BGI Incorporated

58 Guinan St.
Waltham, MA 02451

Ph.: 781 891 9380
Fx.: 781 891 8151
E mail: bsk29@attglobal.net
www.bgiusa.com

Technical Report: *Evaluation of a Sharp Cut Cyclone for PM 1 Sampling*

January 2000

Robert Gussman

Summary

The information contained in this report details the design parameters and test results relating to a new variant of the Sharp Cut Cyclone (SCC) specifically configured for ambient sampling of PM 1 particulate at a flow rate of 16.7 Lpm.

Introduction

SCC (Sharp Cut Cyclone), is the designation for a tangential, round-entry cyclone geometry. This report details an experimental evaluation of the aerosol size-selective performance of a prototype SCC cyclone, constructed by BGI Inc. for PM 1 ambient aerosol sampling applications.

The dimensions of the cyclone designed for testing was calculated using a model recently refined by Dr. L.C. Kenny of the HSL while performing contract studies for BGI Inc. (HSL Report IR/L/EXM/99/03-Restricted). This model was derived from previous work on novel cyclones by HSL (in preparation for Journal submission).

Description of Sampler

The Sharp-Cut Cyclone is based on the design of the SRI-III cyclone originally described by Smith *et al*. (1979). A scaled-up cyclone with SRI-III geometry was tested by Kenny and Gussman (1997). The results of these tests were used to calculate dimensions for the SCC ambient cyclone, which has a cut point (D_{50}) equal to 2.5 µm at a flow rate of 16.7 $l.min^{-1}$. An extensive series of tests were carried out on this cyclone, in order to validate its performance when clean, and also after loading (Kenny *et al.,* 2000).

The new PM 1 cyclone was developed using the latest SCC model for a flow rate of 16.7 Lpm. This resulted in a cyclone body diameter of 2.229 cm The complete set of design dimensions are shown in Figure 1.

EXPERIMENTAL METHODS

The experimental methods used to test the cyclones were similar to those described in detail by Maynard and Kenny (1994). Their technique involves the use of either the TSI APS 3310 or 3320, measuring the penetration, through the test device, of polydispersed solid glass microspheres. The latest refinement of this technique is detailed by Kenny *et al* (2000).

The SCC 2.229 cyclone was tested at a single flow rate of 16.7 l/min. All Tests were performed in the horizontal position with the inlet pointing at a right angle to the chamber flow.

Two tests were performed by Dr. Kenny, (HSE Report IR/L/EXM/99/03 – t 066 and t 069) and one by R. Gussman (t 156).

RESULTS

Figure 2 summarizes the individual penetration curves measured. All data is sensibly identical and differences are minor. A PM 1 cut at 16.7 Lpm is confirmed. D_{50} = 1.04 ìM, Sharpness = 1.17.

DISCUSSION

The SCC cyclone design, herein reported, was tested in the HSE Laboratory. The work was carried out as part of a study of various size selective devices.

During the course of this and previous investigations, the concept of measuring the sharpness of the size selector penetration curve was adopted. This concept was first suggested by Peters *et al* (1996). This method of defining slope is analogous to the Geometric Standard Deviation (GSD) and is calculated from the penetration curve as: Sharpness = $(D_{16}/D_{84})^{0.5}$. For ambient sampling EPA has emphasised steep (numerically low numbers) curves as being desirable. The SCC 2.229 is superior in this regard, as can be seen, below.

Device	**D_{50}**	**Sharpness/HSL**	**Sharpness/EPA**
WINS	2.5	1.23	1.18
SCC	2.5	1.19	
SCC	**1**	**1.17**	

CONCLUSIONS

- The SCC model, refined from earlier work, has been further confirmed by these tests and is considered finished, at the PM 1 size cut. The SCC 2.229 has sharpness comparable to the EPA WINS.
- The SCC 2.229 has not been the subject of ambient testing. No information has been developed on the long term loading effects. However, previous extensive studies on the PM 2.5 SCC were extremely favorable in this regard. (Kenny *et al* 2000).

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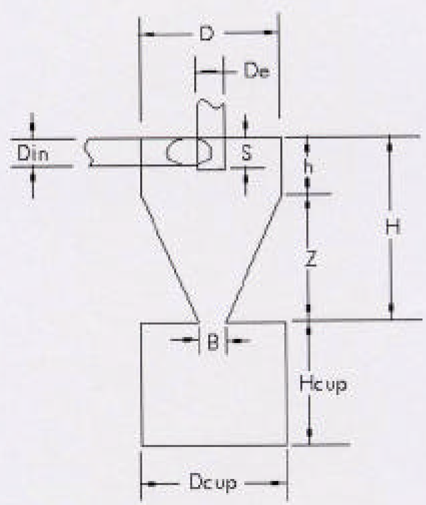
FIGURE 1 - CYCLONE DESIGN PROPORTIONS - SCC

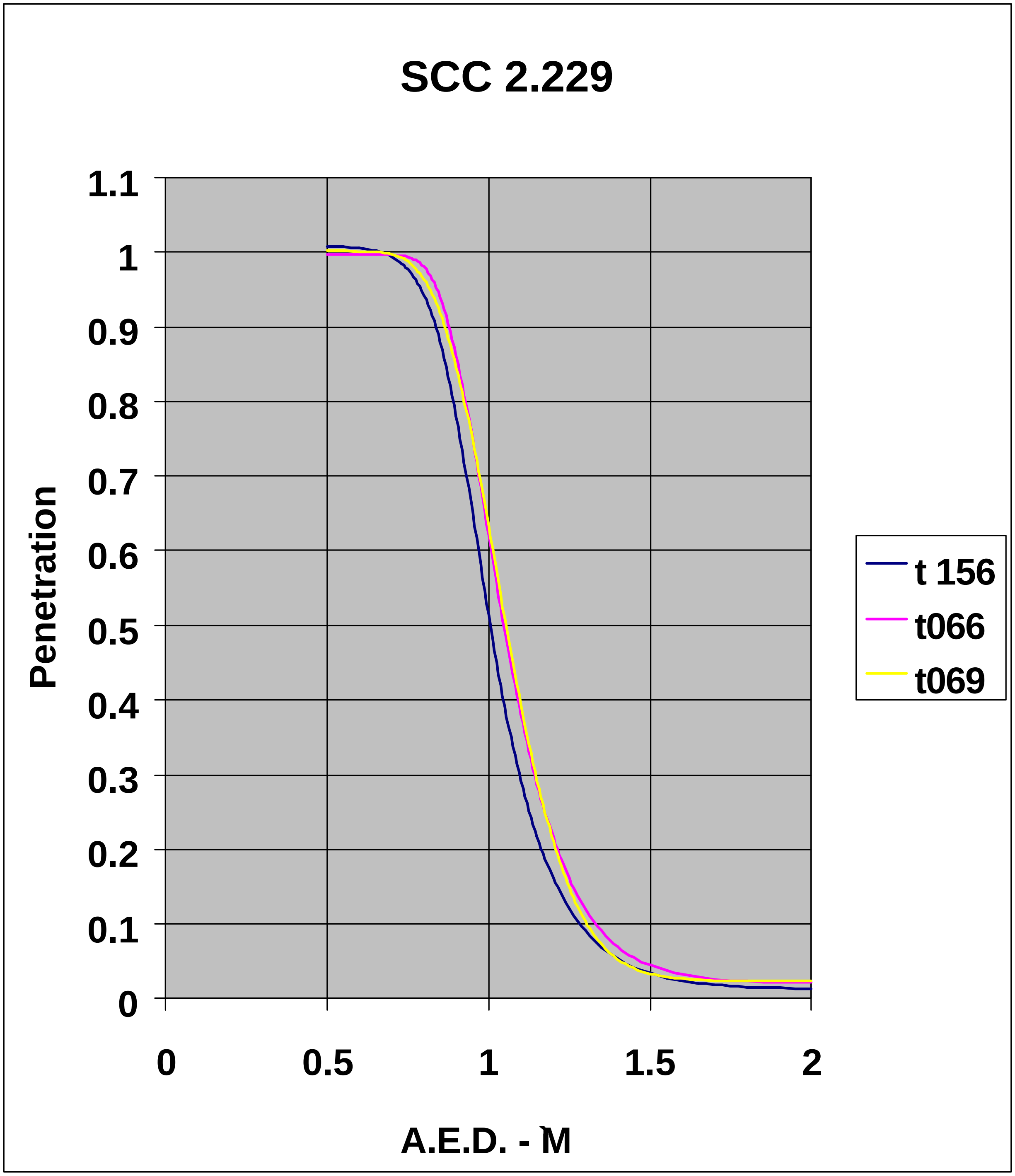
$D = 2.229$ CYCLONE DESIGN DIAMETER

cm. ver.

Design solutions

$0.24 \cdot D = 0.535$	Din
$0.27 \cdot D = 0.602$	De
$0.25 \cdot D = 0.557$	B
$1.56 \cdot D = 3.477$	H
$0.43 \cdot D = 0.958$	h
$1.13 \cdot D = 2.519$	Z
$0.35 \cdot D = 0.78$	S
$0.87 \cdot D = 1.939$	Hcup
$0.635 \cdot D = 1.415$	Dcup




SCC 2.229
Penetration
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.5
1
1.5
2
A.E.D. - M
t 156
t066
t069