Labs21 Annual Conference 2010

Sustainability of laboratories – A historic approach

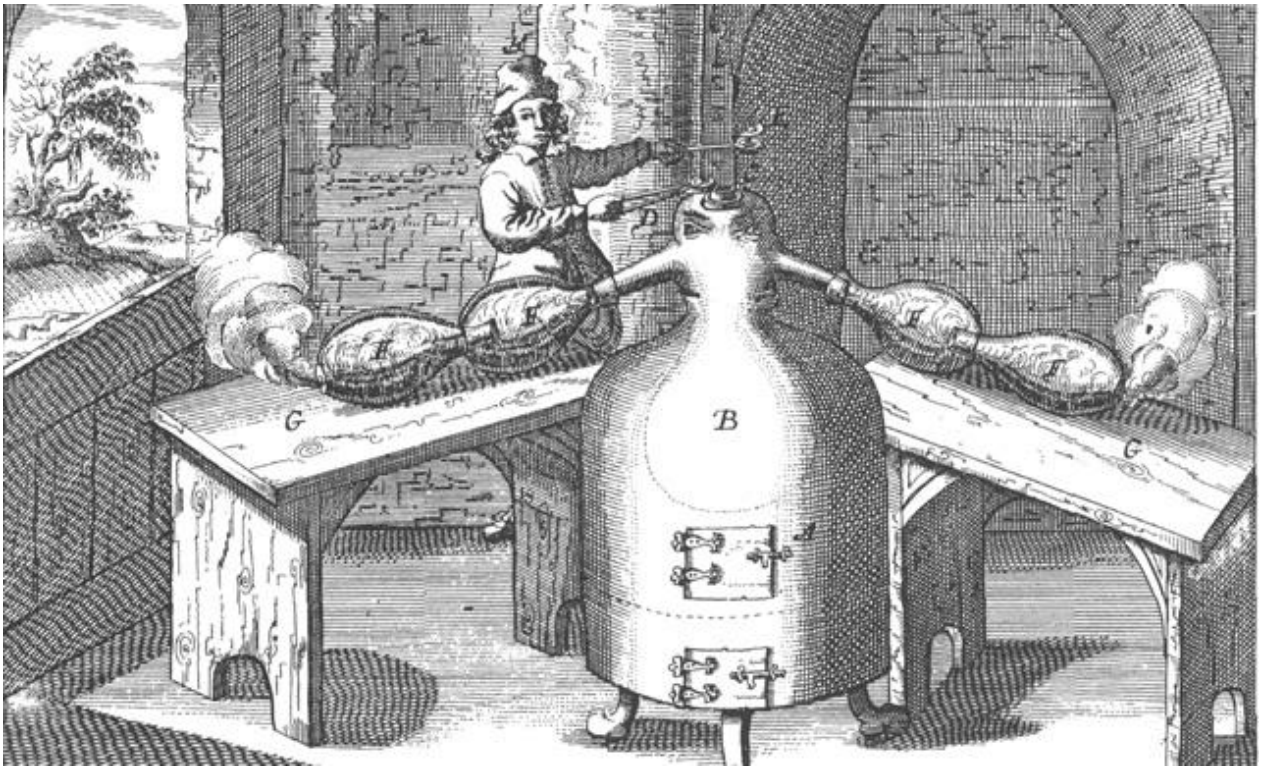
Germans typically approach a new subject in a very fundamental way: the first thing they try to do is giving basic definitions:

- What is sustainability?
- What is a laboratory?

and resulting from that: what is a sustainable laboratory?

I will try to be less German today and to be more pragmatic by having a look on ancient laboratories and their obvious features.

The first picture I present originates from 1684. It shows the German chemist Johann Glauber distilling sulfuric or nitric acid. Glauber is claimed to be the first chemist in Europe able to make his living from chemistry. He synthesized numerous substances which he sold and he is sometimes designated as father of industrial chemistry. At the first moment we would tend to say: this can never have been a sustainable lab! But let's take a closer look.



One thing that we can see is the absence of an energy intensive HVAC system for heating, ventilation and air conditioning of the room. Ventilation is performed by open doors and windows. Very nice in warm middle-European summers, but unconvenient in winter time. Nevertheless it saves a lot of energy for the HVAC system.

The next thing to be seen is that the distilling apparatus is heated by coal, charcoal and wood. These days we claim it sustainable – at least in Germany, Austria and Switzerland – to have a wood pellet heating for our houses. I'm not quite sure whether this modern attitude is really sustainable, because it neglects some lectures from European history: have a look here to the left through the window where you see the poor and sick tree obviously used as energy source for the heating of the distilling apparatus.

If you ever come to Europe and have a rainy day, visit one of our museums of Old Masters. You will see many famous paintings showing scenes with similar isolated and sick trees in the background. This is the result of centuries, where wood was the major energy source for cooking and heating. Anyhow, this laboratory of Glauber seems to have some features which we today deem "sustainable".

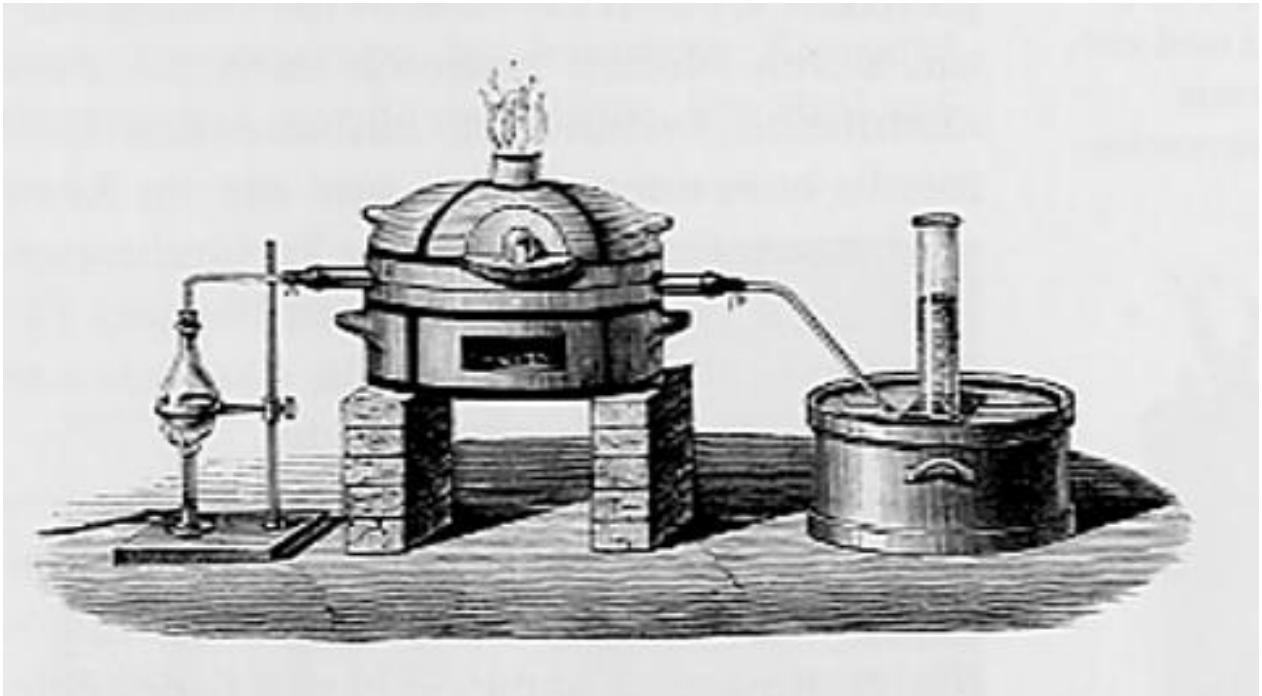
But now the poor part of my message: Glauber lived from 1604 to 1670 and in the last decade of his live he was so sick that he was forced to sell his lab equipment to support his family. The well-founded assumption is that he suffered from intoxication, because he worked a lot with nitric acid and gases, arsenic, antimony and mercury. You can imagine that this laboratory is not really suited to handle hazardous substances and this brings us to a key feature of a sustainable laboratory: occupational health and safety aspects.

The next picture from about 1750 presents the proceedings that industrial chemistry has made since Glauber who was about 90 years ago.

We can call it an early high temperature laboratory and the heating systems did well advance. The man in the door brings new wood and charcoal to the furnaces equipped with air bellows to reach higher temperatures in the ovens. Ventilation of the room is still done by open doors and windows, but the room is much higher and has openings here allowing fumes and gases to evade. The picture shows a lot of amusing details such as smoking was permitted in the labs of this time.

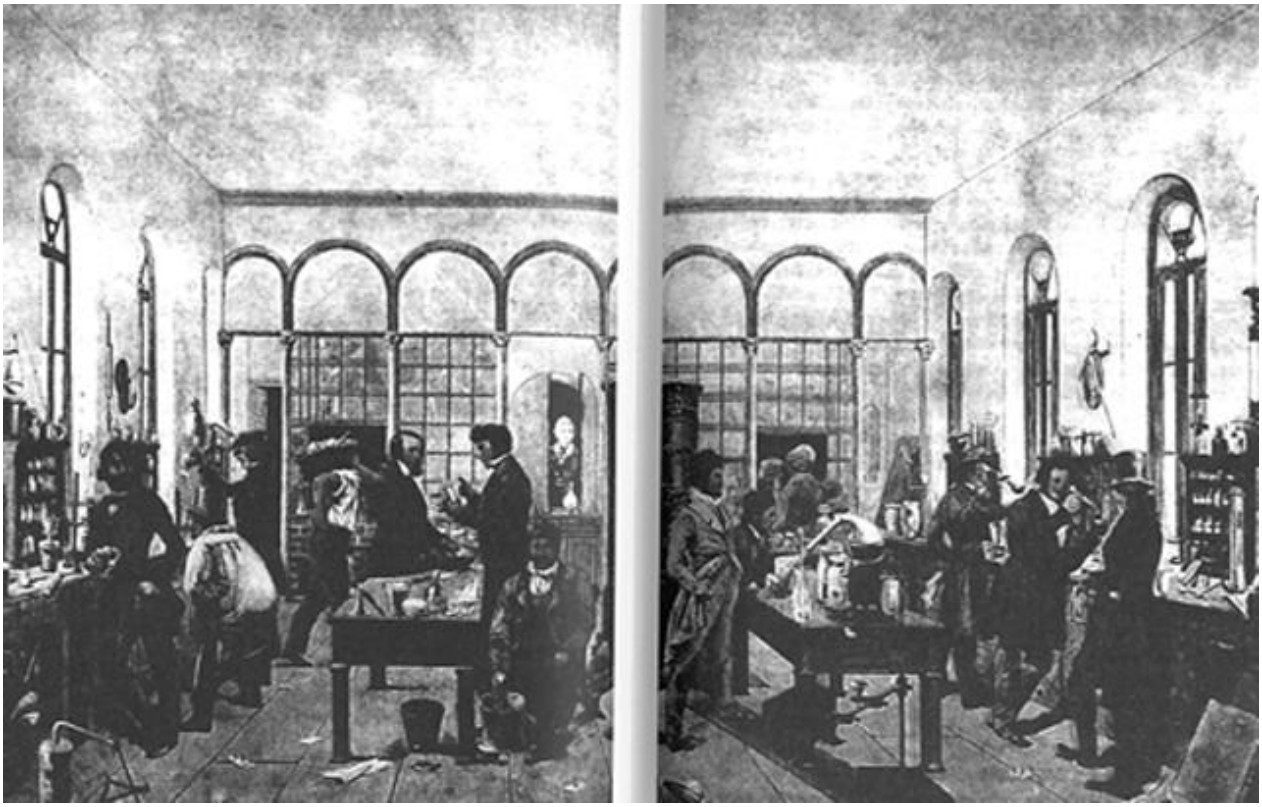
The next picture shows a much more scientific scene.

It is the famous French chemist and physicist Antoine Laurent de Lavoisier producing – here – hydrogen gas and to collect the gas – here – in a pneumatic tank filled with water. Madame de Lavoisier is sitting – here – and documenting the experiment. This is a not unrisky way to handle hydrogen and please watch the open and unprotected storage of all kind of chemical substances in this shelf. The next picture shows in more detail an apparatus used to produce hydrogen by routing steam – produced here – over red-hot iron – in this furnace – and here you have the pneumatic tank to collect the hydrogen.



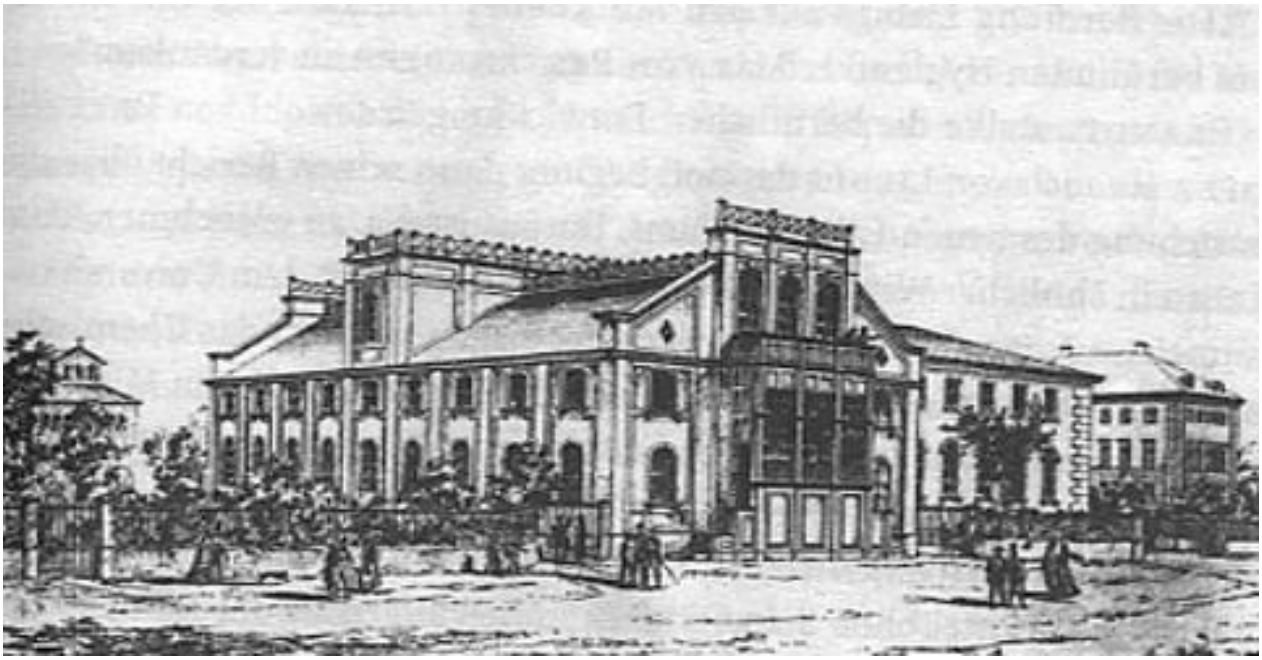
Lavoisier was about 1790 and lets go ahead another 50 to 60 years.

This is the laboratory of the famous chemist Justus von Liebig 1842 in Giessen/Germany. Watch the funny dress of the persons and all the garbage on the floor and under the benches (next picture). What a difference to the clean lab of Lavoisier.



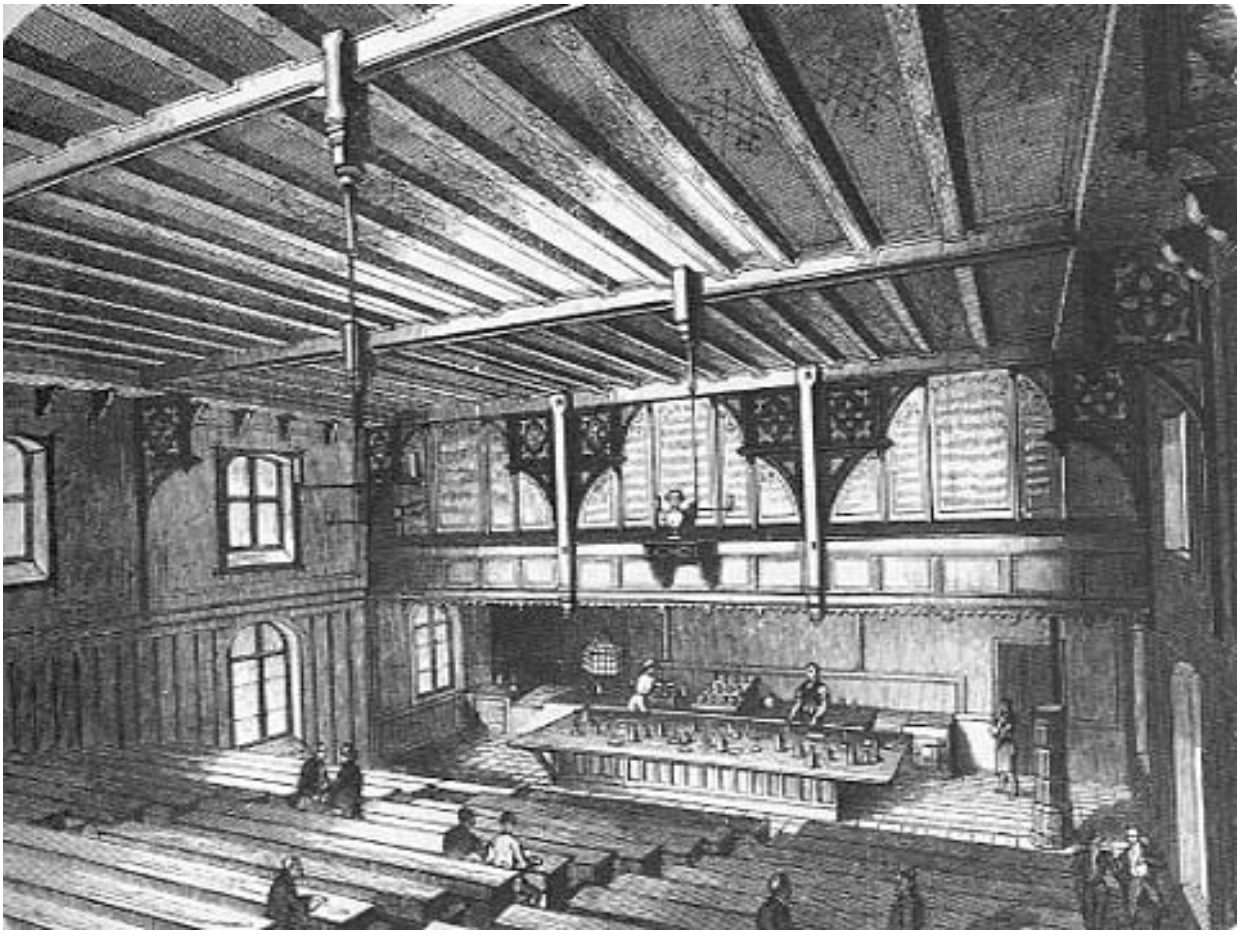
But Lavoisier was a pure scientist and aristocrat whereas von Liebig produced chemicals in a semi-industrial scale.

About 1850, von Liebig got a call from the king of Bavaria to teach chemistry at the University of Munich. This picture shows the laboratory and chemistry building of the Munich university and of the Bavarian academy of sciences like it was in 1859. It has been built 1815 – 1825.



The ground plot was square and it has two floors. The lecture auditorium for 220 people was located in the middle of the building and ranged over both floors. The laboratories were located around the lecture auditorium at the outer walls.

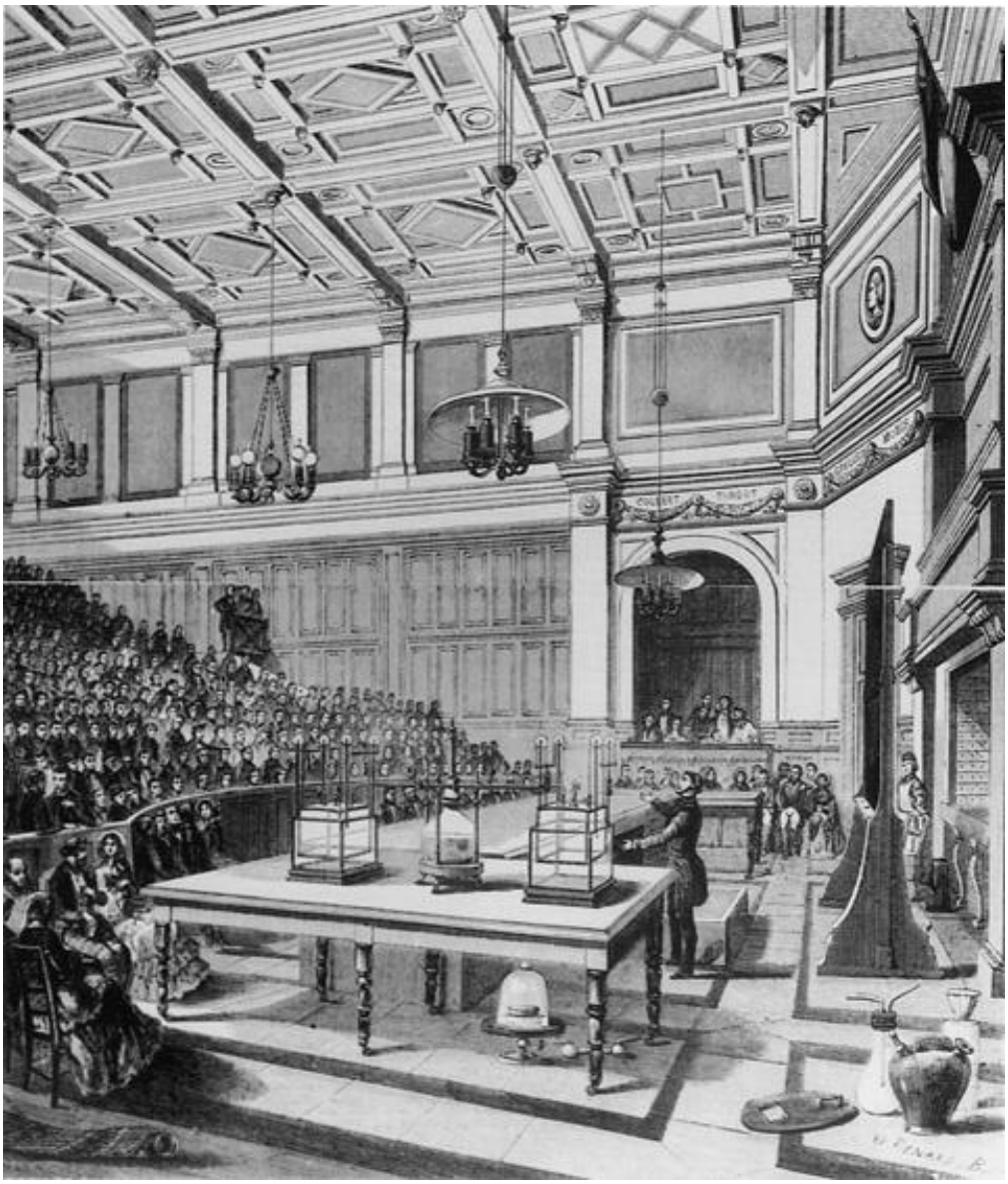
The next picture gives the interior view of the lecture auditorium which had as fume cupboard an octagonal glass bell which could be drawn from the ceiling of the room over the work bench. Liebig gave here also public evening lessons which were attended among others by the bavarian royal family.



Liebig describes in one of his letters how queen Therese and prince Luitpold have got hurt during the demonstration of a too vehement oxyhydrogen reaction. The prince had a bloody face from a glass splinter. The royal family took it with grandeur, because it was the golden age of chemistry and aristocrats like craftsmen were excited about all the discoveries of the new natural sciences. Today, many people see only threats and dangers arizing by science and technology.

North front of the chemistry building:

The picture below shows a public lecture in Paris at the “Conservatoire des Arts et Metiers”. It is likely that the synthesis of water from oxygen and hydrogen gas is also demonstrated here, because the volume ratio in these two gas reservoirs is 2 : 1 which is typical for the oxyhydrogen reaction. The ladies were allowed to sit in the first row where it was most dangerous.

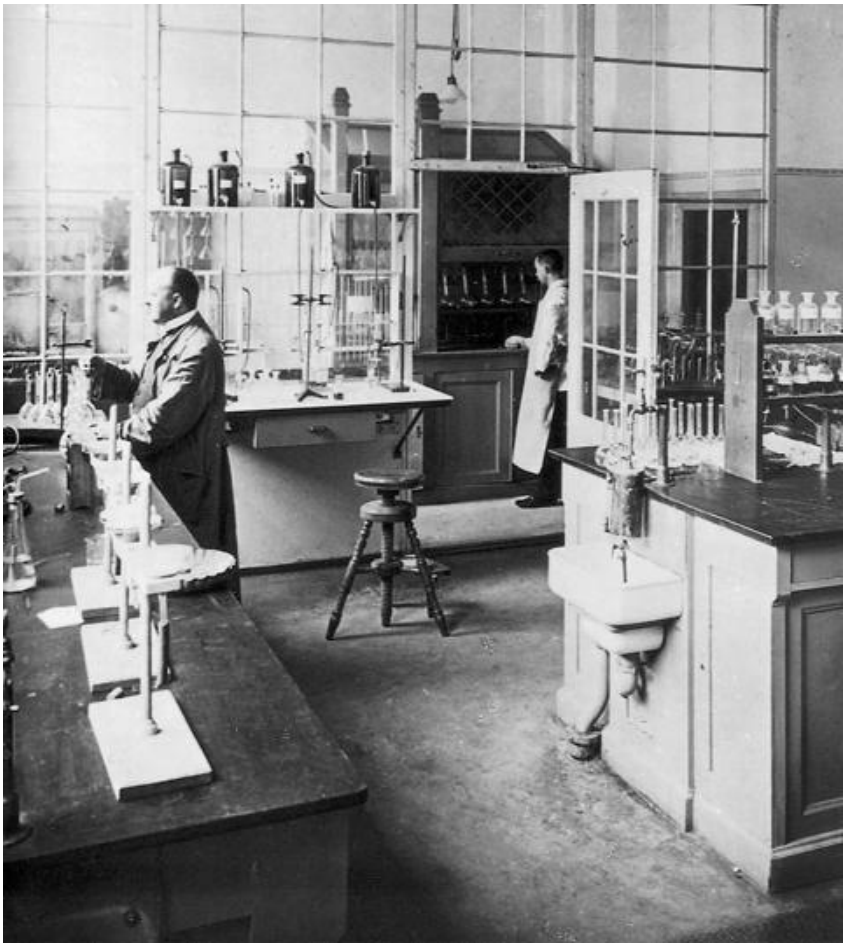


The oldest picture from a very early fume cupboard that I managed to find shows the famous Swedish chemist Alfred Nobel in one of his laboratories. You can see the chimney for the air flow here in the side wall of the fume cupboard.

You remember all the chemicals in the open shelves of the laboratory of Antoine de Lavoisier ? Lateron in the 19th century, it became popular to store the chemicals in separated rooms like in the chemistry building of the University Munich; thus, they could not contribute to the fire load in case of a fire.

For practical reasons and ease of work, people returned in the beginning of the 20th century to the open storage in the lab like shown here in a fragrance laboratory of a detergent plant about 1920.

The Kjeldahl process for the determination of nitrogen and protein always was a dirty and very corrosive affair. In this brewery lab from about 1925 the acidic digestion was banned in a wooden fume cupboard located in a side room and separated from the main lab by a glass wall.



A quite modern fume cupboard whith glass front sash and glass side walls and a cupboard below the work surface is found in this drug laboratory of a hospital about 1925. You can see that laboratory coats became more and more popular in the first decades of the last century.

And like lab coats, fume cupbards did spread over the laboratories:

You can see 5 fume cupboards in a row in the laboratory of the Nobel-laureate Hans Fischer in 1935.

When we finally see the service supply of a todays lab under the ceiling, we can realize the systematic development that laboratories have experienced during the last four centuries.

By the way: As German I owe you the definition for the sustainable lab. Here it is and I leave it to you to decide whether this definition contributes more to the comprehension of sustainability in a lab than the pictures previously shown.

- **sustainable laboratory**
- establishment including technical-scientific equipment, typically inside a building, intended to achieve cognition in natural sciences or to educate in natural sciences and related areas, without compromising the needs of future generations