International Journal of General
Engineering and Technology (IJGET)
ISSN(P): 2278-9928; ISSN(E): 2278-9936
Vol. 6, Issue 3 , Apr – May 2017; 1-12

International Academy of Science,
Engineering and Technology
Connecting Researchers; Nurturing Innovations

DESIGN AND EVALUATION OF A NOVEL AIR PYCNOMETER FOR TRUE VOLUME MEASUREMENT OF SOLID PARTICLES

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ABSTRACT

Precise measurement of volume, true density and specific gravity of small grains and food particles is a challenging task in the laboratories without sophisticated equipment. Therefore, a low-cost gas pycnometer was designed and evaluated for true volume measurement of solid particles as an alternative for expensive air comparison pycnometers. The theoretical principle is based on the Boyle's law of volume pressure relationship. The instrument was designed with three main components: a sample cup, two 20 mm diameter liner pneumatic cylinders and a differential pressure gauge. Two identical pneumatic cylinders were used to convert the liner displacement of the piston to the proportional volume change in both cylinders. The reading accuracy of displacement was increased by using a 0.01 mm dial indicator gauge. As the reading of the instrument is the liner motion of the piston shaft, the volume is calculated using an equation developed through calibration using some known volumes. In the calibration process, seven known volumes were used with three replications. The co-efficient of determination value for the calibration data set was 0.86. Two known volumes of 4.49 cm^3 and 17.21 cm^3 were used to evaluate the optimum volume to be measured and the standard deviations (SD) of linear measurements were calculated as 0.2658 cm and 0.2163 cm, respectively. Volume errors were calculated based on the SD values and the error percentages were calculated as 3.7% and 0.78% for 4.49 and 17.21 cm^3 objects, respectively. Results revealed that the percentage error for the larger volume object was less than 1%. The accuracy of the instrument can be enhanced further using gases like helium or argon which, are more closed to ideal gases. Temperature influence on the reading has to be minimized by conducting the test in a temperature controlled chamber. Unlike commercially available instruments this can be fabricated at very low-cost using readily available components in the local market. The device is portable and no need of external power supply for the operation.

KEYWORDS: Air Pycnometer, Boyle's Law, Particle Volume, Specific Gravity, True Density