

Surfaces of Stainless Steel Tubes



We make the
differences visible!

Foreword

Dear Customer,

TPS-Technitube Roehrenwerke GmbH is known worldwide as a leading manufacturer of pipes and tubes and their accessories. Our long term customers know that they can trust and rely on our products and services. An answer to the question, what makes us stand apart from our competitors, we reply: „**The Quality!**“

Now Marketing-Experts will throw their hands up and declare that just about everybody claims that the quality of their products is first class. And this is exactly where the problem starts, **Quality is not just Quality.**

Even specifications are sometimes interpreted very differently. In order to show you the serious differences, we examined the surface quality of stainless steel tubes with a Raster Electron Microscope*. The result is that you will redefine the term **Quality** for yourselves.



Dietmar Weides
Managing Director



* all REM-pictures in 500-fold magnification

The hazards of deposits

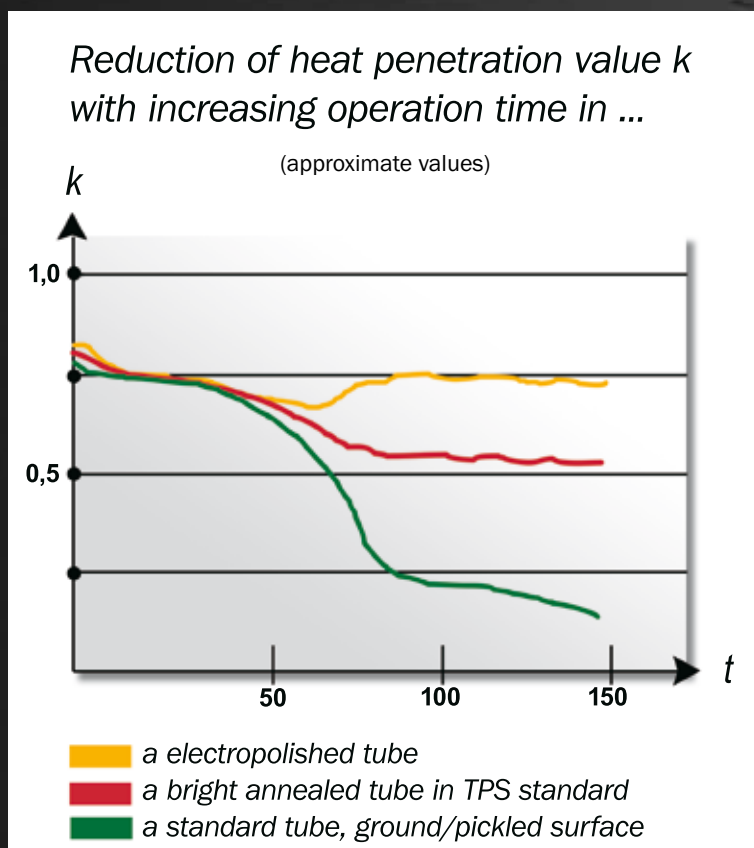
A smooth reflecting stainless steel surface is wanted, when easy cleaning, together with first class corrosion resistance characteristics, are required.

The formation of deposits, which adhere firmly to the tube surface, is hindered by smooth closed surfaces. Fissured surfaces promote the formation and build up of hard deposits, since the particles can attach themselves more easily here. When a deposit coating has been developed, then highly concentrated and aggressive centres of corrosion can be formed. The result is then that the passivated layer is quickly destroyed and the material is damaged by local attack.

This development is even more dramatic with unfavourable flow conditions in the tube. The formation of deposits in the tube is accelerated by the ever present turbulence, of the medium flowing in the tube. Add to this a poor lushing effect with a fissured surface, then deposits are built up very quickly. Internal deposits automatically reduce the size of tube bore and can completely block the tube.

Especially with Tube Bundle Heat Exchangers, which transfer heat to the medium, flowing either inside or outside the tubes, the prevention or delay in the formation of deposits plays an important role for the heat conductivity. Even thin deposits make it necessary to increase the heat energy input.

In practice, it has been shown that, depending on the flow medium, the Heat Transfer Value (K) is reduced within a few hours by up to 10% from its original value (see chart). As the service time progresses, isolating layers are formed, which can cause the heat transfer to completely stop. By manufacturing smooth tube surfaces, it is exactly this phenomena, that can be prevented or inhibited.



Annealed, chemically descaled - pickled surface

In the manufacture of stainless steel tubing, the type of final heat treatment has an important influence on the quality of the tube surface. The standard specifications for stainless steel tubes require the tubes to be delivered with a scale free surface.

On the world market, the most common form of cold finished stainless steel tubes are those with a pickled surface. The reason for this is the use of the simplest form of heat treatment. The heat treatment is performed in a so called open furnace, where atmospheric oxygen causes scaling of the heat treated material.

The descaling of the tube surface is normally done by pickling in a nitric acid hydrofluoric acid solution, after which they are passivated in an alkaline solution. The pickling process removes the hard scale from the tube surface. At the same time the tube surface is automatically chemically attacked (see A2). The tube surface, depending on the concentration of the pickling solution

and its temperature, as well as the pickling time, becomes dull and matt (see A1). The use of nitric acid and hydrofluoric acid is ecologically extremely questionable.

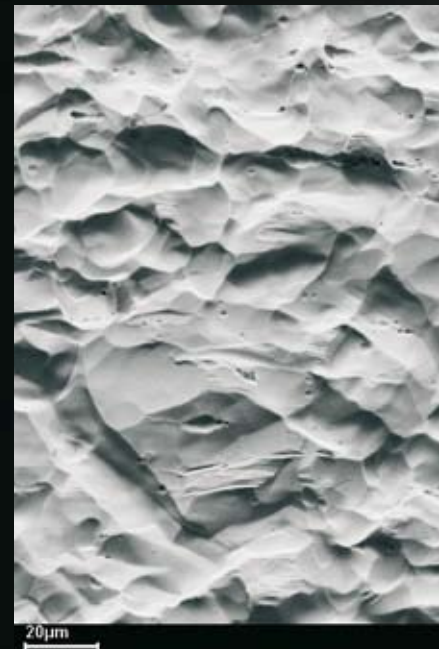
Bright annealing equipment with the required capacity is only available to a few manufacturers. Therefore some manufacturers use the term solution annealed, "free of scale" instead of "bright annealed". A scale free surface is hereby offered, which does not have to comply with a bright annealed reflecting surface (see photos C1 & 2).

Instead, a large number of manufacturers descale the tube surface by pickling after the heat treatment (see photo A1). This surface promotes the formation of hard deposits on the tube surface.



A1

outside surface pickled
roughness Ra approx. 2,5 µm



A2

inside surface pickled
roughness Ra approx. 2,5 µm

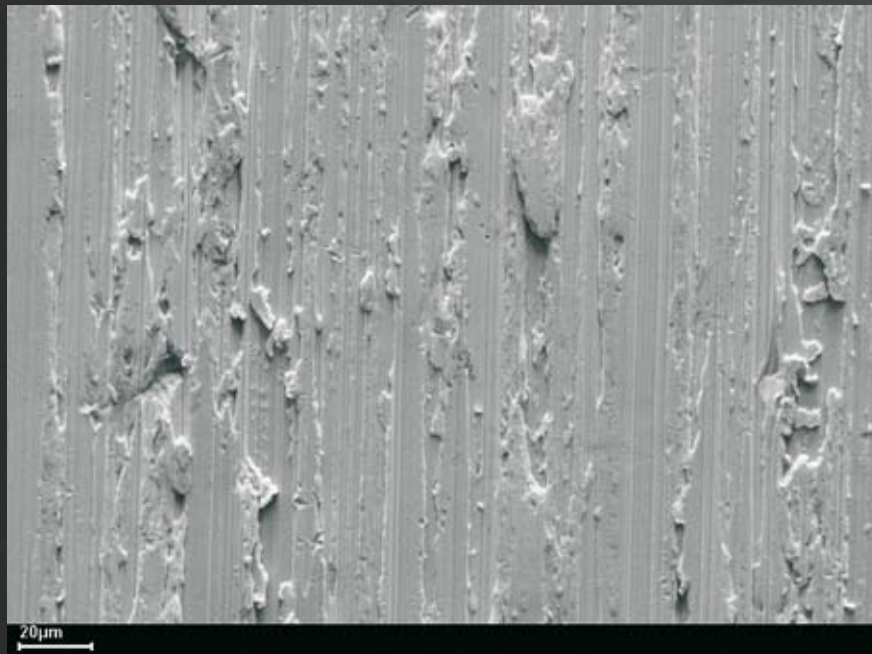
Outside surface ground - inside pickled

Instrumentation and heat exchanger tubes are usually ground after they were pickled, so that they show an optically metallic untarnished surface. The internal surface of these tubes, however, is still in a pickled condition (see A2).

The grinding process causes serious damage to the external tube surface. Photo B2 shows a highly magnified ground surface. One can see a ripped, sharp edged and fissured surface, which shows where particles of the material have been ripped out, deposited and ground into the fissures. This surface promotes, as written at the beginning, the formation and build up of deposits together with their negative characteristics.



B1
outside surface ground
roughness Ra approx. 2,0 μm



B2
outside surface ground by 320 grit
roughness Ra approx. 2,0 μm

TPS-Standard: Super Bright Surface Level 2 TPS SBS Level 2

The aim in Europe must be to produce a high quality stainless steel surface without having to use ecologically harmful acids and alkalis.

TPS have developed a special bright annealing process, which does not require the use of any acids or alkalis afterwards. The heat treatment is performed in a so called closed furnace. The heat treated material is protected by an inert gas atmosphere.

This atmosphere guarantees that oxygen cannot enter the furnace or come into contact with the material and react to form scale on or tarnish the material.

The surface finish of the bright annealed material is of the same quality as that of cold finished surfaces before the heat treatment (see C1 & C2).

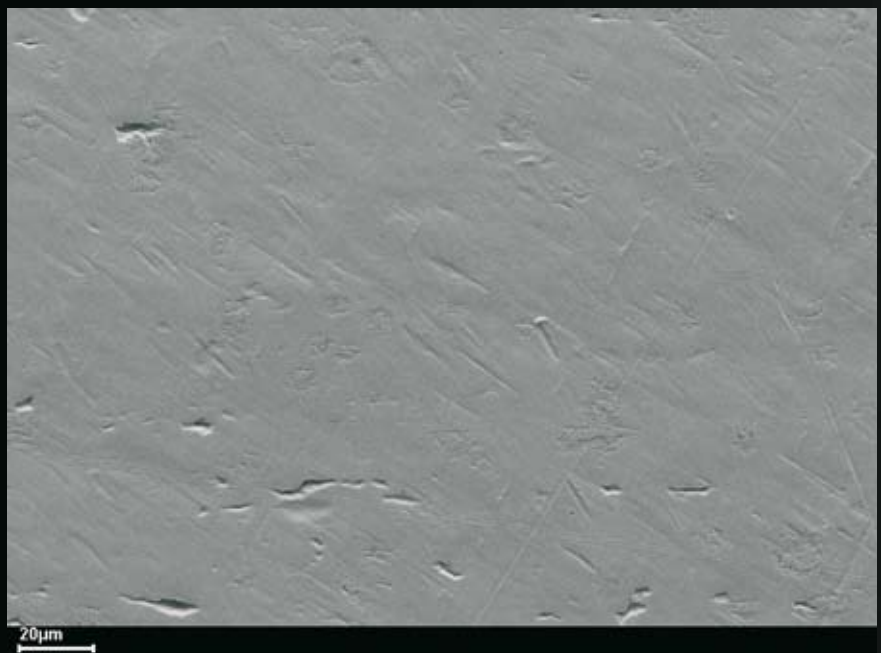
C1

TPS SBS Level 2
inside roll polished
roughness outside and
inside Ra max. 0,8 μm



C2

TPS SBS Level 2
roughness Ra max. 0,8 μm



TPS-Execution: Super Bright Surface Level 1 TPS SBS Level 1 - suitable for electro-polishing

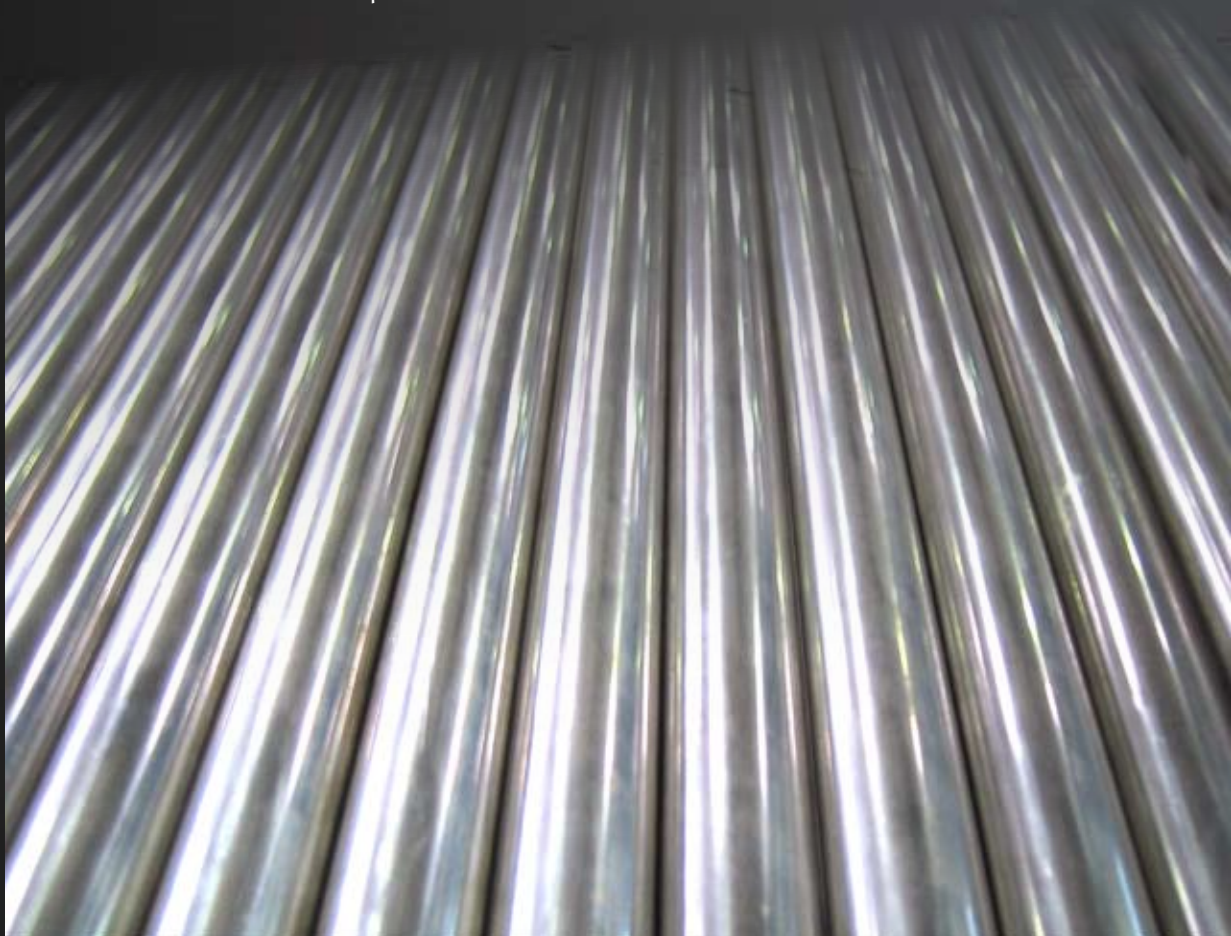


The tendency for deposits to be formed on undamaged bright annealed tube surfaces, is considerably lower than for pickled or ground surfaces. The reason for this is the topography of the surface. The irregular hills and valleys in the surface structure of pickled or ground surfaces favour the adhesion of particles.

Tubes used in the clean room processes, semiconductor, chip manufacture, bio-technology or other special chemical processes, should have a roughness below Ra 0.4 μm . By electro-polishing the roughness of the surface can be reduced by 50% to a value of max. Ra 0.2 μm .

The inside surface of the tubes manufactured by other suppliers, annealed in an open furnace with water quenching and pickling, must accurately be honed before they can be electro-polished. This is a separate and expensive additional production process.

Tubes manufactured by our cold pilgering and bright annealing process in **TPS SBS Level 1** achieve a maximum roughness of Ra 0.4 μm , which is an excellent starting point for electro-polishing.



Intergranular Corrosion on stainless steel tubing in „cheap import quality“

Quality control is extremely important!

Ever since the world markets have been opened, the amount of cheap imports of “Seamless Stainless Steel Tubes” has increased.

This was accompanied by an increase in the number of cases of intergranular corrosion (see photo E1 - E3) that were observed on a large percentage of these tubes. This applies particularly to small diameter tubes. Unfortunately not every customer has the technical possibility to detect this type of corrosion on tubes, which should no longer occur, according to our actual quality standard.

A simple visual inspection of the external tube surface is normally not enough to detect intergranular corrosion, since this is nearly always

present on the internal surface. This type of corrosion is only recognisable, when the tube is cut longitudinally in half.

With this in mind, there is in fact a large number of “Time Bombs” ticking (also on the shelves). This is because it can take months, depending on the future use of the tubes, until the intergranular corrosion in them has progressed to a stage at which the damage caused can be seen and technical problems occur.

The short term gain, by buying cheap imports can be quickly eaten up by maintenance and reduced lifetime.



E1

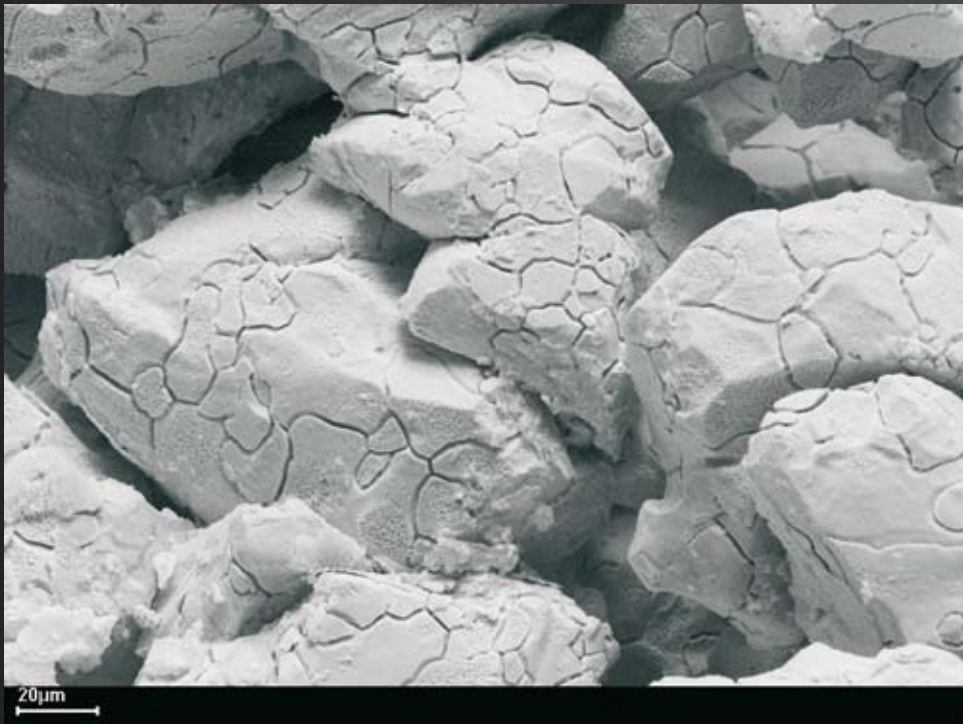
heavy intergranular
corrosion attack

**„The bitterness of poor quality
lasts longer than the sweetness
of low prices.“**



E2

Intergranular Corrosion
on the internal surface



E3

Larger view:
Visible dissolution
of the grain boundary

Annealed and pickled:
**Hard to be distinguished from the
outside at first view**



The difference is inside:

inside: pickled

inside: intergranular
corrosion attack

inside: heavy intergranular
corrosion attack

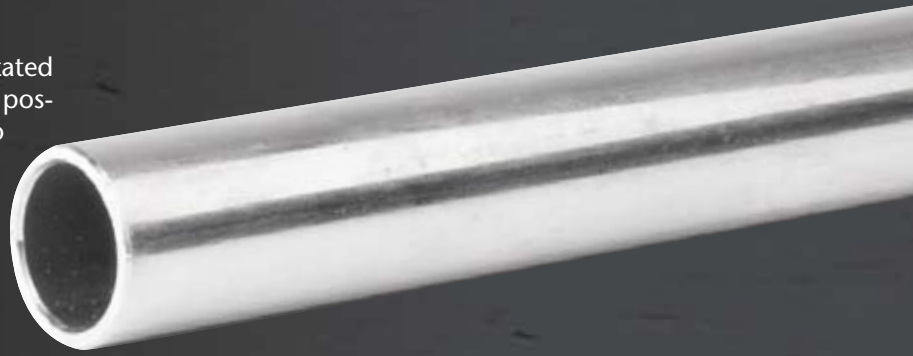


TPS-Quality - the bright difference

Contrary to this stands our future orientated Quality Policy, together with the maximum possible customer satisfaction. We are able to achieve this with the best possible prices, first class quality, top services, a high grade of flexibility and continuous reliability.

TPS tubes are used all over the world in a large number of industrial applications, such as refineries, petrochemical and chemical plants, for the transportation of high purity gas in the semi-conductor industry as well as for oxygen supply pipes in hospitals.

The quality of our products is our top priority.

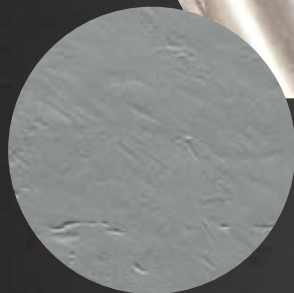


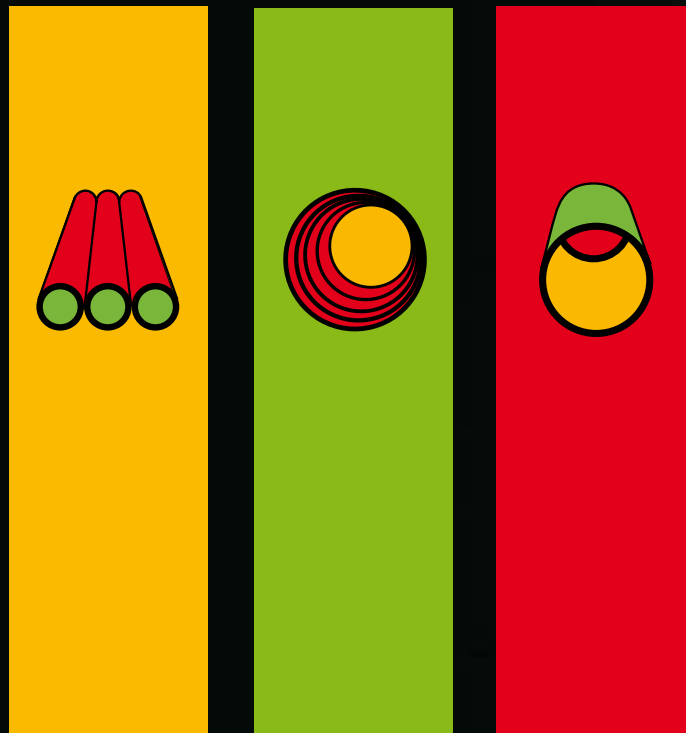
TPS

„The Perfect Surface“

**Distinctive
TPS surface**

**TPS SBS Level 2
inside roll polished**





TPS **TECHNITUBE**
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