

Characterization of the Cylindrical Humidifier for Gases Used in

CMS RPCs in the VAL4-309 laboratory of the Eco-campus (BUAP)

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Summary

This report presents the detailed characterization of the cylindrical humidifier used in the laboratory for the

research on Resistive Plate Chambers (RPC's) at CERN. The device in question exhibits dimensions specific, including a height of (29.80 ± 0.05) cm, a diameter of (15.80 ± 0.05) cm, and differentiated heights for

the dry and humidified gas inlet and outlet tubes, respectively. Furthermore, a reference is established

critical for the optimal water level through a glass tube, whose red line is at a height of

(0.90 ± 0.05) cm. The relevance of the height from the base of the humidifier to the laboratory floor is highlighted,

set at (42.70 ± 0.05) cm for the purpose of addressing considerations regarding atmospheric pressure.

1. Humidifier Specifications

The humidifier features the following key dimensions:

Total height: (29.80 ± 0.05) cm.

Diameter: (15.80 ± 0.05) cm.

Height of dry gas inlet tube: (2.00 ± 0.05) cm.

Height of humidified gas outlet tube: (2.30 ± 0.05) cm.

Length of the humidified gas inlet tube inside the humidifier: (29.30 ± 0.05) cm.

Length of the humidified gas outlet tube inside the humidifier: (2.40 ± 0.05) cm.

2. Optimum Water Level Reference

To maintain an optimal water level, a glass tube with a red line located at a height of (3.70 ± 0.05) cm with respect to the base of this tube. This reference provides a visual indicator of the water level demineralized that the humidifier will contain.

3. Height from the Base to the Laboratory Floor

The position of the humidifier relative to the laboratory floor is a crucial factor in addressing variations

with respect to the atmospheric pressure and the pressure that will be inside the humidifier. The current height from

the base of the device to the ground is (42.70 ± 0.05) cm.

3.1. Heat Transfer and Evaporation

Humidification is achieved through heat exchange between dry gas and water. The dry gas, upon entering

through the inlet tube, it undergoes an evaporation process upon contact with the surface of the water

present inside the device. This heat transfer phenomenon results in the incorporation of water vapor to the gas, thus increasing its moisture content.

3.2. Relative Humidity and Parameter Control

The relative humidity of the resulting gas is a critical indicator of the humidification process. The capacity of

control physical parameters, such as temperature (I'm still thinking about how to delve deeper into this part) and

gas velocity, plays an essential role in obtaining specific levels of relative humidity, optimizing thus the conditions for experimental research.



Figure 1: Height of the humidifier and measurement of the amount the inlet (pink) and outlet (green) tubes protrude

of gas with respect to the lid of the humidifier



Figura 2: Diámetro del humidificador

4. Evaluation of Gas Introduction Capacity

The application of 3 liters of gas per hour to the cylindrical humidifier under consideration has been proposed. To determine

the suitability of this flow in relation to the dimensions of the device, the volume of the cylinder has been calculated by

the formula $V = \pi r^2 h$, where r is the radius of the cylinder and h is the height.

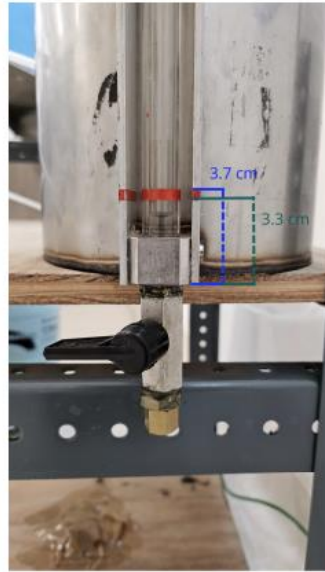


Figura 3: Altura recomendada a la que debe administrarse agua desmineralizada.

Figure 3: Recommended height at which demineralized water should be administered.



Figura 4: Altura desde la base del humidificador al suelo del laboratorio.

Figure 4: Height from the base of the humidifier to the laboratory floor.

$$V = \pi (15.8/2)^2 \times 29.8 \text{ cm} \approx 3694.24 \text{ cm}^3$$

The conversion of 3 liters per hour to cubic centimeters per hour is 3000 cm³/hour. When comparing this value with the volume of the free cylinder (there will be approximately 725.4 cm³ of water, so the free volume will be of 2968.79 cm³), a verification of the suitability of the gas flow is obtained.

Verification: .791

The verification result indicates that the proposed flow exceeds the volume of the cylinder, which suggests that the

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Application of 3 liters of gas per hour is not ideal in relation to the dimensions of the cylindrical humidifier. HE

recommends checking and adjusting the gas flow to ensure compatibility with the device.

5. Necessary pressure of the gas so that it can leave the humidifier.

The water inside the humidifier will be exerting pressure on the walls that contain it called pressure.

hydrostatic that must be overcome by the gas that is introduced so that it can leave. The hydrostatic pressure is

calculated with:

$P = \rho gh + p_0$ Where:

P = hydrostatic pressure

ρ = density of the liquid g = gravity h = height of the liquid whose pressure is to be measured p_0 = atmospheric pressure

Assuming that the container has one liter of water (1000cm³

), 'this will have a height of 5.1cm contained within

of the humidifier. Furthermore, it is known that the density of water is 997kg/m³.

Thus, knowing the atmospheric pressure,

The pressure that the gas needs to overcome in order to leave the water is: $P = (\rho g h + p_0)$

$(9.8 \text{ m/s}^2$

$)(0.051 \text{ m}) + p_0$

$= 498.3 \text{ Pa} = 0.004983 \text{ bar} = 4.983 \text{ millibar}$

It was found that the pressure that the gas needs when entering is approximately 5 millibars so that it can leave.

of the water