

生活垃圾焚烧发电碳排放计算方法研究

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摘要: 利用生活垃圾焚烧处理的余热发电, 在节约能源的同时, 也减少了二氧化碳的排放。结合某垃圾焚烧发电无害化处理工程, 依据 CDM方法学 AM0025 对该项目的碳减排量进行计算, 结果表明, 该项目 10年共减少二氧化碳排放量 477560t, 具有可观的环境效益和经济效益。

关键词: 垃圾焚烧发电; 温室气体; 减排

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引言

20世纪80年代以来, 随着中国国民经济的飞速发展, 城市化进程日益加快, 居民生活水平不断提高, 城市生活垃圾数量大幅度增加^[1]。城市生活垃圾中由于含有大量碳基物质(塑料、纸张、纤维等)而成为温室气体排放的一个重要来源^[2]。因此, 垃圾处理已经成为全球面临的共同问题。

近年来, 受温室效应影响, 全球气候正在加剧地发生着变化, 而二氧化碳和其他温室气体的排放正是引起气候变化的元凶^[3]。

作为气候变暖的重要原因, 碳排放已经引起了我国的高度重视, 并在哥本哈根会议之前宣布了到2020年要在2005年的基础上单位GDP二氧化碳的排放降低40%~45%^[4]。因此, 合理处置固体垃圾, 不对环境造成二次污染, 已成为当务之急。

垃圾焚烧处理是实现垃圾无害化、减量化和资源化的最有效的手段之一^[5]。垃圾焚烧发电是指在800~1000℃的高温下使有毒有害物质充分热解, 产生的大量高温烟气经除尘设施净化后通过余热锅炉将热量回收, 获得一定温度和压力的热蒸汽, 再通过发电机组使其转化为电能, 电能通过电网输送到各地, 实现了垃圾处理的资源化^[6]。

1 垃圾焚烧发电项目描述

垃圾焚烧发电项目, 利用垃圾焚烧处理的余热发电, 变废为宝, 本身就是一个节能、环保工程。故该项目的能耗不能与采用优质燃料(煤炭和油等)

的火力发电机组的能耗水平相比较, 但该项目在工艺方面采用了具有先进水平、热效率较高的生活垃圾焚烧炉、余热锅炉, 以及发电效率较高的汽轮发电机组, 在最大程度上做到了节能减排。

项目流程图如图1所示。

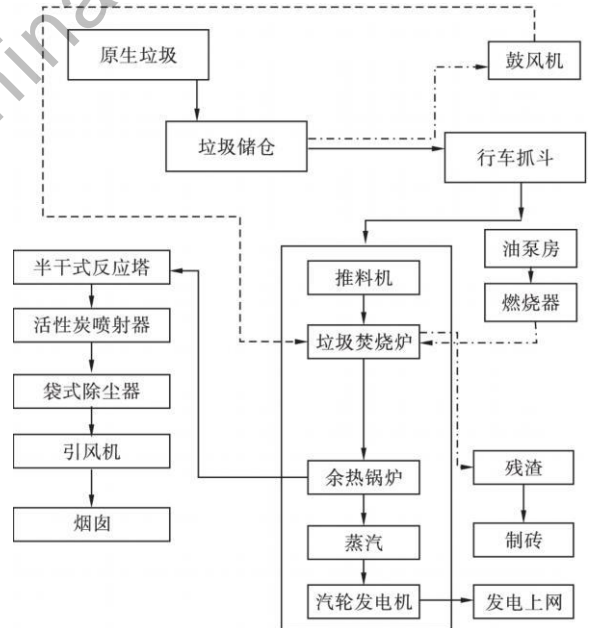


图1 垃圾焚烧发电无害化处理工艺流程图

2 温室气体减排量计算

该项目的评价方法采用清洁发展机制 CDM下的整合基准线和检测方法学 AM0025: “通过可选择的垃圾处理方法避免有机垃圾温室气体排放”^[7]来计算二氧化碳的减排量。其方法学的

描述,该项目第 y 年的减排量为:

$$ER_y = BE_y - PE_y - I_y \quad (1)$$

式中: ER_y —第 y 年项目活动的减排量, t_{O_2} ;

BE_y —第 y 年的基准线排放量, t_{O_2} ;

PE_y —第 y 年项目排放量, t_{O_2} ;

I_y —第 y 年项目的泄露排放量, t_{O_2} 。

2.1 项目排放量的计算

$$PE_y = PE_{elec,y} + PE_{fuel, on-site,y} + PE_{i,y} + PE_{w,y} \quad (2)$$

式中: PE_y — y 年项目排放量, t_{O_2} ;

$PE_{elec,y}$ — y 年项目活动现场电力消耗产生的排放量, t_{O_2} ;

$PE_{fuel, on-site,y}$ — y 年项目活动现场化石燃料消耗产生的排放量, t_{O_2} ;

$PE_{i,y}$ — y 年垃圾焚烧产生的排放量, t_{O_2} ;

$PE_{w,y}$ — y 年废水处理产生的排放量, t_{O_2} 。

1) 项目活动现场电力消耗产生的排放量。

由于该项目自用电量来自项目自身发电量,因此该项目排放量为 0。

2) 项目活动现场化石燃料消耗产生的排放量。

项目参与者应该计算现场除发电外的任何燃料燃烧产生的 CO_2 排放量,例如:现场车辆使用、热能生产、气化炉启动、添加到焚烧炉的辅助化石燃料、机械 热处理工艺所需的热能生产等^[8]。排放量基于燃料消耗量及各燃料的 CO_2 排放因子计算:

$$PE_{fuel, on-site,y} = F_{cons,y} \times NCV_{fuel} \times EF_{fuel} \quad (3)$$

式中: $F_{cons,y}$ — y 年现场燃料消耗量, 或 $k\bar{g}$;

NCV_{fuel} —燃料的净热值, $MJ/$ 或 $MJ/k\bar{g}$;

EF_{fuel} —燃料的 CO_2 排放因子, t_{O_2}/MJ 。

3) 垃圾焚烧产生的排放量。

$$PE_{i,y} = \sum_i A_i \times CCW_i \times FCF_i \times EF_i \times \frac{44}{12} \quad (4)$$

式中: $PE_{i,y}$ — y 年化石基垃圾在燃烧过程产生的 CO_2 排放量, t_{O_2} ;

A_i —填入垃圾焚烧炉的 i 类垃圾的量, t ;

CCW_i — i 类垃圾的含碳量, %;

FCF_i — i 类垃圾的含碳量中化石基碳的比例, %;

EF_i — i 类垃圾的燃烧效率, %;

44/12—转化因子, t_{O_2}/t 。

4) 垃圾焚烧过程排气管排放的 N_2O 和 CH_4 量。

$$PE_{i,y} = Q_{i, mass,y} \times (EF_{N_2O} \times GWP_{N_2O} + EF_{CH_4} \times GWP_{CH_4}) \times 10^{-3} \quad (5)$$

式中: $Q_{i, mass,y}$ — y 年被焚烧的垃圾量, t ;

EF_{N_2O} —垃圾焚烧 N_2O 排放因子, $kg_{N_2O}/t_{垃圾}$;

EF_{CH_4} —垃圾燃烧 CH_4 排放因子, $kg_{CH_4}/t_{垃圾}$ 。

5) 废水处理过程中产生的排放量。

如果项目活动包括废水排放,那么也应当估算这部分甲烷排放。如果废水处理采用好氧工艺,那么相应的 CH_4 排放假设为 0^[9]。如果废水处理采用厌氧工艺或未经处理直接排放,那么 CH_4 应按照如下方法进行估算:

$$PE_{CH_4,w,y} = Q_{COD,y} \times P_{COD,y} \times B_0 \times MCF_p \quad (6)$$

式中: $PE_{CH_4,w,y}$ — y 年废水处理产生的甲烷排放量, t_{CH_4}/a ;

$Q_{COD,y}$ — y 年厌氧工艺处理的或未经处理直接排放的废水量, m^3/a 该值应该每月监测,每年汇总;

$P_{COD,y}$ —废水的化学需氧量, t_{OD}/m^3 , 该值需每月监测,每年求平均值;

B_0 —最大产甲烷量, t_{CH_4}/t_{OD} ;

MCF_p —甲烷转化因子, %。

如果所有的 CH_4 被直接排入空气,那么:

$$PE_{w,y} = PE_{CH_4,w,y} \times GWP_{CH_4} \quad (7)$$

式中: GWP_{CH_4} — CH_4 全球变暖潜势值, $t_{O_2}e/t_{CH_4}$ 。

2.2 基准线排放量

$$BE_y = (MB_y - MD_{reg,y}) + BE_{EN,y} \quad (8)$$

式中: BE_y — y 年基准线排放量, t_{O_2} ;

MB_y — y 年无项目活动情况下垃圾填埋场产生的甲烷量, t_{O_2} ;

$MD_{reg,y}$ — y 年无项目活动情况下削减的甲烷量, t_{O_2} ;

$BE_{EN,y}$ — y 年项目活动所替代的电网电量的基准线排放, $t_{O_2}e$ 。

2.3 泄漏量

$$L_{i,y} = A_{residual,i} \times FC_{residual,i} \times \frac{44}{12} \quad (9)$$

式中: $L_{i,y}$ — y 年 MSW 焚烧炉残余垃圾产生的泄露

排放, t_{CO_2} ;

$A_{residual}$ —焚烧炉中残余垃圾的数量, t/a ;

$FC_{residual}$ —残余垃圾包含的残余碳量, %。

计算该项目减排量所需的数据和参数如表 1 所示, 该项目第 y 年份的减排量如表 2 所示。

表 1 计算该项目减排量所需的数据和参数

参数	数值	数据来源
$Q_{biomass, y} / t \cdot a^{-1}$	166700	项目的可研报告
$F_{cop, y} / kg$	160000	项目的可研报告
MCF_p	0.8	2006年 IPCC指南默认值
$B_o / kg_{CH_4} \cdot kg_{CO_2}^{-1}$	0.265	PCC2006指导手册
EG_y / MWh	45950	项目的可研报告

表 2 该项目第 y 年份的减排量 t_{CO_2}

年份	基准线排放量估算	项目活动排放量估算	泄漏估算	减排量估算
第 1 年	56526	50222	4015	2289
第 2 年	70717	50222	4015	16480
第 3 年	82934	50222	4015	28697
第 4 年	93481	50222	4015	39244
第 5 年	102612	50222	4015	48375
第 6 年	110541	50222	4015	56304
第 7 年	117448	50222	4015	63211
第 8 年	123483	50222	4015	69246
第 9 年	128772	50222	4015	74535
第 10 年	133424	50222	4015	79187
年平均减排量				47756

3 结论

城市生活垃圾焚烧发电是一项新兴的产业, 它解决了垃圾造成城市污染问题的同时, 也减少了二氧化碳的排放, 并利用垃圾处理过程的余热进行发

电, 节约了煤炭资源^[10]。

该项目建成后, 每年可处理生活垃圾 16.67 万吨, 10 年共减少二氧化碳排放量 477560 t, 平均每年可减少排放二氧化碳 47756 t, 实现了垃圾处理的减量化、资源化、无害化, 进一步改善生态环境, 促进我国经济、环境、社会的可持续发展。

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bias block elbow and Venuri tube. The concentration distribution characteristics of the special burner have been studied by numerical method and gas-solid flow characteristics have been analyzed. Through changing the angle of bias block and compared with the case without Venuri tube, the effects of bias block angle and Venuri tube on burner rich-lean separation have been researched. RNG- $k\epsilon$ model and Euler multiphase flow model were used to investigate gas-solid flow. The results show that bias block contributes to enhancing elbow's effects on the rich-lean separation of coal. With the angle of bias block increasing, the rich-lean separation of coal becomes more and more obvious and the resistance along the way increases. With Venuri tube, the high concentration area of pulverized coal can be away from the wall and at outlet, the dense phase of pulverized coal accumulates in the upper of the export. The composite structure helps to reduce coke at the outlet of burner. The rich-lean separation ability of burner can be adjusted by changing the angle of bias block.

Key words: the bias block Venuri tube rich-lean separation of coal gas-solid multiphase flow

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A comparison between the thermal siphon and solar collector storage water heater and the calculation of their thermal efficiencies

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Abstract: The thermal siphon water system and solar collector storage water system have been introduced in the paper firstly. Then the advantages and disadvantages of the two systems have been compared and their thermal characteristic also been calculated by MATLAB and Origin software. The conclusion has been found is that their thermal efficiency approximately same. The former system has wide running range and thermal efficiency variation and its system is not stable compared with later. The former can be used beginning at 30 in the morning compared the later 00. As the solar collector storage water system has more reasonable layouts and operations, it deserve to promotion.

Key words: solar hot water system collector thermal efficiency

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Study on the phase change material of heat recovery system

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Abstract: Selected $FeCl_3 \cdot 6H_2O$ as phase change material for the heat recovery unit of refrigeration system, established a phase change model under the nature convection influence, analyzed the storing and releasing performance of phase change material, the variation of solid-liquid interface temperature field, velocity field, liquid fraction, heat transfer coefficient, heat flux were found out.

Key words: heat recovery unit refrigeration system phase change material phase change for thermal energy storage

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A study on calculation method of carbon emission in power generation with MSW incineration

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Abstract: MSW incineration for power generation which uses waste heat for power generation not only saves energy but also reduces carbon dioxide emissions. It has given an analysis to the CDM project of free-pollution disposal engineering with Garbage incineration for power generation which is on the basis of concrete situations of the project in Tangshan city Hebei province. The emission reductions are calculated based on methodology AM0025 of CDM. The result indicates that the emission reductions will be 477560 tCO₂ ten years and it can also brought considerable environmental benefits and economic benefits to our country.

Key words: power generation with MSW incineration greenhouse gases emission reduction

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Load distribution of power systems based on hybrid genetic algorithm

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Abstract: The use of Matlab programming, the principle of using least squares curve fitting unit coal consumption. Application of MATLAB Hybrid genetic algorithm has produced the outcome of the procedure and the basic genetic algorithm and compared to the average distribution of the program come to the optimal. The last four with a rated power of 328.5 MW thermal power unit load to the example of the distribution of Hybrid genetic algorithm and verify that the load distribution in the superiority of optimal allocation.

Key words: allocation load Matlab programming hybrid genetic algorithm

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Combustion analysis of mine Ventilation Air Methane as boiler combustion wind

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Abstract: Direct discharge of Ventilation Air Methane (VAM), as a non-renewable resource is not only a waste of natural resources but exacerbation of greenhouse effect. In order to save energy and reduce exhaust, how to use low concentration of methane is a subject needed urgently to be studied. This paper firstly introduces combustion calculation of VAM as boiler combustion wind and comparative analysis the thermal economy through thermodynamic calculation and the prospects for utilization of low concentration methane are described in the paper. Secondly, through simulate boiler combustion process by using computational fluid dynamics (CFD) software Fluent, ignition conditions under different conditions in the combustion chamber are simulated. The feasibility of VAM as boiler combustion wind is analyzed which provide experimental evidence for the rational use of VAM.

Key words: Ventilation Air Methane tangential firing boiler thermal equilibrium numerical simulation

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Aircraft digital flexible assembly technology research

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