National Measurement Laboratory

Report of Calibration

Calibration Laboratory
N0882

Date of Issue: April 23, 2019

Report No.: F190147A

Instrument: Turbine Flow Meter

Manufacturer: CONFIDENTIAL

Model: CONFIDENTIAL

Serial Number: CONFIDENTIAL

Applicant: NOVAX Material & Technology Inc.

Address: No.31, Ln. 142, Sec. 2, Nankan Rd., Luzhu Dist., Taoyuan City 33855,Taiwan (R.O.C)

The result of this calibration, performed by the National Measurement Laboratory, is specified in this report. When the cover and the following 3 pages are separated, the validity of this report no longer exists.

NATIONAL MEASUREMENT LABORATORY R.O.C.
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國家度量衡
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新竹市光復路二段321號

Win-Ti Lin

Approved Signatory

Tzeng-Yow Lin

Chief Executive
National Measurement Laboratory

INSTRUCTIONS OF THE CALIBRATION REPORT

1. The result of this calibration, performed by the National Measurement Laboratory, is specified in this report. Only to the designated instrument is the calibration result applied.

2. The calibration data was obtained under the specific conditions of this laboratory. After the calibration, the accuracy and precision of this measuring instrument/standard will depend on the care of handling as well as the frequency of use.

3. Unless otherwise specified, no adjustment to the measuring instrument/ standard will be made in our laboratory. It is recommended that the clients have the measuring instrument/standard adjusted by its manufacturer or dealer if needed. The measuring instrument/standard should be recalibrated to ensure its accuracy after any adjustment.

4. Periodical recalibration, with a user-defined period, is recommended for ensuring the accuracy of the measuring instrument/standard.

5. The calibration result has been confirmed and authorized by the technical manager of the National Measurement Laboratory.

6. The client should not dismantle this report. This calibration certificate shall not be reproduced or excerpted from any part of the contents except in full, without written approval of our laboratory.

7. This certificate is consistent with the capabilities that are included in Appendix C of the MRA drawn up by the CIPM. Under the MRA, all participating institutes recognize the validity of each other's calibration and measurement certificates for the quantities, ranges and measurement uncertainty specified in Appendix C (for details see http://www.bipm.org).

National Measurement Laboratory

321, Sec. 2, Kuang Fu Rd., Hsinchu, Taiwan 30011, R.O.C.

Report No.: F190147A

Instrument: Turbine Flow Meter
Manufacturer: CONFIDENTIAL
Model: CONFIDENTIAL
Serial No.: CONFIDENTIAL

Ambient Temp.: (21.7 ± 0.2) ℃
Relative Humidity: (85 ± 1) %
Ambient Pressure: (100.4 ± 0.2) kPa

Calibration Results and Descriptions

I. Calibration Results

Meter Flowrate (L/min)	Relative Deviation (%)	Average Meter Flowrate (L/min)	Average Relative Deviation (%)	Expanded Uncertainty (%)	Coverage Factor
25.28	-0.49	25.28	-0.48	0.03	2.09
25.29	-0.47				
25.27	-0.49				
25.29	-0.46				
20.42	-0.07	20.42	-0.08	0.03	2.07
20.42	-0.08				
20.42	-0.09				
20.42	-0.07				
15.12	0.43	15.12	0.42	0.03	2.07
15.12	0.41				
15.12	0.41				
15.12	0.42				

II. Descriptions

1. Date and Location of Calibration

   This calibration was performed at 30 Ta Hsueh Rd., Hsinchu, Taiwan on April 18, 2019.

2. Calibration Methods

   2.1 This calibration was carried out according to Instrument Calibration Technique for Small Water Flow Calibration System-Weighing Method[1].

   2.2 The device under test (DUT) was calibrated against the static weighing method with the "flying-start-and-finish" mode.

   2.3 The calibration result is expressed in terms of relative deviation E_R defined as follows.

$$E_R = \frac{V_m - V_s}{V_s} = \frac{N_m / K - V_s}{V_s}$$

   where

V_s is the standard fluid volume obtained by the calibration system;

V_m is the fluid volume measured by the DUT;

N_m is the number of pulses output by the DUT;

K is the K-factor, which is the number of output pulses per unit fluid volume passed through the DUT.

3. Standard Used

Standard	Serial No.	Calibration Organization	Certificate No.	Certificate Date (Calibration Interval)
Weighing platform	WI-101	ITRI	10707C04604-1-1-03 Ver. A	2018/12/11 (2 years)
PRT temperature sensor	47269	ITRI (TAF 3080)	10807C00001-3-1-03 Ver. A	2019/01/17 (1 year)
PRT temperature sensor	050301	ITRI (TAF 3080)	10807C00001-4-1-03 Ver. A	2019/01/17 (1 year)
Pressure transmitter	496042	ITRI (TAF 3080)	10707C00232-1-1-03 Ver. A	2018/01/17 (2 years)
Pressure transmitter	493699	ITRI (TAF 3080)	10707C00232-2-1-03 Ver. A	2018/01/17 (2 years)

ITRI: Industrial Technology Research Institute

4. Expanded Uncertainty

4.1 The expanded uncertainty was evaluated according to the Measurement System Validation Procedure for Small Water Flow Calibration System–Weighing Method[2].

4.2 The reported expanded uncertainty was obtained by multiplying the combined standard uncertainty with a coverage factor k, corresponding to a level of confidence of approximately 95 %, where the coverage factor k was taken from the t-distribution according to the effective degrees of freedom.

4.3 The combined standard uncertainty was calculated by the following equation.

$$u_c(E_R) = \sqrt{[-\frac{V_m}{V_s}\frac{u(V_s)}{V_s}]^2 + [\frac{1}{V_s \times K}u(N_m)]^2 + u_{rep,DUT}^2}$$

where

$u(V_s)/V_s$ is the relative standard uncertainty of the fluid volume measured by the calibration system, and its value was quoted to be 0.013 % from the Measurement System Validation Procedure [2];

$u(N_m)$ is the standard uncertainty of number of meter pulses, and it was evaluated to be $1/\sqrt{3}$ pulse;

$u_{rep,DUT}$ is the standard uncertainty resulted from the repeatability or short-term reproducibility of measurements, and it was evaluated by the standard deviation of the mean of repeated calibration results..

5. Notifications

5.1 The working fluid is tap water. The working condition and properties during calibration are shown below.

Temperature:	(27.1 ± 0.5) ℃
Density:	(0.9966 ± 0.0002) g/cm^3
Viscosity:	(0.94 ± 0.01) mm^2/s

5.2 The collected volume of fluid during each calibration was about 120 L. The *K*-factor of the DUT is 89.4 pulses per liter. Through counting the number of meter pulses during each calibration, the fluid volume measured by the DUT could be determined. The maximum error due to counting the number of pulses was estimated as one. Comparing to the collected volume during each calibration, the relative error caused by the counting is less than 0.01 %.

5.3 The performance of turbine flow meter is affected by the viscosity and temperature of the fluid. If the property of the working fluid differs significantly from that used in the calibration, measurement error might occur.

III. References

1. Instrument Calibration Techniques for Small Water Flow Calibration System - Weighing Method, 07-3-85-0092, 6th ed., Center for Measurement Standards / ITRI, 2015.
2. Measurement System Validation Procedure for Small Water Flow Calibration System - Weighing Method, 07-3-85-0095, 7th ed., Center for Measurement Standards / ITRI, 2016.