## METALLURGY AND MATERIALS SCIENCE

# STUDYING THE ABSORPTION OF A MIXTURE OF GASES CONTAINING SULFUR OXIDES IN AN ALKALINE MEDIUM

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# ИЗУЧЕНИЕ ПОГЛОЩЕНИЯ СМЕСИ ГАЗОВ, СОДЕРЖАЩЕЙ ОКСИДЫ СЕРЫ, В ЩЕЛОЧНОЙ СРЕДЕ

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**ABSTRACT**

In the article, the absorption of a mixture of gases containing sulfur dioxide and sulfur trioxides in an alkaline environment is considered. In the mixture of gases consisting of sulfur oxides, good absorption of sulfur trioxide in solutions was determined, and it was shown that the problem requires a deeper study of the laws of absorption of sulfur dioxide in solutions. Accordingly, it is recommended to use an alkaline medium for better absorption of sulfur dioxide in solutions.

**АННОТАЦИЯ**

В статье рассмотрено поглощение смеси газов, содержащих диоксид серы и триоксиды серы, в щелочной среде. В смеси газов, состоящей из оксидов серы, установлено хорошее поглощение сернистого ангидрида в растворах и показано, что проблема требует более глубокого изучения закономерностей поглощения сернистого ангидрида в растворах. Соответственно, рекомендуется использовать щелочную среду для лучшего поглощения диоксида серы в растворах.

**Keywords:** sulfur gases, sulfur dioxide, sulfur trioxide, utilization, absorption, alkaline medium.

**Ключевые слова:** сернистые газы, диоксид серы, триоксид серы, утилизация, абсорбция, щелочная среда.

The disposal of sulfur dioxide ($SO_2$) and sulfur trioxide ($SO_3$) gases emitted from metallurgical plants is necessary because these gases are harmful to both human health and the environment [1]. $SO_2$ is a highly reactive gas that can cause respiratory problems such as bronchitis, asthma and emphysema when inhaled in large quantities. It can also contribute to the formation of acid rain, which damages crops, forests and buildings. In addition, $SO_2$ emissions can negatively affect local air quality and contribute to smog [2-3].

$SO_3$ is also a highly reactive gas that can cause similar health problems when inhaled and is even more dangerous than $SO_2$. It can react with water to form sulfuric acid, which is highly corrosive and can damage infrastructure and buildings. In addition, it contributes to the formation of acid rain [4-5]. Sulfur gases are often released during the production of non-ferrous metals and are released into the atmosphere due to improper absorption in the chimneys of metallurgical furnaces.

To reduce these negative effects, metallurgical plants should take measures to control and eliminate $SO_2$ and $SO_3$ gases. The most common method of disposal is to convert $SO_2$ to sulfuric acid through a contact process. In this, $SO_2$ is reacted with oxygen in the presence of a catalyst, resulting in the formation of $SO_3$, which is then hydrated to form sulfuric acid. This process not only eliminates harmful gases, but also helps in the production of valuable industrial chemicals [6].

The absorption coefficient of $SO_2$ and $SO_3$ gases in water indicates the rate of dissolution of these gases in water. This coefficient depends on several factors, including temperature and pressure [7]. At a given pressure, the absorption coefficient of $SO_3$ gas in water generally increases with increasing temperature. This is because higher temperatures generally increase the kinetic energy of gas molecules, making them more likely to collide with water molecules and dissolve in solution. In addition, $SO_3$ gas has a high activity and reacts with water to form sulfuric acid, and this process continues until there are no excess water molecules left in the solution. But due to weak interaction of $SO_2$ gas with water, its solubility in water can be determined [8]. The volume ($m_3$) of $SO_2$ gas absorbed by $1m_3$ of water at a gas partial pressure of 101325 kPa changes depending on the temperature. This can be clearly seen from the graph depicted in Figure 1.

However, the relationship between temperature and absorption coefficient is not linear, and other factors such as gas concentration and solution pH can also affect the coefficient. In addition, with an increase in the concentration of $SO_2$ or $SO_3$ in the gas phase, the absorption coefficient can be saturated, that is, further increases in concentration do not significantly increase the absorption rate [7]. The concentration of the gas in the water affects the Henry's law constant because the solubility of a gas in water is directly proportional to its partial pressure in the gas phase. The pH of the solution also affects the Henry's law constant because it can alter the chemical properties of the gas and the water molecules.

Due to the fact that the absorption of $SO_3$ gas in the mixture of $SO_3$ and $SO_2$ gases from the metallurgical industry is very good, the absorption of the mixture of these gases was considered only on the example of $SO_2$. When $SO_2$ gas is absorbed into an alkaline solution, it reacts with hydroxide ions ($OH^-$) to form sulfite and bisulfite ions.

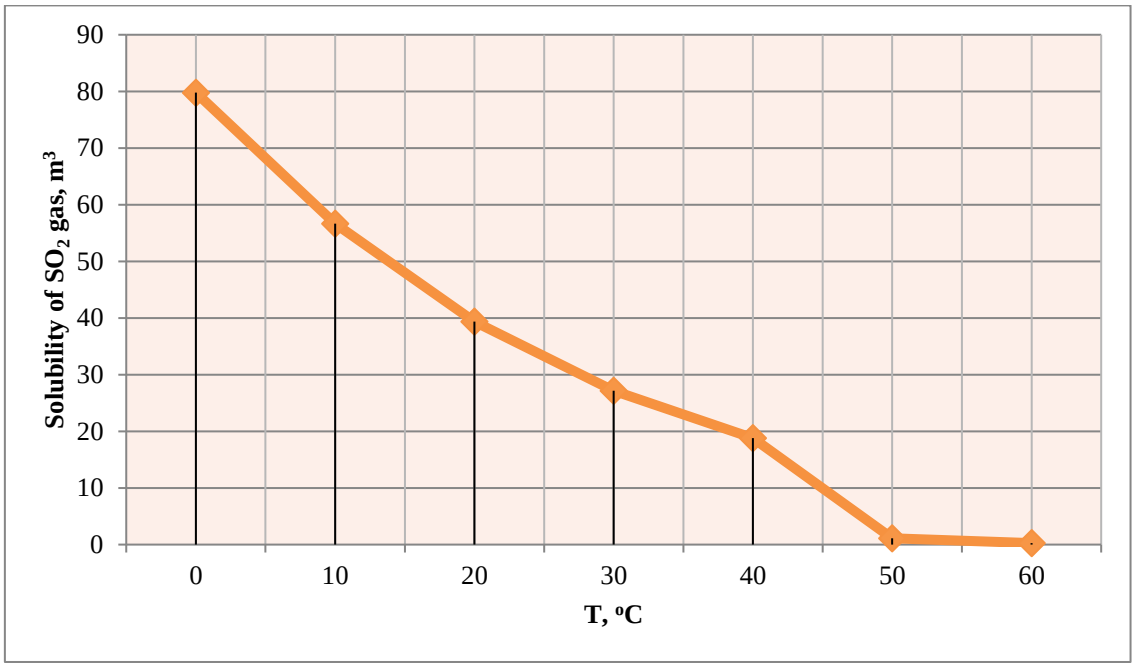


***Figure 1. Solubility of $SO_2$ gas in water with increasing temperature***

The degree of absorption of $SO_2$ in solution depends on several factors, such as the concentration, temperature, pressure and gas flow of the alkaline solution. The dependence of $SO_2$ gas absorption on alkaline environment can be described by the following equations:

1. Absorption rate equation:

The absorption rate of $SO_2$ in an alkaline solution is expressed by the following equation:

$$r = K_1 * C_{SO2} * C_{OH-} \quad (1)$$

Here: r is the rate of absorption, $K_1$ is the rate constant, $C_{SO2}$ is the concentration of $SO_2$ in the gas phase, $C_{OH-}$ is the concentration of hydroxide ions in the solution.

2. Equilibrium equation:

Absorption of $SO_2$ in solution reaches equilibrium when the rate of absorption is equal to the rate of desorption. The equilibrium state can be expressed by the following equation:

$$K_{eq} = C_{sulfit} * C_{OH-} / C_{SO2} \quad (2)$$

Here: $K_{eq}$ is the equilibrium constant, $C_{sulfite}$ is the concentration of sulfite ions, $C_{SO2}$ and $C_{OH-}$ are the concentrations of $SO_2$ and hydroxide ions, respectively.

3. Equation of dependence on pH:

The pH of the solution affects the absorption of $SO_2$ gas because it affects the concentration of hydroxide ions. The dependence of absorption rate on pH can be described by the following equation:

$$r = K_2 * C_{SO2} * (1 - 10^{(pH - pKa)}) \quad (3)$$

Here: $K_2$ is the rate constant, pH is the hydrogen indicator of the solution, pKa is the acidic dissociation constant of sulfuric acid.

In conclusion, the absorption of $SO_2$ and $SO_3$ gases in water can have significant effects on the environment and health. $SO_2$ is a major contributor to acid rain and can cause respiratory problems in humans, while $SO_3$ can react with water to form sulfuric acid, which is highly corrosive and can damage buildings and other structures.

The disposal of $SO_2$ and $SO_3$ gases from metallurgical plants is important for the protection of human health, the environment and infrastructure. Converting $SO_2$ to sulfuric acid through a contact process is an efficient and sustainable way to achieve this. However, there is no practical possibility to process the sulfurous gases released directly around the metallurgical plants by the contact method. This made it necessary to dispose of the mixture of sulfur gases by soaking them in alkaline solutions.

The absorption of $SO_2$ gas in an alkaline solution depends on the concentration of hydroxide ions, which in turn depends on the pH level of the solution. The equilibrium constant is also affected by the concentration of sulfite ions and the concentration of $SO_2$ in the gas phase.

**References:**

1. Mukhametdjanova Sh., Khojiev Sh., Rakhmataliev Sh., Avibakirov I., Mamatov M. Modern Technologies of Copper Production // IJEAIS, 2021. – Vol.5, Issue 5. – P. 106-120.
2. Khojiev Sh.T., Ergasheva M.S., Khamroqulov Sh.F., Khamroev J.O'. The Current State of Copper Metallurgy and Its Raw Material Base // IJEAIS, 2021. – Vol.5, Issue 5. – P. 7-14.
3. Khojiev Sh.T., Berdiyarov B.T., Kadirov N.A., Obidov B.M., Turan M.D. Utilization of household waste-based solid fuel // Technical science and innovation, – Vol.1. – P. 168-176.

4. Toshpulatov D.D., Khojiev Sh.T., Berdiyarov B.T., Kholmominova S.F. Technological analysis of the process of metals recovery of large dust from the converter using metallurgical methods // International Journal of Engineering and Information System, 2021. – Vol.6, Issue 7. – P. 67-71.
5. Khojiev Sh., Berdiyarov B., Mirsaotov S. Reduction of Copper and Iron Oxide Mixture with Local Reducing Gases // Acta of Turin Polytechnic University in Tashkent. – Tashkent, 2020. – Vol.10, Issue 4. – P. 7–17.
6. Hojiyev Sh.T., Berdiyarov B.T., Xotamqulov V.X., Ismatov Sh.O‘. Oltingugurt dioksidining rux kekiga ta’sirini o‘rganish // Proceedings of Uzbekistan-Japan International Conference on “Energy-Earth-Environment-Engineering”, Tashkent, November 17-18, 2022. P. 42.
7. Khasanov A.S., Khojiev Sh.T., Ochildiev Q.T., Abjalova Kh.T. The main factors affecting the rate of separation of the slag and matte phases by their density: a general overview // Universum: технические науки: электрон. научн. журн. – Москва, 2022. – № 10(103), часть 6. – С. 23-27.
8. Berdiyarov B.T., Khojiev Sh.T., Matkarimov S.T., Munosibov Sh. Study of the thermodynamic properties absorption sulfur storage gas of zinc and copper industry // Technical science and innovation, 2021. – Vol.4. – P. 293-301.