The research progress of sugar industry cleaner production

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Keywords: Sugar cane, sugaring, cleaner production, water-saving and reducing emission, cyclic utilization

Abstracts: From the beginning of the last century, the sugar industry has been undergoing reform and advance. In the global economy, the traditional sugar industry chain has been unable to promote economic development, and this development is not based blindly on raise sugar content and sugar yield of sugarcane. We should combine development with current increasingly serious environmental pollution situation. Sugar waste water and sludge and other waste contains high concentrations of organic matter and high acidity [1]. According to the concept of cleaner production, make targeted help in the press, clarification, filtration, evaporation, boiling sugar crystals each step of sugar production can improve efficiency both of technology and equipment. Through closed circuit process such as condensation and cooling recycled water supply system to achieve water-saving and reducing emission, it could also help the sugar industry to achieve sustainable development.

1. Introduction

Sugar is the third major economic crops after oil and cotton in China [2]. As one of the amount of sugar production and consumption country in the world, China's sugar market connect with many of the related manufacturing industries, and directly affects the interests of sugar industry, sugarcane farmers and consumers. In recent years, China's total sugar output is limited by the resources utilization and the competition of foreign sugar industries, resulting in large sugar prices fluctuations, causing a strong impact on the development of sugar industry.

China’s sugar industry has continued the traditional development mode which has lower productivity, cane sugar per unit area yield was only 76% of the United States and Brazil, 56% of Australia [3]. The traditional industrial development model in the process of adapting social progress gradually expose all the disadvantages, which hinders the development, and then economic benefit keeps a decline trend. Besides, In the wake of developments in the eco-industrial, the large number of industrial pollution caused by the sugar industry has become a significant issue for sustainable development of the sugar industry. Adoption of cleaner production, relying on improved production technology and enhance management are more efficiently measures to eliminate pollution. Reduce pollution from the production process, improve the comprehensive utilization of resources which not only relieve the pressure of resource environment, but also profitable for the sugar business.

2. The direction of sugar cleaner production

Cleaner production refers to continuous design improvements, use cleaner energy and materials, adopt advanced technology and equipment, improve management, comprehen- sive utilization, etc. We could starting prevention from pollution sources, improve resource utilization efficiency, reduce

and avoid the generation and emission of pollutants in production, service and products, eliminate hazards to human health and the environment.
a. Keep the fuel energy clean, use non-polluting or less polluting energy and materials.
b. Use low consumption, high efficiency, non-polluting or less polluting pollution process and equipment in the sugar production process.
c. Maximize the use of energy and raw materials, Making effective utilize of sugarcane byproducts and residual waste to achieve circulation in factory including closed economy and recycling economy.
d. Take precautions in each aspect of all running processes, and combine production technology, production processes, management and products with energy, material losses and other factors to achieve sustainable use of resources and economic development.

3. The cleaner production of sugar process

3.1 Sugarcane juice extracted

a. Process

After crush sugarcane, we usually extracting juice by one of the two methods between squeezing and exudation. Juice's extraction rate of physical squeezing is limited. JinGuang sugar factory began to use saturated percolation process in 1987, which refer to lead the dilute juice from squeezer back into cane shred of machine, played a promotion role in percolation efficiency with no more percolation flooding [4]. Take roller feeding technology as a aid, that can keep cut balanced and maintain uniform while feeding. This technology will reduce equipment load, peak impact, power consumption, and effectively improve the extraction of sugar. In addition, both the cooling water and the oily sewage in bearing of squeeze workshop can recycling after treatment. The method of leakage was started in 1960s, which has lower requirement on equipment that is easy to repair, but requires high degree of fragmentation, temperature and water injection. The process will increase the amount of waste water in evaporating and steam consumption in the late stage [5]. The existing technology of exudation is not good at solving these problems, because of the increase of environmental pollution and gradually being replaced by squeezing method.

b. Equipment update

Before squeezing, the use of decoiler, cane cutting machine and shredder can Improve fragmentation as high as 90% in 2-3 times' crushing. The shredder generally has a bad sealing,so that cane silk and cane juice could easily affect the workshop environment because of leakage, and causes unnecessary loss of raw materials. Transport mode can be changed to enclosed type, then do a flexible installation and adjustment [6].

3.2 Sugarcane juice clarification

a. Process

The traditional method of clarifying sugarcane juice including lime, sulfurous acid and carbonate method. This process is aim at remove the non-sugars like pigment, colloid, protein, organic acid and some salt, etc. It is an important step in reducing waste loss of honey, increase of sugar recovery rate and product quality. Lime method is a simple process use only lime to deal with cane, the cleaning ability of non-sugar is low, and more is used to purify red sugar [7]. Sulfurous acid method used lime and sulfur dioxide as clarifying agent, which has add some other phosphate as auxiliary clarifying agent behind the improvement in 1964. The method remove the non-sugars by producing calcium sulfite and calcium phosphate with adsorption and flocculation. Carbonation method use lime and carbon dioxide as a clarifying agent, it need to consume large amounts of lime and carbon dioxide to remove non-sugar completely, the production costs is high and the calcium carbonate of filter mud is a serious environmental pollution.

Low-temperature phosphorus floating method is a clarification method since the studies began in 2000, It can solve the pollution problem of the original filter mud of carbonate method. The filter mud is divided into two parts, which are used as fertilizer or as cement raw materials, all the pollutants are changed into useful resources. The combination of these clarification methods can significantly improve the quality of sugar [8]. Zhengqing Gao, et al. Reported a newly added

adsorbent made by bagasse in the improvement of sulfurous method can absorb color source material, pigment and surplus sulfur, while also removing alarge number of colloidal substances, improve the clarification efficiency [9].

b. Equipment update

In the settling of clarified juice stage, the use of single rapid settling tank can shorten the time of the settlement of interference, and decreases at least 50 percent of the cane juice residence time. Chinese enterprise began the trial of non-cloth vacuum filter system in 1998 which avoid the discharge of wash the filter cloth water. The system handles a large mass of mud, and the filtered juice could participate loop processing by returning sedimentation tank. The Advantage of this equipment truly improve the operating environment, reduce the labor intensity and the sugar content in filter mud, and eliminate pollution of environment from Wash the filter cloth water.

3.3 Juice concentrated, separation and desiccation

Currently the vast majority of Chinese sugar mills adopts quintuple-effect evaporation system in vacuum. Increase the number of effect will decrease the temperature of each tank, there are researches shows the quintuple-effect evaporation system is the best choice on heat loss and material balance. The improvement should be started with automation of clear juice heating, exhaust gas cooling and decompress, liquid level control in evaporation tank, it can grasp the changes of various parameters in the sugar production process to calculate and regulate.

In the boiling and crystallization process of sugar, and the crystals' deposition and diffusion are performed simultaneously, Adding a mechanical forced circulation device that can shorten a lot of time to cook sugar, reduce the level of steam, and to achieve energy saving. An automatic contrifugal for honey separation could greatly enhancing productivity of the centrifuge.

4. The closed-loop process in sugar

4.1 The use of bagasse

The development and utilization of bagasse is more extensive in recent years, due to its′ high degree of lignification, sugar mill often using bagasse as fuel instead of coal, and the bagasse ash as fertilizer is applied back to the cane fields eventually. Bagasse after depithing can be used in the pulp and paper, the cleaner production based on papermaking of bagasse black liquor in the alkali recovery process can reach more than 86%. Besides, the bagasse pulp is bleached easily with low chemical consumption, it can also reduce the emissions of toxic waste [10].

4.2 Condensation water, cooling water circulation

Sugar production adopts condensed and cooling water reuse round system, taking uses of the condensate after boiling and latter-effect evaporate as the whole plant's process water, and steam condensate after cooling can be used instead of fresh water. The cleaning water of heater, evaporation tank and boil tank which passed decontamination triage could be applied as squeeze infiltrate water and to clean the filter, then sewage discharge into the boiler sluicing water system, eventually closed circulatory system is composed through the slag water separator and water dust scrubber.

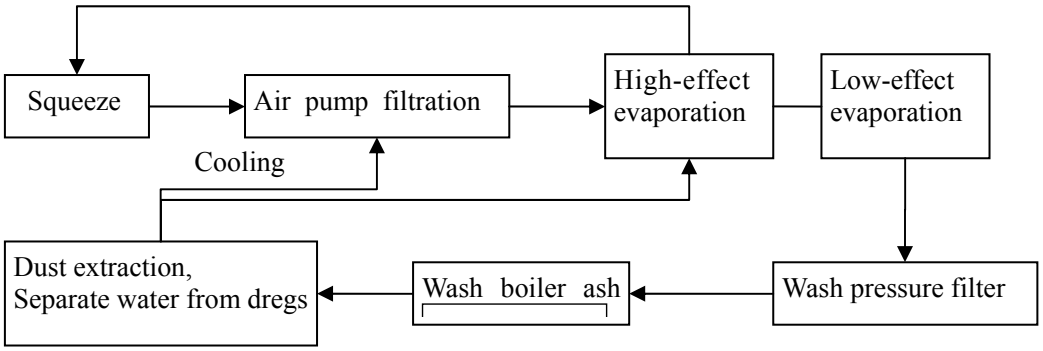

Fig.1 Circulating water system

5. Summary

On the basis of market operation to promote cleaner production and with full awareness of the necessity to cleaner in the production, handling the pollution by switching end-of-pipe treatment to cutting in the source and constantly improve the level of cleaner production to establish a green enterprise image, enhance the public's favor cognition and improve the market mechanism to ensure the lasting resources and economic cycle. Yet, notice that some other industries which derived from the sugar industry should establish an independent plant and sewage systems to avoid polluting the edible product.

Acknowledgements

This research was sponsored by the Guangxi Talent Highland for Hazardous Waste Disposal Industrialization, Guangxi Scientific Experiment Center of Mining, Metallurgy and Environment.

The authors thank the Guangxi Natural Science Foundation (2011GXNSFF018003 and2013GXNSFBA019210),Guangxi scientific research and technology development projects（GuiKeGong14124004-3-7), Guangxi Colleges and Universities Key Laboratory of Agricultural Environment and Ecological Security, Guangxi Colleges and Universities Key Laboratory of Heavy Metal Pollution Prevention Theory and Technology.

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