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WEAR OF SILVER COINS

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The wear of coins has been analysed in several annual reports of the Mint in the Netherlands (Muntverslagen). The report for the year 1925 states that wear, i.e. loss of weight, seems to be caused by the disappearance of the copper from the silver-copper alloy which was used for the coins.

In this article I am using part of the schedules concerning wear published in the Mint Reports for the years 1925 and 1935.

If we accept the Mint's conclusion that

1. wear occurs through chemical reactions only (not because coins are scratched or knocked about),

and further assume that

2. wear on the rim is negligible. This means that wear occurs only on the surface of the obverse and the reverse of a coin,

3. wear is, within margins, independent of the alloy (fineness) of the surface,

4. although wear may not be constant in any given period of time, we assume that wear is linear: i.e. the wear in each year is the same as the average p.a. over the entire period,

we can formulate that for any type of coin

$$w = c \cdot d^2 \qquad (1)$$

wherein w = the wear in grammes p.a.
wherein d = the diameter in mm
wherein c = a constant

If we want to express the wear in a percentage of the original weight then the formula becomes

$$w = c^1 \frac{d^2}{m} \qquad (2)$$

wherein w = percentage of wear p.a.
wherein d = the diameter in mm
wherein m = the original weight in grammes
wherein c^1 = again a constant

The average wear for the guilder of the third type of Wilhelmina was according to the Mint Report[1] 4,5 milligrammes p.a. On the basis of the original diameter and weight the constant from formula 2 works out at $5.74 \cdot 10^{-4}$ (or 0.000574).

For the guilders the Report for the year 1925 lists the weights in schedule 3; the predominating weights for the coins from those years have been used for column 2, and the average of these years for column 3.

1	2	3	4
year	*weight according to Report*	*weight according to formula 4*	*2:3*
1922/4	9.975	9.991	0.998
1915/9	9.975	9.964	1.001
1910/4	9.975	9.941	1.003
1904/9	9.925	9.919	1.001
1898/1901	9.925	9.887	1.004
1892/7	9.875	9.865	1.001
1865/6	9.775	9.730	1.005
1860/4	9.725	9.716	1.001
1850/4	9.675	9.672	1.000
1845/9	9.625	9.649	0.998

All results calculated in column 3 stay within 1 % of the formula.

As we assumed that the alloy would not affect wear, this constant can be used for the 25 and 10 cent pieces also. For these coins the weights according to formula 2 for the respective years can now be calculated and compared with actual weights given in the Mint Report for the year 1935[2].

1. The loss of 4.5 mg p.a. for the guilder is mentioned in the Mint Report for 1925 page 66.
2. To make the mint reports useable in this context I had to regroup the data presented in the schedules.

10 cent coins (Mint Report 1935 schedule 4)

New head after	1929	1.386		
Wienecke	1910-1917	1.345	average 1913	1920 + 7 years
Pander	1900-1909	1.297	average 1905	o.k.
Schammer	1892-1897	1.296	average 1895	1890 ./. 5 years
Willem III/II		1.212	average 1865	1875 + 10 years

Correction p.a. according to formula 3 $12.46 \cdot 10^{-3} \cdot 15^2 = 2.8$ mg p.a.

1	2	3	4
coin dated	*weight according to Report*	*weight according to calculation*	*2:3*
		25 cent pieces	
1935	3.575 g	uncirculated	–
1920	3.515 g	3.544	0.99
1905	3.435 g	3.513	0.98
1890	3.341 g	3.482	0.96
		10 cent pieces	
1935	1.400 g	uncirculated	–
1920	1.365 g	1.381	0.99
1905	1.297 g	1.361	0.95
1890	1.272 g	1.342	0.95

The figure for Willem III/II has not been used, as sizeable amounts of these coins had been withdrawn previously from circulation because they were underweight. The same applies for the 25 cent coins.

1920	1.345 + 7 × 0.0028	= 1.365
1905		= 1.297
1890	1.296 ./. 5 × 0.0028	= 1.272

For 25 cent pieces (schedule 1)

1919	3.511 + 1 × 0.0045	= 3.515
1901-6	3.428 + 1½ × 0.0045	= 3.435
1892-1898	3.368 ./. 6 × 0.0045	= 3.341

As column 4 shows, there is a progressive deviation of the results derived from the formula compared to the weights as shown in the schedules.
This points in all probability to a factor not included in our assumptions. If the chemical factor is related to chemicals deposited by fingers when handling coins, wear will be proportional to the contact surface, not to the total surface of a coin. Only part of the guilder coin wil be in contact with the fingers but the whole surface of the 25 cent piece will be touched. This would explain the deviation. A further clue to the role of this factor may be found in the actual wear of ¾ % of a parcel of 2½-guilderpieces[3] whereas formula 2 would give 2.67 % or three times as much.
To summarize, compared to the figures resulting from formula 2 the wear of the 2½-guilderpiece is too low and that of the 10 and 25 cent piece too high.

To the four factors for formula 2 we can add a fifth (always neglecting the influence of differences in fineness and in velocity of circulation):

5. Wear occurs on the contact surface, where the fingers actually touch the coin. We propose that the size of this surface is the same as that of a 25 cent piece (diameter 19 mm).

The formula now becomes

$$w = c \frac{d_c^2}{m} \% \qquad (3)$$

wherein w = the percentage of wear p.a.
wherein dc = the diameter on the contact surface (at most 19 mm)
wherein m = the weight in grammes
wherein c = a constant (here $12.46 \cdot 10^{-4}$ or 0.001246)

3. When I discussed the problems of weight loss with Messrs. Schulman they mentioned a parcel of 1000 2½ guilder coins which their firm had turned into bullion during the recent boom in silver.
These coins, which had lost all numismatic appeal, came from Indonesia and must have circulated for over 80 years. The loss of the theoretical silver content was ¾ %.

For all coins with a diameter of at least the diameter of the contact surface $c \cdot d_c^2$ can be combined to form a new constant which is always based on the constant for the guilder piece 0.45. So for all coins with a diameter of 19 mm and more the formula becomes

$$w = \frac{0.45}{m} \% \text{ p.a.} \qquad (4)$$

wherein w = the percentage of wear p.a.
wherein m = the weight of the coin in grammes

For the guilder piece this formula gives the same result as formula 2.

We can apply this formula, of course, to the 2½ guilder piece with a diameter of 38 mm. The pieces of footnote 3 should have lost

$$\frac{0.45}{25} \cdot 80 = 1.44,$$

whereas the reported figure was 0.75 %. According to information kindly provided by Prof. H. Enno van Gelder, the major part of these 2½ guilder pieces had rested in the vaults of banks and had not been in circulation from 1875 to 1914. If we therefore reduce the period of circulation from 80 to 40 years, the formula gives 0.74 %.

For the 25 cent piece formula 4 applies, but for the 10 cent piece with a diameter of 15 mm we must apply formula 3.

A recalculation based on formula 4 (and 3) gives the following result.

1	2	3	4
coin dated	*weight according to Report*	*weight according to calculation*	*2:3*
		25 cent piece	
1935	3.575	uncirculated	–
1920	3.515	3.508	1.002
1905	3.435	3.440	0.999
1890	3.341	3.372	0.991

		10 cent piece	
1935	1.400	uncirculated	–
1920	1.365	1.358	1.005
1905	1.297	1.316	0.986
1890	1.272	1.274	0.998

Looking at the results we find that only the actual figures for the 10 cent piece of 1905 are more than 1 % out.
The largest difference in percentage remains that of the 2½ guilder pieces; however, the information in this case is somewhat less precise.
The difference in fineness between the large (0.945) and the small (0.640) coins, seems to be irrelevant, as no great deviations have shown up.

In Edwardian Monetary Affairs (B.A.R. 36, 1977) T. H. Lloyd mentions that pennies subject to normal wear, in the 14th century are believed to have lost 2 - 2.75 % per decade. Formula 4 gives

$$\frac{0.45}{1.45} \cdot 10 = 3.1$$

which is rather close to that figure. My own investigations into the 13th-century deniers of Holland which I intend to publish in another paper, resulted in comparable percentages of wear.

If we suppose that the velocity of the circulation in the 14th century was lower than in the 19th and 20th centuries the results are even better. *Therefore I propose formula 4 (and 3) for general application as a method of evaluating the average weight loss through normal wear for silver coins.*

The formula can also be expressed in other words: every coin with a diameter of more than 19 mm loses 0.45 milligrammes p.a. through normal circulation; for coins of smaller size the loss would be reduced by a factor of

$$\frac{d^2}{19^2},$$

where d is the diameter in mm.

As the formula is derived from averages it should not be used for single coins, nor for clipped coins, as it is based on coins from a period in which clipping was no longer usual.
We do not know if corrosion in the soil will affect silver coins.
The formula may be found to corroborate datings by other methods but it should not be used as a sole basis for dating.

The formula may explain why small silver coins in good condition are so rare. They lose a substantial percentage of weight much faster than larger coins. To visualise the difference, I have calculated the number of years in which, according to the formula, some well-known types of medieval coins would have lost 3 % in weight. In modern times this is the point where coins should be withdrawn from circulation.

			3 % loss after
Taler	28	grammes	188 years
Gros Tournois	4	grammes	27 years
Gros Vierlander	3	grammes	20 years
Sterling	1.45	grammes	10 years
Denier Tournois	0.86	grammes	6 years
Bracteate Lindau (Cahn 182)	0.48	grammes	3 years

For gold coins with a high gold content it may be assumed that the chemical factor does not apply, so that wear will be negligible.

It would be very useful if more facts would become available to test the formula.

Finally, I should like to thank all fellow numismatists who helped me with this article and especially Mr. E. J. A. van Beek.