

Thermal stability chamber construction for analysis of the formaldehyde emission in wood.

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Abstract: The formaldehyde analysis in everyday materials can be performed in various ways, this study is based on the construction of a climate chamber to capture and quantification of volatilized organic compound in an atmosphere of variables such as temperature and air velocity, controlled, monitored and registered, as well as providing security against ingress of external contaminants, the camera ensures thermal stability and enables the test in small and medium-sized samples, ensuring emissions in accordance with the limits established by regulations.

Keywords: Formaldehyde, Analysis, Emissions, Exposure.

1. INTROCUCTION

Formaldehyde is a volatile organic compound (VOC) used as an industrial fungicide, germicide and disinfectant in various manufactured products [1]. In standard temperature and pressure, is a colorless, flammable, strong-smelling chemical and evaporates easily

This gas also occurs naturally in the environment, through combustion processes, vegetable decomposition and can be found in foods such as fruit. It constitutes about 50% of all aldehydes present in the air [2].

Formaldehyde produced by natural sources is not harmful to human health. But high concentrations produced by the pulp and paper industry, vehicle emissions, other sources such as paints, varnishes, tobacco, furniture, disinfectants, fungicides, textiles and cosmetics becomes harmful to human health.

Considering the applicability and toxicity of this compound, the objective of this study is to

build a climate chamber, to capture volatilized formaldehyde everyday materials, for further quantitative analysis and verification of concentration and toxicity.

The chamber aims to ensure an airtight and controlled environment to direct emissions of organic compost for containers with water, where formaldehyde is mixed due to solubility, and the concentration in the atmosphere of proof chamber is calculated by the concentration found in the water and the chamber air exchange rate.

1.1 Who is subjected to exposure to formaldehyde

Formaldehyde is classified in group 2A, based on the little information evidenced in humans and on sufficient evidence in animals [3]. Professionals who work directly on the handling, application and use of cosmetic and health professionals are considered the most affected by emissions of formaldehyde. However any human being exposed to industrial products such as furniture,

textiles and paints, is subject to a source of emission of the volatile organic compound.

Formaldehyde presents risks ranging from moderate to severe damage to the eyes, skin and respiratory system, is mutagen, teratogen and probably carcinogenic to humans [4].

1.2 How to measure formaldehyde emissions

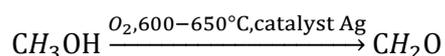
At room temperature, formaldehyde evaporates materials in which it operates, and it is necessary to capture it and quantify it. By means of a double climate chamber system, it is possible to simulate environmental conditions stable, temperature and humidity control, as well as speed and air flow on the sample surface.

The air flow is addressed and controlled before entering the analysis chamber, the emissions of the organic compound are concentrated in wet with water, the external sample environment, for filtering formaldehyde, and content is subsequently determined by spectrophotometry [5].

The research shows the operating principle and manner of construction of the equipment for analyzing the concentration of volatilized organic compound, monitoring and recording the variable throughout the time of sampling, ensuring the quality of the test.

2. FORMALDEHYDE

It is the simplest compound of the family of aldehydes, the most abundant and the most dangerous [4]. Molecular formula CH₂O, whose official name is methanal is considered the most important industrial aldehyde, produced by methanol oxidation:



Have as product the formalin in aqueous solution and can be used as a fungicide and disinfectant [1]. The low molecular weight

aldehydes are miscible in water and have a boiling point as shown in Table 01 [2].

Table 01. Boiling aldehydes.

Formula	Name	Boiling point (°C)
CH ₂ O	Formaldehyde	-21
CH ₃ CHO	Acetaldehyde	21

Formaldehyde is one of the products of incomplete burning of organic compounds, and has a preservative function, such as the smoked meats that are maintained by the bactericidal effect of the formaldehyde by action of coverage and other phenolic substances occur in the smoke [1].

The compound is considered harmful to human health and cancer, but can cause other effects as variation and exposure time, as Table 2 [3,4].

Table 02. Effects of formaldehyde in humans after exposure of short duration.

Average concentration	Mean Time	Health Effects
0,8 a 1 ppm	Repeated exposure	Olfactory perception.
to 2 ppm	Single or repeated exposure	Irritating to eyes, nose and throat.
3-5 ppm	30 minutes	Lacrimation and intolerance by some people.
10-20 ppm	Not specified	Difficulty breathing.
25-50 ppm	Not specified	Pulmonary edema, Risk life.
50-100 ppm	Not specified	May cause death.

3. CLIMATE CHAMBER

3.1. Conception

The equipment developed for the capture of formaldehyde emitted timber consists of an inner tube made of 304 stainless steel with a volume of 1m³ completely sealed against the external environment. This chamber is inserted into the sample from which to quantify the organic compound. This treatise has a compressed air inlet point, six points for extraction of gas during sampling and reading sensors for temperature, relative humidity, air velocity and differential pressure.

The outer chamber completely surrounds the first mentioned, has inner lining of stainless steel, consists of plates with thermal and acoustic insulation polyurethane with a thickness of 80 mm, with a density of 40 kg / cm³, fully collapsible and easy to transport and fixation.

Externally has an enameled metal wall in white.

This chamber is heated through indirect expansion, using environmentally friendly refrigerant gas, which does not affect the ozone layer, and term external tank with fluid as water.

The second chamber is responsible for maintaining the stable temperature throughout the rehearsal process and ensure, that air contaminants do not come into contact with the inner chamber.

3.2. Controlled variables

During the analysis it is necessary to control variables that directly impact the bottom line of the sample. The temperature should be stabilized at 23 ° C with a maximum variation of ± 0.5 ° relative humidity should be 45% with a variation of $\pm 3\%$ and the air speed on the sample surface can be varied between 0 and 0.1 3 m / s [4].

Also covered is the differential pressure of the inner chamber, which must not be lower than 3 mbar.

3.3. Compressed air

The fluid inserted during the sampling process is compressed air, generation of free oil. The drying air has a dew point cooling at -40 ° C or absorption silica same efficiency. Still has filtering with active carbon for the removal of odors coming from the external environment and to filter solid particulate suspension in air with 99.9% efficiency for particles of 0,01µm. This compressed air generation and filtering system has the ability to renew the air inside the analysis chamber 1m³ / h.

3.4. Control and data logging

The equipment has an automation system for controlling variables and record data issued by the camera except the concentrations of formaldehyde. In this system are inserted into the reference variables (default values) which are known values, needed to determine the sample concentration. Through MIMO (multiple input and multiple output) control, ON / OFF, Split-range and PID (proportional integral derivative), stable speed on the sample surface by increasing or decreasing the speed of the internal recirculation motor in addition to this variable controls the relative humidity of the system controlling the opening of dry compressed air valves and wet, just as with temperature switches on or off the term system of accumulation and secondary fluid movement in the internal heat exchanger by controlling the temperature of the inner chambers and external retaining according impact on variables direct reading of concentration.

4. PRINCIPLE OF ANALYSIS

A known surface sample not exceeding the load factor of the camera 1m² / m³ is inserted into the

inner chamber analysis, this chamber temperature, relative humidity and air velocity at the surface of the sample are controlled, while the rate is renewal of air is regulated and fixed. All variables are recorded in the supervisory system automation equipment.

Formaldehyde evaporating surface area of known sample is mixed with the compressed air that is inside the chamber in constant movement, due to an internal recirculation fan which has the function to homogenize the volatile compound emitted by the sample with air treaty that enters the camera.

The analysis of the air chamber is constantly renewed at a rate of $1\text{m}^3 / \text{h}$. Concentration of VOC is determined causing the air inside the bubble chamber container with water, forming a gas washer and retaining the formaldehyde emitted by the sample, which is due to the high miscibility of formaldehyde in water; The concentration of compound in the atmosphere in the chamber is determined by the water analysis with the aid of a spectrophotometer and system of air renewal rate. Assays are terminated when the formaldehyde concentration in the analysis chamber is stabilized [5].

5. RESULTS

After the construction of the chamber and development of the monitoring and control system, preliminary tests were performed the variables reached all the required needs.

In the predetermined temperature value was 23°C during the tests with 48-hour reached the maximum and minimum values of 23.1°C and 22.9°C , the envisaged tolerance was 0.5°C for

more or less. As for the fixed value relative humidity was 45% humidity with maximum variation of 3% above or below the set value, in this case we managed to reach a low of 43.8% and a maximum of 44.8%. The air velocity at the sample surface is floating through the internal recirculation fan for drive and control of the fan rotation frequency is changed when the read value is different from the predetermined value, this variable can oscillate 0.1 to 0.3 m / s and the reference value 0.2 m / s, the velocity analysis period has reached a minimum value of 0,178m / s up to 0,219 m / s.

The tests lasted 48 hours uninterrupted, of which no records variables outside the pre-established patterns after stabilization chamber.

Through the results presented, it is possible, through this equipment, capture volatilized formaldehyde in a sample, without external interference temperature, relative humidity or contaminants transportable, qualifying materials as the concentration of organic compound.

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