

## A new harmless disposal method of aluminium phosphide residue

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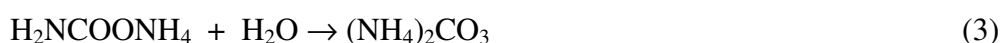
**Abstract.** Treatment phosphine gas with absorption oxidation, let gas went through the oxidant solution. Use concentration of sodium hypochlorite 1%-8% (w/w) as oxygenate, the absorption rate of phosphine [φ] was various from 41% to 61%. Compared with the other phases, such as hydrogen peroxide, potassium permanganate, iron trichloride, sodium hypochlorite is better as oxidation agent in the process of phosphine gas absorption oxidation.

### Introduction

56% Aluminium phosphide fumigant is used extensively at home and abroad, it has already been applied to the pest control range of other food outside the industry, and has achieved very good results. Aluminium phosphide absorbed moisture in the air to produce phosphine in process of decomposition. Phosphine is colorless and tasteless, low boiling point, and the diffusion is speedy, slightly heavier than the air, insoluble in water, slightly soluble in water, soluble in alcohol and ether. Aluminium phosphide fumigant decomposes to produce a large amount of residue after fumigating treatment. Aluminium phosphide residue containing phosphine 3% above has not been volatilized<sup>[1]</sup>, decomposed and utilized. So, we have always attached great importance to deal with aluminium phosphide residue. Treatment of aluminium phosphide residue generally adopts two ways, one is chemical treatment, and the other is buried in a deep pit far away from the water source region. How to do better on the proposal of aluminium phosphide residue in a non-toxic, harmless treatment, safety, environmental protection way, had been explored in the topic of us.

Residue processing for a completely reaction residue, another is incompletely reacted residue. Complete reaction residue, which is the main component of some impurities (Paraffin) and alumina, there is no toxic and harmful substances. Safe transport to the far away from water and animal living area of at least 50 meters place, can dig deep and bury. The incompletely reacted residue must be specially treatment.

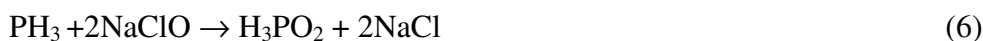
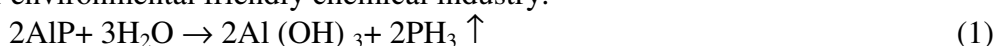
56%Aluminium phosphide tablets in the ingredients are mainly aluminium phosphide, ammonium carbamate and talcum powder. Aluminium phosphide (tablet, pill, powder) reacted with acid /water to release phosphine, carbon dioxide, ammonia and other gases. The following related chemical reaction such as:





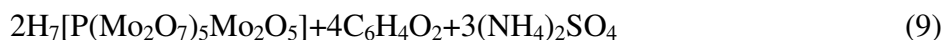
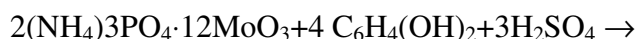
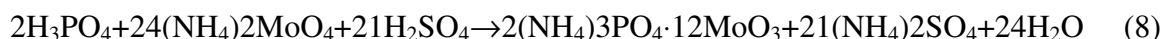
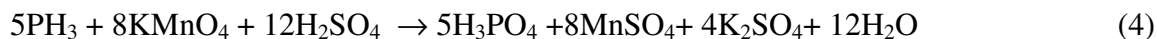
Aluminium phosphide residue decomposed is offwhite appearance, mainly ingredients were aluminium hydroxide, ammonium carbonate and eupholite or talcum powder and so on, individual are taupe or celadon because of containing impurities.

Our research method is adopting hydrolysis and oxidation to treat aluminium phosphide residue. First, Aluminium phosphide residue is hydrolyzed to phosphine and aluminum hydroxide, then phosphine was oxidized to phosphate, such as phosphoric acid, sodium phosphate and so on. And aluminum hydroxide was further converted to poly aluminium chloride (PAC). The PAC is one kind of important water treatment medicinal drug. Harmless treatment complete, in accordance with the requirements of environmental friendly chemical industry.



## Experiment

**Measurement.** Detection method of phosphine gas be measured through GB/T16037-1995. Phosphine absorbed in potassium permanganate solution was oxidized to phosphate, and then reacted with ammonium molybdate into ammonium molybdophosphate, ammonium molybdophosphate is reduced with p-benzenediol to phosphomolybdate blue, Shades of blue is proportional to the phosphine content, so the content of phosphine can be determined by colorimetry. The chemical reaction involved as following:



Oxidation absorption liquid consists of oxidant dissolved in aqueous solution<sup>[2]</sup>. When the phosphine gas flow through the absorption liquid, it was oxidation and absorption. The absorption rate of phosphine[φ] was calculated based on the original concentration of phosphine gas(C<sub>0</sub>) and final concentration (C) as follows:

$$\varphi = \frac{C_0 - C}{C_0} \times 100\% \quad (10)$$

According to the literature<sup>[3]</sup>, determine alumina and basicity in the aluminium polychloride (PAC).

Use Ion Chromatography to determination content of sodium hypophosphite in solution.

**Process of Aluminium phosphide hydrolysis(P1).** *Preparation of phosphine* Put 56% Aluminium phosphide tablets 60g into 250ml four necked flask with thermometer, nitrogen inlet protection, stirring, 100ml water was dripping slowly, the gas of phosphine generated by absorption

into the solution which containing an oxidizing agent to turn into hypophosphorous acid or hypophosphite.

Keep the temperature not more than 25°C . The tail gas discharged outdoors.

**Process of poly aluminium chloride(PAC).** *Preparation of PAC* -- In the former four necked flask, the residual was transfer to another 500ml reactor, added 150ml 20% hydrochloric acid and 12ml 20% sulfuric acid, stirring, keep the temperature between 95°C to 110°C after 4h-5h reaction. When the temperature reduced to 50°C, the solid particles were filtered from the solution, then adjust pH = 3.5-4 with aqueous ammonia. Cooling, solution of PAC was gained. Appearance was yellowish transparent liquid; specific gravity was not less than 1.19.

## Results and discussion

**Different absorption rate vs different concentration of sodium hypochlorite.** Studies show that, in the process of preparation of phosphine, the absorption rate of phosphine [ $\phi$ ] was different with the different concentration of sodium hypochlorite[C]. Under the condition of pH=10, the concentration of effective chlorine was from 1% to 8%, absorption time was 30 minute, comparative study of the effect of oxidation. Result was shown in Fig. 1.

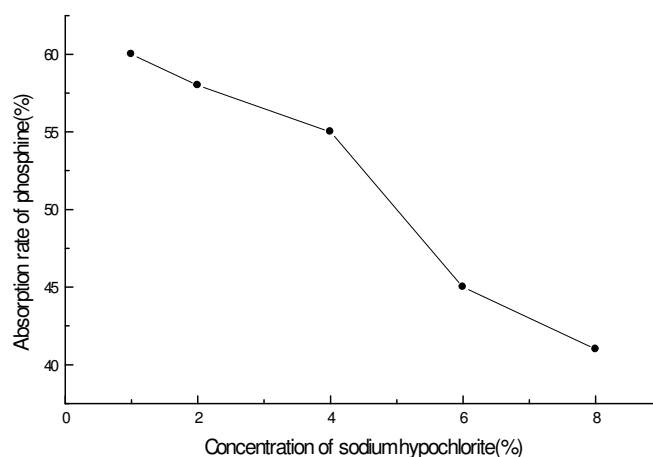
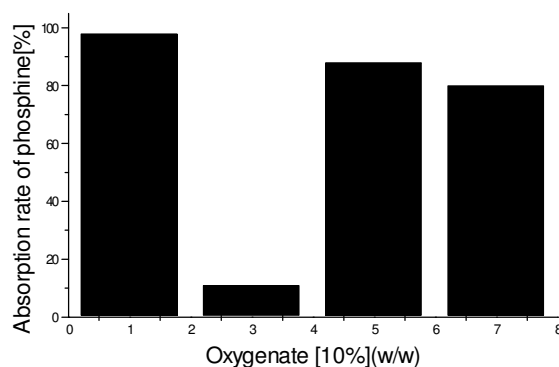


Fig. 1 Effect of absorption vs the different concentration of sodium hypochlorite

The data in Fig.1 indicated that the absorption oxidation effect of low concentration liquid was better than high concentration, but in order to keep the speed of response necessary, need to add sodium hypochlorite constantly, and need to add potassium hydroxide or sodium hydroxide to maintain basic.

### Effect of different oxygenate on phosphine gas

In the same condition of 10% (w/w) by absorption into the oxygenate solution, flow the phosphine gas as the process P1. Researches the absorption oxidation rate was different from oxygenant. Result was shown in Fig. 2.



1-sodium hypochlorite, 2- hydrogen peroxide, 3- potassium permanganate, 4- iron trichloride

Fig. 2 Effect of different oxygenate

The data in Fig.2 indicated that compared with the other phases, such as hydrogen peroxide, potassium permanganate, iron trichloride, sodium hypochlorite is better as oxidation agent.

According to research, whether the acidic, alkaline or neutral conditions, always gained hypophosphite.

### Conclusions

The concentration of sodium hypochlorite effect oxidation evidently. Low concentration sodium hypochlorite liquid was better than high concentration. In the process of absorption oxidation, the phosphine gas was completely converted to hypophosphite.

### Acknowledgements

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