EXPERIMENT 3

Subject

Density Analysis

Objective

To learn how to measure the density of sintered ceramic bodies by archimedes method.

Theory

In almost all ceramic based processing, especially in high strength or high temperature required applications, the density of the materials constitutes great importance. Porosity affects a material's mechanical properties, thermal properties (especially heat transfer, especially for refractory materials), and corrosion, mechanical wear behavior due to the materials present in the different environment. Porosity in ceramic materials is also important depending on the application area in which they are used (floor and wall tiles, ceramic filters). Since it is difficult to detect closed pores, in most cases determining only the proportion of open pores in ceramics is important and useful in practice. In principle, the volume of pores in a sample is calculated from the weight of the liquid required to fill them (water will be used in this experiment). Since this method is based on the Archimedes Principle, it is also called the Archimedes Method.

Bulk Volume, volume of the whole material, including samples solid part's and open, closed pores volume.

Apparent Solid Volume, volume of the material's solid part and closed pores.

Actual Volume, volume of the material's solid part.

Bulk Density, can be calculate as sample weight dividing by bulk volume

Apparent Solid Density, can be calculated as sample wieght dividing by apparent solid volume.

Theoretical Density, can be calculated as sample weight dividing by actual volume.

Relative Density, is ratio of the sample density and referance density, unitless.

In SI unit system, density unit is kg/m^3, g/cm^3.

$1\ kg/m^3 = 0.001\ g/cm^3$
$1\ g/cm^3 = 1\ kg/dm^3 = 1000\ kg/m^3$

Experimental Calculations

Water Absorption (%) = $(W_D - W_K) / W_K \times 100$

Bulk Density: Sample Weight / Bulk Volume = $[W_K / (W_D - W_A)] \times \rho_{liq}$

Apparent Solid Density: Sample Wieght / Apparent Solid Volume = $[W_K / (W_K - W_A)] \times \rho_{liq}$

% Apparent Porosity: (Open Pore Volume / Bulk Volume)$\times 100 = [(W_D - W_K)/(W_D - W_A)] \times 100$

% **Total Porosity**: $(1 - \rho_{bulk}/\rho_{theo}) \times 100$

In this calculations;

W_K = Weight of dry sample (g)

W_A = Weight of holding water absorped sample (wet) (g)

W_D = Weight of holding water absorped sample (dry) (g)

ρ_{liq} = Density of liquid used in experiment (water)
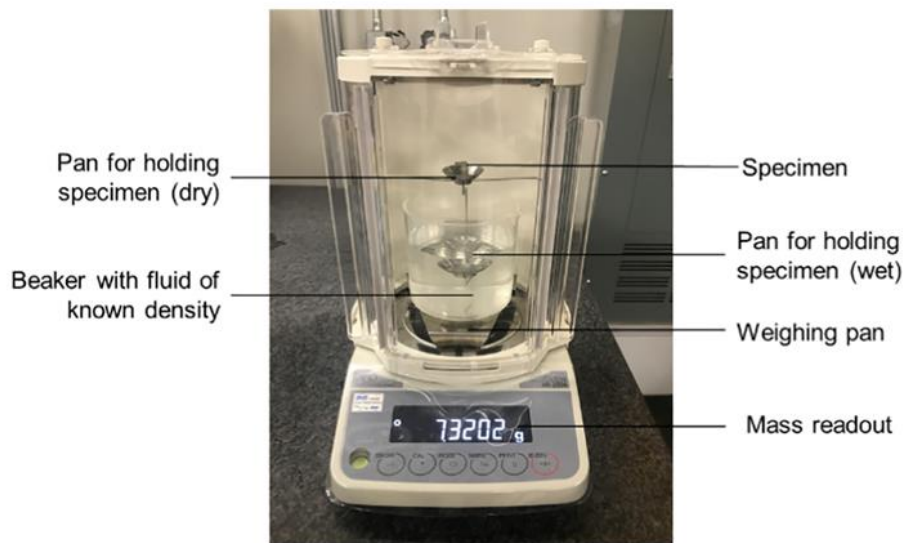
Experimental Setup

Figure 1. Archimedes density measurement setup.[1]

Content of the Report

- Use report cover page template fort the first page of report. (You can download from web site of department)
- Every page should have page number. Text size should be 12 punto.
- Briefly explain the experiment's aim and theory with your own words.
- Draw a table with your experiment data. (W_K, W_D, W_A, 2r and h)
- Draw a table with your calculated data.
- Calculated data table incudes; Water absorption, Bulk density, Apparent solid density, Theoretical Density, % Apparent Porosity, % Total Porosity.
- You can use photos that taken from experiment day in your report.

1. Bruce, D., Paradise, P., Saxena, A., Temes, S., Clark, R., Noe, C., ... & Bhate, D. (2022). A critical assessment of the Archimedes density method for thin-wall specimens in laser powder bed fusion: Measurement capability, process sensitivity and property correlation. *Journal of Manufacturing Processes, 79*, 185-192.