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The industrial practice of co-processing sewage sludge in cement kiln

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Abstract

With the increasing of sludge emissions and people's increasing demand for better dwelling environment, resource utilization of sludge receives much concern in recent years. Currently, the co-processing of sludge in cement kiln has been considered as a sustainable way to dispose sludge in Japan as well as Europe and the United States. Huaxin has begun the co-processing of sludge in cement kiln since 2008. So far, 65000 tons of sludge has been successfully disposed. This paper focus on 3 ways of co-processing sludge in cement kiln through certain project examples.

Keywords: sewage sludge; dewatering; cement kiln; co-processing

1. Introduction

Sewage sludge refers to the residual, semi-solid material left from sewage treatment processes. It is rich in organic matter, nutrients, heavy metals as well as potentially pathogenic organisms (viruses, bacteria etc) [1]. The most common treatment options for sludge include landfill, compost and incineration [2]. These treatment technologies play an important role in the practical application, but they have some drawbacks. How to treat sludge in a safe and effective way has become a major problem in the process of urban development.

Currently, co-processing of sludge in cement kiln has been considered as a sustainable way to dispose sludge in Japan as well as Europe and the United States. In Japan, from 1996 to 2004, sludge used to produce cement showed a trend of rapid growth, and has become an important way of the final disposal of

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sludge [3]. Relying on the state-of-the-art NSP cement production lines, Huaxin has carried out several engineering practices in Yichang, Huangshi and Wuhan since 2007. At present, Huaxin has developed three ways of co-processing sludge in cement kiln. This paper gives a brief introduction of the processes and technical characteristics of them.

2. Composition and characteristics of sewage sludge

To learn more about the characteristics of sewage sludge, we analyzed sludge with different water content. Table 1 shows the relationship of water content and calorific value. It can be seen from the table, the higher the water content, the lower the calorific value. According to the production data, sewage sludge with 50% water content can be easily co-processed in the cement kiln without feeding any additional fuel.

Table 1. The relationship of water content and calorific value

Water content （%）	Calorific value （kcal/kg）
0	1781.5
10	1543.4
20	1305.2
30	1067.1
40	828.9
50	590.8
60	352.6
70	114.5
80	-123.7
90	-361.9

Figure 1 shows the chemical composition of sludge, coal, clinker and raw material. It can be seen from figure 1, the composition of sludge is between marl and coal. Sludge can be used as alternative raw material in cement kiln.

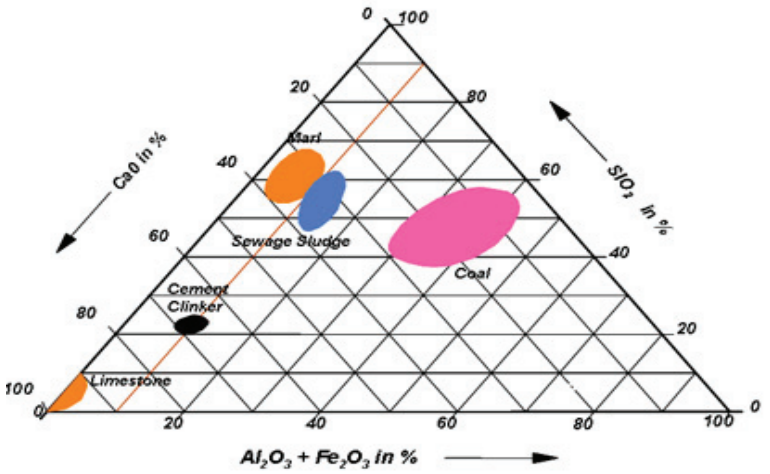

Fig.1 Composition of sludge, coal, clinker and raw material.

3. The industrial practice of co-processing sewage sludge in Huaxin

3.1. Wet sludge fed to cement kiln directly

In 2008, Yichang tried to create national environmental model City. To dispose the sewage sludge in a safe and environmental friendly way, Huaxin reconstructed the 2500t/d clinker production line, and buit a 100 t/d sludge co-processing line in a short time. Since the co-processing line put into operation, it has disposed a total of 5500 tons of sludge.

The process flow is as follows: wet sludge from sewage treatment plant (water content of about 80%) is transported to a reservoir in Huaxin Yichang cement plant, and then fed directly to the inlet of the kiln through high pressure pumps. Sludge is transported in closed trucks to avoid secondary pollution.

More than 3 years of industrial practice has fully proved that feeding wet sludge directly into the cement kiln has no effect on the flue gas emissions, and cement products can meet the requirements of national standards. The process is simple and low cost. It can realize the harmless disposal of sludge in a short time. However, the drawback is that the transportation cost is high, and when the sludge feeding to the cement kiln exceeds a certain amount, cement fuel cost will increase.

3.2. Sludge dewatering and cement kiln co-processing

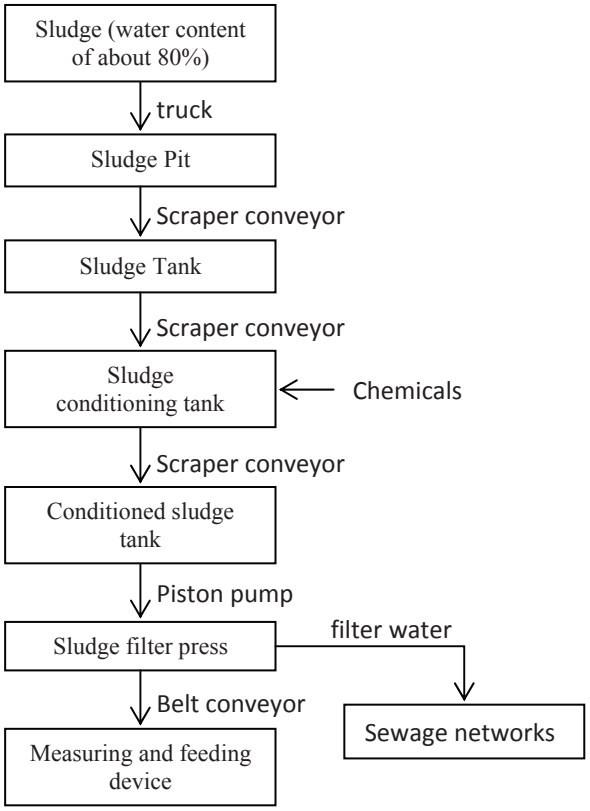

Fig.2 The process flow diagram of Huangshi sludge dewatering system

Sludge with water content of about 80% fed directly to the cement kiln will increase the coal consumption in the cement production. It can achieve the harmless disposal of sludge, but can't realize resource utilization. Huaxin developed a dewatering system on the basis of summing and integrating the chemical conditioning and mechanical dewatering technology. The system is put into operation in 2011 in Huangshi Huahu Sewage treatment plant. We built a 100t/d sludge dewatering plant there, reducing the water of sludge from 80% to 50%. Sludge with only 50% water can be easily co-processed in the cement kiln without feeding any additional fuel. Huangshi sludge dewatering plant has successfully disposed about 10500 tons of sludge since December of 2011. It provides an effective solution to the problem of local sludge disposal.

Figure 2 shows the process flow diagram of Huangshi sludge dewatering system: wet sludge from sewage treatment plants is transported to the sludge dewatering plant, discharged to a sludge pit, and then conveyed to a sludge tank through a scraper conveyor. Then the sludge is conveyed to a conditioning tank, followed by the adding of some chemicals to improve the dewatering properties of sludge. After conditioning, the sludge is conveyed to conditioned sludge tank and stored for filter pressing. At last the conditioned sludge was pumped to a dedicated sludge filter press which can reduce the water content of sludge to 50%. The mud cake was conveyed by belt conveyor, and transported to the cement plant for disposal. The filter water is sent to the sewage networks.

3.3. Sludge dewatering, low waste heat drying and cement kiln co-processing

The cement plant with waste heat recovery system has waste heat (<120℃) which is not fully utilized. To utilize this part of heat effectively, Huaxin developed a low temperature waste heat drying system. Sewage sludge is dried further in this system after dewatering. The system has put into use in Huaxin Huangshi plant. At present, the project has entered the commissioning phase.

The process flow is as follows: crushing the mud cake(water content <50%); conveying them to a independently developed preheat device using the low temperature waste heat from cement plant; drying the sludge to water content below 50%; conveying them to the calciner via measuring pocket and screw pump; burning them in sludge burner. The exhaust gas produced in the sludge drying process is disposed through the exhaust gas treatment system to achieve standard discharged

The disposal way can save the transportation cost, avoid the secondary pollution during the logistics process, utilize the waste heat of the cement kiln fully, use the heat of sewage sludge effectively, and achieve the resource utilization of sludge.

4. Conclusion

Taking into account the investment in facilities, transportation costs and other factors, feeding sewage sludge directly into the kiln is more reasonable to small and medium size city or town. By this way, the local government can safely dispose the sewage sludge in environmental sound manner in short term with low investment. Meanwhile, the disposal price is comparative economical.

To the big city with great output of sewage sludge, it is suggested to build a set of dewatering facilities in or near the waste water treatment plant. The water content of sewage sludge can be reduced from 80% to 50%. The primary dewatered sewage sludge will be send to the cement plant for co-processing. Saving the transportation cost and avoiding the secondary pollution during the logistics process. Sewage sludge with 50% water content can be easily co-processed in the cement kiln without feeding any additional fuel.

The plant with waste heat recovery system can utilize the waste heat to dry the primarily dewatered sewage sludge. The water content can be reduced to 30%. The deeply dried sewage sludge will be conveyed into the kiln. After these, we achieve the target of harmless and recycle treatment.

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