

## **Performance Evaluation of VIP Latrines in the Upper West Region of Ghana**

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The prevalence of Ventilated Improved Pit (VIP) latrines in Ghana suggests that the design must have a high user acceptance. The two key factors attributed to user acceptance of a VIP latrine over an alternative latrine design, such as the basic pit latrine, are its ability to remove foul odors and maintain low fly populations; both of which are a direct result of an adequate ventilation flow rate. Adequate ventilation for odorless conditions in a VIP latrine has been defined by the United Nations Development Program (UNDP) and the World Bank, as an air flow rate equivalent to 6 air changes per hour (6 ACH) of the superstructure's air volume.

Additionally, the UNDP determined that the three primary factors that affect ventilation are: 1) wind passing over the mouth of the vent pipe, 2) wind passing into the superstructure, and 3) solar radiation on to the vent pipe. Previous studies also indicate that vent pipes with larger diameters increase flow rates, and the application of carbonaceous materials to the pit sludge reduces odor and insect prevalence.

Furthermore, proper design and construction is critical for the correct functioning of VIP latrines. Under-designing could cause problems with odor and insect control; overdesigning would increase costs unnecessarily, thereby making it potentially unaffordable for benefactors to independently construct, repair or replace a VIP latrine. The present study evaluated the design of VIP latrines used by rural communities in the Upper West Region of Ghana with the focus of assessing adequate ventilation for odor removal and insect control. Thirty VIP latrines from six communities in the Upper West Region of Ghana were sampled. Each VIP latrine's ventilation flow rate and microenvironment was measured using a hot-wire anemometer probe and portable weather station for a minimum of four hours. To capture any temporal or seasonal variations in ventilation, ten of the latrines were sampled monthly over the course of three months for a minimum of 12 hours. A latrine usage survey and a cost analysis were also conducted to further assess the VIP latrine as an appropriated technology for sustainable development in the Upper West Region. It was found that the average air flow rate over the entire sample set was 11.3 m<sup>3</sup>/hr. The minimum and maximum air flow rates were 0.0 m<sup>3</sup>/hr and 48.0 m<sup>3</sup>/hr respectively. Only 1 of the 30 VIP latrines (3%) was found to have an air flow rate greater than the UNDP defined odorless condition of 6 ACH. Furthermore, 19 VIP latrines (63%) were found to have an average air flow rate of less than half the flow rate required to achieve 6 ACH.

The dominant factors affecting ventilation flow rate were wind passing over the mouth of the vent pipe and air buoyancy forces, which were the effect of differences in temperature between the substructure and the ambient environment. Of 76 usable VIP latrines found in one community, 68.4% were in actual use. The cost of a VIP latrine was found to be equivalent to approximately 12% of the mean annual household income for Upper West Region inhabitants.