Study on the preparation of composite flocculant for solid-liquid separation of livestock manure

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Abstract. Through several flocculants flocculation effect on solid-liquid compared with two kinds of good flocculation effect of flocculant FeCl₃ and AlCl₃, Select two better flocculant by composite flocculation test to find the best dosage, the optimum proportion and optimum dosage form for composite flocculant .Through the experiment, it can provide the effective compound flocculant flocculation for the treatment of the wastewater from the solid-liquid separation.

Key words: Solid-liquid separation water, flocculant, Screening preparation

1. Preface
At present, a certain degree of solid-liquid separation is required for the wastewater from large livestock farms at home and abroad before biochemical treatment, but it is often difficult to achieve the ideal solid-liquid separation effect [1], However, the poor effect of solid-liquid separation will result in a large number of solid substances that are difficult to be degraded in the wastewater of the aquaculture farm, and a large number of solid substances that are difficult to be degraded will seriously affect the biochemical treatment effect of the wastewater in the later stage [2]. It is urgent to develop a new coagulant which can adapt to the water quality characteristics of pig farm wastewater to separate the solid substances in the wastewater. The solid substances separated by solid-liquid separation method can be made into high-quality organic compound fertilizer urgently needed in agriculture, which can bring economic benefits to pig farm and reduce the cost of wastewater treatment.

2. materials and methods
2.1. reagents, instruments and materials
Reagent Ferric chloride, aluminum chloride, PFS
The material fecal water is the effluent with different solid content obtained by feeding pig feces with different moisture content into pig farm through XY solid-liquid separator, which is collected and stored in freezer (40C) for standby, and waste liquid of various concentrations is prepared according to the needs.
Instrument HJ-4 magnetic mixer, 722 spectrophotometer
2.2. analysis method

The transmittance is measured by 722 type spectrophotometer, and the CODCr is measured by chemical oxygen consumption meter. The removal rate of CODCr is calculated according to the following formula:

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\text{CODCr removal rate} = \frac{\text{COD}_{\text{raw wastewater}} - \text{COD}_{\text{after flocculation}}}{\text{COD}_{\text{raw wastewater}}}
\]

Data is the average of 3 repeated tests.

Several flocculants with better flocculation effect selected by pre experiment are dissolved in 1% of \(\text{M/v}\). Under the same conditions, the solid-liquid separation liquid with solid content of 93.2% was flocculated and precipitated. After 4 hours of reaction, it was determined. The flocculant with the largest amount of water was the best flocculant. At the same time, the reduction rate of CODcr and the transmittance of flocculation effluent were measured as auxiliary indexes to help judge the flocculation effect. Then the best two flocculants are selected according to a certain proportion, in order to obtain a better flocculant with the same dosage.

3. results and discussion

3.1. comparison of several flocculants

Feces with water content of 93.2% were flocculated with FeCl3, AlCl3 and PFS. Under the same conditions, they were used to flocculate a group of 100ml feces samples after solid-liquid separation and the prepared flocculant (after adding flocculant, stirring with magnetic mixer for 2 minutes, and then standing for sedimentation). After standing for a certain period of time, the SVI value of each sample after flocculation treatment (SVI value is the ratio of the volume of the effluent to the total volume of the precipitated solid matter) is measured respectively, and it is found that the flocculants that reach the maximum SVI value after flocculation are the best flocculants.

| Name  | time(h) | SVI/% | COD Reduction rate/% | Transmittance/% |
|-------|---------|-------|----------------------|-----------------|
| FeCl3 | 4       | 52.67 | 57.00                | 22.15           |
| AlCl3 | 4       | 51.51 | 57.30                | 10.40           |
| PFS   | 4       | 43.36 | 35.00                | 5.20            |

It can be seen from the table that under the same conditions, when the dosage is 1%, the SVI value of FeCl3 is the highest, and the water quality index of flocculation effluent is higher than that of the other two flocculants. The COD reduction rate of FeCl3 flocculation effluent is 22 percentage points higher than that of PFS flocculation effluent, and the COD removal rate is significant. Compared with AlCl3, the highest COD reduction rate of FeCl3 flocculation effluent is almost the same, but the water quality of FeCl3 flocculation effluent passes through The highest rate is 22.15%. Compared with the other two flocculants, the effect is significant. Based on the above indicators, PFS is the worst for the dewatering and flocculation of fecal liquid, and FeCl3 and AlCl3 are the best. However, considering that iron ions are contained in the iron salt, it is easy to make the effluent of fecal flocculation show iron ion color [3]. Therefore, in order to ensure high flocculation effect and get good flocculation effluent quality, and make full use of their respective advantages, we explore the mixed use effect of FeCl3 and AlCl3, in order to get a better composite flocculant aiming at the water quality characteristics of solid-liquid separation effluent.
3.2. comparison of the effect of flocculant used alone and in combination

According to the above experimental method, with 0.2% drug content as a gradient, the effect of FeCl3 alone and the mixture of FeCl3 and AlCl3 with the same concentration for 12 hours was compared, and the results are shown in table 2 and table 3.

Table 2. Flocculating effect of by using FeCl3 and AlCl3 under the different addition dosage

| dosage         | SVI/%  | COD Reduction rate (%) | Transmittance (%) |
|----------------|--------|------------------------|-------------------|
| 0.2%FeCl3+0.2%AlCl3 | 52.67  | 30.54                  | 0.3               |
| 0.4%FeCl3+0.2%AlCl3 | 62.60  | 35.00                  | 1.15              |
| 0.6%FeCl3+0.2%AlCl3 | 83.40  | 42.50                  | 10.3              |
| 0.8%FeCl3+0.2%AlCl3 | 85.19  | 50.41                  | 18.85             |
| 1.0%FeCl3+0.2%AlCl3 | 86.92  | 51.01                  | 25.75             |

Note: 0.2% FeCl3 + 0.2% AlCl3 means adding 0.2% FeCl3 first and then 0.2% AlCl3 (the same below).

Table 3. Flocculating effect of by only using FeCl3 under the different addition dosage

| dosage | SVI/%  | COD Reduction rate (%) | Transmittance (%) |
|--------|--------|------------------------|-------------------|
| 0.4%FeCl3 | 51.52  | 28.52                  | 0.55              |
| 0.6%FeCl3 | 61.29  | 29.33                  | 4.9               |
| 0.8%FeCl3 | 81.82  | 34.80                  | 16.3              |
| 1.0%FeCl3 | 81.82  | 41.69                  | 25.45             |
| 1.2%FeCl3 | 85.19  | 42.30                  | 26.25             |

From the comparison of the above two tables, it can be seen from the SVI value of the main indicators of flocculation that the flocculation and dehydration effect of FeCl3 and AlCl3 mixed flocculant with the same concentration under different concentration gradients is better than that of FeCl3 with the best flocculation and dehydration effect of the same concentration alone. From the above table, it can be seen that with the increase of dosage, SVI value increases gradually, when the dosage is increased to 1%, the efficiency is obvious. If the dosage continues to increase, the overall flocculation effect is not obvious. When using 1.0% (0.8% FeCl3 + 0.2% AlCl3) content mixed flocculant, its SVI value is significantly higher than the flocculation effect of FeCl3 alone, which can achieve the flocculation effect of 1.2% FeCl3 alone, and the COD reduction rate is significantly higher than the flocculation effect of 1.2% FeCl3 alone, which can reduce the later load of flocculation effluent. It can be seen from the above experiments that the composite flocculant with the ratio of FeCl3 and AlCl3 is better than that with FeCl3 alone, and the optimal dosage of the composite flocculant is 1%.

3.3. determination of the best way of adding compound flocculant

Three schemes can be obtained by combining the two flocculants in different ways: first adding ferric chloride, then adding aluminium chloride, first adding aluminium chloride, then adding ferric chloride, at the same time adding ferric chloride and aluminium chloride. Under the same condition of adding 0.5% flocculant and 1% total flocculant respectively, the flocculation effect of several ways of adding flocculant was compared. The test method is as described before, and the results are shown in table 4 after 20 hours of standing.
Table 4. Effect comparison of the flocculating effluent by different adding drug ways

| Dosing method                        | SVI/% | COD Reduction rate (%) | Transmittance (%) |
|--------------------------------------|-------|------------------------|-------------------|
| 0.5%FeCl3+0.5%AlCl3                  | 100   | 53.04                  | 13.7              |
| 0.5%AlCl3+0.5%FeCl3                  | 88.67 | 52.03                  | 16.65             |
| Add 0.5% FeCl3 and AlCl3 at the same time | 81.82 | 44.33                  | 13.9              |

It can be seen from the above table that the best way of dosing is to add FeCl3 first and then AlCl3, while the worst way is to add two flocculants at the same time. The difference of SVI between the two ways is about 20 points. The difference of COD reduction rate was about 10 points, and the two indexes showed significant effect, but had no significant effect on the light rate. However, the flocculation and dehydration of salts often rely on their own hydrolysis to form flocs to achieve this goal. The flocculation effect of two kinds of salts is the worst when they are put into flocculation at the same time, which may be caused by the addition of two kinds of salts at the same time that they inhibit each other's hydrolysis, and it is difficult to form flocs to reduce the flocculation effect [4].

3.4. determination of the best mix proportion of composite flocculant

After mixing FeCl3 and AlCl3 according to different mass ratios according to 1% of the optimal dosage, they are respectively mixed with water to form a composite flocculant solution with a total mass fraction of 1%. Under the same experimental conditions, the solid-liquid separation solution is flocculated. The flocculation effect of each proportion of FeCl3 and AlCl3 is shown in table 5 below:

Table 5. Flocculating effect under the different proportion of FeCl3 and AlCl3

| mFeCl3: mAlCl3 | SVI/% | COD Reduction rate (%) | Transmittance (%) |
|----------------|-------|------------------------|-------------------|
| 1%: 0%         | 81.82 | 45.03                  | 11.53             |
| 0.8%: 0.2%     | 100.00| 44.51                  | 7.70              |
| 0.6%: 0.4%     | 85.19 | 45.03                  | 6.30              |
| 0.5%: 0.5%     | 83.49 | 43.57                  | 4.90              |
| 0.4%: 0.6%     | 82.82 | 45.98                  | 6.87              |
| 0.2%: 0.8%     | 92.30 | 44.24                  | 4.73              |
| 0%:1%          | 80.18 | 45.45                  | 4.77              |

Note: 1%: 0% means that FeCl3 dosage is 1% and AlCl3 dosage is 0%; the same below.

According to table 1-5, when the ratio of mfecl3: malcl3 is 0.8%: 0.2%, SVI is the largest, and its dehydration effect is the best. Therefore, the best ratio of mfecl3: malcl3 is 0.8%: 0.2%. There was no significant difference in COD reduction rate and transmittance under different ratios. In the above table, when the ratio of mfecl3: malcl3 is 1%: 0% and 0%: 1%, the SVI value is lower than that of other mixing ratios, which further verifies that the mixed flocculant prepared by using is better than the single use effect of various flocculants.

4. Conclusions and suggestions

4.1. through the comparison of flocculation effect of several flocculants in solid-liquid separation effluent, it can be seen that the flocculation effect of various flocculants is: FeCl3 > AlCl3 > PFS.

4.2. under the same conditions, the flocculation effect of FeCl3 and AlCl3 in combination is better than that of the two alone; the best dosage of FeCl3 and AlCl3 for solid-liquid separation effluent is 1%, and the best ratio is 0.8%: 0.2%; the dosage method should be adding FeCl3 first and then AlCl3.
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