

Comparison of the actual measured fineness of Netherlands gold ducats with the values of the fineness required by law

Dariusz F. Jasek *

Samenvatting – In dit artikel wordt het gehalte – gemeten via de XRF-methode – van de gouden dukaten uit het Teylers Museum vergeleken met het voorgescreven gehalte. De dukaten uit de hagemunten Batenburg, 's-Heerenberg, Hedel en Nijmegen zitten ruimschoots onder de wettelijke norm, maar ook de dukaten uit de officiële munthuizen voldoen er lang niet altijd aan.

Summary – In this article the fineness of the gold ducats – measured by the XRF method – from the Teylers Museum is compared with the fineness required by law. The ducats from the 'hagemunten' Batenburg, 's-Heerenberg, Hedel and Nijmegen fail the required standard by far, but also the ducats from the official Mints often do not meet it.

The legal fineness of Netherlands gold ducats minted between 1586 and 1816 was 0.986 (in decimal units), and 0.983 since 1817, with a weight of $\frac{1}{70}$ of a mark or c. 3.49 g (*idem*). But until now, no comprehensive study has been made to check to what extent the real fineness corresponds to the legal one. This article will analyze and address this issue by testing a representative sample of Netherlands ducats to determine how close they are to the legally required fineness.

For my research, I was able to leverage some of the preliminary data from ongoing research by Jan Pelsdonk. He conducted metal analyses of the Netherlands gold ducats in the collection of Teylers Museum, using the X-ray fluorescence (XRF) method, with a handheld Niton XL3t GOLDD+. Using the XRF measuring method offers the opportunity to examine many objects in a relatively short time with every specimen being tested once. Moreover, the XRF method is non-destructive, which means that it does not penetrate the object as it only takes a reading slightly underneath the surface of the metal. Consequently, the recorded value is not 100% reliable, as part of the measuring result may be influenced by blanching or a not fully homogeneous metal alloy. The precision for the specific XRF scanner used in these tests is 0.05% or 0.0005. Each coin has been tested in a single place, the size of the sample surface being approximately 1 cm².

Prior to the work done by Teylers Museum on the fineness of Netherlands gold ducats with modern techniques, there was very little work performed on the subject. There are only two publications that provide the actual measured fineness of Netherlands gold ducats: Tangelder's book on the Bergh coinage and Van der Beek's article on the Amsterdam ducats minted in 1673. Unfortunately,

* Dariusz Jasek is an independent researcher, based in Cracow. @: djasek@goldducats.com

Tangelder only gave measurements for Hedel and 's-Heerenberg ducats¹, whereas measurements from Van der Beek's article are limited to Amsterdam piedfort ducats.²

In addition, with the assistance of Mr Vojtěch Váňa (Assay Office, Prague), measurements of the fineness of three Netherlands gold ducats are available. These were made by the Assay Office in Prague with a XRF spectrometer in July 2017 and are as follows:

- the Holland 1733 gold ducat – 0.980 fineness
- the Holland 1748 gold ducat – 0.980 fineness
- the Utrecht 1733 gold ducat (contemporary forgery) – 0.960 fineness

These results are in line with values obtained from testing coins from the Teylers Museum.

The following research will answer the question as to what extent the actual measured fineness values coincide with the fineness values required by law.

Gold ducats minted before 1586

In the period prior to the standard of 0.986 fineness introduced in 1586, ducats with a lower fineness have been minted in the Low Countries. Gold ducats from the mints of Batenburg, 's-Heerenberg, Hedel and Nijmegen were struck from the mid-16th century until 1579, and in the last years of this period, the volume of production and diversity of coin types were at their highest. One thing that is similar across all these mints was that their mintmasters were known for striking debased coins. Peter van Bossenhoven was one of the most prolific individuals who engaged in this. He was mintmaster in Batenburg from 1556 till 1559³, and worked subsequently as a mintmaster in Gronsveld (1560-1564)⁴, Thorn (1563-1564 and 1569-1570)⁵, Weert (before 1568)⁶, Hedel (1577-1578)⁷ and Stevensweert (1581-1582)⁸. Despite having been arrested in Cologne in 1565 and found guilty of minting debased coins, this did not deter him from continuing his mintmaster activities.⁹ It is a good example of how minting debased coins worked during this period in history. Minting more coins from a given amount of gold yielded an extra profit for merchants, the mintmaster and the issuing authority.¹⁰

¹ Tangelder, 1955: 257-259, 302-303.

² Van der Beek, 2011: 11.

³ Pannekeet, 2007: 51.

⁴ Van der Wis & Passon, 2009: 192.

⁵ Passon 2003: 7-8.

⁶ Pannekeet, <http://www.duiten.nl/weert.html> [28 August 2017].

⁷ Pannekeet, 2007: 171.

⁸ Hendrickx, Janssen, Rutten & Sangers, 1982: 8.

⁹ Jasek, 2015a: 36.

¹⁰ *Idem*: 123.

Batenburg

The first eight gold ducat types were minted under the issuing authority of Willem van Bronckhorst (1556-1573). They were struck while Peter van Bossenhoven (1556-1559) and Peter Becx (1560-1565) were mintmasters. The subsequent twelve ducat types were minted under the issuing authority of Herman Dirk (*aka* Diederik) van Bronckhorst (1573-1602), with Hendrik Velthuysen (1576-1578), Hendrik Hanssen (1578-1581), Clemens van Eembrugge (1581-1582), and/or an additional unknown mintmaster.¹¹

Undated single ducats minted in Batenburg were those of the Hungarian type (with Madonna), and there were also ducats minted with a coat of arms or with a lion on the reverse. Only ducats minted in 1577 and 1578 are dated. The one bearing the date 1578 is an imitation of a ducat minted in Simmern Palatinate.¹² What is called the Batenburg 1579 ducat is actually a Transylvania ducat.¹³

It is possible to divide all gold ducats minted in Batenburg into three categories based on their measured fineness and the issuing authority.

The first and the second categories were gold ducats minted under the issuing authority of Willem van Bronckhorst (from about 1560), but with various finenesses. Ducats in the first category were minted with a lower fineness, about 0.805 – 0.810. In this category we know of a double ducat with St. Stephanus and a single ducat with Ferdinand and Madonna (crowned), both minted without a date. The fineness of ducats from the second category is significantly higher, about 0.902 – 0.911. In this category we know of a double ducat with Jesus Christ and single ducats with St. Victor and Madonna (two types); all were minted without a date.

Ducats in the third category were minted under the issuing authority of Herman Dirk van Bronckhorst, with a fineness of around 0.846 – 0.858, with one type known with a higher fineness, *viz.* 0.904. In this category we find one type of a double ducat with Jesus Christ and various types of single ducats. Undated ducats were minted with St. Victor and various reverse designs (Madonna, lion, or coat of arms). The first ducat types with a date were minted in 1577, with St. Victor and lion (a fineness of 0.904). Subsequent 1577 ducats bear the coat of arms of Bronckhorst-Manderscheid and the coat of arms of Bronckhorst and Stein on the reverse. The last two types of ducats minted in 1578 were imitations of a ducat minted by Richard of (Palatinate-)Simmern.

There is also a ducat with St. Victor and Madonna, incorrectly identified in Schulman's auction catalog in 1896 as a Batenburg 1579 ducat, listed as such by

¹¹ Pannekeet, 2007: 51.

¹² *Idem*: 60.

¹³ Jasek, 2015c: 247.

Delmonte as no. 698 and repeated by a number of other catalogs.¹⁴ It is in fact a Transylvania 1579 ducat, minted in Hermannstadt.¹⁵

It is also worth noting that there are a number of ducats, listed in the tables below, with an unknown fineness (they were not found in Teylers Museum Coin Cabinet and thus were not tested). These types of ducats are only known from drawings, none of which have ever been found to exist in actual collections. Thus it is possible, and we emphasize *possible*, that these ducats never existed or no longer exist.

's-Heerenberg

Gold ducats of 's-Heerenberg were minted under the issuing authority of Willem IV van den Bergh, with a fineness much lower than required by law. Willem van den Bergh was a supporter of Willem of Orange during the war with Spain, probably because he was married to his sister, Maria.¹⁶ Being a brother-in-law of Willem of Orange resulted in more freedom with respect to the minting of coins. What was also of significance for this mint was that profits from minting accounted for 40-50% of count Willem's income.¹⁷ While other mints like Hedel, Bommel and Batenburg were harassed with complaints by the States General and the Empire, the 's-Heerenberg mint remained unaffected.¹⁸

The first type, an undated ducat with Ferdinand and Madonna, is only known from drawings of Van der Chijs and Verkade, but has not been found *in natura*.¹⁹ The subsequent five types are:

- undated ducat with St. Oswald and Madonna
- 1577 ducat with St. Oswald and coat of arms
- undated ducat with St. Oswald and coat of arms, with CVSA in the legend
- undated ducat with St. Oswald and coat of arms, with DIERE in the legend
- undated ducat with St. Oswald (W-B) and Madonna.

With the exception of the first type listed with St. Oswald and Madonna, all of these ducats were heavily debased. For example, the 1577 ducat with St. Oswald and coat of arms should have been minted with a fineness of 0.986. In fact, the actual measured fineness of this coin is only 0.834.²⁰ The measured fineness of the 's-Heerenberg single ducats from the Teylers Museum Coin Cabinet varies between 0.776 and 0.858, with the average for six coins being 0.803.

¹⁴ Schulman, 1896: 4; Delmonte, 1964: 108; Purmer, 2009: 93; Friedberg, 2009: 606.

¹⁵ Jasek, 2015c: 247.

¹⁶ Jasek, 2015a: 122.

¹⁷ Te Boekhorst & Bisselink, 1986: 21.

¹⁸ *Idem*: 18.

¹⁹ Jasek, 2015a: 128.

²⁰ Tangelder, 1955: 257-258.

Additionally with respect to the fineness, the 's-Heerenberg mint never had an assayer.²¹

Hedel

Gold ducats minted in Hedel were struck under the issuing authority of Frederick van den Bergh. As was the case of the 's-Heerenberg mint of his brother, the Hedel mint debased its coinage. The first four types of the Hedel ducats were produced when Van Bossenhoven was mintmaster. The successive three types were struck under a new mintmaster, Anthonis van Eembrugge.²² Coins minted in Hedel were the subject of complaints coming from all provinces as well as the Empire.²³

The first type, “*Scrot und Korn*” minted in 1577, should have been struck to the standard of genuine Hungarian ducats, with a fineness of 0.989.²⁴ In fact, the actual fineness was much lower. The tested fineness (reported by Tangelder) showed to be only 0.910.²⁵

The subsequent six types, which should have been minted with a fineness of 0.917, are:

- an undated ducat with St. Pancras and Lion
- 1577 “ducat of Nijmegen” with St. Martin Episcop
- 1578 “new ducat of Nijmegen”
- 1578 ducat with St. Pancras and coat of arms of Bergh
- 1578 ducat with St. Pancras and coat of arms of Hedel
- 1579 ducat with St. Pancras and coat of arms of Hedel.

The measured fineness of the first two types is 0.890 – 0.897, of the subsequent two (reported by Tangelder) about 0.833, and finally of the last two (also reported by Tangelder) about 0.750.²⁶

Nijmegen

All the single and double gold ducats that were minted in Nijmegen were struck under the acting mintmaster, Jasper Vlemminck.²⁷ They bear the city's coat of arms (an imperial two-headed eagle with a small shield with a rampant lion of Gelderland on its breast). The city was granted minting rights by the German Emperor.

²¹ Jasek, 2015a: 72.

²² *Idem*: 140-145.

²³ *Idem*: 135, 137.

²⁴ Tangelder, 1955: 257-258.

²⁵ *Idem*.

²⁶ *Idem* 55: 258-259.

²⁷ Jasek, 2015a: 152.

Nijmegen gold ducats were imitated in the Batenburg and Hedel mints.²⁸ Based on the seigniorage records, minting of undated Nijmegen ducats took place between 1552 and 1557 (income derived from the Nijmegen city coinage in years 1552, 1556 and 1557 was equal to – respectively – 4,024, 2,734 and 2,690 guilders; for comparison, in the following years 1558, 1559 and 1560, it was respectively 917, 500 and 441 guilders).²⁹ Gold ducats portraying Ferdinand I were minted in 1558, with the date in the legend.³⁰

In addition, an undated double ducat with St. Stephanus standing was minted. Delmonte also listed in his catalog a similar type with this Saint kneeling. However, it appears to be a wrongly identified Nijmegen undated double ducat with St. Stephanus standing, because the only reported specimen, supposedly in the Vienna Coin Cabinet, was never there. The reference to the Vienna Collection was published by Delmonte and followed by other authors, but in December 2014, I received confirmation directly from the *Kunsthistorisches Museum* that this reference is indeed incorrect.³¹ The coin listed by Delmonte as a double ducat with St. Stephanus kneeling is probably an incorrectly recognized “regular” Nijmegen undated double ducat with St. Stephanus standing.

Two other Nijmegen ducats are:

- an undated ducat, minted with Charles V on the obverse
- 1558 ducat, minted with emperor Ferdinand II on the obverse.

The measured fineness of the Nijmegen single ducats remains unknown; both types are only known from one specimen each. Fortunately, we know the measured fineness of the Nijmegen double ducats – it varies between 0.900 and 0.903, with the average from four coins being 0.902. These values are somewhat lower than required, because all these ducats should have been minted following the Nijmegen standard with a fineness of 0.917 as specified by law.³²

Gold ducats minted in 1586 or later

The purity of gold (coins) was expressed in karats (*karaat* in Dutch) and grains (*grein* in Dutch), with pure gold containing 24 karat and 1 karat subdivided into 12 (karat) grains; in other words, pure gold was specified as 288 grains.³³ The fineness of the first Dutch gold ducats was 23 karats and 8 grains or equivalently 284 grains (with $284/288 = 0.986$). The tolerance was between 1 and 1.5 grains.³⁴

²⁸ *Idem*: 102, 139.

²⁹ Passon, 1980: 26.

³⁰ *Idem*: 48.

³¹ Jasek, 2015a: 159.

³² *Idem*: 156.

³³ Cooley, 1851: 84.

³⁴ Polak, 1988: 67.

Over the years, tolerances sometimes changed, e.g. for the Gelderland ducats of the Hungarian type the tolerance was lowered on September 1, 1590, from 1 to $\frac{3}{4}$ grain.³⁵ The tolerance of 1 grain per mark meant that coins with a fineness lower than 0.983 were supposed to be melted down.

According to the Ordinance of August 4, 1586, all provincial gold ducats were required to be minted with a fineness of 23 karat and 8 *greins*, or 0.986. However, as stated in the manuals for money changers, coins with a minimum fineness of 23 karat and 6 $\frac{1}{2}$ *greins*, or 0.981, could be accepted because of the maximum tolerance level of 1 $\frac{1}{2}$ *grains*.

When coins were minted with a fineness that was too low and were discovered by the warden (whose role was to test random samples of coins), this resulted into a fine (*boete*) for the mintmaster.³⁶ Amounts of these fines are found in several archives, and also in Polak's mint reports. The highest fines for minting debased gold ducats occurred in the early period of minting coins in the Republic, up to the 1640s. Also, the majority, 188 of 211 (over 89%), of genuine provincial gold ducats tested were minted by the provincial mints of Gelderland and West Friesland provinces. For these mints, the following fines were found³⁷:

Table 1: Fines for the Gelderland and West Friesland provincial mints

Province	Period	Amount of fine (in guilders)
Gelderland	18/04/1606 – 08/09/1609	2,122.20
	16/09/1609 – 09/04/1619	609.52
	08/05/1635 – 20/04/1640	2,636.02
West Friesland	unknown (before 10/04/1619)	1,209.88
	06/10/1637 – 14/08/1643	2,777.99

What is interesting is that fines in Gelderland were only recorded for single ducats, so either the double ducats seem to have been minted in accordance with the mint law, or records of fines for double ducats are lacking. Also, of the total amount of 5,379.41 guilders of fines imposed between 1606-1640 for minting debased coins, 99.78% were for ducats!³⁸ In West Friesland, fines for minting debased ducats were only recorded twice (see table 1 above) for total of 3,987.88 guilders, which represents 20% of the total amount of fines paid until 1643 in West Friesland (19,940.62 guilders).³⁹

³⁵ Jasek, 2015a: 247.

³⁶ Polak, 1988: 103-164; see also Jasek, 2015a: 233.

³⁷ Polak, 1988: 115-116, 143-144.

³⁸ Polak, 1988: 144-146.

³⁹ *Idem*: 115-118.

In the set of coins tested six counterfeit ducats were found. In addition to these contemporary forgeries (mostly from the West Friesland mints) there are coins of questionable genuineness, because of their very low gold content. These counterfeits are marked *in italics* in the Appendix.

The second most prevalent metals and trace elements

In 233 of the 265 tested gold ducats, the metal with the highest concentration after gold was silver; in 28 of the 265 ducats, it was copper, in 2 of the 265 ducats, it was iron, and in two single ducats it was platinum and mercury.

Note that in the aforesaid 28 specimens, the gold content was high: the measured fineness of 20 of them is between 97.486% and 98.543%, with only eight coins showing a gold content between 96.295 and 97.320% (surprisingly, six of them were the youngest coins in the set tested: they were minted in 1960 or later).

The gold content of the two ducats with iron as second element is 97.042% (TMNK 07019) and 94.214% (TMNK 09971); that of the ducat with platinum as second element is 97.726% (TMNK 10261); and that of the ducat with mercury is only 88.245% (TMNK 06981), making it probably a contemporary forgery.

As mentioned at the beginning of this article, the measurements presented here were taken with an XRF scanner, which was mainly intended to measure the gold-silver-copper content. However, in addition to gold and the second most prevalent metal, some trace elements were found in every coin tested. This was usually determined to be copper, iron, and – in much lower concentrations (mostly in coins minted before 1586) – zinc.

Some coins tested were found to be contemporary forgeries or imitations of genuine ducats. Besides, some coins were minted during the period of *hagemunterij* (i.e., in unofficial or semi-official mints)⁴⁰ and they were discussed previously in this article. Table 2 contains the average, the highest and the lowest fineness of all genuine gold ducats tested, struck in the 16th-18th centuries, divided by mints and period of minting.

The fineness required by law changed over time. As stated in the manuals for money changers from the 16th century, ducats minted following the Ordinance from August 4, 1586, could be accepted with a minimum fineness of 23 karat and 6 ½ *greins*, or 0.981. This threshold remained 0.981 for all ducats until 1816.

It is important for readers to understand something particular at this stage. Up until 1816, the fineness required by mint law was 0.986 but there was a tolerance level of 0.005. That is why money changers were allowed to accept coins with a fineness as low as 0.981. In 1817 the mint law changed and the new fineness required was 0.983. But the tolerance level changed to, to 0.003, so the lowest fineness that could be accepted by money changers was now 0.980.

⁴⁰ Jasek, 2015a: 19, 28-30.

Table 2: The average, the highest and the lowest fineness of genuine gold ducats tested, minted up to 1805

Mint	The lowest highest and average fineness of genuine ducats tested (number of coins tested in brackets)			Total number of genuine coins being tested
	16 th century	17 th century	18 th century or later	
<i>Hagemunten</i>				
Batenburg	0.805 0.911 0.861 (15)	–	–	15
's-Heerenberg	0.788 0.836 0.819 (6)	–	–	6
Hedel	0.750 0.910 0.852 (2)	–	–	2
Nijmegen	0.900 0.903 0.902 (4)	–	–	4
<i>Official provincial and city mints</i>				
Gelderland	0.972 0.979 0.976 (7)	0.968 0.981 0.975 (44)	0.972 0.985 0.979 (11)	62*
Holland (Dordrecht)	0.977 (1)	0.969 (1)	0.976 0.982 0.979 (11)	13
Holland (Amsterdam)	–	0.950 0.963 0.957 (2)	–	2
West Friesland	0.965 0.982 0.979 (24)	0.966 0.984 0.977 (60)	0.970 0.988 0.979 (42)	126**
Utrecht	0.974 (1)	0.966 0.966 0.966 (2)	0.974 0.977 0.975 (3)	6
Friesland	–	0.975 (1)	–	1
Overijssel (provincial)	0.973 (1)	–	–	1
Kampen (city mint)	0.968 (1)	–	–	1
TOTAL NUMBER OF GENUINE COINS BEING TESTED				239

* In addition, one Gelderland ducat was not genuine (63 Gelderland genuine and counterfeit ducats were tested).

** In addition, five West Friesland ducats were not genuine (131 West Friesland genuine and counterfeit ducats were tested).

*** Van der Beek⁴¹ presented values of the fineness of nine piedfort ducats struck at the Amsterdam mint in 1673. These were minted with a higher fineness (0.969 – 0.979, six coins tested) or with a lower fineness (0.932 – 0.941, three coins tested). All tested piedfort ducats originated from the former Geldmuseum, currently the NNC (Nationale Numismatische Collectie). The tested fineness of the Amsterdam 1673 piedfort ducat

⁴¹ Van der Beek, 2011: 11.

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with a lettered edge from Teylers Museum was identical to the average fineness of all the Amsterdam 1673 piedfort ducats from the NNC – 0.963. The second specimen of the Amsterdam 1673 ducat found in Teylers Museum (a double piedfort) was minted with a plain edge, with a lower fineness of 0.950⁴².

Table 3 presents the average, the highest and the lowest fineness of all genuine gold ducats struck in the 19th-21st centuries, divided by period of minting.

Table 3: The average, the highest and the lowest fineness of genuine gold ducats tested, minted from 1806

Mint	The lowest highest and the average fineness of genuine ducats tested (number of coins tested in brackets)			Total number of genuine coins being tested
	19 th century	20 th century	21 st century	
Kingdom of Holland (under Lodewijk Napoleon Bonaparte, 1806-1810)	0.951 0.978 0.965 (2)	–	–	2
The Netherlands 1814-1816 (required fineness: 0.986)	0.974 0.974 (1)	–	–	1
The Netherlands after 1817 (required fineness: 0.983)	0.969 0.981 0.976 (4)	0.963 0.985 0.975 (11)	0.970 0.975 0.973 (2)	17
TOTAL NUMBER OF GENUINE COINS BEING TESTED				20

Table 4: Number of coins minted (up to 1805) as required by law, within tolerance and below tolerance

Mint	Number of coins minted as required by law within tolerance below tolerance			Total number of genuine coins being tested
	16 th century	17 th century	18 th century or later	
<i>Hagemunten</i>				
Batenburg	0 0 15	–	–	15
's-Heerenberg	0 0 6	–	–	6
Hedel	0 0 2	–	–	2
Nijmegen	0 0 4	–	–	4

⁴² Jasek, 2015b.

<i>Official provincial and city mints</i>				
Gelderland	0 0 7	0 2 42	0 4 7	62*
Holland (Dordrecht)	0 0 1	0 0 1	0 3 8	13
Holland (Amsterdam)	–	0 0 2	–	2
West Friesland	0 8 16	0 8 52	2 13 27	126**
Utrecht	0 0 1	0 0 2	0 0 3	6
Friesland	–	0 0 1	–	1
Overijssel (provincial)	0 0 1	–	–	1
Kampen (city mint)	0 0 1	–	–	1
TOTAL NUMBER OF GENUINE COINS BEING TESTED:				239

* Additionally one Gelderland ducat tested was not genuine (in total 63 Gelderland genuine and counterfeit ducats were tested).

** An additional five West Friesland ducats tested were not genuine (in total 131 West Friesland genuine and counterfeit ducats were tested).

Table 5: Number of coins minted (from 1806) as required by law, within tolerance and below tolerance

Mint	Number of coins minted as required by law within tolerance below tolerance			Total number of genuine coins being tested
	19 th century	20 th century	21 st century	
Kingdom of Holland (under Lodewijk Napoleon Bonaparte, 1806-1810)	0 0 2	–	–	2
The Netherlands 1814-1816 (fineness required by law is 0.986)	0 0 1	–	–	1
The Netherlands after 1817 (fineness required by law is 0.983)	0 2 2	3 1 7	0 0 2	17
TOTAL NUMBER OF GENUINE COINS BEING TESTED:				20

Conclusions

Prior to the recent testing conducted at Teylers Museum, Tangelder was the only author providing information on the actual fineness of Netherlands gold ducats.⁴³ Even approximate tested values regarding fineness would have been valuable. Fortunately, the fineness results provided by this specific testing and this resulting article are far more accurate than approximate and provide a proper insight into the fineness of the Dutch Ducat throughout the ages.

Although the total number of coins tested was relatively low at only 265 specimens, we have to remember that the accuracy of testing fineness today is different from what was possible when most of the coins presented in this article were minted. What is also important is that we need to remember that an assayer always tried to reach the lowest fineness permitted by law when he mixed his alloy. This meant he made as much use as possible of the value of the fineness tolerance allowed by law. For example, although mint law required a fineness of 0.986, there was a tolerance level of 0.005. This means that coins with a fineness of 0.981 were perfectly acceptable. So the alloy could easily result in an actual fineness slightly lower than the lowest allowed by law.

The measured fineness of the ducats struck by the *hagemunten* was significantly lower than the fineness of the ducats struck by the official mints in the Republic of the United Provinces after 1586. How heavily they were debased has been indicated in detail in the specific sections of this article where the coins of each mint are listed.

Based on the test results, from the beginning of the provincial period until present times, the measured fineness was usually slightly lower than the fineness required by law. The total amount of ducats minted with the minimum fineness required was as expected minimum.

Coins TMNK 13586 (West Friesland 1757 ducat) and TMNK 10268 (West Friesland 1716 double ducat) with a fineness of respectively 0.988 and 0.986 are the only ducats of all the ones tested with a fineness meeting 0.986. In addition, the measured fineness of three coins minted in the 20th century (in 1972, 1986 and 1988) also met the value of 0.983, as required by law.

Of all 265 coins only 41 coins – 6 from Gelderland, 3 from Holland (Dordrecht), 29 from West Friesland and 3 from the Kingdom of the Netherlands – were minted with a fineness that was within the tolerance levels as required by law (the threshold was 0.981 up to 1816 or 0.980 after 1817).

There is no significant trend to be discovered in changes of the measured fineness over the various time periods involved.

⁴³ Tangelder, 1955: 257-259, 302-303.

Given the fact that the fineness of gold ducats, called “the ducat standard”, was widely known and accepted as it was written in acts of law, the results of the measurements are surprising. Now we can see that the actual fineness was in fact lower, albeit not a lot in many cases, but still lower than required by law, and in some examples even lower than the tolerance levels allowed. For a mint striking hundreds of thousands of coins, this led to significant increases in the amount of money (or profit) the mint potentially could make.

So, is this precisely what was occurring? Is it just a textbook example of the mints trying to make more money by minting ducats from an alloy with a spurious fineness? One can certainly make this claim from the onset. However, through testing a small subset of varied examples and taking the standard deviation of 0.05% of the testing method used into account, the results are rather close to what they should be, and in some rare cases, even exceed the standard if we also take into consideration the legal tolerance levels. To be completely sure we would of course have to measure the fineness with destructive methods, to actually test the core of each coin. Obviously, it is not possible, and the measurements published here may even be the only reference regarding the fineness of Netherlands gold ducats that can be found in literature for some time. Even taking into account the precision of the XRF method, it can be concluded that the fineness of many gold ducats was slightly below the legally prescribed level.

End note

The author would like to thank Mr. Pelsdonk for sharing the results of the XFR measurements presented here and for his kind cooperation, without which the publication of this material would not have been possible.

Biographical note

Dariusz F. Jasek (Cracow, 1978) is a Polish numismatist, specializing in Dutch coinage. He graduated from Cracow University of Economics. His book *Gold Ducats of the Netherlands* won the 2016 Numismatic Literary Guild Award for Best Specialized Book on World Coins.

APPENDIX

Measured gold content of the ducats of Teylers Museum Numismatic Cabinet

No.	Inv.no. TMNK	Date	Description	% gold
1	05659	1673	Amsterdam piedfort ducat	96.297
2	05691	1759	Holland ducat	97.881
3	05695	1773	Holland ducat	97.551
4	05697	1783	Holland double ducat	97.772
5	05705	1651	West Friesland ducat	97.861
6	05760	1596	Utrecht ducat	97.429
7	05764	1654	Utrecht double ducat	96.632
8	05773	1741	Utrecht double ducat	97.546
9	05776	1750	Utrecht ducat	97.691
10	05795	1612	Friesland ducat	97.457
11	05847	1818	ducat (under King Willem I, 1815-1840)	97.502
12	05858	1841	ducat (the Russian strike of the ducat minted under King Willem II, 1840-1849)	98.083
13	05870	1849	ducat (under King Willem III, 1849-1890)	98.009
14	06842	ND	Gelderland double ducat	97.252
15	06843	ND	Gelderland ducat (minted in 1591 or later)	97.532
16	06844	ND	Gelderland ducat (minted in 1591 or later)	97.178
17	06877	1596	Gelderland ducat	97.630
18	06880	1597	Gelderland ducat	97.524
19	06881	1598	Gelderland ducat	97.931
20	06884	1599	Gelderland ducat	97.897
21	06891	1602	Gelderland ducat	97.510
22	06901	1608	Gelderland ducat	96.757
23	06906	1611	Gelderland ducat	97.687
24	06928	1649	Gelderland ducat	96.942
25	06954	1631/1629	Gelderland ducat	97.652
26	06956	1632	Gelderland ducat	97.749
27	06957	1633	Gelderland ducat	97.554
28	06960	1634	Gelderland ducat	98.092
29	06963	1635	Gelderland ducat	97.576
30	06964	1639	Gelderland ducat	97.078
31	06969	1639/1638	Gelderland ducat	97.791

Actual vs. official fineness of Netherlands gold ducats

32	06970	1638	Gelderland ducat	97.671
33	06971	1639	Gelderland ducat	97.233
34	06972	1640	Gelderland ducat	97.525
35	06976	1641	Gelderland ducat	97.821
36	06979	1642	Gelderland ducat	97.624
37	06981	1643	<i>Gelderland ducat (not genuine)</i>	88.24
38	06982	1643	Gelderland ducat	97.864
39	06985	1646	Gelderland ducat	97.393
40	06986	1646	Gelderland ducat	97.635
41	06990	1647	Gelderland ducat	97.825
42	06993	1648	Gelderland ducat	97.390
43	06994	1648	Gelderland ducat	96.981
44	06999	1649	Gelderland ducat	97.750
45	07000	1649	Gelderland ducat	97.728
46	07001	1649	Gelderland ducat	97.490
47	07002	1649	Gelderland ducat	97.365
48	07007	1650	Gelderland ducat	96.993
49	07008	1650	Gelderland ducat	97.124
50	07010	1651	Gelderland ducat	97.411
51	07014	1652	Gelderland ducat	97.606
52	07015	1652	Gelderland ducat	97.691
53	07018	1653	Gelderland ducat	97.611
54	07019	1653	Gelderland ducat	97.042
55	07021	1654	Gelderland ducat	97.883
56	07022	1654	Gelderland ducat	97.141
57	07024	1635	Gelderland ducat	97.644
58	07027	1656	Gelderland double ducat	98.146
59	07029	1656	Gelderland ducat	97.865
60	07032	1658	Gelderland double ducat	97.833
61	07033	1659	Gelderland double ducat	97.607
62	07034	1659	Gelderland ducat	97.624
63	07042	1661	Gelderland ducat	97.851
64	07053	1664	Gelderland double ducat	97.666
65	07183	1740	Gelderland ducat	97.198
66	07212	1758	Gelderland ducat	97.747
67	07214	1759	Gelderland double ducat	97.787
68	07215	1759	Gelderland ducat	97.847

Actual vs. official fineness of Netherlands gold ducats

69	07223	1760	Gelderland double ducat	98.543
70	07224	1760	Gelderland ducat	97.813
71	07232	1761	Gelderland double ducat	97.985
72	07252	1763	Gelderland ducat	97.962
73	07271	1766	Gelderland ducat	98.147
74	07317	1800	Gelderland ducat – COIN NOT TESTED	UNK
75	07319	1801	Gelderland ducat	98.245
76	07320	1802	Gelderland ducat	98.132
77	07387	ND	Batenburg double ducat (Willem V van Bronckhorst, 1556-1573)	79.763
78	07388	ND	Batenburg double ducat (<i>idem</i>)	81.251
79	07389	ND	Batenburg double ducat (<i>idem</i>)	91.063
80	07393	ND	Batenburg ducat (<i>idem</i>)	81.087
81	07394	ND	Batenburg ducat (<i>idem</i>)	81.010
82	07395	ND	Batenburg Hungarian ducat (<i>idem</i>)	90.195
83	07396	ND	Batenburg Hungarian ducat (<i>idem</i>)	90.385
84	07462	ND	Batenburg ducat (Herman Dirk van Bronckhorst, 1573-1602)	85.754
85	07463	ND	Batenburg Hungarian ducat (<i>idem</i>)	85.701
86	07464	ND	Batenburg Hungarian ducat (<i>idem</i>)	85.369
87	07465	ND	Batenburg Hungarian ducat (<i>idem</i>)	84.577
88	07466	ND	Batenburg Hungarian ducat (<i>idem</i>)	85.863
89	07467	1577	Batenburg ducat (<i>idem</i>)	90.377
90	07489	1578	Batenburg ducat (<i>idem</i>)	84.627
91	07490	1578	Batenburg ducat (<i>idem</i>)	84.878
92	07585	ND	's-Heerenberg ducat (Willem IV van den Bergh, 1546-1586)	77.579
93	07586	ND	's-Heerenberg ducat (<i>idem</i>)	78.997
94	07587	ND	's-Heerenberg ducat (<i>idem</i>)	78.559
95	07588	ND	's-Heerenberg ducat (<i>idem</i>)	77.766
96	07639	1577	's-Heerenberg ducat (<i>idem</i>)	83.399
97	07640	ND	's-Heerenberg ducat (<i>idem</i>)	85.782
98	07662	1577	Hedel ducat (Frederik van den Bergh, 1577-1580)	88.969
99	07663	ND	Hedel ducat (<i>idem</i>) – COIN NOT TESTED	UNK
100	07664	ND	Hedel ducat (<i>idem</i>)	89.741
101	07848	ND	Nijmegen double ducat	90.321
102	07849	ND	Nijmegen double ducat	89.992
103	07850	ND	Nijmegen double ducat	90.230

Actual vs. official fineness of Netherlands gold ducats

104	07851	ND	Nijmegen double ducat	90.134
105	09884	ND	West Friesland double ducat (Spanish type, minted in 1586)	97.370
106	09885	ND	West Friesland double ducat (<i>idem</i>)	97.059
107	09886	1587	West Friesland ducat (Hungarian type)	98.204
108	09891	1588	West Friesland ducat (<i>idem</i>)	98.172
109	09892	1588	West Friesland ducat (<i>idem</i>)	98.194
110	09893	1588	West Friesland ducat (<i>idem</i>)	96.498
111	09900	1590	West Friesland ducat	98.037
112	09905	1591	West Friesland ducat	98.067
113	09906	1591	West Friesland ducat	97.880
114	09907	1591	West Friesland ducat	98.223
115	09910	1592	West Friesland ducat	97.944
116	09911	1592	West Friesland ducat	97.903
117	09914	1593	West Friesland ducat	97.910
118	09915	1593	<i>West Friesland ducat (not genuine)</i>	92.95
119	09928	1595/1592	West Friesland ducat	97.915
120	09935	1596	West Friesland ducat	97.885
121	09936	1596	West Friesland ducat	97.665
122	09946	1598	West Friesland ducat	98.122
123	09970	1603	West Friesland ducat	97.785
124	09971	1604	<i>West Friesland ducat (not genuine)</i>	94.214
125	09972	1604	West Friesland ducat	97.980
126	09973	1604	West Friesland ducat	97.794
127	09981	1609	West Friesland ducat	98.221
128	09984	1611	West Friesland ducat	97.916
129	09985	1611	West Friesland ducat	97.902
130	10011	1624/1621	West Friesland ducat	96.843
131	10023	1634	West Friesland ducat	97.585
132	10024	1635	West Friesland ducat klippe	97.624
133	10025	1635	West Friesland ducat	97.784
134	10026	1637	West Friesland ducat	97.180
135	10028	1638	West Friesland ducat	97.493
136	10030	1639	West Friesland ducat	98.002
137	10035	1640	West Friesland ducat	98.446
138	10036	1640	West Friesland ducat	98.265
139	10038	1641	West Friesland ducat	97.929

Actual vs. official fineness of Netherlands gold ducats

140	10039	1642	West Friesland ducat	97.649
141	10040	1643	West Friesland ducat	97.880
142	10042	1644	West Friesland ducat	97.688
143	10046	1645	West Friesland ducat	97.540
144	10050	1646	West Friesland ducat	97.709
145	10051	1646	West Friesland ducat	98.079
146	10054	1647	West Friesland ducat	97.273
147	10055	1648	West Friesland ducat	97.796
148	10057	1649	West Friesland ducat	97.662
149	10060	1650	West Friesland ducat	97.557
150	10064	1651	West Friesland ducat	97.885
151	10066	1652/1651	West Friesland ducat	98.069
152	10067	1653	West Friesland ducat	97.694
153	10068	1653/1652	West Friesland ducat	97.801
154	10072	1654	West Friesland ducat	97.959
155	10073	1655	West Friesland ducat	98.015
156	10100	1662	West Friesland double ducat	97.986
157	10101	1662	West Friesland ducat	97.657
158	10116	1666	West Friesland double ducat	97.333
159	10133	1672	West Friesland double ducat	98.121
160	10140	1673	West Friesland ducat	98.170
161	10206	1684	West Friesland double ducat	96.863
162	10237	1696	West Friesland double ducat	97.597
163	10238	1696	West Friesland double ducat piedfort	97.602
164	10261	1712	West Friesland ducat	97.726
165	10268	1716	West Friesland double ducat	98.552
166	10285	1725	West Friesland double ducat	98.261
167	10290	1728	West Friesland ducat	97.598
168	10292	1730	West Friesland double ducat	97.738
169	10293	1731	West Friesland double ducat	98.259
170	10294	1731/1730	West Friesland ducat	98.170
171	10297	1732/1731	West Friesland ducat	98.041
172	10299	1734	West Friesland double ducat	98.172
173	10302	1736	West Friesland double ducat	98.243
174	10321	1749	West Friesland ducat	97.849
175	10326	1752	West Friesland double ducat	97.942
176	10327	1753/1752	West Friesland double ducat	97.479

Actual vs. official fineness of Netherlands gold ducats

177	10328	1753	West Friesland ducat	97.396
178	10335	1758	West Friesland ducat	98.054
179	10336	1758	West Friesland ducat	97.868
180	10340	1759	West Friesland ducat	97.971
181	10348	1760	West Friesland ducat	97.971
182	10357	1761	West Friesland ducat	97.876
183	10399	1776	West Friesland ducat	97.601
184	10402	1777	West Friesland ducat	98.182
185	10404	1778	West Friesland double ducat	97.980
186	10409	1779	West Friesland double ducat	97.683
187	10412	1780/1777.?	West Friesland double ducat	98.060
188	10413	1780/1778	West Friesland ducat	98.164
189	10547	1673	Amsterdam piedfort ducat	95.014
190	10609	1754	Holland ducat	97.902
191	10613	1758	Holland ducat	98.190
192	10617	1760	Holland ducat	98.146
193	10631	1781	Holland ducat	97.824
194	10644	1797	Holland ducat	98.099
195	10820	1753	West Friesland ducat	97.312
196	11412	1587	Holland ducat	97.708
197	11413	1796	Utrecht ducat	97.397
198	11414	ND	Overijssel ducat (Hungarian type, minted ca. 1590-1593)	97.334
199	11415	1776	Holland ducat	97.903
200	11416	1814	ducat (under King Willem I, 1815-1840)	97.417
201	11417	1775	Holland ducat	97.960
202	11418	1605	Utrecht ducat	96.645
203	11419	1645	West Friesland ducat	97.667
204	11420	1590	West Friesland ducat	98.054
205	11423	1872	ducat (under King Willem III, 1849-1890)	96.939
206	11425	1960	ducat (under Queen Juliana, 1948-1980)	97.320
207	11426	1972	ducat (<i>idem</i>)	98.474
208	11427	1974	ducat (<i>idem</i>)	97.991
209	11428	1986	ducat (under Queen Beatrix, 1980-2013)	98.271
210	11429	1988	double ducat (<i>idem</i>)	98.311
211	11430	1655	Holland double ducat	96.868
212	11431	1783	Holland double ducat	97.999

Actual vs. official fineness of Netherlands gold ducats

213	11432	1808	ducat of the Kingdom of Holland (under Lodewijk Napoleon Bonaparte, 1806-1810)	95.093
214	11433	1809	ducat of the Kingdom of Holland (<i>idem</i>)	97.831
215	11434	ND	Kampen ducat (Spanish type, 1582-1593)	96.794
216	12640	2000	double ducat (under Queen Beatrix, 1980-2013)	96.295
217	12641	1999	double ducat (<i>idem</i>)	96.668
218	12642	2002	double ducat (<i>idem</i>)	97.533
219	12644	1999	ducat (<i>idem</i>)	97.003
220	12645	2000	ducat (<i>idem</i>)	96.459
221	12646	2001	ducat (<i>idem</i>)	97.027
222	12652	1974	ducat – medal alignment (under Queen Juliana, 1948-1980)	97.884
223	12653	1974	ducat – coin alignment (<i>idem</i>)	97.486
224	13574	1605	West Friesland ducat (Hungarian type)	97.534
225	13575	1599/1597	West Friesland ducat (<i>idem</i>)	98.014
226	13576	1595/1593	West Friesland ducat (<i>idem</i>)	97.493
227	13577	1595/1592	West Friesland ducat (<i>idem</i>)	97.959
228	13578	1592/1591	West Friesland ducat (<i>idem</i>)	97.909
229	13579	1592/1590	West Friesland ducat (<i>idem</i>)	98.070
230	13580	1588/1587	West Friesland ducat (<i>idem</i>)	97.933
231	13581	1778/1777	West Friesland ducat	97.638
232	13582	1778	West Friesland ducat	98.127
233	13583	1762	West Friesland ducat	98.106
234	13584	1760/1759	West Friesland ducat	98.093
235	13585	1757/1756	West Friesland ducat	97.288
236	13586	1757	West Friesland ducat	98.813
237	13587	1756	West Friesland ducat	97.508
238	13588	1752	West Friesland ducat	97.862
239	13589	1732/1731	West Friesland ducat	98.092
240	13590	1731	West Friesland ducat	97.898
241	13591	1729	West Friesland ducat	97.872
242	13592	1728/1718	West Friesland ducat	97.017
243	13593	1719/1718	West Friesland ducat	98.016
244	13594	1717	West Friesland ducat	97.576
245	13595	1713	West Friesland ducat	97.859
246	13596	1705	West Friesland ducat	97.715
247	13597	1696	West Friesland ducat	97.806
248	13598	1694	West Friesland ducat	97.938

Actual vs. official fineness of Netherlands gold ducats

249	13599	1691/1690	West Friesland ducat	97.451
250	13600	1690	West Friesland ducat	98.046
251	13601	1686/1684	West Friesland ducat	97.382
252	13602	1675	West Friesland ducat	97.665
253	13603	1667	<i>West Friesland ducat (not genuine)</i>	82.716
254	13604	1659	<i>West Friesland ducat (not genuine)</i>	91.460
255	13605	1656	<i>West Friesland ducat (not genuine)</i>	92.160
256	13606	1649	West Friesland ducat	96.594
257	13607	1649	West Friesland ducat	97.309
258	13608	1636	West Friesland ducat	97.395
259	13609	1634/1633	West Friesland ducat	97.625
260	13610	1633	West Friesland ducat	97.549
261	13611	1632	West Friesland ducat	98.143
262	13612	1624/1621	West Friesland ducat	97.657
263	13613	1612	West Friesland ducat	97.767
264	13614	1610	West Friesland ducat	97.613
265	13615	1605/1601	West Friesland ducat (Hungarian type)	97.753
266	14167	1607	West Friesland ducat	97.659
267	16530	1653	Gelderland ducat	97.554

Total coins listed: 267 pcs.

Total coins tested: 265 pcs. (259 genuine and 6 not genuine)

Total coins not tested: 2 pcs. (TMNK 07317 and TMNK 07663)

Internet source

Pannekeet, C.G.J. <http://www.duiten.nl/weert.html> [28 August 2017]

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