

# 大气污染最大落地浓度及其距离计算方法的探讨

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**摘要** 分析《环境影响评价技术导则——大气环境》中最大落地浓度及其出现距离计算方法存在的缺陷和实际运用中存在的问题, 给出简单易算的替代计算方法, 可供环评工作者在实际工作中参考使用。

**关键词** 点源 最大落地浓度 距离

## 0 引言

在大气环境影响评价工作中, 需要对污染源产生的大气污染最大落地浓度及其出现距离进行计算, 以考察污染物对区域环境空气产生影响贡献值的大小。国家环保总局《环境影响评价技术导则——大气环境》(HJ/T2.2-93)<sup>[1]</sup> (以下简称《导则》)对最大落地浓度及其出现距离给出了计算模式, 但没有给出明确的模式来源、推导过程、应用条件, 且计算复杂。很多环境评价单位, 基本都是不分条件直接引用他人编制好的计算程序求解。导致实际应用中出现较大偏差, 且无法很好解释计算结果。本研究对实际工作中最大落地浓度及其出现距离的计算模式存在的问题进行探讨, 结合工作经验给出最大落地浓度及其出现距离的计算方法。

## 1 导则模式

污染物在大气中的运动是一个极其复杂的过程, 且易受到地理条件和气象环境的影响。实际运用中通常要做较多的定常假设, 根据物质守恒原理和浓度梯度传输理论, 可得到著名的连续点源高斯扩散模式<sup>[2]</sup>。

$$q(x, y, z; H) = \frac{Q}{2\pi u \sigma_y \sigma_z} \times \exp\left[-\frac{y^2}{2\sigma_y^2}\right] \times \left\{ \exp\left[-\frac{(z-H)^2}{2\sigma_z^2}\right] + \exp\left[-\frac{(z+H)^2}{2\sigma_z^2}\right] \right\} \quad (1)$$

《导则》大气预测模式基本都是根据公式(1)推演而来, 逐步发展形成了有风时点源扩散模式、最大落地浓度及其距离排气筒距离计算模式、小风和静风点源扩散模式、长期平均模式、熏烟模式等。其中《导则》给出的最大落地浓度及其距离模式为:

$$C_m(X_m) = \frac{2Q}{e^{\pi} \cdot U \cdot H_e^2 \cdot P_1} \quad (2)$$

$$P_1 = \frac{2\gamma_1 \cdot \gamma_2^{-a_1/a_2}}{\left[1 + \frac{a_1}{a_2}\right]^{\frac{1}{2}} \left[1 + \frac{a_1}{a_2}\right] \cdot H_e \left[1 + \frac{a_1}{a_2}\right] \cdot e^{\frac{1}{2} \left[1 + \frac{a_1}{a_2}\right]}} \quad (3)$$

$$X_m = \left[\frac{H_e}{\gamma_2}\right]^{1/a_2} \left[1 + \frac{a_1}{a_2}\right]^{-1/(2a_2)} \quad (4)$$

式中  $X_m$ ——最大落地浓度出现距离;

$C_m$ ——最大落地浓度;

$Q$ ——单位时间排放量;

$U$ ——排气筒出口处平均风速;

$H_e$ ——排气筒有效高度;

$\gamma_1$ ——横向扩散参数回归系数;

$\gamma_2$ ——铅直扩散参数回归系数;

$a_1$ ——横向扩散参数回归系数;

$a_2$ ——铅直扩散参数回归系数。

## 2 问题探讨

式(2)~式(4)在实际运用中存在以下问题:

(1)计算模式是在计算机编程技术未得到普及, 在一定假设条件下根据公式(1)导出的解析表达式, 《导则》未给出公式的推导过程, 事实上缺乏严谨<sup>[3]</sup>。

(2)公式计算方法烦杂, 交叉利用参数次数过多, 《导则》中对参数给出为分段函数形式, 且均为经验值, 选取也存在较多的人为因素, 与计算点距排气筒的距离和气象条件(稳定度、风速)均有很大关系, 导致公式的计算结果容易出现较大偏差。

(3)《导则》根据建设项目污染物排放情况及项目所在地环境情况, 将建设项目大气环境评价分为3个等级, 1、2级的评价需要考虑混合层的反射问题, 表现为在公式(1)中  $k$  取值为  $k=4$ , 而3级评价可适当简化, 不考虑混合层的反射, 表现为  $k=0$ 。根据实际计算结果及相关文献<sup>[4]</sup>, 《导则》中的最大落地浓度公式及出现距离(即式(2)~式(4))只与3级评价计算

结果接近,而与1、2级评价计算结果相差较远。

(4)公式只能计算单点源的最大落地浓度及其出现距离,而在实际运用中通常有几个点源共同影响,该公式无法计算。

基于以上问题,在环评实际工作中,对于最大落地浓度及其出现距离的计算应考虑利用其他方法。

根据实际工作经验,认为有两种替代方法可以考虑:对于单点源的计算可以直接利用点源扩散模式循环迭代求取;对于多点源的计算可以利用多点源模式结合坐标变换求取。

《导则》中最大落地浓度及其距离的计算公式是在计算机编程技术不普及的特定形式下,利用有风点源扩散模式经过一定的假设和简化演算而来的。完全可以利用计算编程直接从点源扩散模式中循环迭代直接求取。这可解决计算偏差问题,使计算参数对计算结果的影响降低到最小;同时,可以根据《导则》对大气环境影响评价的分级,选择是否考虑混合层的反射影响,增加计算结果真实性。

对于多点源的计算,则加入坐标平移,取相对坐标下的浓度贡献值进行叠加,考虑多点源的共同影响。

根据编制的程序,得出的计算结果见表1(以单点源情况为例)。

表1 技术参数

稳定度	A	B	C	D	E	F
最大落地距离/m	1 202	1 402	1 802	4 621	11 702	33 302
最大落地浓度/( $\text{ng}\cdot\text{m}^{-3}$ )	0.0723	0.0560	0.0459	0.0228	0.0148	0.0114
有效源高/m	776.15	205.48	144.62	128.53	149.90	134.20
出口风速/( $\text{m}\cdot\text{s}^{-1}$ )	0.49	2.73	5.31	7.06	4.29	2.99
10 m处风速/( $\text{m}\cdot\text{s}^{-1}$ )	0.4	2.0	3.5	4.2	2.3	1.6
混和层厚度/m	700.0	800.0	900.0	600.0	300.0	100.0

污染源参数: 烟囱高度 80 m; 烟囱出口直径 3 m; 烟气排放强度45 600  $\text{mg}/\text{s}$ 。

环境参数: 环境大气压1 000 hPa; 环境大气温度 25  $^{\circ}\text{C}$ 。

由表1可见,计算结果能清楚地给出在不同稳定性和不同混合层厚度下最大落地浓度及其出现距离,而采用式(2)~式(4)无法实现这些功能,计算所得结果在混合层厚度变化时并不变化。对于原来无法实现的多点源浓度影响计算,只要加入坐标平移变换,引入相对坐标。同样可得到表1的结果。

### 3 结论

《导则》中最大落地浓度及其出现距离计算方法在实际运用中存在较多问题,很多环评工作者未考虑该模式的实际应用条件,直接引用进行计算,对计算结果也无法给出很好的解释。本研究根据实际工作经验,分析了《导则》模式存在的主要缺陷和实际运用中存在的主要问题,针对模式的来源,给出了简单易算的替代计算方法,完善了《导则》对最大落地浓度及其出现距离的计算方法,可供环评工作者在实际工作中参考使用。

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## 新书出版信息

《工业除尘设备——设计、制作、安装与管理》,主编姜凤有,152万字。该书共分两篇:第一篇重点介绍工业除尘设备设计总则和机械式除尘器、袋式除尘器、湿式除尘器、静电除尘器、除尘器壳体结构与输灰设施的设备设计;第二篇分别介绍设备制作、设备安装、设备验收、设备运行和技术经济,并按工作需要附录有工业气体特性、工业粉尘特性和排放标准等技术资料。该书每册售价170元(含邮资),若需购此书的单位和个人,请与《环境工程》编辑部联系。

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## THE ENERGY-SAVING OF BGBS DESULFURIZATION ..... *Du Jijun Shi Yingjie Zhang Fan (30)*

**Abstract** The half dry and half wet de-sulfurization (BGBS) technology used in coal power plant was investigated. The measures and potential of BGBS for energy-saving were analyzed. The results showed that the BGBS technology could incorporate the de-sulfurization agents and the de-sulfurization ash digesting, activation, oxidation and transportation after the steam jet flow technology applied in this technology. As a result, the energy consumption and the operation cost were saved. In contrast, the power driving way which is applied in power plant currently stays in the end of energy transportation chain. It is quite energy consumable.

**Keywords** thermal power plant, BGBS technology, steam jet flow and energy-saving

## STUDY ON PURIFICATION OF HYDROGEN SULFIDE ODOR BY BIO-TRICKLING FILTER INOCULATED WITH DENITRIFYING THIOBACILLUS ..... *Zhang Chengzhong Xing Yi Guo Mingfei et al (33)*

**Abstract** A strain of denitrifying Thiobacillus was isolated from soil, which is inoculated in the bio-trickling filter to purify hydrogen sulfide. Removal efficiency can reach above 92% under following conditions: the concentration of inlet 1 453 mg/m<sup>3</sup>, HRT 78 s, pH 6.0. The strain bacterium can endure the high pollution load and possess the larger buffer capacity and removing efficiency of hydrogen sulfide, which offered a basis for treating H<sub>2</sub>S in the industrial application.

**Keywords** hydrogen sulfide, denitrifying Thiobacillus and bio-trickling filter

## NEW TECHNOLOGY OF DUST REMOVAL AND DESULFURIZATION FOR SMALL-SIZED BOILERS ..... *Niu Taotao Wang Jianguan Li Zhenyu et al (36)*

**Abstract** In this paper, the process composition and principle of double-alkali of sodium calcium—multi-polar spray strong swirl process were introduced. Combining the project design, the environmental and economic benefits were analyzed. The results show that this process features less investment, low running cost and good effect, it has broad development prospects.

**Keywords** flue gas, double-alkali of sodium calcium and dust removal & desulfurization

## STUDY ON LOW-TEMPERATURE ADSORPTION OF NO IN FLUE GAS BY MODIFIED ACTIVATED CARBON FIBER ..... *Wang Xiaoming Xu Lusi Shu Zhan (39)*

**Abstract** A pilot study was done by micro-reactor of rayon-based R-ACF for denitration. The results showed if ACF immersed into sulfuric acid before impregnated with ammonia solution, it can efficiently increase the oxygen functional groups, and nitrogen functional groups, and is feasible for oxygenating removal NO<sub>x</sub> at low temperature. Through successive test record the amount of NO adsorption, the adsorption efficiency of R-ACF before and after desorption of NO reached 15.2% and 11.5% respectively. In addition, through negative air desorption the R-ACF removal efficiency can reach 78.7%. It was verified that R-ACF has good desorption cycle efficiency and renewable NO performance, which has a value of industrial application as well.

**Keywords** rayon-based activated carbon fiber(R-ACF), denitration, modified method and analytic test

## DISCUSSION ON CALCULATING THE GROUND MAXIMUM CONCENTRATION AND MAXIMUM DISTANCE OF ATMOSPHERIC POLLUTION ..... *Wang Feng Cheng Xiaoquan Chen Fei (42)*

**Abstract** It is analysed that the limitations and problems in calculating model for calculation of the ground maximum concentration and maximum distance of Technical Guidelines for Environmental Impact Assessment on Atmospheric Environment. At the same time, a simple substitution method is given. It maybe a reference to the work of EIA.

**Keywords** point source, maximum ground concentration and distance

## THE RECYCLING TECHNOLOGY OF WASTED CRT DISPLAY UNITS ..... *Yin Fengfu Wang Hailong Liu Zhenyu et al (44)*

**Abstract** The harm to the environment of cathode ray tubes(CRT) display units and their dismantling methods are discussed. The physical separating methods like heated-ring, heat-deformation, separating at melten status, laser cutting and diamond cutting, and the chemical separating methods like hot acid ejecting and hot acid in dipping are analyzed. According to the local situation, material reusing status in China is analyzed after the CRT have been separated. It is posed that different trends of separating CRT in both the developed and developing countries.

**Keywords** CRT display unit, separating technology, lead glass and material reusing

## REGENERATION OF WASTE LUBRICATING OIL BY FLOCCULATION-CLAY PROCESS ..... *Zhang Xianming Jiao Zhaojie Li Chuan et al (47)*

**Abstract** Based on the research of regeneration and recycling technology at home and abroad, the non-pollution, low-cost regeneration technology which is on the basis of flocculation and combined with activated-clay was proposed. Depending on the earlier experiment of flocculants decoloring and regeneration, it was emphasized that the best parameters on activated-clay refining the waste oil was that when the clay dosage was 8%~11%, the clay contact reaction temperature was about 130°C, stirring time was 20 min and the constant temperature subsidence temperature