormal 3-dimensional network structure of superabsorbent resin makes it has a sturdy water absorption capability. It can frequently absorb hundreds or even thousands of times of the water than its own weight [7]. After water absorption, it expands right into a hydrogel and slowly releases water for crop absorption and utilization. It is a tremendous drought-resistant and water-saving cloth. If the evaporation loss of water in the soil may be restrained, mainly in arid areas, it's miles of great importance to restrain evaporation, prolong the time of water within the soil and improve the effective utilization of water. The use of superabsorbent resin is a crucial means to reap this intention [8]. Through extinguishing checking out of various gel substances, locally and overseas scholars have verified that the fire-extinguishing gels have a few commonplace operating mechanisms that inhibit the spontaneous combustion of coal, which particularly include separating the coal from oxygen, retaining the humidity of coal, growing the activation strength of the coal's floor-lively businesses and accelerating heat dissipation [9-10]. Therefore, the new gel fire prevention era has been broadly utilized in coal mines in current years. Advanced a fire-extinguishing gel with flame retardant and thermal insulation residences the usage of sodium alginate as a matrix, which became steadily shaped by sodium dodecyl sulfate as well as an ionic flocculant formed with the aid of the reaction of copper carbonate and glucose lactone [9, 11]. Create clever gel, which becomes applied for fire prevention and to manipulate the

spontaneous combustion of coal with the aid of grafting 2-acrylamide-2-methyl propane sulfonic acid (AMPS) and acrylic acid (AA) with corn straw, followed by using including a foaming agent and expandable graphite [12]. Made particularly highly water-absorbent clever gel with a fast water absorption fee and a high-temperature response price through the use of acetone and sodium bicarbonate because the foaming agent [13]. Prepared a hybrid hydrogel-based totally on inverse emulsion polymerization of pregelatinized starch grafted with AA, sodium acrylate, acrylamide, and AMPS. However, all the above gels have sure defects, and the water absorption rate and the fire resistance effect aren't apparent. Therefore, it's far imperative to find an excessive water-absorbing and high fire-extinguishing gel with a low value and brilliant overall performance.

With the protection of the environment and the decision for cost discount, the training of relatively water-absorbent gels the use of natural polyhydroxy substances has become a warm subject matter of current research. Sodium carboxymethyl cellulose (CMC) is anionic cellulose ether with the blessings of clean degradation, easily get admission to raw materials, microbial, and plant utilization. It is the most extensively used cellulose in the world. Acrylic acid (AA) and a couple of- acrylamide-2- methyl propane sulfonic acid (AMPS) are multigroup anionic monomer kinds that have carboxylic acid organizations with good dis- man or woman assets and sulfonic acid corporations with robust polarity inside the molecular structure. These groups reason AA and AMPS to have terrific effects in phrases of water absorption, salt tolerance, and so forth. If sodium carboxymethyl cellulose and acrylic acid and a couple of- acrylamide -2- methyl propane sulfonic acid graft copolymerization to prepare super-absorbent gel, the product isn't most effective environed- mental safety, low fee, but additionally has excessive water absorption and salt tolerance [9,14]. The product performance takes a look at proves that the product is advanced in imparting airtightness and fire resistance. The approach of the use of the fire extinguishing cloth is extraordinarily simple. Only tanks are wanted within the system, one dust pump can be. The quantity of the tank is chosen consistent with the wishes. The mud pump is selected according to the strain and flow, and there aren't any unique requirements for the gadget. According to the desired quantity of water and the selected ratio, the speed of adding water and feeding agent should be mastered, and the rate of including water and feeding agent should be synchronized. When including the agent, pay attention to the intersection of the water flow and the water floor, in order to take complete advantage of the water sprayed up via the touch floor to dispose of and blend the fabric to reap uniform mixing and compact glue formation [16]. Multicomponent polymer systems had been paid superb attention in both fundamental and technological fields in the last 20 years. a multicomponent product possesses such a lot of benefits, it's far extensively organized in an industry, like getting ready water-swellable rubber [18]. Water-swellable rubber is a form of elastomeric cloth that may be prepared through blending rubber, water-absorbent resin, and a few different fillers, and possesses now not simplest homes of standard rubber together with excessive resilience, precise tensile power, but also water-swellability [19]. (WSR) with excessive elasticity, resilience, high toughness, and additionally excessive water swelling potential is widely used as sealing material in caulking purposes, stopping water leakage from pipes and blocking off connections in structures which includes subways and subsea tunnels, sealing of gaps with water-resistant sealing fabric, and upkeep of airtightness in equipment and equipment [20-22]. Both chemical grafting and physical mixing strategies can be used to put together WSR. Synthesis of amphiphilic polymer is a critical chemical change method for the grafting of hydrophilic chains onto hydrophobic rubber, which includes grafting co-polymerization of N, N-dimethyl acrylamide onto natural rubber [22-23].

II. Experimental.

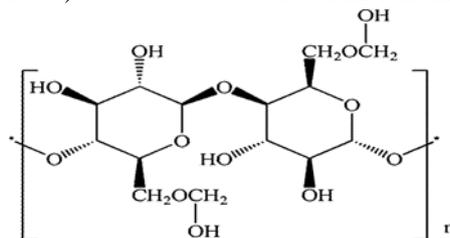
2.1 MATERIALS

Hydroxymethyl Cellulose Sodium (NaHMC, AR), 2-Acrylamido-2-methyl-1- propanesulfonic acid (AMPS, AR), acrylic acid (AA, AR), sodium hydroxide (NaOH, AR), N,N-methylene-bis- acrylamide (MBA,CP), Poly(acrylic acid) (PAA), ethylene glycol (EG), hyperbranched bis-MPA polyester-64-hydroxyl (HB).

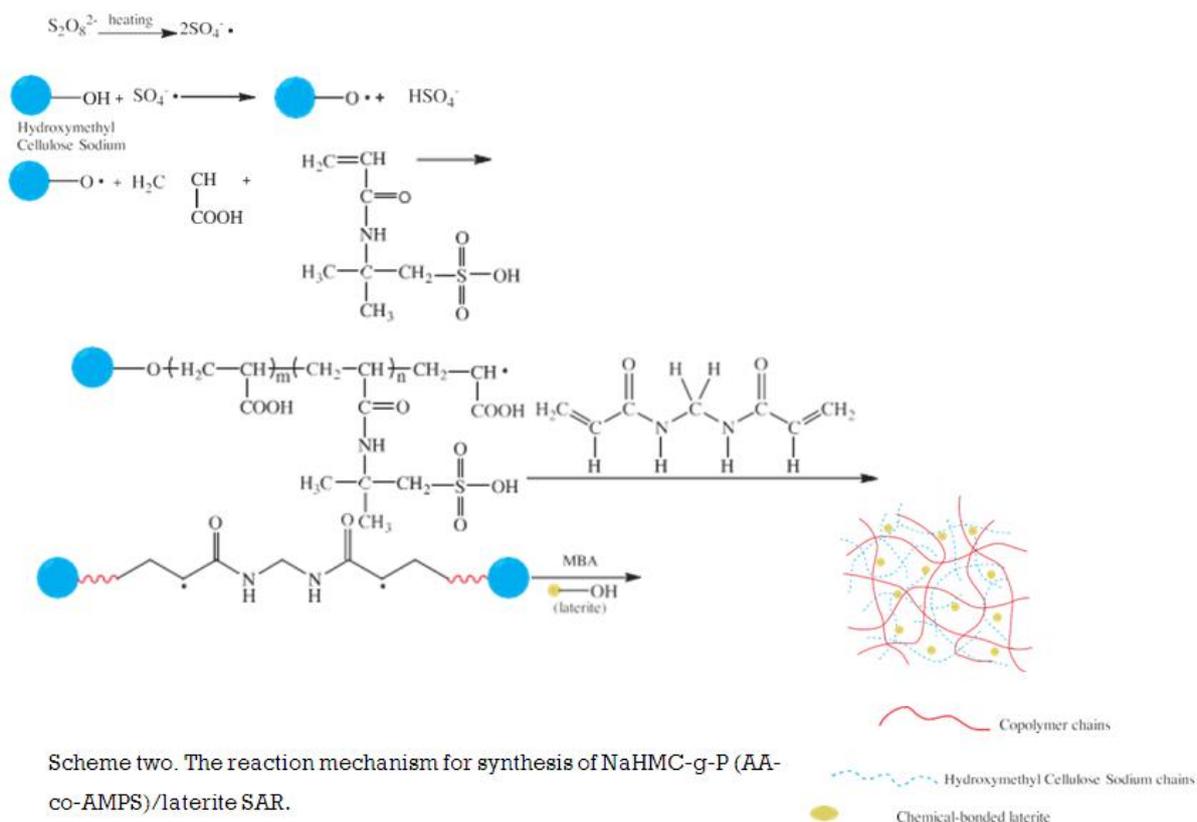
2.2. PREPARATION of NAHMC-G-P (AA-CO-AMPS)

The dispersion solution was designed by way of including 30 mL distilled water and NaHMC to 250 mL four-port flask with a mechanical agitator. In non-stop stirring, the solution becomes heated to 70 °C for 45 min. The reactant turned into cooled to 50 °C and 5 mL of the aqueous solution of APS became delivered. After 10 min, the aggregate containing in part neutralized ac- acrylic acid, AMPS, go-linker MBA, and laterite changed into dripped into the above gadget. Then the temperature was slowly raised to 70 °C, and the reaction for 3 h at a regular temperature. Nitrogen turned into used all through the whole experimental system. After the reaction, the product changed into soaked in absolute ethanol for 1 h, and then washed with distilled water three times. Then the product became placed into the blast drying chamber and dried to steady weight at 60 °C, then beaten and surpassed thru a sieve. The particle size of all resins used for trying out is set 50 meshes.

The training of NaHMC-g-P (AA-co-AMPS) superabsorbent resin became according to with the above system except without laterite. The structure of Hydroxymethyl Cellulose Sodium and the response mechanism for synthesis of NaHMC-g-P (AA-co-AMPS)/laterite had been shown in Scheme one and two [24].



Scheme one. Structure of Hydroxymethyl Cellulose Sodium.



Scheme two. The reaction mechanism for synthesis of NaHMC-g-P (AA-co-AMPS)/laterite SAR.

2.3. PREPARATION of ANTI-EVAPORATION MATERIAL for CLAY-BASED SUPERABSORBENT resin

Put seven hundred g sand (Its characteristic is to simulate the desertification area) into plastic boxes with the same specifications (20.5*13.2*6.5 cm), make the sand level inside the plastic bins, upload 120 g distilled water, make the sand moist flippantly. Then, one hundred fifty g clay (laterite, kaolin, attapulgate) of loess, and brought 5 wt% straw powder of clay or loess and extraordinary- the absorbent resin of different fine, a hundred and seventy g distilled water turned into brought, respectively. The aggregate became stirred frivolously at the rotational speed of 300~400 r/min after which unfolds in the plastic box, respectively [25].

2.4, Preparation of PAA and PAA hybrid solutions

As reported by [25-26] 0.96 g EG became brought to a hundred g 6 wt.% PAA/ethanol solutions as a crosslinking agent with the attention of 16 wt.% relatives to the PAA. After 24 h of mechanical blending at ambient temperature, the PAA-EG electro spun answer was obtained. For the PAA-EG + HB answer, zero.96 g EG as a crosslinking agent with the attention of sixteen wt.% households to the PAA and 0.9g HB with an awareness of 15 wt.% families to the PAA have been introduced to 100 g 6 wt.% PAA/ethanol answer. After 24 h of mechanical stirring at ambient temperature, the PAA-EG + HB electro spun solution became obtained. For the PAA- EG + GO solution, zero.03 g GO turned into dispersed in 5.97 g ethanol by means of ultra-sonication

through a LABEC MRC sonic-950 wt at 950 w for 10 s. The prepared GO/ethanol answer became mixed with 6 g PAA and 88 g ethanol with a GO concentration of 0.5 wt. % families to the PAA. 0.96 g EG was added to the PAA–GO solution as a crosslinking agent with the attention of sixteen wt.% households to the PAA. The combination became ultrasonicated for 30 min, followed with the aid of 24 h of mechanical mixing at ambient temperature, and the PAA-EG + GO electro spun answer was received.

For the PAA-EG + HB + GO solution, 0.03 g GO become dispersed in 5.97 g ethanol through ultrasonication by a LABEC MRC sonic-950 wt at 950 w for 10 s. The organized GO/ethanol solution was mixed with 6 g PAA and 88 g ethanol with a GO concentration of 0.5 wt. % families to the PAA. 0.96 g EG as a crosslinking agent with an awareness of sixteen wt.% loved ones to the PAA and 0.9 g HB with an awareness of 15 wt.% relatives to the PAA become introduced to 100 g 6 wt.% PAA/ethanol solution. The combination changed into ultrasonicated for 30 min, accompanied by 24 h of mechanical blending at ambient temperature, and the PAA-EG + HB + GO electrospun solution turned into received. Once the electrospun answers had been received, sulfuric acid (1 mol • L⁻¹) became added to the PAA and PAA hybrid solutions at the attention of fifty μL • mL⁻¹ immediately earlier than electro spinning processing.

2.5 Preparation of PAA and PAA hybrid NFN mats

The homogeneous PAA and PAA hybrid solutions have been electro spun the usage of an electro spinning gadget (NaBond Technologies TL01, China). The parameters of the system were optimized to attain the excellent fibers without beads. Taking the PAA–HB–GO solution, for instance, 20 mL PAA-EG + HB + GO answer turned into loaded right into a hypodermic syringe (50 mL). A syringe pump was used to manipulate the flow rate of one.5 mL/h. The tip-to-collector distance and the implemented voltage among the needle and the collector have been set at 10 cm and 15 kV respectively to attain a constant-state circumstance. The x-axis shifting speed of the needle and the drum velocity turned into the set at three.5 mm/s and 200 rpm respectively to acquire a uniform fiber mat. An exhaust fan and a heater were used to manipulate the temperature of the chamber at 35 °C, making sure that the ethanol inside the PAA-EG + HB + GO answer could volatilize at a proper speed. After settling, the PAA-EG + HB + GO solution became electro spun onto silicon oil sprayed on aluminum foil that blanketed the drum. After 3 h electro spinning technique of the PAA-EG + HB + GO liquid, the freshly made PAA-EG + HB + GO NFN mats had been cross-linked thru heat treatment in a vacuum oven at a hundred thirty °C and a discounted strain of 25 in Hg (84.7 kPa) for 30 min and then cooled to room temperature. Thus 0.04 mm PAA-EG + HB + GO NFN mats have been obtained. The coaching scheme of an electro spun PAA-EG + HB + GO NFN mat is shown in Fig. 1 detailed from [16].

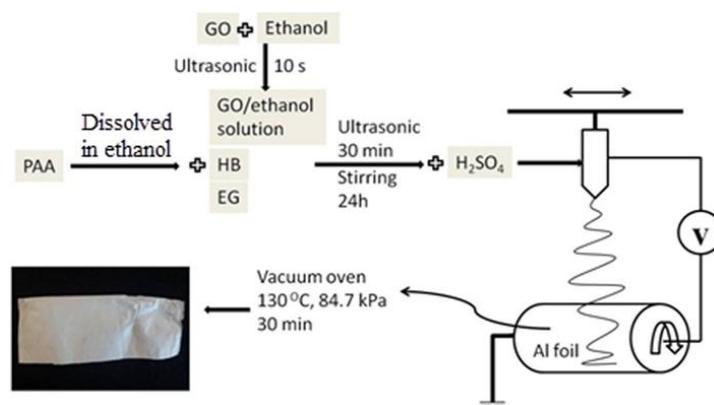


Fig. one. Preparation of electrospun PAA-HB-GO NFN mat.

III. Results and discussion using only FTIR

The FTIR spectra of the NaHMC (see Fig. 1a), the absorption peaks of 1128 cm⁻¹ and 1031 cm⁻¹ have been the CeOH bond stretching vibration, which fundamentally disappeared next to the polymerization reaction, showing that CeOH in NaHMC was involved in a chemical reaction. In the FTIR spectrum, (see Fig. 1b) of AMPS, the stretching vibration absorption top of C]O of the amide institution became at 1663 cm⁻¹, and the peak of the sulfonic acid institution changed into at 1083 cm⁻¹. The depth of these absorption peaks reduced the FTIR spectra of the NaHMC-g-P (AA-co-AMPS), and NaHMC-g-P (AA-co-AMPS)/laterite (2 wt%) (see Fig. 1c and d). The absorption height of -CN in the amide organization at 1236 cm⁻¹ essentially disappeared after polymerization. The stretching vibration top of O] S of sulfonic at 632 cm⁻¹ shifted after polymerization (Singh & Singh, 2017). This indicated that NaHMC grafted AMPS efficiently. In Fig. 1c and d, the uneven stretching vibration peaks of -COO- at 1456 cm⁻¹ and 1411 cm⁻¹ were observed respectively, indicating that the acrylic acid chain had grafted to the NaHMC skeleton. Compared with the height at 3435 cm⁻¹ in Fig. 1c, the intensity

of the extensive peak of OeH at 3433 cm^{-1} in Fig. 1d increased. In addition, we observed the bending vibration peak of SiO–Si at 465 cm^{-1} within the laterite, which indicated that the laterite participated within the graft copolymerization. TGA curves of (a) NaHMC-g-P (AA-co-AMPS) and (b) NaHMC-g-P (AA-co-AMPS)/laterite (2 wt%) had been proven in Fig. 3. From it can be found that the 2 superabsorbent resins showed 4 stages of degradation. Stage first degree: at $30\sim 230\text{ }^{\circ}\text{C}$ the pattern weight lost approximately thirteen% of its weight, which became resulting from the dehydration of the sugar ring on the NaHMC chain. Stage the second one degree took place between 230 and $330\text{ }^{\circ}\text{C}$ samples (a) and (b) misplaced 10% and 8% respectively, likely because small molecules of the resin started to decompose. At the 1/3 stage, the weight reduction of samples approximately 33% within the range of $330\sim 510$

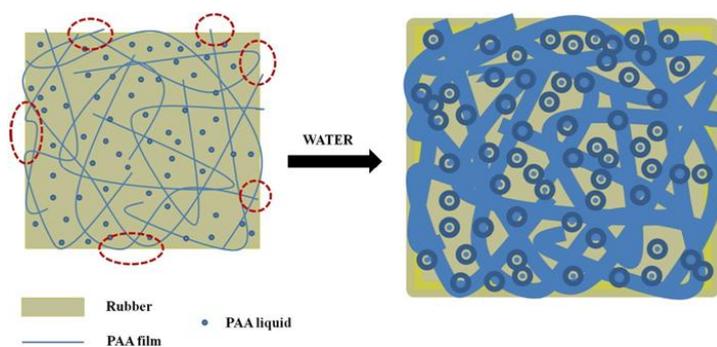


Fig. two. Schematics of water channel in WSR containing electrospun NFN mat.

$^{\circ}\text{C}$ are ascribed to the polymer commenced decomposing and the 3-dimensional network shape is destroyed. Stage fourth stage ranged from 510 to $800\text{ }^{\circ}\text{C}$ samples (a) and (b) lost sixteen% and thirteen%, respectively, which changed because of the elimination of SO_2 molecules. By reading the weight loss of the two samples, we are able to draw a conclusion that the in-manufacturing of laterite at some point of the polymerization system should improve the thermal stability of the resin, and additionally proved that laterite became in- concerned inside the reaction [15].

It has been confirmed that if WSR is im- merged in water, the hydrophilic segment within it absorbs water and an expansion force is exerted. The higher the amount of absorbed water, the higher the expansion forces are. When the ex- pansion force reaches the balance value restriction of the elastomer, equilibrium of swelling is achieved [49]. The water absorption of the original WSR increased 56.84% in 1800 h and the water absorption of the WSR + PAA-EG, WSR + PAA-EG + HB, WSR + PAA-EG + GO, and WSR + PAA-EG + HB + GO composites increased 60.65, 60.79, 62.21, and 65.04% respectively, being 3.81, 3.95, 5.37, and 8.2% higher than that of the original WSR. The fibrous mats acting as water channels could rapidly induce water into the rubber and im- prove the water absorption due to the high absorption properties of the composites. Moreover, by bonding to SAP particles, the mats also prevented the migration of SAP from the rubber. As a result, better water swelling ability was achieved, as shown in the schematics (Fig. 9).

IV. Conclusion

A collection of NaHMC-g-P (AA-co-AMPS)/laterite superabsorbent re- sins were prepared by way of loose radical graft copolymerization. The consequences showed that the superior response situations of the superabsorbent resin have been that the mass of NaHMC, AMPS, APS, MBA, and laterite become 12 wt%, 30 wt%, 0.8 wt%, 0.08 wt%, and 2 wt% of AA, respectively. The response time was three h and the ND of AA became 70%. The most water absorption turned into 1329 g/g, 269 g/g, and a hundred and forty g/g in distilled water, faucet water, and 0.9 wt% NaCl answer, respectively. The polymerization becomes confirmed by means of FTIR, SEM, and TGA. The swelling mechanism of SAR is explained by using the pseudo-second-order swelling kinetics version and Ritger- Peppas version. The outcomes showed that the swelling system of SAR is greater constant with the previous. We prepared clay-based totally anti-evaporation substances and studied the elements affecting the water evaporation rate in soil. The effects confirmed that after the soil type turned into

Kaolin and the particle length of the superabsorbent resin became $187.5\sim 375\text{ }\mu\text{m}$ and the content became 0.10%, the effect of the anti-evaporation the cloth was nice, and the evaporation charge changed to 9.45% lower than the neat soil.

Superabsorbent SAP fiber mats with hyper branched polymer and/or grapheme oxide having multi-scaled structure fibers were electro spun. The mats with fibers of Nano- and submicron-diameter had superior water swelling competencies (swelling rate and swelling ratio). When hyper branched polymer and grapheme oxide have been delivered, the hybrid mats confirmed synergistic outcomes on water swelling capability, due to

the formation of spider web-like multi-scale systems and multiplied unique surface areas. The electro spun fiber mats have been delivered into conventional rubber by way of easy physical mixing and the rubber composites confirmed the enormous enhancement of water swelling capability, in particular because of the water channels built by using the multi-scaled fiber mats to link the isolated superabsorbent debris together in the hydrophobic rubber matrix. The rubber composite containing hybrid fillers (hyper branched polymer and grapheme oxide) confirmed the highest water swelling potential (both quick- and lengthy-term) compared to the opposite rubber composites.

Acknowledgements

ABBREVIATIONS

polychloroprene (CR)

superabsorbent resin (SAR)

crosslinked sodium polyacrylate (CSP)

poly(ethylene oxide) (PEO)

Hydroxymethyl Cellulose Sodium (NaHMC, AR),

Acrylamido-2-methyl-1- propanesulfonic acid

(AMPS,

N,N-methylene-bis- acrylamide (MBA,CP),

Acknowledgements

I would like to to express my sincere gratitude to my supervisor (**Xiaoli Song**) department of chemistry and chemical engineering of Yangzhou University. support and encouragement in my time of writing this paper I want to say thank you much for your helping me .

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