DOI: https://doi.org/10.53052/9788366249981.21

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WERYFIKACJA KLUCZA DYNAMOMETRYCZNEGO

Streszczenie: W artykule opisano badania klucza dynamometrycznego o indywidualnej specyfikacji i postaci geometrycznej. Ta metodologia może być stosowana przez użytkowników kluczy dynamometrycznych, gdy konieczne jest zachowanie wysokiej/precyzyjnej dokładności mierzenia używanego momentu obrotowego, aby uniknąć wszelkich uszkodzeń.

Słowa kluczowe: klucz dynamometryczny, weryfikacja

INTERNAL TORQUE WRENCH VERIFICATION

Summary: The article contains an internal verification of a torque key with individual descriptions and graphical representation. It is intended for users of torque gauges where it is necessary to maintain an accurate tightening torque to avoid various damages.

Keywords: torque wrench, verification

1. Current market status and applications of torque wrenches

In each of the technical focus areas, precision and reliability are important factors, so getting the right torque is essential. Achieving the necessary torque when tightening bolts or nuts is an essential factor from a safety point of view, where we can prevent potential damage or personal injury.

A torque wrench is a tool used to apply a specific tightening torque to a fastener such as bolt or nut. It is mainly used in technical industry where precise tightening of bolts is required to increase customer safety. These are mainly industries such as automotive tire replacement, mechatronics, robotics, various robot anchorages or their maintenance and repair.

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Different manufacturer specified torque ratings applications to each device or mechanism and must be strictly adhered to. Not only for the wheels, but also for any other bolted parts such as cylinder heads or bolts for anchoring the mechanism, a torque-controlled solution must be used to tighten a required torque.
A calibrated torque wrench or torque-off pneumatic wrench is used to set the correct torque. It is good to note that the torque wrench measures only resistance when turning. Due to the specific conditions of the various bolt and nut threads, the relationship between torque and induced stress depends on their conditions.
The current hand tool market has a wide range of choices. Most customers prefer size, weight, and ease of use as well as the price of the tool itself. The growing popularity of DIY projects has greatly increased the market penetration of these devices.

1.1. Inspection and distribution of torque gauges

Verification of a specified measuring instrument consists of test, confirmation of its conformity with the approved type, technical and metrological requirements.

Table 1. Distribution of torque wrench prescription approval method.

Mechanical testing of material	Type of designated gauge	Metrological inspection			Verification validity period in years	Annex number
		National type approval	National initial verification	Pursuant to a special regulation		
	Torque wrench	Yes	Yes	No	1	42

The intended gauges are divided into torque wrenches:

a) Type I indicating torque wrenches - these include gauges that indicate the amount of torque by means of a mechanical scale and dial.
b) Type II limit torque wrenches - these include gauges where the torque magnitude is pre-set and when desired value is reached, an audible or visual signal is released.

Maximum permissible deviation of Type I torque wrench:

Table 2. Maximum permissible deviation for type I

Class Accuracy	Maximum permissible deviation	
	≤ 10 Nm	> 10 Nm
A a B	± 6 %	
D, C a E	± 6 %	± 4 %

Maximum permissible deviation of the Type II limit torque wrench:

Table 3. Maximum permissible deviation for type II

Class Accuracy	Maximum permissible deviation	
	≤ 10 Nm	> 10 Nm
A	± 6 %	± 4 %
D, G	± 6 %	

Each of the torque wrenches must undergo type approval and initial verification before being placed on the market and sold. As with probably every tool and device over time in use, the torque wrenches are also subjected to subsequent verification. Subsequent verification is subject to the same conditions and procedures as initial verification.
Before actual verification begins, the torque wrench in question must be left in the measurement environment until it has stabilized in the environmental conditions of laboratory. It should be carried out at a temperature range of 18 ℃ to 28 ℃.

The actions required before the actual test for each type of torque wrench:

a) Type I torque wrenches - one pre-load of the mass value shall be carried out prior to the test.
b) Type II limit torque wrenches - 5 unmeasured releases must be performed.

To minimize error, damage, and poor torque setting, it is important to observe the following steps:

1) A torque wrench is a tightening tool and should never be used to loosen bolts.
2) Avoid various impacts, falls. Always place the gauge in the appropriate box to protect it from damage.
3) For the durability of the spring in the torque wrench, the scale should be set to the lowest value to release the spring pressure.
4) Use only one hand in a smooth and continuous motion. Most torque wrenches have a mark on the handle to indicate where to apply pressure.
5) Do not use an extension on the handle.
6) Avoid over-tightening; excessive tightening torque can result broken parts and early damage; insufficient torque can result in loose parts that may fail or break unexpectedly.
7) As a high precision tool, the torque wrench needs to be recalibrated with regular frequency and it is responsibility of a tool user. If a tool falls off or becomes damaged, it should be sent for service immediately.
8) For safety reasons, do not use the torque wrench in a high voltage room.

2. Internal verification of the torque wrench

Verified gauge
For the verification itself, we have chosen a classic torque wrench used in normal operation and servicing, shown in Figure 1. This is a mechanical gauge that when tightened mechanically, stops the over-tightening of the bolted joint further. Adjustment is made by turning the handle according to the scale.

Table 4. Technical parameters for the selected torque wrench

Model: 43.OMK-210-12	
Tightening torque range	28 – 210 Nm
Gauge accuracy	± 4 %
Size of the square	½
Lever length	465 mm
Weight	1,70 kg

Figure 1. Verified torque wrench

Etalon gauge

The electronic etalon gauge is designed for verification of torque wrenches, and it is used for internal verification of torque gauges. This gauge can be considered as a working standard, with a maximum permissible relative error of ±1% specified by the manufacturer.

Table 5. Technical parameters for the electronic etalon gauge

Model: Hazet 7901E	
Measurement range	10 – 350 Nm
Gauge accuracy	± 1%
Size of the square	½
Operating temperature	0 °C – 50 °C
Weight	3,28 kg

Figure 2. Electronic torque etalon gauge

Experimental verification of the torque wrench

When the selected torque wrench is internally verified, it is checked:

a) The relative reverse error of the torque wrench,
b) The relative error margin of the torque wrench,
c) The relative error of the torque wrench.

Figure 3. Verification of the selected torque wrench

The verification was carried out in the horizontal position of the torque wrench at a temperature of 22.5°C and a relative humidity of 46%. During the verification it was necessary to consider the deviation of the reference sensor, which showed a value of -0.3 Nm. All values from the torque wrench scale were selected for verification. The

measured values with the correction of the deviation can be found in the following graphical representation.

Table 6. Measured torque values from the reference gauge for each torque wrench setting step

Set torque [Nm]	1. M.	2. M.	3. M.	4. M.	5. M.	6. M.	7. M.	8. M.	9. M.	10. M.
6	6	6	6,1	6,1	6	6,1	6	6,1	6,1	6
8,4	8,4	8,5	8,5	8,5	8,5	8,4	8,5	8,4	8,4	8,5
10,8	10,6	10,7	10,5	10,7	10,5	10,5	10,6	10,5	10,7	10,7
13,2	13	13,2	13,2	13	13	13	13,2	13,2	13	13
15,6	15,4	15,5	15,6	15,5	15,5	15,6	15,5	15,4	15,5	15,6
18	18	17,9	18,1	17,9	18	18	18,2	18	18,1	18,1
20,4	20,3	20,1	20,3	20,1	20,3	20,3	20,3	20,1	20,3	20,1
22,8	22,7	22,5	22,8	22,5	22,8	22,6	22,8	22,5	22,5	22,6
25,2	25,1	25	25	25,1	25,2	25,1	25,1	25	25	25,2
27,6	27,4	27,5	27,4	27,4	27,4	27,5	27,5	27,5	27,4	27,4
30	30,1	30,2	30	30	30,1	30,1	30,2	30,1	30,1	30,2

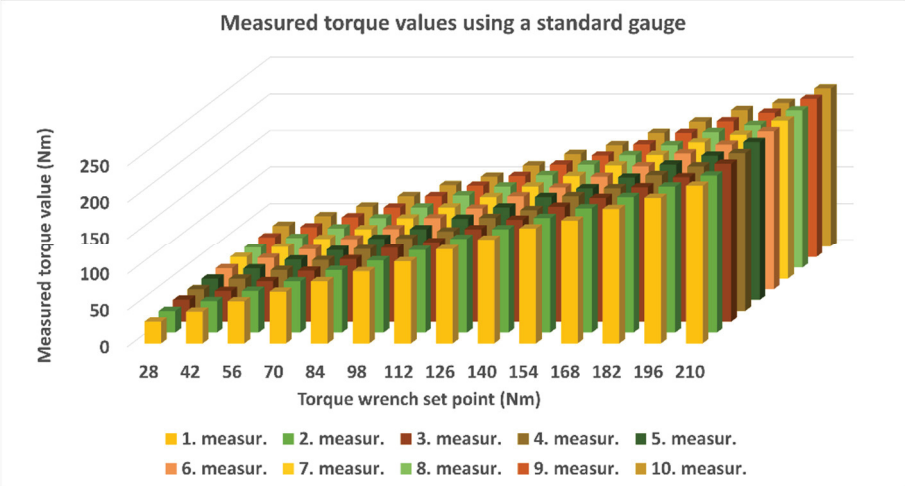

Figure 4. Torque values from the reference gauge for each torque wrench setting step

After the readings were taken, they were further processed computationally, where the results can be seen in the following graphical representations. The torque deviations for the verified gauge were unsatisfactory for measurements higher than 154 Nm (Figure 6). We can know whether they meet the required limits by comparing the relative deviations with the maximum RMPE errors (Figure 5).

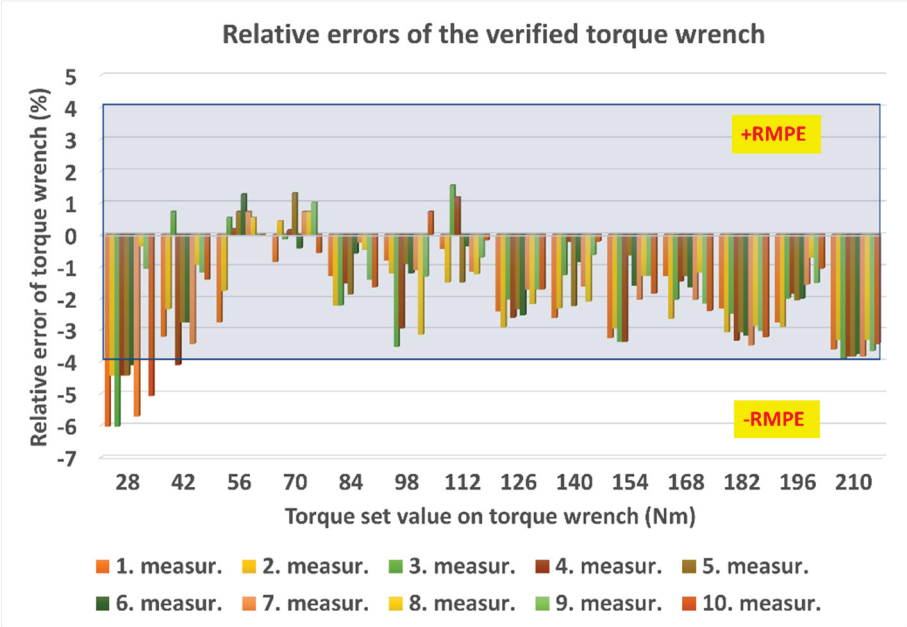

Figure 5. Relative errors of the verified torque wrench

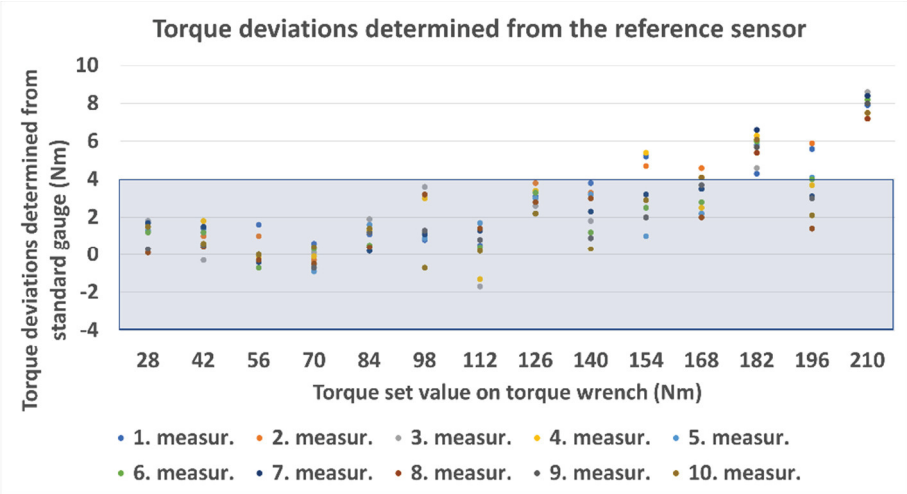

Figure 6. Torque deviations of the verified torque wrench

In each series of measurements, a relative error range was also generated for the gauge being verified, which must be less than 0.6 times the RMPE (Figure 7). For the selected torque key, 7 values were outside the required interval and thus these values did not meet this condition.

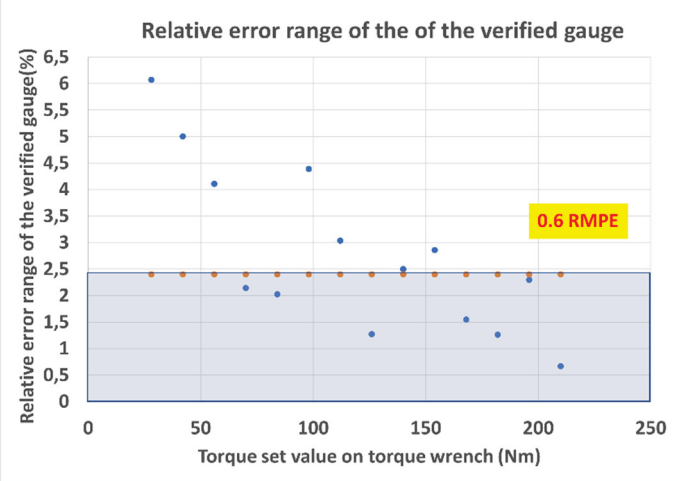

Figure 7. Relative error range of the verified instrument

The selected torque wrench did not meet all the requirements and is therefore unsuitable for further use and tightening of bolted joints.

3. Internal verification of the torque wrench

With this article we want to point out, for example, tire service stations, where in a similar way they can regularly do an internal verification of their torque gauges and thus prevent various damages or even injury of customers.

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