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Parameter choice optimization of ventilating air cleaning equipment while designing and constructing industrial buildings

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Abstract

Functioning of industrial buildings is impossible without correctly organized ventilation system. Its work both regulates heat moist mode and the required indoor air purity that is cleaned with the help of air cleaning equipment. To make decision to construct the required air cleaning equipment at the enterprise a comparative economic assessment of various options is likely to be used, but due to the uncertainty factor, the economic analysis does not always allow to give a definite answer. Therefore, it is worthwhile to give additional parameters and to solve a problem of multicriteria optimization to get the best results. The choice of the best variant is supposed to be carried out using Harrington's desirability function. The conducted multicriteria analysis allowed to reveal optimum characteristics of air cleaning equipment, based on the required purification air degree, the geometrical sizes of the equipment and profit ratio while introducing any particular device.

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*Keywords:*ventilating emissions; air cleaning equipment; purification efficiency; device dimensions; economic efficiency; profit ratio; optimum criteria.

1. Introduction

The problems of atmospheric air protection are an integral part of aspects defining environmental conditions [1]. Ventilating emissions of industrial enterprises containing firm or liquid weighed particles pollute the atmosphere heavily. Technological processes and equipment development intended for emissions decrease from industrial

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enterprises, that is ventilating emissions cleaning from aerosols are an integral part of environmental protection measures.

Nomenclature

η	cleaning efficiency
L	sedimentation element length
D (D_e)	tube diameter (channels equivalent diameter)
Δp	aerodynamic resistance
t	time from the receiving result moment (expenses) until comparison measured in years
R_t	the results achieved on t calculation step
$З_t$	the expenses carried out on t step
T	calculation time period
z_i	the coded value of the i-th kind values of an indicator representing non numerical values
x_i	value of the i-th kind informative indicator
x_{i0} and x_{i1}	area borders of "satisfactory" in an initial scale.

On the other hand, functioning of industrial buildings is impossible without correctly organized ventilation system. Its work both regulates heat moist mode and the required indoor air purity that is cleaned with the help of air cleaning equipment. [2-4].

To increase the efficiency of ventilating system work it is worthwile to provide air cleaning equipment especially from high-disperse aerosol particles with sizes less than 1 micron being most harmful for human body [5-9].Utilization efficiency of ventilating emissions cleaning equipment from submicronic sizes aerosols is defined mainly by their cost, convenience and profitability of installation and operation, as well as the possibility to return the trapped production raw materials [2,8].

When using ventilating emissions cleaning equipment which is based on high-disperse particles sedimentation in thin tubes and slot-hole channels [10-13] air purification degree, geometrical characteristics and aerodynamic resistance (loss of pressure) of the device are the parameters characterizing utilization efficiency of equipment:

$$\eta = f(L / D; \Delta p) \tag{1}$$

Researches have shown [6-9] that it is possible to achieve given efficiency value using a combination of (L/D; Δp). Values in the range $\eta \geq 90\%$.are of great interest. For identical value of cleaning efficiency, increase in L/D value leads to the losses pressure reduction of Δp. To find an optimum combination of L/D values and Δp, giving the maximum effect is the aim of this paper.

2. Comparative economic assessment of device modifications

In the market economy conditions the most important factor of a firm enterprise development is the efficiency of investment activity which is characterized by the efficiency increase of business and operations of the enterprise due to the cleaning equipment installation [14]. While introducing cleaning equipment it's worthwhile to give an economic assessment of the proposed solutions. For this purpose it is necessary to carry out the comparative economic analysis of the device modifications characterized by a pair of values (L/D; Δp).

Assessment methods of financial and economic efficiency of the project taking into account time factor assume expenses and income matching at different time to a basic timepoint, in our case, to project implementation date.

Reduction coefficients calculation is carried out on the basis of a rate or discount rate (E). As approximate value of the discount rate the existing average interest rates for long-term rates of refinancing established by the Central Bank of the Russian Federation can be used. Reduction of expenses sizes and their results is carried out by their multiplication by the discounting coefficient (α_t) determined for constant norm of discount E by a formula: