CREATION AND EVALUATION OF INDICATOR COMPOSITIONS FOR ETHANOL DETECTION IN GASEOUS ATMOSPHERES

Tolibova Bakhora Zafarovna
Student of the Pediatric Faculty of Samarkand State Medical University
Uktamov Ozodbek Sharofiddinovich
student of the General Faculty of Samarkand State Medical University
Abdurakhmanova Zamira Ergashboevna
assistant of Department Pharmacology of Samarkand State Medical University.

Annotation. An indicator composition for high-quality detection of ethyl alcohol in human exhaled air and process gases has been developed. The results of using the indicator in real operating conditions have shown that the selected indicator is characterized by high sensitivity, rapidity, brightness of color and its stability.

Keywords. Indicator, ethanol, chemical method, human exhaled air, vanadium 8-oxyquinolinate, sodium vanadate, 8-oxyquinoline.

Annotatsiya. Inson ekshalatsiyalangan havo va texnologik gazlarda etil spirtini yuqori sifatli aniqlash uchun indikator tarkibi ishlab chiqilgan. Haqiqiy ish sharoitida indikatordan foydalanish natijalari shuni ko'rsatdiki, tanlangan indikator yuqori sezuvchanlik, tezkorlik, rangning yorqinligi va uning barqarorligi bilan ajralib turadi.

Kalit so'zlar. Ko'rsatkich, etanol, kimyoviy usul, inson ekshalatsiyalangan havo, vanadiy 8-oksikinolinat, natriy vanadat, 8-oksikinolin.

Аннотация. Разработан индикаторный состав для качественного определения этилового спирта в выдыхаемом человеком воздухе и технологических газах. Результаты использования индикатора в реальных условиях эксплуатации показали, что выбранный индикатор характеризуется высокой чувствительностью, быстротой, яркостью свечения и его стабильностью.

Ключевые слова. Индикатор, этанол, химический метод, выдыхаемый человеком воздух, 8-оксихинолинат ванадия, ванадат натрия, 8-оксихинолин.

Introduction

Of all the methods used in the practice of analytical chemistry for monitoring ethanol content, the most widely used are chemical, gas chromatographic and thermocatalytic methods [1-4].

Of the known chemical methods for determining ethanol in human exhaled air, the simplest and most accessible is the method based on the use of chemical indicators. A chemical indicator is a convenient tool for express control of ethyl alcohol in gas environments (human exhaled air, industrial emissions, etc.) [5,6]. Despite the fact that chemical indicators began to be actively used in the middle of

ISSN 3030-3907

the last century, their widespread use is currently becoming increasingly relevant due to their simplicity, low cost and ability to quantitatively measure, the ability to carry out multicomponent analysis with small means directly on site. In many cases, monitoring using chemical indicators successfully replaces complex, expensive, and inaccessible instrumental and laboratory methods for determining ethanol [7].

Chemical indicators of ethanol have the following advantages:

- speed of analysis and obtaining results directly at the sampling site;
- simplicity of the method and equipment design, allowing gas analysis to be carried out by operators without special training;
- small weight and dimensions, as well as low cost of equipment;
-sufficient sensitivity and accuracy of analysis;
- convenience in preparing and performing measurements – no adjustment or configuration of equipment is required before conducting the analysis;
- no need for sources of electrical and thermal energy.

The established advantages allow the effective use of chemical indicators for autonomous express monitoring of ethanol concentration in closed rooms and open spaces.

The use of chemical indicators at the initial stage of work allows to rationalize the analytical process, obtain primary information and minimize the costs of obtaining the entire array of analytical information, and in some cases, even limit ourselves to the information obtained. Transfer of samples for analysis to the laboratory is replaced by information on obtaining the results of the analysis.

The above advantages and merits have contributed to the widespread introduction of chemical indicators in monitoring ethanol in the air and gas environments. Indicators can be successfully used to conduct medical examinations of drivers when establishing the state of intoxication, to control the quality of air and other gas environments, which ensures the protection of public health, environmental protection, etc.The scope of application of the indicator developed in the work: conducting inspections of vehicle drivers; identifying drunk drivers on the roads; use as a means of self-control, etc.

The manufactured indicator tubes are sealed glass tubes filled with a solid carrier treated with an active reagent (chemical indicator). Various powdered materials are used as carriers: silica gel, aluminum oxide, porcelain, glass, etc. In the work, silica gel was used as a carrier, which was treated with HCl acid before use (boiled with HCl and brought to a neutral medium with distilled water), dried and calcined at a temperature of 350 ^{0}C, and then crushed to the required size. After this, a solution of the indicator reagent was prepared. The reagent of the required

ISSN 3030-3907

concentration was applied to the silica gel, and then dried at a certain temperature to a free-flowing state.

The position of the indicator powder (filler) in the indicator tube was fixed with tampons made of air-permeable materials: hygroscopic cotton wool, fiberglass, and perforated Teflon gaskets. The concentrations of the component being determined are found by changing the intensity of the indicator powder color by comparing it with color scales or by the length of the colored layer. The first option is subjective, since the results depend on the operator's color vision acuity, time of day, illumination of the observation site, and color stability of the scale. The essence of the method is to change the color of the indicator powder as a result of interaction with ethanol contained in the analyzed air pumped through the tube.

The length of the colored zone is proportional to the concentration of the substance being determined - ethanol. The length of the colored zone is affected by a number of factors: the internal diameter of the glass tube, the speed of air shaking, the blurriness of the border of the colored zone due to blurring, fluctuations in humidity and temperature, the quality of the calibration of the indicator tubes, compliance with the terms and conditions of storage.

Chemical reactions based on the use of indicator powders provide qualitative or semi-quantitative determination of ethanol in human exhaled air. The relative standard deviation in analysis using a chemical indicator fluctuates widely from 0.20 to 0.50, which is partly explained by the irreproducibility of observing the tube parameters. But since the unequal density of the indicator powder packing in the tube has a slight fluctuation in the height of its layer, then the change in the diameter of the tubes, the uneven impregnation of the carrier with reagents, the unequal sizes of the carrier granules and the aerodynamic resistance of the tampons are due to all of the listed parameters.

In order to select the composition of highly sensitive chemical indicators for detecting ethanol content in vapor-gas mixtures, the patterns of the reaction of ethanol interaction with various reagents were studied. As is known, only compounds that quickly interact with the component being determined can be used as a chemical reagent for ethanol and selectively forming with it brightly colored reaction products that differ in color from the indicator powder. As a rule, selectivity is often increased by using auxiliary oxidizing, drying or filter tubes. The range of ethanol contents determined can be changed by varying the content of the main components of the indicator powders and the volume of the sample taken.

The most widely used chemical reactions for determining ethanol are based on the interaction of alcohols with potassium permanganate or dichromate, vanadium 8-oxyquinolinate, copper(II) oxide, benzoyl chloride, nitric acid (in a

ISSN 3030-3907

benzene medium), iodine (in the presence of alkali), etc. Another fairly widely used chemical method for determining ethanol is based on the strictly specific enzymatic oxidation of ethanol, accompanied by the formation of hydrogen peroxide, which causes the stoichiometric formation of a colored chromogen.

The ethanol content can also be controlled by determining the amount of acetaldehyde formed during the oxidation of alcohol. In this case, sodium nitroprusside or fuchsine sulphurous acid is used as a reagent.

The most widely used chemical methods for determining ethanol are based on the reaction of alcohol with potassium dichromate, which is reduced in an acidic medium to a salt of trivalent chromium. In practice, for chemical control of ethyl alcohol in human exhaled gas, "Sobriety Control" indicator tubes are used, the reagent of which is silica gel impregnated with a solution of chromic anhydride in concentrated sulfuric acid. When exposed to ethyl alcohol vapors, a reaction occurs during which ethyl alcohol vapors reduce chromium (VI) to chromium (III), due to which the orange or yellow color of the reagent changes to green, which is a qualitative characteristic of the reaction. The reagent used is not selective for ethanol, since it also changes color to green when exposed to methyl alcohol vapors, acetone, aldehyde and hydrogen sulfide. When exposed to gasoline, turpentine, acetic acid, camphor, phenol and dichloroethane, the reagent acquires a dark brown or brown color. When exposed to vapors of validol, menthol, water, chloroform, chloranhydrate, kerosene, ammonia, alkali, ethylene glycol, carbon monoxide, clean exhaled air and saliva, the reagent turns orange.

Of all the chemical reactions used to determine ethanol in the air, the simplest, most accessible and most sensitive is its oxidation with potassium permanganate in the presence of concentrated sulfuric acid, and the reaction of alcohol with vanadium 8-oxyquinolinate, characterized by high sensitivity (up to 4 10-4 vol.%), is also widely used. Under optimized conditions, the color of black-green benzene solutions of vanadium oxyquinolinate turns red.

Despite its simplicity, the method of determining ethanol with nitric acid in a benzene environment is comparatively labor-intensive, and the analysis takes a lot of time. A sensitive chemical reaction to ethyl alcohol is the iodoform test. This reaction can establish the presence of alcohol in a solution even at a concentration of 0.05%, but it is not specific to ethyl alcohol, but at the same time is characteristic of acetone, lactic acid, etc. Oxidation of ethyl alcohol with copper(II) oxide is used for its qualitative determination. When ethanol interacts with benzoyl chloride, ethyl benzoate is formed, which has a characteristic odor.

During the experiments, the possibility of using vanadium 8-oxyquinolinate, fuchsine sulfurous acid, benzoyl chloride, potassium permanganate and sodium nitroprusside as reagent indicators for determining ethanol was studied.

ISSN 3030-3907

Experiments to identify changes in the color of various reagents when they interact with ethanol were carried out under the following optimized conditions: temperature 20±2 0C, indicator tube dimensions 3 x50 mm, silica gel carrier, reagent content on it - 5%, alcohol concentration in the mixture 1500 mg/m3, flow rate of steam-gas mixture 2.0 l/min, time of its passage through tubes - 10 min. In all compositions of the test mixture the height of the layer of colored zone was controlled. To control the content of acetaldehyde in the steam-gas mixture with sodium nitroprusside and fuchsine sulfurous acid, the steam-gas mixture of ethanol in air was preliminarily passed through a layer of catalyst (CuO) at a temperature of 150 ^{0}C. Under such conditions 100% conversion of ethanol to acetaldehyde was ensured. During the experiment the dependence of the height of the colored layer of the indicator on the composition of the reagent was studied. The experiments were conducted under the following conditions: temperature 20 ^{0}C, indicator layer size 5x50 mm, reagent content on the carrier - 5%, alcohol concentration in the mixture 1500 mg/m3, flow rate of the vapor-gas mixture 2.0 l/min, time of passing the vapor-gas mixture through the tubes 300 s. The results obtained are presented in Table 1.

Table 1.

Dependence of the height of the colored layer of the indicator on the composition of the reagent

№	Composition of the indicator	Indicator color		Height of painted layer, mm
		Original	Worker	
1	Vanadium 8-hydroxyquinolinate	green	red	46
2	Potassium dichromate	yellow	green	41
3	Potassium permanganate	violet	colorless	34
4	Diosonic benzene sulfonic acid	colorless	yellow	24
5	Fuchsine sulphurous acid	colorless	red	27
6	Sodium nitroprusside	colorless	blue	16

As follows from the data in Table 1, of the indicator compositions studied under identical conditions, the indicator tubes filled with vanadium 8-oxyquinolinate correspond to the longest colored zone.

It was found that when determining ethanol, the length of the colored zones of the indicator tubes filled with the studied compounds decreases in the series: vanadium 8-oxyquinolinate (4.6 cm)> potassium dichromate (4.1 cm) > potassium permanganate (3.4 cm) > fuchsine sulphurous acid (2.7 cm) > diozonium binzenesulfonic acid (2.4 cm) > sodium nitroprusside (1.6 cm).

Consequently, under identical conditions, the most sensitive indicator tube is the one filled with vanadium 8-oxyquinolinate, and the least sensitive is the tube

ISSN 3030-3907

with sodium nitropusside. Table 2 shows the results of determining the time required for complete coloration of the indicator layer in a tube with a height5 cm.

Table 2.

Time required for a complete colour change of a 50 mm layer of various indicators

№	Composition of the indicator	Indicator color		Time, s.
		Original	Worker	
1	Vanadium 8-hydroxyquinolinate	green	red	325
2	Potassium dichromate	yellow	green	366
3	Potassium permanganate	purple	colorless	442
4	Diozonium binzenesulfonic acid	Colorless	Yellow	625
5	Fuchsine sulphurous acid	Colorless	Red	555
6	Sodium nitroprusside	colorless	blue	935

As follows from the data in the table for a complete color change50 mmlayer, depending on the composition of the indicator, requires from 6.5 to 23 minutes of time. In this case, the greatest time is spent on coloring the tube with sodium nitropusside, and the least time - with vanadium 8-oxyquinolinate.

The results of comparative experiments on the sensitivity of indicator tubes with different compositions of indicator powders show that the most sensitive in determining ethanol is the indicator tube filled with silica gel impregnated with vanadium 8-oxyquinolinate. Less sensitive is the tube with potassium dichromate and diazonium benzene sulfonic acid, therefore, in subsequent experiments, the characteristics of indicator tubes filled with vanadium 8-oxyquinolinate, potassium dichromate and diazonium benzene sulfonic acid were studied.

Experiments to study the dependence of the height of the colored layer and the color intensity of the indicator powder on the amount of reagent in the tube were carried out in the reagent concentration range from 0.1 to 10 mass.%, where a vapor-gas mixture of ethanol with an alcohol content of 0.5 vol.% was used. The experimental results obtained in this case are presented in Table 3.

Table 3.

Dependence of the height of the colored zone of the indicator layer on the reagent content in the mixture

№	Indicator reagent content in the mixture, mass%	Height of the painted area of the indicator layer, mm		
		Vanadium 8-hydroxyquinolinate	Bichromate potassium	Diazonium benzene sulfonic acid
1	0,1	6	2	2
2	0.5	18	13	6
4	1.5	34	22	15

ISSN 3030-3907

6	2.5	39	27	24
8	3.5	46	35	23
10	4.5	42	38	18
11	5.0	39	40	16
16	10.0	17	26	6

As follows from the data given in the table, in all the studied indicators with an increase in the reagent content to a certain concentration in the mixture, an increase in the colored zone of the indicator is observed. The longest layer of the colored zone is observed on the tube with vanadium 8-oxyquinolinate with an indicator component content in the mixture equal to 4.0 mass%. At the same time, both a decrease and an increase in the reagent in the indicator mixture leads to a decrease in the height of the colored zone of the indicator tube. A similar nature of the change in the length of the indicator zone is observed with all the studied reagents. The optimal ones are potassium dichromate (6.0 mass%) and diazobenzoyl sulfonic acid (2.5 mass%).

In subsequent experiments, the characteristics of an indicator tube filled with silica gel impregnated with 4 wt.% vanadium 8-oxyquinalinate were studied. The dependence of the height of the colored zone of the indicator layer on the experimental temperature and the ethanol content in the mixture was also studied.

The influence of temperature on the time and length of the colored layer of the indicator was studied using a thermostat TS- 80 M, where the required temperature of the gas mixture was set and maintained with an accuracy of ±0.1 °C. During operation, the gas mixture, entering a copper spiral tube, was heated to the required temperature, and then entered a glass tube filled with silica gel treated with an appropriate indicator composition. The temperature and flow rate varied in the range from 0 to 50 ^{0}C and from 1 to 10 l/h. The dependence of the indicator tube layer height on the gas mixture flow rate was studied in the range of the vapor-gas mixture velocity of 5-15 l/h.

The results obtained in studying the influence of temperature and flow rate on the change in color of the indicator powder are presented in Table 4.

Table 4

Results of the influence of various factors on the indication time

№	Ambient temperature, ^{0}C	Gas carrier consumption, l/h	Indication time, min
1	10	5	468
2	20	5	463
3	50	5	438
4	10	10	329
5	20	10	325

ISSN 3030-3907

6	50	10	315
7	10	15	306
8	20	15	298
9	50	15	282

As follows from the data in the table, with an increase in temperature, no sharp change in the layer height is observed.

Experiments have shown that with increased consumption of the steam-gas mixture, the height time of the colored layer increases, but at a flow rate above 10 l/hour, the colored zone in the indicator tube becomes blurred. The most distinct and contrasting coloring of the zone is observed at the optimal mixture consumption of 10 l/hour.

Conclusion. As a result of the conducted research, an indicator composition for the qualitative detection of ethyl alcohol in human exhaled air and process gases was developed. The results of the indicator application in real operating conditions showed that the selected indicator is characterized by high sensitivity, rapidity, brightness of color and its stability.

LITERATURE

1. Indicator of ethanol vapors in exhaled air with automatic control IPE-"Shark" // Manual for operation of the device. OOO "ERA-COMPANY", 2002. - P.11-15.
2. Indicator strip for qualitative and semi-quantitative determination of alcohol in saliva (ALCO-SCREEN) // Operating manual for the device, Progressive Bio-Medical Technologies LLC, 2006. - P.5-10.
3. Romanyuk N.P. Method for determining the concentration of ethyl alcohol in the human body by its gas chromatic determination without constructing a calibration graph // Forensic medical examination. - M., 1980. - No. 4. - P. 38-39
4. Abdurakhmanov E., Ruziev E.A. Selective thermocatalytic sensors in eco-analytical monitoring of gaseous emissions // Chemical industry. - 2003. - No. 9. - p. 19-25.
5. Indicator strips for qualitative and semi-quantitative determination of alcohol in saliva "ALCOSENSOR" // Passport and operating manual for the device. OOO "BIOSENSOR AN", 2003. - P.21-24.
6. Exhaled air ethanol indicator "Alcotester" // Operating manual for the device. ZAO NPF "META", 2004. - 39 p.
7. Indicator for detecting alcohol in saliva Alcoscan / Bioscan: Based on materials from the sitehttp://www.bioscan.su/.

ISSN 3030-3907