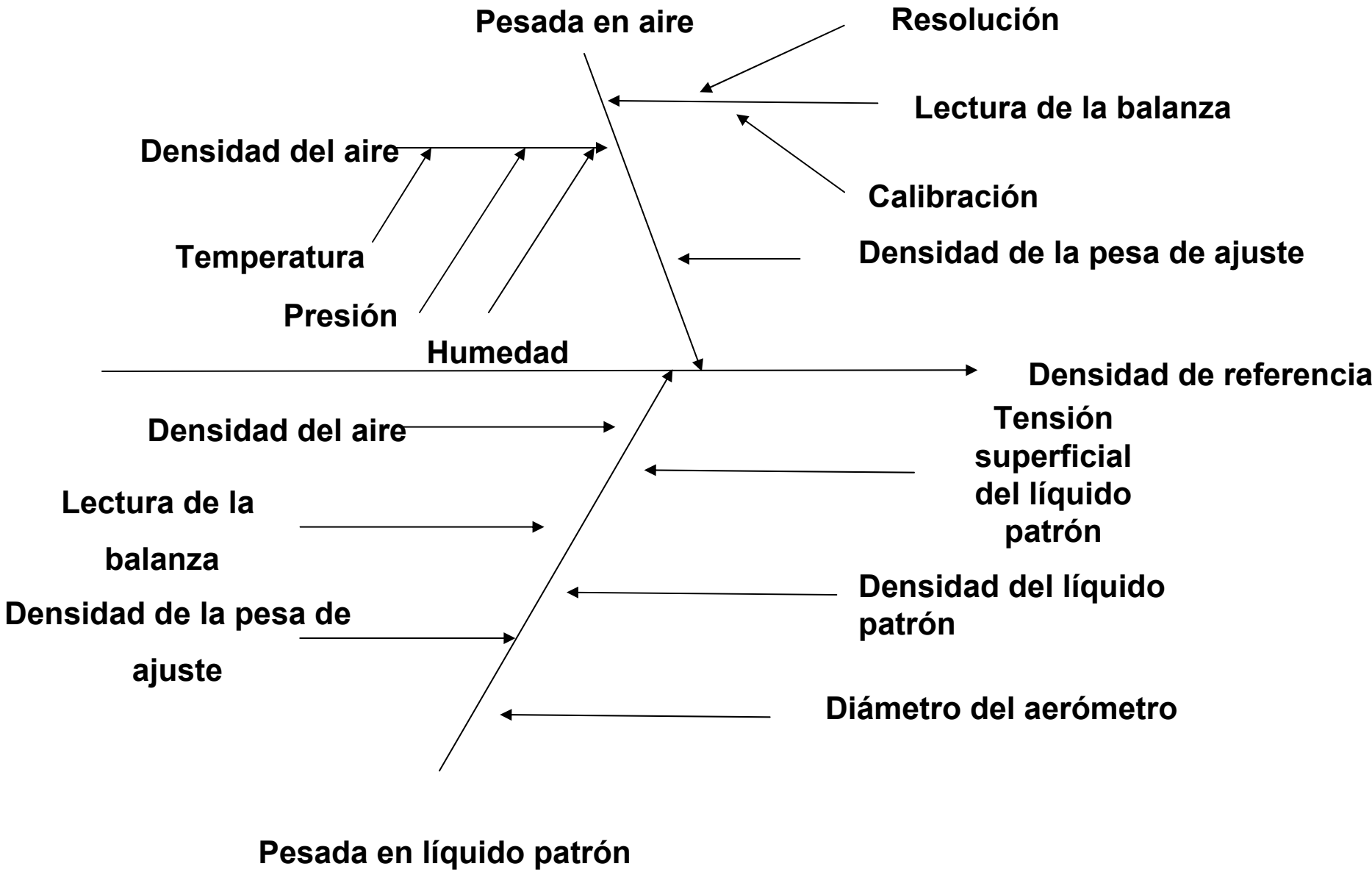
Incertidumbre en calibración de un aerómetro por el Método de Cuckow .


Pesada en aire
Resolución
Lectura de la balanza
Densidad del aire
Calibración
Temperatura
Densidad de la pesa de ajuste
Presión
Humedad
Densidad de referencia
Densidad del aire
Tensión superficial del líquido patrón
Lectura de la balanza
Densidad del líquido patrón
Densidad de la pesa de ajuste
Diámetro del aerómetro
Pesada en líquido patrón

Ecuación de transferencia:

$$\rho_L = \frac{\beta\left(R_a\rho_s - R_s\rho_a\right) + \frac{\pi D}{g}\left(\gamma_s\rho_a + \gamma_L\left(\rho_s - \rho_a\right)\right)}{\beta\left(R_a - R_s\right) + \frac{\pi D}{g}\gamma_s}$$

$$\beta = \left(1 - \frac{\rho_a^{'}}{\rho_{cal}}\right)$$

where

$\rho_a^{'}$ = air density during balance calibration

$\rho_{\text{cal}} = 8000\ \text{kg/m}^3$ = density of calibration weight

hydrometers by hydrostatic weighing

Model Equation:

Cd=(b((Ra+w)*ds-(Rs+w)*da)+Pl/g*(D+dc)*(Ss*da+SL*(ds-da)))/(b*(Ra-Rs+2*w)+Pl/g*(D+dc)*Ss)-Ld*

b=1-da/dcal;

*da=(0.34848*Pa-0.009024*Ha*exp(0.0612*ta))/(273.15+ta)*

Symbol List:

Symbol	Unit	Definition
Cd		correction of aerometer in the calibration point
b		
Ra	kg	weighing value of hydrometer in air
w	kg	uncertainty of the balance
ds	kg/m3	density of test liquid at test temperature
Rs	kg	weighing value of hydrometer in liquid
da	kg/m3	air density when balance calibration is performed
Pl		
g	m/s2	
D	m	diameter of aerometer
dc	m	calibration uncertainty of caliper
Ss	N/m	surface tension of test liquid
SL	N/m	reference surface tension of use liquid
Ld		reading of aerometer
dcal		density of balance adjustment weight
Pa		pressure of air during balance calibration
Ha		humidity of air during balance calibration
ta		temperature of air during balance calibration

Cd: Result

b: Temporary

Ra:

Type A
Method of observation: Direct
Number of observation: 5

No.	Observation
1	.0407315
2	.0407316
3	.0407313
4	.0407315
5	.0407314

Arithmetic Mean: 0.0407314600 kg
Standard Deviation: 114E-9 kg
Standard Uncertainty: 51.0E-9 kg
Degrees of Freedom: 4

w:

Type B normal distribution
Value: 0 kg
Expanded Uncertainty: .00000067 kg
Coverage Factor: 2

ds:

Type B rectangular distribution
Value: 998.20 kg/m3
Limits: ±0.01 kg/m3

Rs:

Type A
Method of observation: Direct
Number of observation: 5

No.	Observation
1	.0193635
2	.0193642
3	.0193643
4	.0193634
5	.0193637

Arithmetic Mean: 0.019363820 kg
Standard Deviation: 409E-9 kg
Standard Uncertainty: 183E-9 kg
Degrees of Freedom: 4

da:

Temporary

Pl:

Constant
Value: 3.14159265358979323846

g:

Constant
Value: 9.79732 m/s2

D:

Type A
Method of observation: Direct
Number of observation: 6

No.	Observation
1	.00394
2	.00393
3	.00394
4	.00394
5	.00394
6	.00395

Arithmetic Mean: 3.94000E-3 m
Standard Deviation: 6.32E-6 m
Standard Uncertainty: 2.58E-6 m
Degrees of Freedom: 5

dc:

Type B normal distribution
Value: .0000 m
Expanded Uncertainty: .0000020 m
Coverage Factor: 2

Ss:

Type B normal distribution
Value: 40E-3 N/m
Expanded Uncertainty: 1.5E-3 N/m
Coverage Factor: 2

SL:

Constant
Value: .055 N/m

Ld:

Type B rectangular distribution
Value: 1900
Limits: ±0.25

dcal:

Type B rectangular distribution
Value: 7950
Limits: ±140

Pa:

Type B normal distribution
Value: 1020
Expanded Uncertainty: 5
Coverage Factor: 2

Ha:

Type B normal distribution
Value: 50
Expanded Uncertainty: 5
Coverage Factor: 2

ta: Type B normal distribution
Value: 20.6
Expanded Uncertainty: .15
Coverage Factor: 2

Uncertainty Budget:

Quantity	Value	Standard Uncertainty	Degrees of Freedom	Sensitivity Coefficient	Uncertainty Contribution
b	0.99984848	1.59E-6			
Ra	0.0407314600 kg	51.0E-9 kg	4	-42100	-2.15E-3
w	0.0 kg	335E-9 kg	50	-131E3	-0.0439
ds	998.20000 kg/m3	5.77E-3 kg/m3	infinity	1.90	0.0110
Rs	0.019363820 kg	183E-9 kg	4	88700	0.0162
da	1.20462 kg/m3	3.00E-3 kg/m3			
PI	3.14159265358979				
g	9.79732 m/s2				
D	3.94000E-3 m	2.58E-6 m	5	-316	-817E-6
dc	0.0 m	1.00E-6 m	50	-316	-316E-6
Ss	0.040000 N/m	750E-6 N/m	50	-112	-0.0840
SL	0.055 N/m				
Ld	1900.000	0.144	infinity	-1.00	-0.144
dcal	7950.0	80.8	infinity	23.8E-9	1.92E-6
Pa	1020.00	2.50	50	-1.07E-3	-2.68E-3
Ha	50.00	2.50	50	98.1E-6	245E-6
ta	20.6000	0.0750	50	4.01E-3	301E-6
Cd	0.449	0.174	838		

Result: Quantity: Cd
Value: 0.45
Expanded Uncertainty: ±0.35
Coverage Factor: 2.0
Coverage: 95.45%