

Gas Analyzer Error Analysis

The derivation of VO_2 , and similarly VCO_2 , is complex involving quite a few variables; these variables may either be measured or estimated:

- O₂ concentration; both inspiratory, fiO_2 , and expiratory, feO_2
- CO₂ concentration; both inspiratory, $fiCO_2$, and expiratory, $feCO_2$
- Calibration Gas
- Flow, usually during inspiration and/or expiration
- Temperature, Pressure, and humidity at the flow device [used for STPD and BTPS correction]
- Sample gas humidity
- Time, usually of one inspiration and/or expiration period

Each of these variables has multiple sources of error. To simplify the error analysis some assumptions are necessary. For a typical Metabolic Cart assume:

- Perhaps the biggest assumption is that the published accuracy specifications for each measurement device in the system takes into account all of its sources of error.
- The Calibration Gas introduces no error.
- Textbook equations can be applied to derive VO_2 and VCO_2 ; another big assumption because most manufacturers do not publish their equations; with the exception of AEI.
- The same O₂ analyzer measures both fiO_2 and feO_2 , and the same CO₂ analyzer measures both $fiCO_2$ and $feCO_2$.
- One flow device is used for either inspiration or expiration but not both.
- The humidity in the calibration gas equals the humidity in both inspiratory and expiratory gas measurements.
- The error in time measurements is negligible.
- The system incorporates a Mixing Chamber and does not sample directly from the mouth.

These assumptions do apply to both the Moxus and the MAX-II metabolic carts manufactured by AEI Technologies.

VO₂, VCO₂, and RER Gas Analyzer error examples

Utilize the textbook equations for Exercise:

$$VO_2 = (V_i * fiO_2) - (V_{e_{avg}} * feO_2);$$

$$VCO_2 = (V_e * feCO_2) - (V_{i_{avg}} * fiCO_2);$$

$$\text{Where } V_e = V_i * (100 - fiO_2 - fiCO_2) / (100 - feO_2 - feCO_2) \text{ [Haldane transform]}$$

MOXUS Metabolic Cart Example:

<u>Expected Values</u>		<u>Worst Case Values</u>	
fiO_2	20.93	fiO_2	20.94
$fiCO_2$	0.03	$fiCO_2$	0.05
feO_2	17.00	feO_2	16.99
$feCO_2$	4.00	$feCO_2$	3.98
Haldane	1.00	Haldane	1.00

Vi (L/min)	150.00	Vi (L/min)	150.00		
Ve	150.08	Ve	149.96		
VO ₂	5.88	VO ₂	5.93		
VCO ₂	5.96	VCO ₂	5.89		
RER	1.01	RER	0.99		
				<u>Gas Analyzer Error Contribution</u>	
				VO₂ %Error	0.84
				VCO₂ %Error	-1.08
				RER %Error	-1.91

Competitive Metabolic Cart Example:

<u>Expected Values</u>		<u>Worst Case Values</u>			
fiO ₂	20.93	fiO ₂	21.03		
fiCO ₂	0.03	fiCO ₂	0.13		
feO ₂	17.00	feO ₂	16.90		
feCO ₂	4.00	feCO ₂	3.90		
Haldane	1.00	Haldane	1.00		
Vi (L/min)	150.00	Vi (L/min)	150.00		
Ve	150.08	Ve	149.32		
VO ₂	5.88	VO ₂	6.31		
VCO ₂	5.96	VCO ₂	5.63		
RER	1.01	RER	0.89		
				<u>Gas Analyzer Error Contribution</u>	
				VO₂ %Error	7.28
				VCO₂ %Error	-5.53
				RER %Error	-11.94

Analysis and Conclusions

The above examples are typical of an Exercise Test. Resting Energy testing would produce much greater error in both examples. The AEI Technologies MOXUS Metabolic Cart gas analyzer error is within accepted limits for VO₂, VCO₂, and RER. Other Metabolic Carts utilizing less accurate gas analyzers may have errors far outside of acceptable limits.



AEI Technologies, Inc.
 1-630-548-3545
 Fax: 1-630-548-3546
 Sales@aeitechnologies.com
 www.aeitechnologies.com