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Methodology for uncertainty calculation of net total cooling effect estimation for rating room air conditioners and packaged terminal air conditioners

Néstor Fonseca Diaz[a,b,*]

[a]*Universidad Tecnológica de Pereira, Facultad de Ingeniería Mecánica, Pereira, Colombia*
[b]*University of Liège, Campus du Sart Tilman, Bât: B49, P33, B-4000 Liège, Belgium*

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ABSTRACT

This article presents the general procedure for uncertainty calculation of net total cooling effect estimation for rating room air conditioners and packaged terminal air conditioners, by means of measurements carried out in a test bench specially designed for this purpose. The uncertainty analysis presented in this work looks for establishing a confidence degree or certainty of experimental results. It is particularly important considering that international standards related to this type of analysis are too ambiguous when treating this subject. The uncertainty analysis is on the other hand an indispensable requirement to international standard ISO 17025 [ISO, 2005. International Standard. 17025. General Requirement to Test and Calibration Laboratories Competences. International Organization for Standardization, Geneva.], which must be applied to obtain the required quality levels according to the Word Trade Organization WTO.

Méthodologie pour le calcul de l'incertitude dans l'évaluation du refroidissement total avec comme objectif l'évaluation des conditionneurs d'air et les diffuseurs des systèmes de conditionnement d'air monoblocs

Mots clés : Conditionnement d'air ; Système de conditionnement d'air ; Calcul ; Efficacité ; Énergie ; Précision ; Mesure

* *Corresponding author*. Fax: +57 6 3137124.
E-mail address: nfonseca@utp.edu.co
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Nomenclature

AA1	inner chamber for reconditioning equipment
$h_{w:1}$	specific enthalpy of steam provided to maintain humidity at the inner chamber (kJ/kg)
$h_{w:2}$	specific enthalpy of condensed moisture leaving the inner chamber (kJ/kg)
k	coverage factor
Pr	electrical power (W)
W_r	water flow rate supplied to the inner chamber (g/s)
P	pressure (Pa)
u	individual uncertainty
U	expanded uncertainty
UT	unit under the test
w	humidity ratio for air–water gas mixtures (kg/kg)
γ	effective degrees of freedom
ϕ_{tci}	total cooling effect inner chamber (W)
ϕ_{lp}	heat leakage rate into the inner chamber through separating partition (W)
ϕ_{lr}	heat leakage rate into the inner chamber through walls, floor and ceiling (W)
δ	partial derivatives

Subscripts

A	type A uncertainty
a	air
b	barometric
bs	dry bulb
bh	wet bulb
C	constant
ci	cooling effect on inner chamber
cal	calibration
deriva	derive
dp	dew point
estra	stratification
H_2O	water
hum	humidifier
met	method
PT100	platinum resistance thermometer
res	resolution
rep	repeatability
sal	exhaust
sat	saturated
temp	temperature
t	total
TC	heat transfer
T	temperature
v	vapor
vol	voltage

1. Introduction

The importance of uncertainty analysis in any type of experimental test is to allow result's users (in this case manufacturing and final users of air-conditioning equipment) to keep a certain confidence degree and credibility on the values reported like test results.

The available information related to this type of analysis at international standards considers procedures in which only one or two variables are combined for propagation of uncertainty analysis. Generally too simple and/or ambiguous application examples are shown (ISO GUM, 1995; ASHRAE Guideline 2, 1986). In this work a synthesis of applied uncertainty calculation method is shown, when the final test result depends on a combination of a considerable number of independent measurements. In addition, some application examples are shown, where additionally to the proposed methodology for uncertainty calculation described on international standards, the researcher criteria and his experience must be used to estimate the final uncertainty result, which can be applied to engineering experimentation level. In this work, the detailed analysis of uncertainty calculation for net total cooling effect estimation for rating room air conditioners and packaged terminal air conditioners is shown as an example.

2. Uncertainty analysis of net total cooling effect estimation for rating room air conditioners and packaged terminal air conditioners

The test bench used in this test considers three compartments each one with an air reconditioning equipment (AA1, AA2, AA3) (Fig. 1) (ISO 5151, 1994; ANSI/ASHRAE 16, 1999). The outer chamber is used to simulate the external ambient

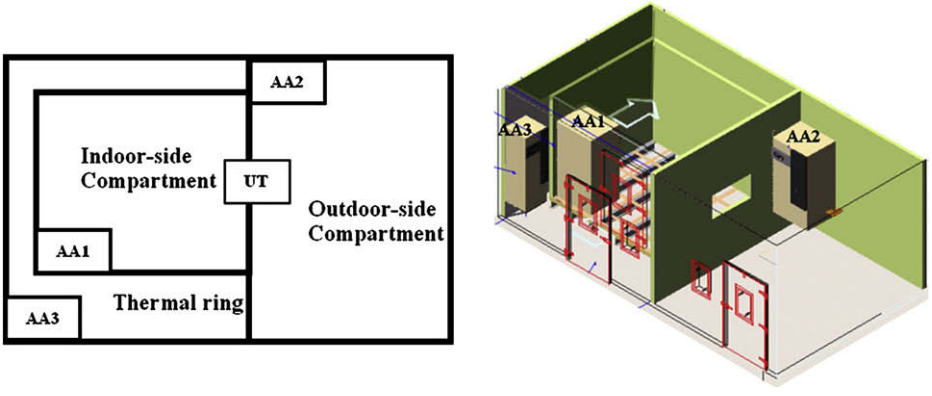

Fig. 1 – Typical balanced ambient room type calorimeter.