Last Charcoal Smelter in Germany

Illustration

Schmalkalden is a small "city" with about 20.000 inhabitants smack in the exact middle of Germany (also known as "the (very pretty) sticks"). It boasts "Wilhelmsburg Castle", the former residence of the Hessian landgraves (sort of dukes), built about 1590 and containing interesting things. Its claim to fame comes from the *Schmalkaldic League*, a historically important military alliance, founded in 1531 by "early" Protestant princes, for protecting religious and political interests within their domains.
The area has a long standing history of mining, metal smelting and metal working, going back to at least 1300. The guns made in nearby Suhl, for example, have been world-famous for quite some time. Close to Schmalkalden is the "**Neue Hütte** " (*New Smelter*), now an open-air museum.

Parts of Schmalkalden today as seen from the castle.

Source: H. Föll

The "Neue Hütte Schmalkalden" (New Smelter of Schmalkalden) was raised in 1835 and produced pig iron until 1924 - *with charcoal!* That makes it the last charcoal-run smelter in Germany, if not in Europe or the world

- You would not necessarily recognize the smelter for what it is. From the outside it is just a solid wooden framework building:

The building housing the smelter.
Large picture

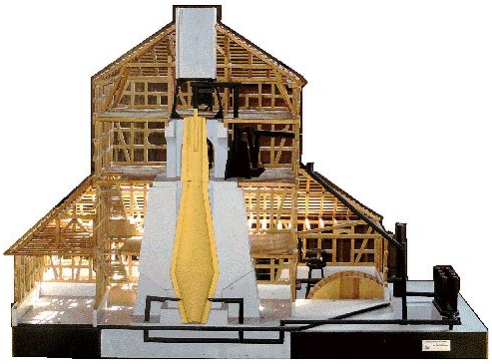
Source: H. Föll

- The inside, however, contains a rather massive smelter made from solid stones. The picture below shows the lowest part, the "hearth" where the liquid metal came out

The bottom of the smelter

Source: H. Föll

- A detailed model in the museum gives a good feeling for the over-all construction, and a brochure informs about he working principle of the smelter:



A model of building and smelter.
Large picture

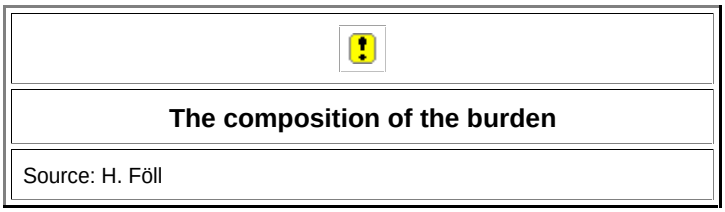
The working of the smelter (from a brochure)
Large picture (with "chemistry")

  - Note that the narrowing of the cross-section above the reaction zone provides for some mechanical support of the fuel / flux / ore filling by friction and some mixing of the contents by "folding".
- The product of the smelter is rather unspectacular. It is **pig iron**, produced in plates:

The product of the smelter

Around 1900 the rest of the world had been using coke for quite some time, but Schmalkalden stuck to charcoal. Charcoal is more reactive than coke and thus offers certain advantages for smelting but supply relies on the wood available, and forests near a major smelter will be depleted soon enough. Transportation of charcoal over long distances is not very economical since it has a low density, and transport costs typically scale with the volume, not the weight.
In antiquity it was thus easier to move the (small) smelters to a new woody area than to transport charcoal for distances larger than about 10 km.

- The Schmalkalden smelter, however, like all smelters just a few hundred years old, was tied to its source of energy: a waterwheel supplying the power for blowing enough air into the tuyeres. In addition, you needed the ore and that was mined in the general region.
  Somehow, albeit with large difficulties, the supply of charcoal was kept up until less than a hundred years ago. I guess it was either charcoal or closing down the whole industry because transportation of coke from (far away) coal mining areas would have been too costly.
- The people running the smelter had clear ideas about the precise composition of the burden, the mix of ore, flux and charcoal, that went into the "Gicht", the feeding opening on top:



The composition of the burden

Source: H. Föll

- We have:

  - 43 kg of ore from three different locations (...berg = ...mountain).
  - 22 kg of **flux** with 7.4 kg "*Braunspat*" (brown spar) and 14.6 kg of "*Eisenkalk*". Both names refer essentially to variants of siderite or iron carbonate ($FeCO_3$), a mineral where substantial amounts of iron atoms can be replaced by others, like manganese, (Mn), calcium (Ca) or magnesium (Mg). "Braunspat" typically means calcium-rich siderite, properly called "ankerite" ($CaFe[CO_3]_2$). "Eisenkalk" is also a synonym for siderite but probably meant some special variety.
  - 35 kg charcoal, a mix of 8.8 kg beech and mixed or common stuff, and 17.4 kg of pine.

  That makes for a total of 110 kg for one "feeding" of burden. Note that the numbers are precise to 1 % and that the composition was defined by *weight* and not by volume as had been the custom for millennia.

Some numbers of interest for the smelter are:

- Water wheel. Diameter 6.30 m; with 1.6 m
- Power of water wheel: 30 kW; akin to 250 hard-working people.
- Air supply: 0.44 m^3/s. Guessing a cross-sections at tuyere level of 3 m^2, that makes for a space velocity of 0.15 m/s or 9 m/min, which is about right for a furnace of this size.
- Charge per day about 140 "feedings" = 15.400 kg
- Iron produced per day: (400 - 500) kg
- Composition of iron: C: 2.18 %; Mn: 4.12 %, Si: 1,45 %; P: 0.13 %; S: 0.05 %

- This is a rather peculiar iron. Very rich in Manganese (Mn) and with a carbon concentration that is relatively low for cast-iron. It might have been well-suited (after some fining in order to reduce the carbon content somewhat) for the production of tools like hammer heads, drill bits, screw driver blades, wrenches etc., a major local industry needing particularly hard steel, or for casting oven parts.