APPLICATION OF ALTERNATIVE ENERGY IN CEMENT INDUSTRY

Liu,X, Zhou, Y, Wang,L, Chen,S.
Ruitai Technology Co,.Ltd, Beijing, china

ABSTRACT

One of the main characteristics of the second generation new dry process cement technology is wates disposal harmless and resources utilization technology, which point out that the utilization rate of alternative energy in cement industry reaches 40% for developed countries, while China cement groups do not have experience in managing alternative fuels.This essay discussed application of alternative fuels, such as petrol coke, used tire and municipal solid waste, and their impact on refractory.

Keywords: alternative energy, petrol coke, TDF,MSW

INTRODUCTION

China building materials federation proposed “the second generation new dry process cement technology”, one of the main characteristics is “wastes safety and harmless disposal and comprehensive utilization”, pointing out that alternative energy(including domestic waste,used tire) accounts for 40% of whole energy consumed. According to figures offered by China Cement Association, at present time China Cement groups chosen coal and natural gas as main energy source, had short history for selecting alternative fuels. About 1764 cement kilns operated around China in 2015, clinker capability reached 2 billion tons and more than 2300 million tons coal was consumed. While only 10 cement kilns used alternative fuels, which means that save 5 tons of standard coals per year, substation rate is approximately zero. While early in the 2005, alternative proportion for cement manufacturing in the Netherlands is higher than 83%, the ration on average is between 20%-40% in developed areas. What is more, used tire, solid wastes, bones and meats disposed by butchery, second-handed plastic, used engine oil, bio-fuels and so on. Following characteristics supporting 1) gas temperature inside rotary kiln reaches 2000 degree, temperature in decomposing furnace reaches 1100 degree; 2) residence time inside kiln is 8-20 seconds, while for decomposing furnace is 3 seconds; 3) all chemical and physical reaction are all in an oxidation atmosphere.

MUNICIPAL SOLID WASTES

In the year 2010, China became the second largest economic entity replacing Japan. The amazing developing speed generates many by-products at the same time, seriously imparting environmental and eco conditions, municipal solid Waste was one of the byproducts. Now waste production capability increases 8%- 10% per year, in 2015 china’s waste capability ranked the first position, reaching 2600 million tons. It is predicted that China will produce 3200 million tons of wastes in 2020. In comparison with harmless treatment ratios of the United States (95%), the ration of China is merely 63.5%(77.9% for city, 27.4% for county). Now landfill, compost and incineration are main methods for disposing domestic wastes. Due to difference in economic development, lifestyle, various methods are employed in wastes disposal. American, Italy and UK governments prefer sanitary landfills, Denmark, Japan, Holland and Sweden governments prefer incineration, while Finland and Belgian government select compost. But main disposal methods for China is landfill (85%), which is followed by compose(10%) and incineration(3%-5%). And high proportion of landfills leads to land resources waste.

During the process of cement production, main gases emitted contains N_2, CO_2, O_2,H_2O,CO,N_XO and sulfide and other organic compounds. Exclude gases, waste slags involves basic materials(Na_2O, K_2O), acid materials(HCl,SO_3), and heavy metal (Stibium, Arsenic, Chromium, Cadmium, Mercury, Titanium and Vanadium). Main resources of gaseous contaminants: chlorine hydride comes from combustion of PVC, SO_2 comes from combustion of sulfide, HF comes from combustion of fluorine, NO_X comes from combustion of N_2 in the wastes.

Volatile components, such as Na_2O, K_2O, S,Cl , are easily concentrated in kiln tails, decomposing furnace and preheater, cooperative treatment municipal solid wastes intensify corrosion of refractory materials in related areas, lower refractories’ lifetime. Therefore, refractories in co-processing municipal solid wastes focus on anti-basic corrosion property, it is advised that decomposing furnace should select anti-spalling high-alumina bricks and anti-buildup SiC castables, while preheater should select high-strength anti-alkali bricks and castables.

TIRE DIRED FUEL

Ministry of Industry and Information Technology published "Guidance on used tires' comprehensive utilization" on 30th Dec,2010, which pointed out that tire is the main rubber product in China. In 2009, tire consumed approximately 70% rubber, annual capability reaches 2330 million pieces, weighting 8.6 million tons, amounted to 300,000 tons' rubber. Level of used tire comprehensive utilization cannot meet the basic requirement of severe environmental conditions. According to uncompleted statistic, used tire capacity reached 299 million pieces, reaching the weight of 10.80 million tons, with the 8%-10% growth rate. For example, cement production line of 5000t/d every year dispose 70,000 tons used tire with 40% substitution rate.

Tired Derived Fuel, due to advantages like high carbon content, high thermal value and low moisture, Eastern European countries prefer TDF as cement fuel (substitution rate is 60%). Input method can be adjusted: whole or pieces, and decomposing furnace in kiln tail, smoking chamber, and middle positions.When tire burning in the kiln, every component is helpful to cement production. Especially whole tire is used as raw materials, reinforced iron wires can reduce the addition of iron ore. Appropriate amount of ZnO could lower firing temperature.Puertas and Blanco-Varela pointed out that Clinker's chemical composition do not have much difference using TDF or fossil fuels, and tire particles with various sizes can be used as alternative fuel.

Tire is composed of 60% volatile organic compounds, 30% fixed carbon and 10% ashes. Thermogravimetric analysis shows that rubber tire decomposes at 250 ℃, end at 550 ℃. In general, cement clinker fused with solid ash produced by tire decomposition. Usually edge roll contains 1.4% ZnO, exerting negative effect on hydration and hardening. Another point needs special consideration is high sulfur content. Sulfur content in tire is about 2%, sulfur content in coal is about 0.3%. At last, heavy metal are not easily diffused once reacted with clinkers.

Tire produce 25% thermal value more than standard coal of the same weight, that is to say, heat value generated by 1 ton TDF equals to 1.25 tons' coal. In comparison with exclusively use TDF or coal, TDF utilization in an appropriate percentage could obviously improve coal's firing character,especially ignition performance. It signifies that co-combustion between TDF and low-grade coal could reduce premier coal consumption. Furthermore, during cement production buildups caused by the volatilization of KCl, K_2SO_4, Na_2SO_4 and $CaSO_4$ should be prevented, so anti-buildup castables containing SiC should be employed in slope area and inlet parts.

PETROL COKE

In recent years, petrol coke, instead of coal, plays an increasingly significant role in North American Cement Production base. In the past few years, some production base raised the replacement ratio from 10%-25% to 100%. Cheap price and higher thermal value made petrol coke as an effectual way to lower energy consumption. Excluding price factors, other factors relating to its application should be take into account:

1. Increase in NOx discharge: higher thermal value caused by petrol-coke produce higher fire temperature, more NOx is released. Higher NOx discharge needs denitrification treatment or other methods to restrict emission in a reasonable range;

2.Increase in heat consumption: higher oxygen contents improve secondary air temperature, so thermal consumption increased;

3.Clinker composition: high sulfur content in raw materials and ash content could change clinker's chemical composition, alternation of raw materials optimizes clinker's chemical composition and alkali sulfur ratio;

4.Maintenance Fees: petrol coke's utilization needs delicacy management, every stage like coal mill, rotary kilns should enhance maintenance costs

5.Extra Fuel fees: several production bases use natural gas or oil to control fire

6.Stability and service lifetime of refractory materials

Sulfur content in petrol-coke is about 4.9%, 2.5 times of that in used tire, even 7 times of that in standard coal, so refractory materials should have excellent resistance to sulfur; sulfur and alkali vapor penetrate bricks' hot face, and have chemical reaction with inner structure, so refractories should have resistance to infiltration; unstable fire temperature leads to sudden temperature fluctuation, so refractories should have excellent thermal shock resistance. Kiln Sulfur cycles generated by higher alkali sulfur ratio causes formation of thickness coating, cycle and buildups. So, above factors should be considered, writer give several advice according to experience.

1.AZS castables have excellent anti-buildup capability. AZS grain has excellent thermal shock resistance, low expansion coefficient, low thermal conductivity and erosion-resistance capability. Numerous trials approved that AZS has better anti-buildup capability, low thermal conductivity than SiC..

2.High-alumina product with 4-8% ZrO2 powder, fill the interstice between matrix. Wetting angle is larger than 90°, this product is used in areas of buildup and tertiary air duct.

3.Magnesia-spinel brick of low porosity is helpful to kiln shell corrosion，because this type of brick has high modulus of elasticity Castables with high percentage of Aluminate silicate cement should be avoid in the 1400 ℃.

CONCLUSION

Development tendency of refractory materials in cement industry can be summarized in two aspects: on one hand, energy-saving and emission-reduction is future development orientation, new types product, multilayer mullite bricks and magnesia-spinel brick with reduced thermal conductivity , meet requirement of energy saving, these products normally have high porosity; on the other hand, in the next few years, new technique of alternative energy and cooperative disposal wastes in cement kiln will be promoted, in order to avoid the erosion of harmful substances, like potassium, sodium , sulfur and heavy metals, refractory materials should select direction of low porosity and densification. Transitional enterprises like RHI, accumulated plenty of experimental data and technical information to face following market change. While refractories company in developing countries are not equipped with complete production lines to confront with this tendency. In this situation, to seek competitive advantage in pattern of intense global competition, China enterprises' transformation and upgrading need continuously increase R&D development, but also management experimental and production data. Especially in the times of Internet, famous enterprises should organize strategic alliance to dismantle patent barriers and share information on a quid pro quo basis, so as to improving refractory industry's technical and equipment level.

REFERENCE

[1] Zhichu Huang, Dengfeng Zhang, Dan Xie, Reacting condition of harmful substances as waste materials being incinerated in cement kiln and its control, "Cement Engineer" No.5,2004.

[2] Juntao Wang, Songlin Chen, Lin Yuan, Corrosion of disposing urban domestic wastes to refractories for cement rotary kilns, "Refractory" Vol 49, No 3,2015.