

VOL VI

Estudos em Ciências Agrárias e Ambientais

Eduardo Spers
(Organizador)



EDITORA
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2026

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PRÓLOGO

O volume VI da coletânea *Estudos em Ciências Agrárias e Ambientais* reúne um conjunto de trabalhos que evidenciam a diversidade e a complexidade das investigações contemporâneas no campo agrário e ambiental, articulando perspectivas que vão desde a gestão dos territórios até os sistemas produtivos e o cuidado com a saúde e o bem-estar animal.

Organizado em três eixos temáticos, o volume inicia com discussões voltadas ao meio ambiente, à sustentabilidade e às dinâmicas socioecológicas, contemplando estudos que abordam questões relacionadas à governança territorial, aos saberes locais, às estratégias de gestão ambiental e à conservação da fauna. As contribuições deste eixo evidenciam a importância da articulação entre conhecimento científico e práticas sociais na compreensão dos desafios ambientais contemporâneos, bem como na construção de respostas sustentáveis e na preservação da biodiversidade em diferentes contextos.

O segundo eixo, dedicado à produção agrária, aos sistemas produtivos e aos recursos naturais, reúne pesquisas que exploram aspectos fundamentais da produção agrícola, incluindo qualidade de sementes, rendimento de culturas, organização de sistemas produtivos e manejo fitossanitário. Os trabalhos destacam a relevância de abordagens técnicas e científicas para o fortalecimento da produção, ao mesmo tempo em que apontam para a necessidade de práticas mais sustentáveis e eficientes no uso dos recursos naturais.

Por fim, o eixo voltado à saúde, produção e bem-estar animal apresenta estudos que discutem aspectos sanitários, comportamentais e de manejo na produção pecuária. As investigações evidenciam a importância de integrar conhecimento científico, tecnologia e práticas de cuidado para garantir não apenas a produtividade, mas também o bem-estar dos animais e a sustentabilidade dos sistemas produtivos, reforçando a centralidade dessas dimensões na pecuária contemporânea.

Ao reunir essas diferentes perspectivas, este volume reafirma o caráter interdisciplinar das Ciências Agrárias e Ambientais e sua relevância para enfrentar os desafios atuais relacionados à produção, à conservação dos recursos naturais e à sustentabilidade. Trata-se de uma obra que contribui para o avanço do conhecimento científico e para o fortalecimento de práticas mais responsáveis e integradas no campo agrário e ambiental.

Eduardo Eugênio Spers

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MEASUREMENT OF THE DUST CONCENTRATION ELIMINATED BY A COMPOUND FEED FACTORY FOR THE PURPOSE OF ENVIRONMENTAL PROTECTION

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ABSTRACT: Given the increasingly diverse needs of people, as well as the more and more rapid technological developments, a growth in competition between companies of a certain profile or field of activity can be observed. All these aspects greatly influence economic activities at the national and even worldwide level. That is why the Romanian economy has set as a long-term objective the implementation of a real market economy, which fully respects international norms and standards. Thus, also for the compound feed industry, achieving this objective requires equipping the profile factories with modern and high-performance equipment, with a high degree of mechanization, automation and computerization, with high productivity and low specific consumption. Within this article

are presents some theoretical aspects about the equipment used to monitor flue gases eliminated by the production installations of compound feeds. This study continues with an analysis of dust concentrations removed through flue gases in order to confirm compliance with international standards regarding the protection of employed personnel and the environment.

KEYWORDS: combustion installation; gases; dust concentration; temperature; granules.

1. INTRODUCTION

In the combustion installations that produce the steam jets at very high temperatures that are necessary for the sterilization of the mixture, but also for the homogenization of the compound feeds in various forms, as well as in the cooling plants of the final product, both noxious substances and certain amounts of dust or powders are eliminated into the atmosphere, which affect the environment and implicitly have a negative impact on life and the surrounding nature. (Heinsohn, 1999; Bond, 2003; Bollen, 2014; Klippel, 2014)

Fly ash, eliminated through the chimney of combustion installations, fine ash

dust carried by the wind from ash dumps and coal dust originating from coal dumps or from its transportation and preparation, together constitute a solid noxious substance, which is also found in the form of aerosols. Ashes pollute and degrade the environment, deposit on vegetation, buildings, streets and give an unpleasant appearance, ultimately being inhaled by people.

Toxic aerosols are the category of pollutants that have the most harmful effects on humans. Fortunately, these ashes have a very low content of heavy metals (Cr, Ni, Cd, As, Pb), so in most cases the aerosols formed are non-toxic.

More important is the activity of moving harmful gases through dust and exerting their dangerous effects at very great distances from the emission site.

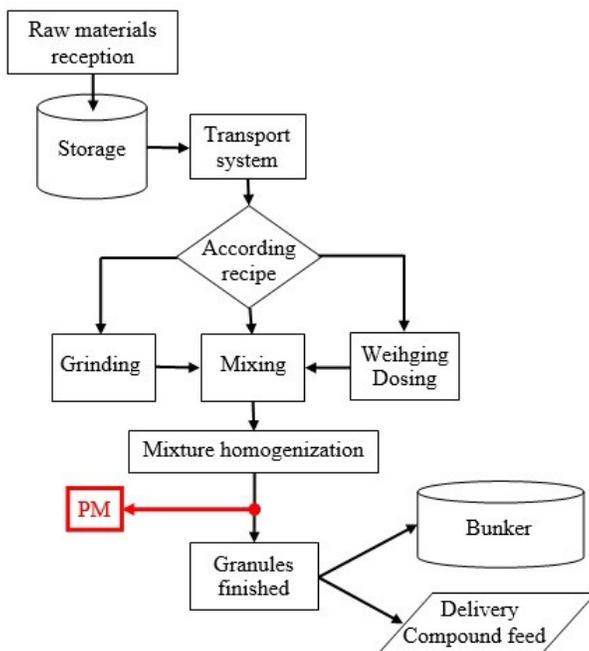
That is why it is absolutely necessary the monitoring and rigorous control of dust concentrations in gases emitted by work facilities that have combustion sources, internal combustion engines or air ventilators that collect various particles. This paper presents the activities carried out to study and experimentally measure dust concentrations resulting from the technological process performed in a compound feed factory, in order to ensure environmental protection.

2. MATERIALS AND METHODS

The technological flow corresponding to the activities effectuated in a compound feed factory is very complex, considering that a compound feed recipe is made up of a mixture of plant and animal feed with mineral salts, antibiotics, vitamins, enzyme preparations and medicinal substances, with a very precise dosage so as to correspond to the physiological needs of the different categories of animals that are fed. (lonel, 2002; Lailer, 2005; Feifei, 2017; Vasile, 2023)

In figure 1 it is schematically presented the technological flow from the compound feed factory where the experimental analyses were performed and indicates the working point for performing measurements (PM) regarding the dust concentration in the gases eliminated by the working installations.

Figure 1. The diagram of technological flow in compound feed factory where is marked the measurement point (PM).



Two of the very important activities in the compound feed production process have been analyzed in this article: the activity of producing steam at very high temperatures and then the activity of cooling the obtained granules.

Thus, the steam produced in the installation of combustion using the steam generator have an important role both for homogenizing the granules and for sterilizing them. The granules thus obtained are then cooled with the help of air in a cooling installation, and after cooling the granules will be transported to the finished product storage bunker or directly to packaging for delivery.

At the second activity which was analyzed, in the cooling process of the obtained product, the air used as a thermal agent heats up due to the increased temperatures of the granules, but at the same time it also carries in its movement the particles released following the drying phase of the respective compound feeds, in this way forming the dust.

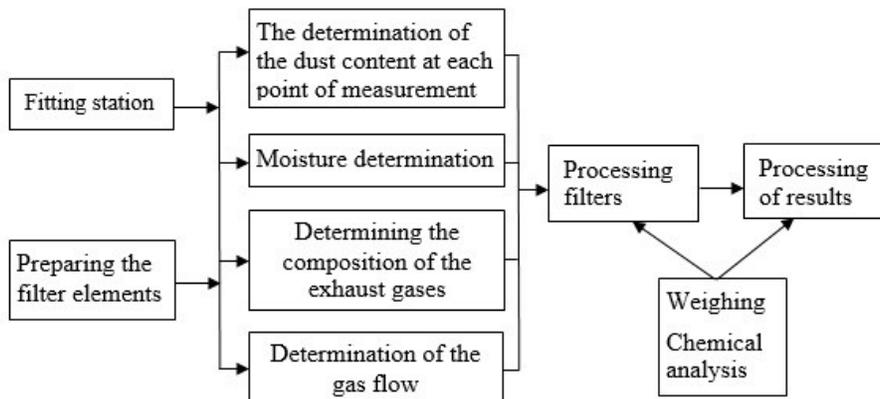
The installation with which the measurement is carried out the quantity of powders in the flue gases from their exhaust ducts is complex and practically is formed of several independent component parts. (Ionel, 1994; Roden, 2006)

After correct mounting the installation, it is brought to the normal operating temperature, respectively the suction tube is brought to about 120°C, the tightness is

checked by closing the probe, an operation followed by starting the suction pump, so that the pressure drop is 200 mbar. The flow rate passing through the installation must be less than 2% of the flow rate that will pass through it during the measurements.

Follows the probe is then positioned at the point of experimental measurement in the direction of gas flow, after which the probe is watertight in the opening area of the channel wall, the suction pump is started and through the by-pass system is moving on to the suction of the gas from the smoke duct (exhaust tube).

Figure 2. Logic scheme of the steps performed to determine the dust content in the flue gases.



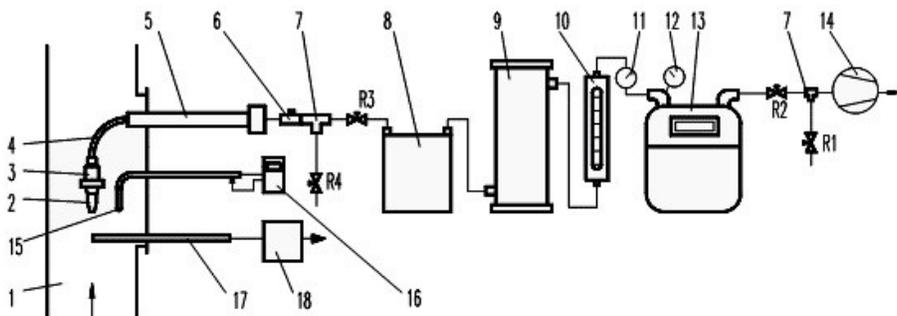
Throughout the entire duration of measurements are monitored the flow parameters of the emitted gases (velocity, flow rate) and the measured values are periodically noted.

Knowing that there is an uneven distribution of dust in the flow section, measurements are made by arranging several sampling points in the section of the probe used, which will allow the correct determination of the average concentration of dust emitted per section.

To evaluate the optimal operating conditions of combustion plants serving the work process of obtaining compound feed, it is necessary to measure the pressure, temperature, and also the volume participation of the main components of the gases eliminated by the combustion plants by using the TESTO 350 M/XL gas analyzer, in order to correctly calculate the density of the exhaust gases.

The device used for measuring the dust concentrations in emitted combustion gases, by type STROHLEIN STE4, is shown in figure 3.

Figure 3: Structure of the measuring device type STROHLEIN STE4 1-gas passage, 2-nozzle calibrated, 3-housing filter cartridge, 4-connectors, 5-socket electrical heating, 6-thermocouple, 7-tees, 8-tank condensate, 9-drying tower silica gel, 10-flow meter, 11-gauge, 12-thermometer, 13-meter vacuum pump exhaust, 14-channel, 15-Pitot-Prandtl tube, 16-electronic micromanometer, 17-well, 18-analyzer TESTO, R1-R4-taps.



The aspirated flue gases will follow the following path: after suction through the calibrated nozzle (2), they will pass through the filters contained in the filter cartridge (3) where the solid particles will be retained, followed by the gas passing through the probe (5) electrically heated to 180°C into the condensate tank (8). To protect the active elements of the used measurement device, the taken gas sample is passed through a drying tower (9). Next, the flue gases pass through the device itself, where the flow rate is determined with the flow meter (10), the pressure with the pressure gauge (11), the temperature with the thermometer (12) and the amount of gases sucked in through the gas meter (13). The volume of gas to be aspirated in is adjusted with the help of valve R1. (Vasile, 2015).

The speed of sample aspirated through the gas channel is determined from the relationship:

$$w_c = \sqrt{\frac{2 \Delta p_{din}}{\rho_{gtc}}} \quad \left[\frac{m}{s} \right]$$

in which:

Δp_{din} – dynamic pressure, measured using the Pitot-Prandtl tube, in [Pa];

ρ_{gtc} – density of the wet gas corresponding to the composition at the pressure and temperature in the channel, in [kg/m³].

To know the exact working conditions at the time of the measurements, the temperature of the compound gases t_{cg} (°C) and the static pressure Δp_{st} [mbar] are determined using a TESTO type measuring device. (Marton, 2016)

Monitoring is carried out throughout the technological process of obtaining the desired type of compound feed. Therefore, throughout the experimental measurements,

the values of the flow parameters for the flue gases removed from the steam generator furnace are monitored and recorded at equal intervals of time (initially every 2 minutes, and then every 5 minutes), namely:

- gas temperature in the probe t_s in [° C];
- gas temperature t_k read on the meter thermometer t_c in [° C];
- gas depression Δp_k , read on the meter's manometer in mbar;
- gas flow rate indicated by the rotometer in m^3/h ;
- barometric pressure, in mbar.

Upon completion of the measurement at a certain point in the exhaust duct, the suction of the gases eliminated by the combustion plant under study is stopped, and at the same time the timer and the electrical power supply to the probe sleeve are turned off and the suctioned gas flow rate is noted, as well as the time elapsed for performing these analyses. (Franke, 2006; Vasile, 2015)

To obtain the final results regarding the dust concentration in the analyzed flue gases, the following steps must be taken: the amount of water collected in the condensate tank is measured and the wetted silica gel is weighed, and after the probe has cooled, the filter element is removed, stored in a specially prepared container and then both the filter cartridge and the flat filter are weighed.

3. RESULTS AND DISCUSSION

During the analyses carried out in the compound feed factory, the dust concentrations were measured at the exhaust duct of the heating agent, represented by jets of steam at very high temperatures.

For the compound feed assortment tested in this work, called "Broiler chicken", will be applied the method for determining of dust concentrations described in the previous paragraphs of this article, about how to handle the Strohlein STE4 device which is specialized for these types of measurements.

According to the standard for measuring dust concentrations, the minimum required sample volume, under isokinetic conditions, is $1 m^3$.

Depending on the speed of the effluent at the exhaust duct, the sampling time can vary from minutes to hours. In order to be able to take the sample under isokinetic conditions, it is necessary to know some thermodynamic parameters of the effluent.

Thus, for the compound feed "Broiler chicken" the determined thermodynamic parameters of the effluent are:

- ambient temperature $t_{amb} = 20$ [°C];
- dynamic pressure $p_{din} = 0.1$ [mbar];
- effluent temperature $t_{ef} = 48$ [°C];
- effluent humidity $Rh = 78$ [%];
- effluent velocity $w_{ef} = 5.2$ [m/s].

In table 1 it is indicated the dust concentration value, as well as a series of other parameters characteristic of that measurement sample.

Table 1. Calculation of dust concentration for “Broiler Chicken”.

Name	MU	Broiler FS
Initial mass of filter cotton wool	g	48.9836
Initial mass of filter paper + box	g	9.7021
Final mass of filter cotton wool	g	48.9847
Final table filter paper + box	g	9.7026
Effluent temperature at the stack	°C	48.0
Pressure difference p	mbar	0.10
Static pressure p_s	mbar	0.00
Initial counter	m ³	627.5370
Final counter	m ³	628.5420
Start time	-	9:00
End time	-	9:42
Initial meter temperature t_i	°C	24.0
Final meter temperature t_f	°C	25.0
Mass of collected dust m_{dust}	g	0.0016
The volume of gas flowing through the meter V_{cont}	m ³	1.0050
Dust concentration in flue gases C_{dust}	mg/ m³ N	1.7462

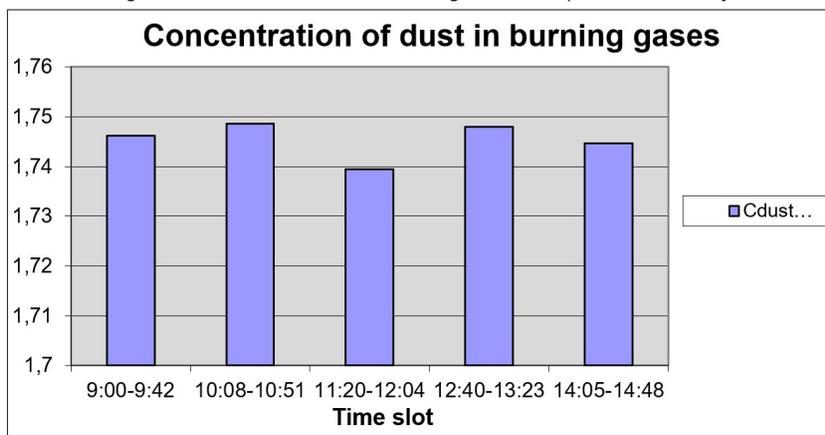
For the specific case of the combustion installation that was analyzed in this article, several experimental measurements were carried out at different time intervals, for different production batches of the compound feed assortment of type “Broiler chicken” and the results obtained for the dust concentration values are presented in table 2.

Table 2. Dust concentration in flue gases C_{dust} .

Measurement sample	1	2	3	4	5
Time slot	9:00-9:42	10:08-10:51	11:20-12:04	12:40-13:23	14:05-14:48
C_{dust} [mg/ m ³ N]	1.7462	1.7486	1.7394	1.7479	1.7446

In the figure 4 it is graphically presents the evolution of the measured values for the dust concentration in the gases emitted from the exhaust duct of the combustion installation studied.

Figure 4: Dust concentration in the flue gas from compound feed factory.



4. CONCLUSIONS

In order to obtain accurate results from the analyses performed to monitor the work process in the compound feed factory where the research was performed, the dust concentrations were measured at the exit from exhaust duct of the heating agent.

Following the international rules and standards for operation in this field of activity, Order 462/1993 was issued in our country. It imposes, in addition to the noxious limits, also limits on dust concentrations. The dust emission limit for compound feed production installations is 5 mg/m³N.

A very important conclusion resulting from these experimental measurements is that the steam generator combustion installation, in terms of dust emissions, falls within the normal limits established by the European and international laws in force.

Starting from the consideration of the importance of respecting national and international rules and standards concerning to environmental protection, it is very necessary that the working installations from the compound feed factories be modernized and equipped with the most efficient automated and computerized control equipment of all activities effectuated, as well as the existence of rigorous control of the concentrations of polluting substances and dust eliminated through combustion gases, through the action of hot steam jets or cooling air jets.

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*** - User manual, Strohleim STE4

SOBRE O ORGANIZADOR

EDUARDO EUGÊNIO SPERS realizou pós-doutorado na Wageningen University (WUR), Holanda, e especialização no IGIA, França. Possui doutorado em Administração pela Universidade de São Paulo (USP). Foi Professor do Programa de Mestrado e Doutorado em Administração e do Mestrado Profissional em Comportamento do Consumidor da ESPM. Líder do tema Teoria, Epistemologia e Métodos de Pesquisa em Marketing na Associação Nacional de Pós-Graduação e Pesquisa em Administração (ANPAD). Participou de diversos projetos de consultoria e pesquisa coordenados pelo PENSA e Markestrat. É Professor Titular no Departamento de Economia, Administração e Sociologia, docente do Mestrado em Administração e Coordenador do Grupo de Extensão MarkEsalq no campus da USP/Esalq. Proferiu palestras em diversos eventos acadêmicos e profissionais, com diversos artigos publicados em periódicos nacionais e internacionais, livros e capítulos de livros sobre agronegócios, com foco no marketing e no comportamento do produtor rural e do consumidor de alimentos.

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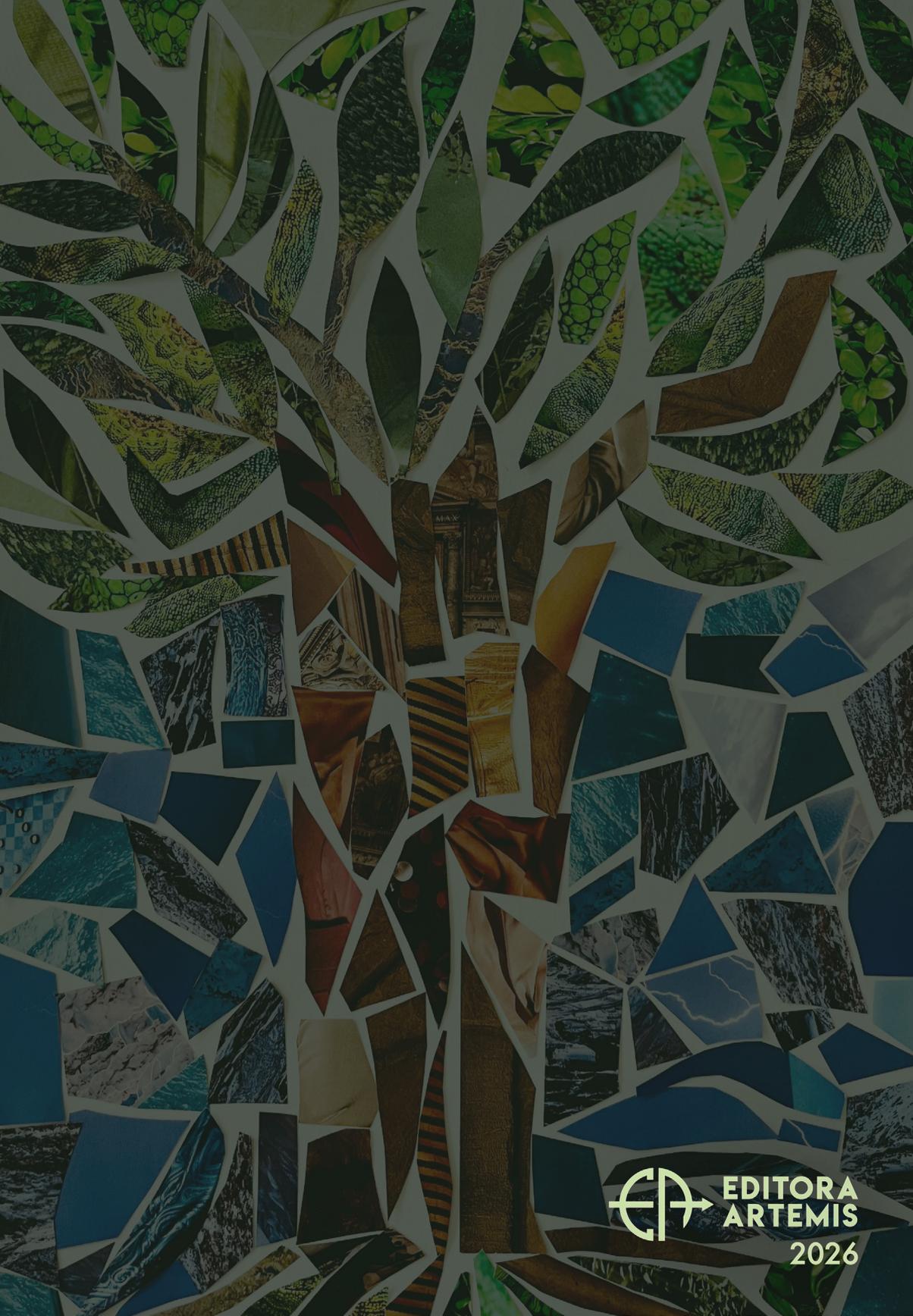
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