Stability Analysis and Strategy of Bag-Type Dust Removal System

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Abstract. With the progress of human civilization and the growth of population, how to properly dispose of garbage to make it resource-based, reduced and harmless has become the focus of current society and governments at all levels. The paper analyzes the operation stability of bag-type dust removal system through mathematical model, looks for the balance between people's environmental requirements and garbage incineration, and proposes relevant monitoring schemes to the government, ultimately seeking to improve the stability of dust removal system. In this paper, the direct proportional relationship between the stability and the concentration difference of the bag dedusting system is obtained. It is shown that the dust concentration in the air decreases after the bag is replaced compared with that before the bag is replaced, and some feasible suggestions for environmental monitoring are put forward according to the model conclusion.

1. Introduction

With the rapid development of social economy, the technology of waste incineration has been continuously improved. Air conditions directly affect the growth and safety of plants and animals, and even directly into the human body through breathing, leading to the occurrence of disease. Therefore, the operation stability of the bag flue gas treatment system is the key at present. With the increasing attention paid by the state to environmental pollution, the current emission standards for atmospheric pollutants have become more stringent. The emission limit of atmospheric particles in all industries is generally $30 \sim 50 \text{mg/m}^3$ [1].

First, we established model 1 based on AHP, and analyzed five factors affecting the stability of the dust removal system, namely, filter wind speed, physical factors, bag pressure, flue gas temperature, and chemical factors. Then, we established a positive reciprocal comparison discrimination matrix to determine the weight vector. Due to the influence of the factors and the priority level is often hard to quantify, so in order to ensure the consistency of the model and the actual situation, we put the main influence factors of dimensionless data processing, and formed the concentration difference of the corresponding random number by MATLAB, it is concluded that the new coefficient matrix, and used the regression analysis and data fitting. Finally, the relationship between the system stability and the total amount of ambient soot emission is obtained. To meet the public requirements for the emission of harmful substances in the air control.

Secondly, we analyze the new ultra-clean dust removal replacement process. The new process features high stability, high emission standards and low cost [2]. Therefore, we need to pursue the...
maximization of benefits under the premise of sustainable development, and then apply the multi-factor comprehensive evaluation method, and conduct comprehensive evaluation according to the evaluation matrix and hierarchical analysis, and give the stability, as well as the quantitative scores of pollution emission and cost price. Based on the existing data, the basic operation status, bag performance, bag quality and bag efficiency of the bag dedusting system were studied when the operating principle of the system was known.

According to the relevant data, the relevant mathematical model is established to analyze the operation stability of the bag dusting system. And draw the relevant chart of dust concentration caused by the change of the objective factors of the dust collector and analyze the influence of the stability of the bag dust removal system on the surrounding dust emission. Finally, by analyzing the data, the influence of bag life, operation and maintenance conditions, as well as various related factors on the dust collector is considered. By finding a balance between the relevant contradictions, the paper explains the scale of the permitted expansion of the incinerator and proposes the relevant monitoring plan to the government. The optimization model of the new ultra-clean dust removal replacement process was considered and popularized to improve the stability of the dust removal system, and the improvement percentage of the model's stability performance was calculated, so as to better monitor and protect the urban air environment.

2. Problem analysis and hypothesis
Given the total emission quota per unit area of the surrounding area of the incinerator (the total emission of the area/the area of the area), the environmental allowable upper limit of the expansion scale of the incinerator is analyzed and discussed on the premise of considering the stability of the dedusting system. First, we get the increase per unit of time that incinerators burn waste \( f(u) = r * u (1 - u / N) \). Then set the formula of the total amount of dust filtered by the dust removal system as \( h(u) = k * u \). When \( f(u) \) and \( h(u) \) are equal to each other, it can be concluded that \( u \) is the upper limit of the expansion scale of the incinerator. In order to make the stability of equilibrium point more accurate, we use the stability theory of differential equation and difference equation to determine.

3. The establishment and solution of the model

3.1. Before the improvement
We need to discuss under the premise of stable dust removal system: how to maximize the benefits of incinerators under the requirements of the public for environmental protection [3]. In the analysis of the operating stability of bag dust removal system, we summarized a large number of previous studies and related papers, and concluded that the key factors [4] determining the stability were smoke temperature, filtration wind speed, bag differential pressure, physical wear and chemical corrosion.

AHP was used to analyze the influence of the above five factors on the stability of the weight matrix \( w \) [5]. The main factors are dimensionless and a new coefficient matrix is obtained. Through forming random Numbers, data fitting is carried out to judge the consistency problem. The optimal equilibrium point was found by using the fishing model to determine the maximum allowable limit of the scale expansion of the incinerator. The total emission quota per unit area of the surrounding area of the incinerator shall be set as \( N \) (the total emission of the area \( C \) the area of the area \( S \)). Firstly, the quantity formula \( f(u) \) of incineration waste in a given area \( S \) is constructed, and then the formula of the total amount of dust \( h(u) \) that can be filtered by the dedusting system is obtained. The value of \( u \) is solved, and the balance point is the upper limit of the expansion scale of the incinerator.

3.1.1. Analyze the operating stability of the dust removal system. We divided the importance of factors into four levels from 1 to 4, and the higher the importance, the higher the number of levels. Because high temperature fly ash will directly lead to bag damage, too small bag spacing will increase the effective filtration area but lead to collision wear between bags and other reasons. So the final rating of the 5 related factors was 3: 2: 3: 4: 1. After calculation, the proportion of physical factors and
chemical factors was determined to be small, which was ignored. Because the hypothesis may be inconsistent with the actual situation, this paper carries out the consistency test and calculates the specific weight vector. And the comparison discriminant matrix is

$$A = \begin{pmatrix}
1 & \frac{1}{3} & \frac{1}{2} & 3 \\
\frac{2}{3} & 1 & \frac{1}{2} & 2 \\
\frac{1}{2} & \frac{1}{2} & 1 & 4 \\
\frac{1}{2} & \frac{1}{2} & \frac{1}{2} & 1 \\
\end{pmatrix}$$

MATLAB to calculate the maximum eigenvalue, get the corresponding eigenvector, normalize the eigenvector, and get the weight vector of the target layer. Calculate the consistency ratio. In the same way, the consistency ratio of the third layer of physical factors to the pressure can be obtained.

3.1.2. The influence of stability on the total emission of ambient soot. In order to solve the influence of different measurement units on the size of the index value and the problem that cannot be added, v, P, T is dimensionless processed. By collecting data, the working range of v, P, T under the normal ideal working state of the dust removal system and the specific parameters of the actual work are obtained respectively. Find the dimensionless value. In order to ensure more accurate coefficients of the equation, the value of v, P, T is multiplied by the corresponding weight vector to obtain the coefficient matrix E for the stability and the influencing factors of v, P, T. According to the random number processing in MATLAB, 27 random data in each interval of v, P, T were obtained, and the combined matrix F of wind speed, pressure and temperature was formed again. In order to more intuitively observe the influence of three factors v, P, T on the system stability, the matrix H can be simplified to obtain the stability equation

$$H = 0.08205v + 0.08115P + 0.23344T$$

The regression analysis method is used to prove the influence of the stability on the total amount of ambient soot emission. Through MATLAB, the linear fitting of scatter graph. After analyzing the data, we get the specific equation \( y = 4.9006x - 366.11 \). The scatter plot is made for linear fitting and data analysis, and the following table 4 and table 5 can be obtained:

![Figure 1. Data fitting scatter plot.](image-url)
Through the regression data analysis of the graph after linear fitting above, the relationship between the operation stability of the bagging dust removal system and the difference of dust concentration can be obtained in direct proportion, that is, the larger $x$ is, the larger $y$ is. The more stable the system operation is, the larger the dust concentration difference is, indicating that after replacing the cloth bag, the lower the dust concentration is and the better the dust removal effect is. From this, we can see the relationship between the stability of the bag dusting system and the concentration difference. It indicates that the dust concentration in the air changes significantly after the bag is replaced, compared with that before the bag is replaced. To sum up, keeping the environmental limit of the expanded incinerator at half of the total emission limit per unit area allows the maximum filtration of garbage dust.

3.2. After the improvement

Based on the stability factor of the 3.1 model. First, the weight vectors of the five factors that affect the stability of the system are obtained based on problem 1. The new coefficient matrix $E'$ is formed by multiplying the new dimensionless values of $v, P, T$, and the new stability matrix $H'$ is formed by combining the former combination matrix $F'$. Substitute in the new stability equation $H = 0.0820v + 0.1353P + 0.2801T$. Then, the equation $y = 3.4987x - 355.541$ of dust concentration difference and stability in the new process can be obtained.

Similarly, SPSS was used for interpolation of missing data values, and the completed data was calculated for concentration difference, and then arranged in order from small to large to obtain the concentration difference matrix $Y$. For the linear fitting and data analysis of the new process, the following chart can be obtained.
By comparing the correlation coefficients with the relations between $x$ and $y$ in the original equation, it can be found that the new correlation index is less than the correlation index of the stability equation of bag dedusting. So if you have a small coefficient you know that the stability has improved. Because the dependent variable $y$ is the same, the correlation is the slope. The larger the independent variable $x$, the higher the stability of the system.

Therefore, it can be concluded that the degree of improvement is $(4.9006 - 3.4984) / 4.9006 = 0.2861$; The stability of the dust removal model was increased by 28.6% by using a new ultra-clean dust removal replacement process.

4. Test of model
In order to test the stability of model 3.1, we will test the consistency of AHP, calculate the consistency ratio to get $CR = C_I / R_I = 0.0527 < 0.1$; Pass the consistency check. Similarly, by analyzing the physical factors and pressure in the third layer, we can get all passed the consistency test. This also indicates that the specific gravity fluctuation between the model and the actual factors given by us is very small, and the experimental results of the model are ideal.
In order to analyze the situation mentioned in model 3.2: the damage degree of garbage to the ecological environment when there is no bagging and dusting system, it is generally believed that in the actual situation, if there are no measures to protect the environment, the garbage will be allowed to grow and the ecological environment will be out of balance without controlled incineration. Here, we use the graphical method to study the change of the total amount of garbage in the absence of the dust removal system, to measure the damage of the incinerated garbage to the ecological environment.

Therefore, we can consider that if the dust removal system fails after reaching the upper limit of environmental allowance, the remaining garbage dust will not cause too much damage to the ecological environment. So the equilibrium point we get from the model is at a more appropriate level.

5. Conclusion
In this paper, the AHP combined with the pair wise comparison matrix (pair wise comparison matrix) is used to greatly improve the accuracy of model parameters and make the final goal quantified. In this model, the law is well applied, and the linear equation is established through appropriate assumptions to obtain the upper limit of environmental allowance for the expansion scale of incinerator. By using the stability theory of differential equation and difference equation, we can judge the stability of the allowable upper limit value of the environment and make the result more accurate.

In order to meet the increasing demand of the public for environmental protection, we analyzed and discussed the changes in dust concentration in the air that occurred or reflected in the process of model establishment and related to the stability of the dust removal system, and proposed the following Suggestions: (1) Innovate the model of environmental monitoring institutions. (2) Accelerate innovation in monitoring technology (3) Strengthen the application of the Internet so that monitoring data can be shared in real time. (4) Improve the quality of monitoring to improve the authenticity.

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