A Model for Estimating Environment Contaminants in Coal-burning Power Plants

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Abstract: Models for estimating main contaminants in coal-burning power plants are established. The prediction of contaminants in waste gas was based on conventional calculating models. The key factors are ascertained the material conservation theory and the on-line data of coal quality are used to establish the model. The prediction of contaminants in wastewater was based on the status quo of ash-flushing systems in national power plants through studying the ash-water in dry ash handling system and wet dust removal system separately. Not only the material conservation for macroscopically consideration, but also several chemical reactions that probably exit in ash-water are taken into account.

Key words: power plant; pollutant; model; prediction
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1 Introduction

There are already many models for predicting the contaminants in waste gas in the different literatures[1-2], however, few prediction models for the wastewater have been reported. This article establishes prediction models for wastewater on the basis of burning different kinds of coal and different ways of drainage while the models of waste gas contaminants were carried on comprehensive summary.

2 Establishing the prediction models for the contaminants in waste gas

The prediction of dust, SO_2 and CO_2 were based on conventional calculation model, the prediction of NO_x was based on analyzing the effects of various operations on boiler efficiency and quantifying this factor arrives at the manipple regression model[3]. Under high temperature, part of F, As and Hg could decompose or volatilize into the fuel gas, while the remainder stayed in the ash. Part of F, As and Hg in the fuel gas could be absorbed by the tiny dust which will be removed and the remainder emit to the air with the fuel gas, so, the material conservation theory and the on-line data of coal quality are used to establish the model.

3 Establishing the prediction models for the contaminants in wastewater

3.1 Source of material

We chose the following ions as our studying objects. Positive ions: H^+, As, Hg^{2+}, Cd^{2+}, Pb^{2+}, Cr; Anions: OH^-, F^-, CO_3^{2-}, SO_4^{2-}, and NO_3^-. The sources of the ions come from the ash, the flue gas and the precipitation.

3.2 Material conservation theory

It was supposed that the gas absorbed by the ash-water, release ratio of ion and quality of added water did not change in every recycling. When ash-water passed the recycling for n times, $C_{n,i}$ was about equal to $C_{n-1,i}$ and expressed by $C_{r,i}$. The materiel conservation of ash-water in the recycling system was given by equation (1)

$$C_{r,i} = C_{q,i} + \frac{C_y + C_h + C_q}{1 - R} \qquad (1)$$

3.3 The prediction models for contaminants

In dry dust removal system, because the flue gas did not contact with ash-water so the effect of flue gas could be neglected and C_y could be ignored. Therefore, we mainly focus on the release of the ion from the ash. In the ash, Hg and F are so little that we may ignore them, CaO made the pH rise. Cd and Pb dissolved

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from the ash in the alkalinity, the solubility of $CdCO_3$ and $PbCO_3$ is bigger than $Cd(OH)_2$ and $Pb(OH)_2$ separately, so we considered the precipitation process of $Cd(OH)_2$ and $Pb(OH)_2$ only. We ignored the chemical reaction of As and Cr and consider the equilibrium concentration between adsorption and description only. The prediction models of Cd, Pb, As and Cr were given by (2), (3), (4), (5).

$$C_{r,Cd}=\frac{K_{sp,Cd(OH)_2}\left[(1-R)C_{0,Cd}+\frac{125\eta_2 d}{14Q}\right]}{[OH^-]}\times 112000 \quad (2)$$

$$C_{r,Pb}=\frac{K_{sp,Pb(OH)_2}\left[(1-R)C_{0,Pb}+\frac{1000\eta_3 f}{207Q}\right]}{[OH^-]}\times 207000 \quad (3)$$

$$C_{r,As}=C_{0,As}+\frac{\frac{40\eta_1 b}{3Q}}{1-R} \quad (4)$$

$$C_{r,Cr}=C_{0,Cr}+\frac{\frac{250\eta_4 e}{13Q}}{1-R} \quad (5)$$

In wet dust removal system, contaminants in flue gas dissolved into the ash-water. SO_2, NO_x, CO_2, HF from the flue gas could dissolve into the ash-water which made the pH reduce, Hg and F dissolved into the ash-water and As, Cd, Cr and Pb can be ignored for the very low quantity. The pH value was almost lower than 7. In this condition, the F^- could react with Ca^{2+} until to precipitate-dissolution balance. Then (6) was the prediction of F^-

$$C_{r,F}=2\times\sqrt{\frac{\frac{500}{19}t}{2.74\times 10^{10}\left(\frac{50}{Q}a-\frac{500}{19Q}t\right)}}\times 18998 \quad (6)$$

The Hg in flue gas does not dissolve in the ash-water, so we only study the Hg^{2+} dissolving. The prediction of Hg^{2+} is given by (7)

$$C_{r,Hg}=C_{0,Hg}=\frac{9\eta_5}{Q(1-R)} \quad (7)$$

4 Conclusions

The prediction models for contaminants in waste gas had been verified in practice. The prediction of contaminants in ash-water is based on analyzing Coal Category, ash collection method, and dissolution of the heavy metal and chemical reaction of the ion to establish the model. Although the contaminants in ash-water were influenced by various factors, it cycled many times and the concentration of the contaminants would be in a certain scope, so it can be predicted. The prediction results are consistent with the monitor values. The prediction models can be used for monitor and management of the contaminants in coal-fired power plants.

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燃煤电厂环境污染物预测模型

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摘 要: 针对燃煤电厂污染物, 建立污染物的预测模型。废气预测模型通过确定主次影响因素, 利用物料守恒理论和煤质在线监测数据建立; 废水中污染物浓度的预测模型在结合国内燃煤电厂冲灰系统的现状, 分别研究了干除灰和湿除灰两种系统冲灰水中污染物含量, 在宏观上考虑物料衡算, 又适当的考虑冲灰水中各组分之间的主要化学作用建立。

关键词: 燃煤电厂; 污染物; 建立模型; 预测

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