Studying Some Parameters of the Composition and Evaluation of the State of Industrial Gas Emissions and Their Components

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A B S T R A C T

The article discusses the issues of determining the composition of mixtures of gas emissions, the choice of parameters, as well as determining the degree of deviation from the ideal state and recommended amendments to them.

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It is possible to unambiguously determine the composition of multicomponent gaseous emissions of a system only if it is in equilibrium, i.e. is in such a state when in any part of it the state parameters are constant and the same. The content of components and other characteristics of a real mixture can only be estimated with a certain degree of approximation. To ensure the possibility of applying mathematical methods to the calculations of real systems, they are greatly simplified, replacing them with ideal models.

Due to the mutual dissolution of mixture components in the region of wet steam, the states of liquids with supercritical temperatures and vapors with supercritical pressures are possible, as well as the processes of reverse evaporation and reverse condensation - evaporation of moisture with increasing pressure and an increase in steam moisture with decreasing pressure in the system. In order to avoid gross miscalculations in the development and design of cleaning devices, it is necessary to take into account the characteristic features of the processed substances.

We represent a homogeneous gas mixture as a mixture of ideal gases, considering it possible to apply the laws of ideal gases to it and to each of its components. There are several generally accepted ways of expressing the composition of such a mixture. For calculations of processes associated with a change in pressure in the system, the composition of the mixture is usually given in units of pressure.

According to Dalton's law, the pressure of a gas mixture can be calculated by adding the partial pressures of its components:

$$p = \sum_{i=1}^{N} p_1$$

The partial pressure of the i-th component is the pressure that it would produce at the temperature of the mixture and in the same amount if one occupied the entire volume of the mixture. Setting the composition of an ideal gas mixture by a set of partial pressures of all components is equivalent to setting the amount (number of moles) of each component in fractions of the total amount (number of moles) of the mixture.

According to Dalton's law, similar to other laws, the additivity of partial volumes is assumed:

$$V = \sum_{i=1}^{N} V_1$$

Each component of the gas mixture, which is in a state of equilibrium, is uniformly distributed throughout the volume provided for the mixture, and its pressure is equal to the pressure of the mixture.

In the practice of dust and gas cleaning, it is customary to set the composition of the carrier gas (air, flue gases) by volume or mass percent, and the content of harmful ingredients - by mass concentrations per unit volume of emissions. The usual value of pollutant concentrations before cleaning is on the order of 10-2...10-3 kg/m^3 after cleaning - 10-4 kg/m^3. The maximum permissible concentrations of chemical compounds of medium toxicity in the atmospheric air are standardized within 10-6 ... 10-9 kg / m^3, and especially hazardous substances (for example, carcinogens) - 10-11 kg / m^3.

In foreign, and sometimes in domestic literature, pollutant concentrations are expressed in mass parts of the pollutant per million (ppm) and billion (ppb) mass parts of emissions. Sometimes ppm is expressed as the number of parts by volume of a pollutant per million parts by volume of gaseous emissions, i.e. volume fraction taken from a million. At the same time, it is not always indicated in what proportions (mass or volume) the information is given, which can give rise to misunderstandings.

The composition of suspended particles is characterized by concentration and dispersion. The concentration of the dispersed phase is most often represented as the mass of particles per unit volume of the dispersed phase. Particles with sizes that make up any interval are assigned to the corresponding fraction. The totality of all aerosol fractions is called the fractional composition of its dispersed phase

$$D_m = \frac{\sum_{i=1}^{N} M_1 D_1}{\sum_{i=1}^{N} M_1} \; \sigma = \left[\frac{\sum_{i=1}^{N} M_1 (D_m - D_1}{\sum_{i=1}^{N} M_1 - 1}\right] 1/2$$

where M_1 is the number of particles in the i-th fraction.

The distribution of particles in real aerosols differs from normal, but for many of them it can still be reduced in shape to normal.

In such cases, it is considered that the sizes of aerosol particles are distributed according to the logarithmically normal law. The logarithmically normal distribution curve can also be specified by two parameters - the logarithms of the average diameter and the standard deviation from it:

$$lgD_m = \frac{\sum_{i=1}^{N} M_1 lgD_1}{\sum_{i=1}^{N} M_1} \; lg\sigma = \left[\frac{\sum_{i=1}^{N} M_1 (lgD_m - lgD_1}{\sum_{i=1}^{N} M_1 - 1}\right] 1/2$$

Distributions that are close to logarithmically normal are approximated by straight lines and considered to be uniquely determined by the parameters σ and D_m.

For the correct choice of methods for treating solid and, in particular, liquid pollutants of gas emissions, it is important to know not only their dispersed, but also their chemical composition. Pollutant ingredients can be inert or chemically active to the material of the cleaning device and communications, to moisture, sorbents, they can evaporate, sublime, decompose, ignite during processing. To avoid negative consequences or unforeseen results of the developed method of neutralization, it is necessary to have information about the chemical composition of pollutants and the properties of ingredients in the range of parameters corresponding to the conditions of their processing.

Certain indicators of the physical properties of gas systems have the same values in the same states, regardless of the nature of the processes, as a result of which the systems come to these states. As the main parameters of the state of homogeneous gas systems, it is customary to use temperature T, pressure p and volume V (specific volume v, density p).

If two of the three state parameters are given, then the physical properties of an ideal gas in a thermodynamically equilibrium state are uniquely determined by the relation T, p, v.

Any combination of parameters (T, p, v) and state functions (u, i, S) is also a state function. In calculation formulas, combinations are most often used that give simple ratios and allow one to calculate in an

explicit form the amount of work done by the system during the transition from one state to another.

At constant volume and temperature, the system performs work by reducing the internal energy by TΔS:

$$A_v = -(\Delta u - T\Delta S) = -\Delta F/m$$

Part of the internal energy TΔS, which, at constant T and v, cannot be converted into work, is called bound energy.

Until now, when defining the state function, we have assumed that the masses of the mixture ingredients do not change during the transition from one state to another. A characteristic of systems in which phase and chemical transformations occur under the conditions under consideration can be the specific Gibbs potential, which is also called the chemical potential ψ:

$$\psi = G/m = -(U - TS + pV)/m$$

The chemical potential has the meaning of useful external work, which is produced by a single amount of the substance of the system under consideration.

The degree of deviation from the ideal gas state can be considered as a measure of the approximation of the state parameters of real systems to the critical ones. The parameters of the critical state for some chemical compounds - pollutants of gas emissions are given in the appendix. They have a strictly defined value for each substance and can serve as physicochemical characteristics of gas systems. Therefore, it can be assumed that objectively there is a certain functional dependence that is universal for all real gases (including gas emissions), connecting the state parameters expressed in a dimensionless form (in fractions of the critical ones):

$f(\pi, \vartheta, \omega)$=*const*

where: $\pi = \rho/\rho_{cr}$, $\vartheta = \mathrm{T}/\mathrm{T}_{cr}$, $\omega = v/v_{cr}$ - reduced pressures, temperature and specific volume of real gases.

This equation underlies the principle of corresponding state parameters, according to which gas systems in states with two identical dimensionless parameters will have the same other state parameters. Calculations according to the principle of correspondence give an allowable error.

The determination of the given state parameters and the compressibility factor, based on the additively calculated values of the critical state of the gas system, is very approximate in many cases - the only possible one, since the number of combinations of pollutants and their concentrations in waste gases is so large that the probability of finding the required information for a specific composition of emissions insignificant.

When designing treatment devices, one often encounters a lack of necessary information on the parameters of gas emissions of a particular composition, and then it remains to calculate them using the additivity rule. Pseudo-critical (average-critical) state parameters in such cases are calculated by the ratios

$$T_{mcr} = \sum_{i=1}^{N} T_{1cr} \cdot r \;\; P_{mcr} = \sum_{i=1}^{N} p_{1cr} \cdot r$$

Corrections for the deviation of the parameters of the states of real gas systems from the values determined by the law of the state of an ideal gas become significant under conditions when the interactions (mutual attraction and repulsion) of molecules noticeably affect their motion. Formally, the deviation is expressed in violation of the unitarity (singularity) of the ratio pv/RT and the linear relationship between pv and T.

List of used literature:

1. Sultonov, A. (2019). Water useplanning: a functional diagramof a decision making systeman ditsmat hematical model. International Financeand Accounting, 2019(5),
2. Alibekova, N.N.(2020).U seofin format i on system sin water useprocesses. Scienceand Education, 1.

3. Kutlimurodov, U.M. Atmospheric pollution with harmful substances and measures to reduce it. Ecology: yesterday, today, tomorrow.-2019.--s, 249-252.
4. Сайдуллаев С. Р. Применение информационных систем в эффективном использовании воды // Наука и образование. - 2020. - Т. 1. - №. 7.
5. Қутлимуродов У.М. Некоторые аспекты экологических проблем, связанные с автомобильными транспортами //European Scientific Conference.–2020.– с.50-52.
6. Masharipovich, Q.U. (2021). Laboratory Equipment of Overpressure Determination on Standard. International Journal of Development and Public Policy, 1(6), 138-143.
7. Тошматов, Н.У., & Мансурова, Ш.П. (2019). Возможности использование сточных вод заводов по переработки плодоовощных продуктов для орошения сельскохозяйственных полей. Me′ morchilik va qurilish muammolari, 44.
8. Мусаев М. Ш. Проблемы совершенствования норм об обстоятельствах, исключающих преступность деяния //Проблемы экономики и юридической практики. – 2008. – №. 3.
9. У.М. Қутлимуродов. Влияние сточных вод с ионами тяжелых металлов города джизака на окружающую среду.//Международной научно-практической конференции «Экономика и управление гостеприимством территории» Россия. Новгород. 2021/5. С. 51-55.
10. Мусаев Ш. Свойства кристаллов кварца //Science and Education.– 2021 – Т. 2. – №. 10.
11. Saydullaev, S. R. (2020). Decision-making system for the rational use of water resources. *Journal of Central Asian Social Studies*, *1*(01), 56-65.
12. Qutlimurodov, U.M. Suv ta’minoti va oqava suvlarni oqizish tizimlari; Darslik. 246 стр. Toshkent - 2021/8/18 - T.: "IMPRESS MEDIA" MCHJ.
13. Мусаев Ш. М. Ишлаб чиқариш корхоналаридан чиқадиган оқова сувларни механик услублар билан тозалаш самарадорлигини ошириш тўғрисида //Science and Education. – 2021. – Т. 2. – №. 5. – С. 343-354.
14. Sultonov A. et al. Pollutant Standards for Mining Enterprises //EasyChair.-2021. – 2021. – Т. 5134.
15. Мусаев Ш. М., Саттаров А. Умягчение состав воды с помощью реагентов //Me′ morchilik va qurilish muammolari. – 2019. – Т. 23.
16. Такабоев К. У., Мусаев Ш. М., Хожиматова М. М. Загрязнение атмосферы вредными веществами и мероприятие их сокращение //Экология: вчера, сегодня, завтра. – 2019. – С. 450-455.
17. Obidovich S.A. The use of Modern Automated Information Systems as the Most Important Mechanism for the use of Water Resources in the Region //Test Engineering and Management. – 2020. – Т. 83. – С. 1897-1901.
18. Султонов А.О. Методы рационального использования воды в орошении сельскохозяйственных культур //Современная экономика: актуальные вопросы, достижения и инновации. – 2019. – С. 207-209.
19. Султонов А.О. Применения информационных систем по использования водных ресурсов в Узбекистане //Научные исследования-основа современной инновационной системы. Международной научно-практической конференции Стерлитамак. – 2019. – С. 141-144.
20. Султанов А.О. Информационная система водных ресурсов сельского хозяйства //Проблемы научно-практической деятельности. Перспективы внедрения. – 2019. – С. 197.
21. Sultonov A.O. Problems of optimal use of water resources for crop irrigation //Journal of Central Asian Social Studies. – 2020. – Т. 1. – №. 01. – С. 26-33.
22. Sultonov A. Water use planning: a functional diagram of a decision-making system and its mathematical model //International Finance and Accounting. – 2019. – Т. 2019. – №. 5. – С. 19.

23. Karimovich T.M., Obidovich S.A. To increase the effectiveness of the use of Information Systems in the use of water //Development issues of innovative economy in the agricultural sector. – 2021. – С. 222-225.

24. Назиров С.Ў.Ў., Султонов А.О. Саноат корхоналари оқова сувларини тозалашнинг долзарблиги //Science and Education. – 2021. – Т. 2. – №. 6. – С. 299-306.

25. Мансурова Ш.П. Децентрализация-один из способов энергоэффективности теплоснабжения //Академическая публицистика. – С. 30.

26. Такабоев К.У. Оценка и прогнозирование фоновых загрязнений города джизака //Экология: вчера, сегодня, завтра. – 2019. – С. 443-445.

27. Такабоев Қ. Ў. Сув тақчиллиги муаммолари ва уларни бартараф этиш чора-тадбирлари тўғрисида //Science and Education. – 2021. – Т. 2. – №. 4. – С. 89-99.

28. Kenjabayev A., Sultonov A. The issues of using information systems for evaluating the efficiency of using water //International Finance and Accounting. – 2018. – Т. 2018. – №. 3. – С. 2.

29. Sultonov A.O. Metodi ratsionalnogo ispolzovaniya void v oroshenii selskoxozyastvennix kultur //sovremennaya ekonomika: Aktualniye voprosi, dostijeniya i.–2019.–S. – 2019. – С. 207-209.

30. Турдубеков У.Б., Жолболдуева Д.Ш., Султонов А.О. Синергетическая интерпретация эффективности управления государственными финансами //Экономика и бизнес: теория и практика. – 2017. – №. 7.

31. Кенжабаев А.Т., Султонов А.О. Применение современных автоматизированных информационных систем как важнейший механизм для использования водных ресурсов региона //Международный журнал прикладных наук и технологий «Integral». – 2019. – №. 4-1.

32. Кенжабаев А.Т., Султонов А.О. Агрокластеризация–важнейший инструмент экономии водных ресурсов //Сборник научных статей по итогам работы Международного научного форума. – 2019. – С. 105.

33. Бобомуродов У.С., Султонов А.О. Методы улучшения реагентного умягчения воды в осветлителях //Молодой ученый. – 2016. – №. 7-2. – С. 51-53

34. Султонов, А.О. (2019). Методы рационального использования воды в орошении сельскохозяйственных культур. In Современная экономика: актуальные вопросы, достижения и инновации (pp. 207-209).

35. Obidovich, S. A. (2021). Effective Ways of Using Water with Information Systems. International Journal on Economics, Finance and Sustainable Development, 3(7), 28-32. https://doi.org/10.31149/ijefsd.v3i7.2051

36. Saydullaev S. R. Decision-making system for the rational use of water resources //Journal of Central Asian Social Studies. – 2020. – Т. 1. – №. 01. – С. 56-65.

37. Тошматов Н. У., Сайдуллаев С. Р. О методах определения потери и подсосов воздуха в вентиляционных сетях //Молодой ученый. – 2016. – №. 7-2. – С. 72-75.

38. Saydullaev S. R., Sattorov A. B. Analysis of fuel consumption and elimination of shortcomings in traditional boiler furnaces //Nauchno-metodicheskiy zhurnal “Uz Akademia. – 2020. – С. 198-204.

39. Сайдуллаев С. Р. Сувдан самарали фойдаланишда ахборот тизимларини қўллаш //Science and Education. – 2020. – Т. 1. – №. 7. – С. 116-122.

40. Rakhmatillaevich S.S. The Use of Solar Energy as a Heat Source and Heat Energy Conservation Issues //Galaxy International Interdisciplinary Research Journal. – 2021. – Т. 9. – №. 11. – С. 672-676.

41. Toshmatov N.U., Saidullaev S.R. On methods for determining air loss and air leaks in ventilation networks //Young scientist. – 2016. – №. 7-2. – С. 72-75.

42. Каримович М.Т., Рахматуллаевич С.С. Некоторые вопросы состава и оценки состояний промышленных газовых выбросов и их компонентов //Science and Education. – 2020. – Т. 1. – №. 8. – С. 108-115.

43. Тошматов Н.У., Мансурова Ш.П. Возможности использование сточных вод заводов по переработки плодоовощных продуктов для орошения сельскохозяйственных полей //Me′ morchilik va qurilish muammolari. – 2019. – С. 44.

44. Sh. P. Mansurova. (2021). Application of renewable energy sources in buildings. *Galaxy International Interdisciplinary Research Journal*, *9*(12), 1218–1224. Retrieved from https://www.giirj.com/index.php/giirj/article/view/897.

45. Tashmatov, N.U., & Mansurova, S.P. (2022). Some Features of Heat and Moisture Exchange in Direct Contact of Air with a Surface of a Heated Liquid. *International Journal of Innovative Analyses and Emerging Technology*, *2*(1), 26–31. Retrieved from http://openaccessjournals.eu/index.php/ijiaet/article/view/905.

46. Tashmatov, N.U., & Mansurova, S.P. (2022). Specific Features of Change in Surface Temperature of Evaporating Liquid from Hydrodynamic and Temperature-Humidity Conditions. *International Journal of Innovative Analyses and Emerging Technology*, *2*(1), 20–25. Retrieved from http://openaccessjournals.eu/index.php/ijiaet/article/view/904

47. Мансурова, Ш.П. (2020). Особенности влажного воздуха при обработке сорбентами. In Высокие технологии, наука и образование: актуальные вопросы, достижения и инновации (pp. 82-84).

48. Усмонкулов, А., Ташматов, Н.У., & Мансурова, М.Ш. (2020). Некоторые аспекты автоматического регулирования теплового режима многоэтажных зданий, оборудованных системой вытяжной вентиляции помещения. Science and Education, 1(8).

49. Мансурова, Ш. П. (2020). Вопросы особенности проектирования воздушных завес. *European science*, (2-2 (51)), 35-38.