

# Research on the Dehydration Property of One of Super Absorbent Resin on the Swill Oil

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## Abstract

The super absorbent resin was synthesized by aqueous solution polymerization using starch, acrylic acid, betonies. Under such conditions, the pure water absorption rate of super absorbent polymers was up to 126.53 g/g and the salt water absorption rate was 31.41 g/g, and the super absorbent resin can absorb the little water in the waste cooking oil. The need for the super absorbent resin is different due to the different water content of the waste cooking oil. When the water content of the waste cooking oil is low (<1%), we can increase the use level of the super absorbent resin to make the water content low as soon as possible.

**Keywords:** Super absorbent resin, Waste cooking oil, Hygroscopic

The waste cooking oil is kind of blended grease after it is filtrated, undergone separation of water and oil, decocted, got rid of odor and so on. In order to prevent the waste cooking oil entering into people's diet, the rationally resourceful utilization of it has become the people's live hood which caused government's much attention. The manufacture of biodiesel by making full use of the cheap and widespread waste cooking oil from the catering industry is the most useful approach. By now, there have been a variety of technologies which have achieved the translation successfully. Considering the benefit of the economy and environment, enzyme catalyst has the most future development, and it is also the trend of making biodiesel from of the waste cooking oil. However, the water-poisoned enzyme has been the technical vellum in the industrialization of the biodiesel. Among the already existent technologies, in order to realize the dehydration techniques in the transform course, we need to distill to dehydrate in vacuum, which making the price of the produced biodiesel higher. Thus, it is of great importance that seeking for the low cost dehydration techniques, which especially promote the development of the biodiesel in a long way, and resolve the issues of high cost, large energy consumption and environment-unfriendliness in the process of dehydration.

This article introduced a kind of high absorbent polymer to solve the above problems. The Super Absorbent Polymer is a kind of water swelling macromolecule polymer which contain hydrophilic groups such as carboxyl, hydroxide and so on as well as some cross linking. Due to the great deal of hydrophilic groups in the polymer, the polymer has the molecule extension quality of polymer electrolyte. At the same time, the tiny cross linking three-dimensional network can block the molecule's further extension, leading to the swelling but dissolution of the molecule in the water, and as a result, the molecule has vagarious water absorption. It can absorb several hundreds or several thousands times as much water and strong water conservation. (Jeannine, E., 2004; Ling H., 2006) At present the polymer has been used in some fields, such as agriculture and forestry horticulture, desertification combating and greening, building construction, oil and gas development, health products, medical apparatus and instruments an so on. (Flory P. J., 1953; Emileh A., 2007)

According to the raw material, the super absorbent polymer could be classed into polymer/starch (Long J.-Y., 2002) and polymer/mineral, each has characteristic respectively. Through research, combined with the excellence of the above SAP materials, optimizing the preparation technology of the polymer/mineral/starch multivariable complex SAP materials to abstain acrylic acid/ sodium betonies/starch material (Yu X.-L., 2005; Li Y., 2009) which has better water absorption quality. Adopting this kind of SAP material to carry out the dehydration of the waste cooking oil which is from the canteen leftovers and oil boxes of hoods, it is indicated that the SAP has sound effects.

## 1. Experimental section

### 1.1 Material and reagent

Material and reagent: All reagents were of purisms quality. Sodium betonies is bought from the; Industry acrylic acid; Marketed corn flour; Marketed salt; The initiator ammonium persulfate; The cross-linking agent MBA, NaOH.

Instruments and equipments: the D25-2F electric governmental agitator, DK-98-1 galvanothermy thermostatically water-bathing pot, electron balance, three-neck flask, galvanothermy thermostatically oven.

### 1.2 The preparation of the SPA

Under stirring conditions, a certain concentration NaOH was added into the ready-prepared acrylic acid solution, the temperature of the solution was kept below 45°C by controlling the rate of neutralization; after that, the sodium betonies, starch and cross-linking reagent was added into the blending solution of acrylic acid/acrylate, and the mixture was stirred for 30 min; then, mix the well-diluted initiator agent with the above solution, increase the rate of stirring until the system reaches stiff peals, and keep the stirring for several hours at this stirring speed and under constant 80°C, at last, the product was taken out to dry and form under low temperature.

### 1.3 The determination of absorption override

The absorption override is defined as the weight of water that has been absorbed by the SPA, and is expressed by means of g/g. It is composed of the absorption override in pure water and in 0.9% physiologic line, and is usually devalued by employing filtration and weighing.

$$M = (m_2 - m_1) / m_1$$

Here, M is the absorption override (g/g);  $m_1$  is the mass of the dry resin (g);  $m_2$  is the mass of resin after absorption (g).

We use the absorption override in pure water and saline to devalue the property of the SPA, the higher absorption override the better of the water absorbtivity and salt tolerance.

### 1.4 The dehydration experiment of the waste cooking oil

Add the home-made SPA to the 1L waste cooking oil in the round bottomed flask, and keep for a while under stirring conditions. Adopt  $\text{CaCl}_2$  method to calibrate the water content in the waste cooking oil, and the specific process is as followed: add 150g anhydrous  $\text{CaCl}_2$  particles to the 1L waste cooking oil, and stir the solution under room temperature, after the specified time, filet the  $\text{CaCl}_2$  particles using the 100 purpose screen, wash the waste cooking water that is absorbed in the  $\text{CaCl}_2$  particles using diethyl, then weigh these  $\text{CaCl}_2$  particles  $m_2$ (g), so, the absorption content of the sample is  $(M) = (m_2 - 150) / 150$ (g/g).

## 2. Results and discussion

### 2.1 The testing of the absorption of the SPA

The color of the home-made SPA is gray, the size distribution is between 50-200, the particle density is 1.02g/cm<sup>3</sup>. Weigh 0.25g SPA actually, and put it in the 500mL beaker which contains 100mL pure water or 0.9% NaCl(aq) for different soaking time, then remove the outside water through nylon wire screen, and keep the SPA stand for 15min, measure the mass of the SPA, so, the absorption of the sample is  $(M) = (m_2 - 0.25) / 0.25$  (g/g).

From Fig.1, we can see the pure water absorption rate of the SPA was up to 126.53g/g; from Fig.2, we can see the saline absorption rate has the largest value 31.41g/g. According to both the graphs, the absorption rate of the SPA can reach a stationary value within about 120min, which illustrated the optimal time for dehydration is 120min.

### 2.2 The influence of pH to the absorption property

In order to detect the influence of pH to the absorption property, we gain five dates by testing five different pH solutions containing the SPA.

From Fig.3, we can see the pH value plays a role on the absorption of the SPA, the absorption property will be restrained in strong acid and strong base, and when the pH change from 7.0 to 4.5, the absorption rate reduced 2 times. The absorption property achieves the largest value when the pH is 7.0.

### 2.3 The test of absorption performance in waste cooking oil (the waste cooking oil from the canteen leftovers)

Getting rid of the solid matter consisted in the collected waste cooking oil, we got the clear liquid, the liquid density is 0.941g/cm<sup>3</sup>, the color of the liquid is light fawn. We gain the water content in the waste cooking oil

2.46wt. % by means of  $\text{CaCl}_2$  calibration. At room temperature, add 50g, 75g, 85g, 100g, 150g SPA to the 1L waste cooking oil respectively, after stir for five hours, the solutions was filtrated and we got the product, that is the water-retaining SPA. Then again, we test the water content in the above treated waste cooking oil by means of  $\text{CaCl}_2$  calibration, the results of the water content are shown: 1.63 wt.%, 1.54wt.%, 1.37 wt.%, 1.23 wt.%, 0.98wt.%, the percentage of the water that has been absorbed by the SPA are 31.93 %, 54.82 %, 56.60%, 58.29 %, 60.48 %. The water content in waste cooking oil is high, and the dehydration of the SPA is obvious, in Fig.4(a), we can see that, the water content in waste cooking oil decreased along with the increased amounts of the SPA. When the amounts of the SPA is up to 75g in 1L waste cooking oil, the water absorption rate change a little in unit time, therefore, the appropriate amount is 75g/L when the water content in waste cooking oil is high.

#### 2.4 The test of absorption performance in waste cooking oil (the waste cooking oil from the oil box of the hoods)

Getting rid of the solid matter consisted in the collected waste cooking oil, we got the clear liquid, the liquid density is  $0.877\text{g/cm}^3$ , the color of the liquid is fawn. We gain the water content in the waste cooking oil 0.46wt. % by means of  $\text{CaCl}_2$  calibration. At room temperature, add 50g, 75g, 85g, 100g, 150g SPA to the 1L waste cooking oil respectively, after stir for five hours, the solutions was filtrated and we got the product, that is the water-retaining SPA. Then again, we test the water content in the above treated waste cooking oil by means of  $\text{CaCl}_2$  calibration, the results of the water content are shown: 0.42wt.%, 0.38wt.%, 0.36wt.%, 0.34wt.%, 0.31wt.%, the percentage of the water that has been absorbed by the SPA are 6.96%, 9.27%, 9.84%, 10.38%, 11.12%. Because the waste cooking oil comes from the evaporation and condensation of the edible oil in cook-process, the most moisture form into the atmosphere in gaseous, and this leads to that the water content in waste cooking oil is low. In Fig.4 (b), we can see that, the SPA possess a certain dehydration which can make the water content in waste cooking oil reduce to 0.31%. When the amount of the SPA is higher than 75g/L, the dehydration efficiency drops, while, in order to insure the water content low enough, we have to increase the amount of the SPA, indicating that the SPA has appeal and wide application for the waste cooking oil from separate sources.

#### 2.5 The recovery property test of the SPA

Wash the SPA from the experiment 1.4.1 using the ethanol, and continue to use 4 times, 6, 8 times, then put them in the 100mL demonized water in the 500mL beakers for 2 hours, after that, filtrate the water in the SPA using the nylon mesh screen and keep the SPA stand for 15min on the mesh screen, we test the percentage of absorbed water is 20.56%, 16.87%, 13.09% respectively.

Experiments showed that the SPA is repeatable but its effect is limited.

### 3. Conclusions

The SPA made of the sodium betonies, starch and acrylic acid has better water absorption, the pure water absorption percentage is 126.53g/g, the saline absorption percentage is 31.41g/g; the pH value has influence on the absorption of the SPA, and when the pH is 7.0, the water absorption percentage reaches the largest.

Adopting the resin adsorption to carry out the dehydration of the waste cooking oil which is from the canteen leftovers and oil boxes of hoods, it shows that the SPA can absorb water in the waste cooking oil effectively. When the water content is higher (about 2%), the optimal amount of the SPA is 75g/L; when the water content is lower (<1%), in order to make sure a low water content, we can increase the amount of the SPA. Experiments indicates that the SPA has appeal and wide application for the waste cooking oil from separate sources and possess better performance.

### References

- Emileh A., Vasheghani-Farahani E. & Omani M. (2007). Swelling behavior, mechanical properties and network parameter of pH-and temperature-sensitive hydrogels of poly((2-dimethyl amino) ethyl methacrylate-co-butyl methacrylate) [J]. *Eur. Polym. J.*, 43(5): 1986-1 995.
- Floury P. J..(1953). *Principles of Polymer Chemistry[M]*. New York: Cornel University Press.
- Jeannine, E. Elliott, Mara Macdonald, Jun Nie, etal. (2004). Structure and swelling of poly (acrylic acid) hydrogels: effect of Ph, ionic strenh, and dilution on the crosslinked polymer structure [J]. *Polymer*, 45(5): 1503-1510.
- Li Y., Chen J. (2009). Research on the Application of betonies in super absorbent compound polymer, *Journal of Non-Metallic Mines*, 32(5): 42-44.
- Ling H., Shen S.-Y., Fan L.-R., et al. (2006). Preparation for fly ash/sodium polyacrylate super absorbent polymer composite material. *Journal of Functional Materials*, 37(11): 1812-1815.

Long J.-Y., Song Z.-Q.. (2002). Progress in the synthesis and application of starch super absorbent polymers. *Journal of Fine Chemicals*, 19(9): 541-543.

Yu X.-L., Zhang R., Sun Y.-G., et al. (2005). The preparation research on acrylic salts/betonies/starch super-absorbent composite. *Journal of Non-Metallic Mines*, 28(6): 18-20.

Table 1. The absorption rate of the SPA in different pH solutions

pH	4.5	5.8	6.5	7.0	8.4
Process-time(h)	2	2	2	2	2
Absorption rate(g/g)	60.4	99.8	120.4	126.5	94.5

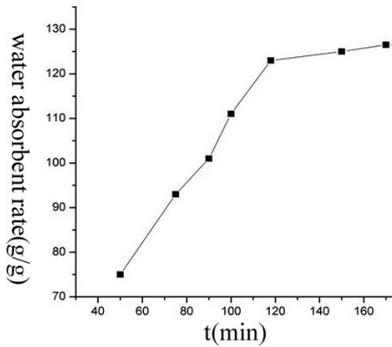


Figure 1. The Pure Water Absorption Rate vs. Time

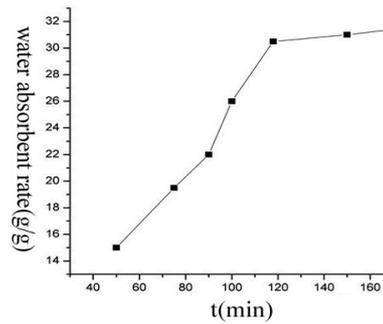


Figure 2. The Saline Absorption Rate vs Time

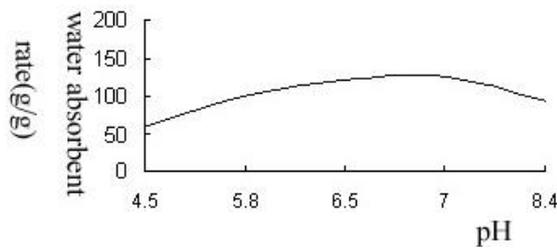
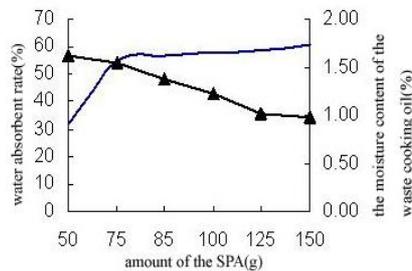
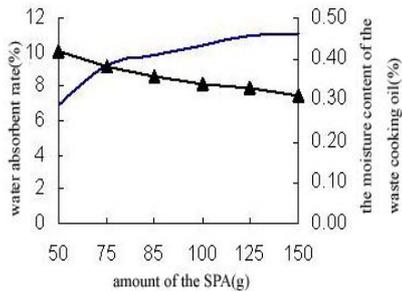


Figure 3. The Influence of pH to the Absorption Property of the SPA



(a: The Waste Cooking Oil from the Canteen Leftovers)



(b: The Waste Cooking Oil from Oil Boxes of hoods)

Figure 4. The Influence of the Amount of the SPA to the Dehydrated Efficiency