De Re Metallica Libri XII 1556

Af Georgius Agricola

Introduktion

Meget af den teknologiske viden som er nødvendig for at kunne fremstille glas er erfaringsviden, som i mundtlig eller i personligt opnoteret form er overleveret fra generation til generation. Tidligt er der dog udgivet bøger om hvorledes man fremstiller glas. Således nedskriver den tyske munk Theophilus i 1100-tallet et større værk på latin med titlen *De diuersis Artibus,* som bl.a. omhandler glasproduktion. Senere i 1400-tallet gengives i sir John Mandevilles manuskript om hans rejser et billede af en glashytte, som han formentlig kan have set under sin rejse i Bøhmen. Billedet er helt uden tekst, men er uendeligt informativt, se s. xx. I begyndelsen af 1500-tallet opholder den svenske præst Peder Månsson sig i Rom og nedskriver formentligt her sit lille manuskript med titlen *Glaskonst,* som her er gengivet s. xx. Den italienske byg- og arsenalmester Biringuccio får i 1540 udgivet sit metallurgiske værk *Pirotechnia,* hvori han også skriver om glasproduktion, se gengivelse s. xx.

Den tyske læge og mineralog Georg Bauer, født 1494 i Glauchau i Sachsen, arbejder indtil sin død i 1555 på det meget omfattende værk *De Re Metallica Libri XII*, som omhandler en detaljeret gennemgang af bjergværksdrift og metallurgi herunder også glasproduktion. Værket bliver året efter færdig fra trykkeren Froben i Basel. Den første udgave er skrevet på latin under navnet Georgius Agricola (fig. 1). Til grund for dette værk, foruden en række andre bøger, ligger et livslangt studie af samtidens minedrift i Erzgebirge, som er en del af de böhmiske randbjerge og som i dag ligger på grænsen mellem Tjekkiet og Tyskland. På sydsiden af denne bjergkæde ligger den vigtige mineby Joakimsthal/Jáchymov, hvor Agricola i en årrække er stadslæge. Mange og store afffaldsbjerge rundt om byen vidner den dag i dag om den betydelige bjergværksdrift, der engang foregik på stedet. Det betød rigdom i byen.[1] Glasset beskriver han i sidste del af bog 12.

Fig. 1. Kartouche med gengivelse af Georg Agricola. Efter: Agricola 1556, genoptryk 2003.

Om glasset skriver Agricola, at han under sit ophold i Italien også studerede glasproduktionen i Venedig, som dog hovedsageligt foregår på øen Murano. Så en del af det han skriver om glas, kan være baseret på iagttagelsen gjort under italiensopholdet, som varede omkring et par år. Men det meste bygger givetvis på viden hentet i de glashytter som dengang lå i de skovrige bøhmiske randbjerge. For at illustrere den ofte komplicerede tekst bliver værket forsynet med ikke mindre end 289 træsnit specielt fremstillet til dette værk. Agricola leverer givetvis skitser og input til hvorledes illustrationerne skal se ud.

De re Metallica kommer allerede i en tysk udgave i 1557, i 1561 kommer en ny udgave på latin, en italiensk følger i 1563 og værket kommer efterfølgende i en række nye udgaver og forbliver et hovedværk om metallurgi de næste 200 år. Det er ikke mindst de fremragende træsnit, som gør, at Agricolas værk forbliver efterspurgt så længe.

Hvad glas angår, kommer der allerede i 1612 et værk af Antonio Neri fra Firenze med titlen *L'arte vetraria,* som supplerer Agricolas værk på den måde, at det fokuserer på glassets kemi, hvorimod Agricola koncentrerer sig om selve produktionen og det nødvendige sæt op med ovne og værktøj.

Neri's værk bliver i 1662 udgivet på engelsk af Christoffer Merrett under titlen *The art of glass.* Ud over Neri's værk supplerer han det med egen viden, som afspejler den teknologiske udvikling, der er sket i mellemtiden.

I 1679 udkommer tyskeren Johan Kunckels væsentlige bog *Ars vitraria eksperimentalis.* Kunckel tilhører en af de betydelige tyske glasmagerfamiler, som i generationer arbejder med glas og som flytter meget rundt, alt efter hvor der er arbejde at få. Kunckelfamilien har således også været i Danmark. Bogen er skrevet på tysk og tager afsæt i bl.a. Agricolas, Neri's og Merrett's arbejder. Kunckel selv tilføjer væsentligt nyt. Det er helt tydeligt, at en del af de illustrationer, som bringes i Kunckels værk, er gjort efter træsnittene i Agricolas værk, se et eksempel på det s. xx. Dette siger noget om at man stadig i sidste halvdel af 1600-tallet kunne bruge indholdet i træsnittene.

Agricolas *De re Metallica* afløses efterhånden af mere opdateret viden. Men værket bliver ved med at have stor historisk interesse og oversættes i 1912 til engelsk af Herbert Clark Hoover og Lou Henry Hoover. Denne oversættelse genudgives flere gange og den oversættelse som bringes her er taget fra en udgave fra 1950, som er genoptrykt i 1986.[2] Et omfattende noteværk er dog udeladt. En moderne tysk oversættelse kommer i 1928. Siden er denne oversættelse genoptrykt flere gange. I såvel den engelske som i den moderne tyske udgave udtrykkes det fra oversætternes side, hvor kompliceret det har været at finde de korrekte fagtermer og at oversætte selve den latinske tekst, da den i nogen grad er infiltreret med tyske ordkonstruktioner. Beskrivelsen af glasset udgør den sidste del af bog XII og er ledsaget af fire træsnit.

Introduktion: Jan Kock

De Re Metallica Libri XII

Af Georgius Agricola

... There remains glass, the preparation of which belongs here, for the reason that it is obtained by the power of fire and subtle art from certain solidified juices and from coarse or fine sand. It is transparent, as are certain solidified juices, gems, and stones; and

can be melted like fusible stones and metals. First I must speak of the materials from which glass is made; then of the furnaces in which it is melted; then of the methods by which it is produced.

It is made from fusible stones and from solidified juices, or from other juicy substances which are connected by a natural relationship. Stones which are fusible, if they are white and translucent, are more excellent than the others, for which reason crystals take the first place. From these, when pounded, the most excellent transparent glass was made in India, with which no other could be compared, as Pliny relates. The second place is accorded to stones which, although not so hard as crystal, are yet just as white and transparent. The third is given to white stones, which are not transparent. It is necessary, however, first of all to heat all these, and afterward they are subjected to the pestle in order to break and crush them into coarse sand, and then they are passed through a sieve. If this kind of coarse or fine sand is found by the glass-makers near the mouth of a river, it saves them much labour in burning and crushing. As regards the solidified juices, the first place is given to soda; the second to white and translucent rock-salt; the third to salts which are made from lye, from the ashes of the musk ivy, or from other salty herbs. Yet there are some who give to this latter, and not to the former, the second place. One part of coarse or fine sand made from fusible stones should be mixed with two parts of soda or of rock-salt or of herb salts, to which are added minute particles of *magnes*. It is true that in our day, as much as in ancient times, there exists the belief in the singular power of the latter to attract to itself the vitreous liquid just as it does iron, and attracting it to purify and transform green or yellow into white; and afterward fire consumes the *magnes*. When the said juices are not to be had, two parts of the ashes of oak or holmoak, or of hard oak or turkey oak, or if these be not available, of beech or pine, are mixed with one part of coarse or fine sand, and a small quantity of salt is added, made from salt water or sea-water, and a small particle of *magnes*; but these make a less white and translucent glass. The ashes should be made from old trees, of which the trunk at a height of six feet is hollowed out and fire is put in, and thus the whole tree is consumed ad converted into ashes. This is done in winter when the snow lies long, or in summer when it does not rain, for the showers at other times of the year, by mixing the ashes with earth, render them impure; for this reason, at such times, these same trees are cut up into many pieces and burned under cover, and are thus converted into ashes.

Some glass-makers use three furnaces, others two, others only one. Those who use three, melt the material in the first, re-melt it in the second, and in the third they cool the glowing glass vessels and other articles (fig. 2). Of these the first furnace must be vaulted and similar to an oven. In the upper chamber, which is six feet long, four feet wide, and two feet high, the mixed materials are heated by a fierce fire of dry wood until they melt and are converted into a vitreous mass. And if they are not satisfactorily purified from dross, they are taken out and cooled and broken into pieces; and the vitreous pieces are heated in pots in the same furnace.

The second furnace is round, ten feet in diameter and eight feet high, and on the outside, so that it may be stronger, it is encompassed by five arches, one and one half feet thick; it consists in like manner of two chambers, of which the lower one is vaulted and is one and one half feet thick (fig. 3). In front this chamber has a narrow mouth, through which

Fig. 2. A-Lower chamber of the first furnace. B-Upper chamber. C-Vitreous mass.

Fig. 3. A-Arches of the second furnace. B-Mouth of the lower chamber. C-Windows of the upper chamber. D-Big-bellied pots. E-Mouth of the third furnace. F-Recesses for the receptacles. G-Opening in the upper chamber. H-Oblong receptacles.

the wood can be put into the hearth, which is on the ground. At the top and in the middle of its vault, there is a large round hole which opens to the upper chamber, so that the flames can penetrate into it. Between the arches in the walls of the upper chamber are eight windows, so large that the big-bellied pots may be placed through them on to the floor of the chamber, around the large hole. The thickness of these pots is about two digits, their height the same number of feet, and the diameter of the belly one and a half feet, and of the mouth and bottom one foot. In the back part of the furnace is a rectangular hole, measuring in height and width a palm, through which the heat penetrates into a third furnace which adjoins it.

This third furnace is rectangular, eight feet long and six feet wide; it also consists of two chambers, of which the lower has a mouth in front, so that firewood may be placed on the hearth which is on the ground. On each side of this opening in the wall of the lower chamber is a recess for oblong earthen- ware receptacles, which are about four feet long, two feet high, and one and a half feet wide. The upper chamber has two holes, one on the right side, the other on the left, of such height and width that earthenware receptacles may be conveniently placed in them. These latter receptacles are three feet long, one and a half feet high, the lower part one foot wide, and the upper part rounded. In these receptacles the glass articles, which have been blown, are placed so that they may cool in a milder temperature; if they were not cooled slowly they would burst asunder. When the vessels are taken from the upper chamber, they are immediately placed in the receptacles to cool.

Some who use two furnaces partly melt the mixture in the first, and not only re-melt it in the second, but also replace the glass articles there. Others partly melt and re-melt the material in different chambers of the second furnace. Thus the former lack the third furnace, and the latter, the first. But this kind of second furnace differs from the other second furnace, for it is, indeed, round, but the interior is eight feet in diameter and twelve feet high, and it consists of three chambers, of which the lowest is not unlike the lowest of the other second furnace (fig. 4). In the middle chamber wall there are six arched openings, in which are placed the pots to be heated, and the remainder of the small windows are blocked up with lute. In the middle top of the middle chamber is a square opening a palm in length and width. Through this the heat penetrates into the upper chamber, of which the rear part has an opening to receive the oblong earthenware receptacles, in which are placed the glass articles to be slowly cooled. On this side, the ground of the workshop is higher, or else a bench is placed there, so that the glass-makers may stand upon it to stow away their products more conveniently.

Those who lack the first furnace in the evening, when they have accomplished their day's work, place the material in the pots, so that the heat during the night may melt it and turn it into glass. Two boys alternately, during -night and day, keep up the fire by throwing dry wood on to the hearth. Those who have but one furnace use the second sort, made with three chambers. Then in the evening they pour the material into the pots, and in the morning having extracted the fused material, they make the glass objects, which they place in the upper chamber, as do the others.

The second furnace consists either of two or three chambers, the first of which is made of unburnt bricks dried in the sun. These bricks are made of a kind of clay that cannot be easily melted by fire nor resolved

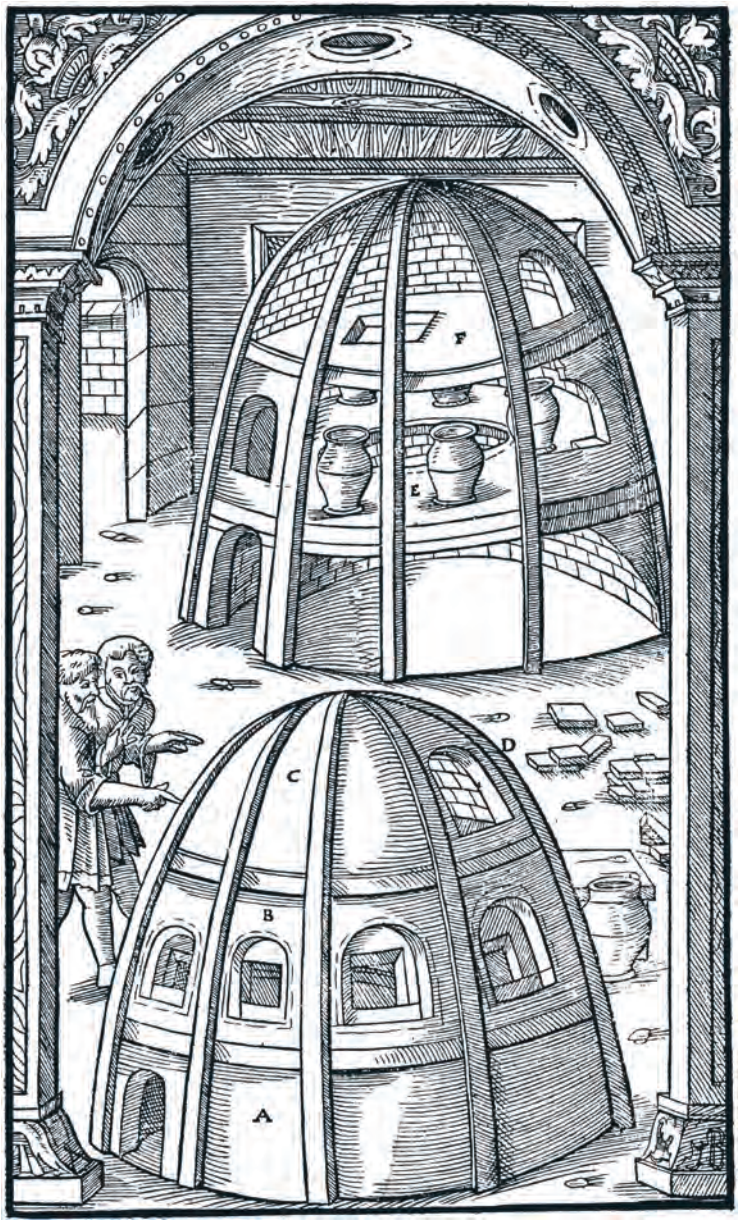

Fig. 4. A-Lower chamber of the other second furnace. H-Middle one. C-Upper one. D -Its opening. E-Round opening. F-Rectangular opening.

Fig. 5. A-Blow-pipe. B-Little window. C-Marble. D-Forceps. E-Moulds by means of which the shapes are produced.

into powder; this clay is cleaned of small stones and beaten with rods. The bricks are laid with the same kind of clay instead of lime. From the same clay the potters also make their vessels and pots, which they dry in the shade. These two parts having been completed, there remains the third.

The vitreous mass having been made in the first furnace in the manner I described, is broken up, and the assistant heats the second furnace, in order that the fragments may be re-melted. In the meantime, while they are doing this, the pots are first warmed by a slow fire in the first furnace, so that the vapours may evaporate, and then by a fiercer fire, so that they become red in drying. Afterward the glass-makers open the mouth of the furnace, and, seizing the pots with tongs, if they have not cracked and fallen to pieces, quickly place them in the second furnace, and they fill them up with the fragments of the heated vitreous mass or with glass. Afterward they close up all the windows with lute and bricks, with the exception that in each there are two little windows left free; through one of these they inspect the glass contained in the pot, and take it up by means of a blow-pipe; in the other they rest another blow-pipe, so that it may get warm. Whether it is made of brass, bronze, or iron, the blow-pipe must be three feet long.In front of the window is inserted a lip of marble, on which rests the heaped-up clay and the iron shield. The clay holds the blow-pipe when it is put into the furnace, whereas the shield preserves the eyes of the glass-maker from the fire. All this having been carried out in order, the glass-makers bring the work to completion. The broken pieces they re-melt with dry wood, which emits no smoke, but only a flame. The longer they re-melt it, the purer and more transparent it becomes, the fewer spots and blisters there are, and therefore the glass-makers can carry out their work more easily. For this reason those who only melt the material from which glass is made for one night, and then immediately make it up into glass articles, make them less pure and transparent than those who first produce a vitreous mass and then re-melt the broken pieces again for a day and a night. And, again, these make a less pure and transparent glass than do those who melt it again for two days and two nights, for the excellence of the glass does not consist solely in the material from which it is made, but also in the melting. The glass-makers often test the glass by drawing it up with the blowpipes; as soon as they observe that the fragments have been re-melted and purified satisfactorily, each of them with another blow-pipe which is in the pot, slowly stirs and takes up the glass which sticks to it in the shape of a ball like a glutinous, coagulated gum (fig. 5). He takes up just as much as he needs to complete the article he wishes to make; then he presses it against the lip of marble and kneads it round and round until it consolidates. When he blows through the pipe he blows as he would if inflating a bubble; he blows into the blow-pipe as often as it is necessary, removing it from his mouth to re-fill his cheeks, so that his breath does not draw the flames into his mouth. Then, twisting the lifted blow-pips round his head in a circle, he makes a long glass, or moulds the same in a hollow copper mould, turning it round and round, then warming it again, blowing it and pressing it, he widens it into the shape of a cup or vessel, or of any other object he has in mind. Then he again presses this against the marble to flatten the bottom, which he moulds in the interior with his other blow-pipe. Afterward he cuts out

the lip with shears, and, if necessary, adds feet and handles. If it so please him, he gilds it and paints it with various colours. Finally, he lays it in the oblong earthenware receptacle, which is placed in the third furnace, or in the upper chamber of the second furnace, that it may cool. When this receptacle is full of other slowly-cooled articles, he passes a wide iron bar under it, and, carrying it on the left arm, places it in another recess.

The glass-makers make divers things, such as goblets, cups, ewers, flasks, dishes, plates, panes of glass, animals, trees, and ships, all of which excellent and wonderful works I have seen when I spent two whole years in Venice some time ago. Especially at the time of the Feast of the Ascension they were on sale at Morano, where are located the most celebrated glass-works. These I saw on other occasions, and when, for a certain reason, I visited Andrea Naugerio in his house which he had there, and conversed with him and Francisco Asulnno.

END OF BOOK XII.

Noter

1. Agricola 1556, genoptryk 2003, s. XIII-XV.
2. Agricola 1556, genoptryk 1986, s. 584-592.

Litteratur

Agricola, Georg: *De Re Metallica Libri XII*. Basel 1556. Oversat til moderne tysk og udgivet i 1928. Uændret optryk, Wiesbaden 2003.

Agricola, Gergius: *De Re Metallica*. Basel 1556. Oversat til engelsk og udgivet i 1912. Uændret optryk 1950, denne udgave New York 1986.