

Sulphuric acid aerosols in anodising plants : how to respect the MAC value ?

A few years ago, the WHO (World Health Organisation) released information stating that sulphuric acid aerosols were carcinogenic. Experts were surprised and not quite convinced that this was correct. When it also turned out that the prescribed limit value is exceeded significantly in all anodising plants, an extended and animated discussion began on whether or not sulphuric acid aerosols really are carcinogenic.

Some experts actually doubted this was true. In many anodising plants the staff were asked if anyone from the anodising section had fallen ill with cancer. There was no known case! Therefore, it was assumed that the WHO information had to be wrong after all. But was the poll representative?

In a recent publication from Mr. Dr. Brodalla (Galvanotechnik 6/2006) we found strong arguments against the suspectability in anodising plants : e.g. : they work in solutions of sulphuric acid and not in the concentrated product and the analysis method by measuring is not correct.

But the issue was also taken up by the EU. The general opinion here was also that a high concentration of sulphuric acid aerosols would cause cancer. The limit value at the workplace was fixed at 0.1 mg/cubic metre, requiring individual member states to incorporate this directive into their national law.

This has put an end to the discussion on the carcinogenic effect of sulphuric acid aerosols. By now, most EU states have incorporated the directive into national law and set the limit value at the workplace at 0.1 mg/cubic metre. Today, the limit value at the workplace has to be complied with irrespective of whether the experts are right. As the saying goes, laws are there not to be understood but to be complied with. But how should this be achieved?

This question triggered a new discussion. There was, after all, no procedure for ensuring straightforward compliance with the required value. What options were available?

Before I answer this question, let me give you a few technical details on sulphuric acid aerosols. I do not want to confuse you by offering a variety of theoretical explanations and lots of formulas but will simply give you a basic overview of the situation. The theorists among you will forgive me if my summary is too rudimentary.

During anodisation, water breaks down into hydrogen and oxygen when voltage is applied. The oxygen is needed at the anode to oxidise the aluminium. The hydrogen is formed at the

cathode and can really be described as a by-product. But without hydrogen, we have none of the oxygen which is indispensable in anodisation.

Hydrogen is a gas, the lightest of all gases. Together with the sulphuric acid it forms a colloidal system, which is also very light. It leaves the electrolyte at a high speed, being more or less shot out. When exposed to the air, the colloidal system disintegrates and the sulphuric acid is released in the form of tiny droplets.

Measurements in various plants have resulted in widely varying values, i.e. between 0.42 and over 20 mg/cubic metre. You will be wondering how such different values can be explained. The answer is simple. If anodising is carried out in the same size bath with 1000 A or with 5000 A or even 15000 A, the higher current ratings result in 5 or 15 times the amount of hydrogen and therefore 5 or 15 times the amount of aerosols.

As I said earlier, so far there has been no possibility of complying with the required values apart from implementing a suction device at a high cost. Suction channels are installed on the edge of the bath. A fan is used to suck off the air together with the aerosols and blow it outside via a pipe system.

That sounds simple, but it is the details that cause the problems. Most anodising baths are very wide, therefore requiring a highly efficient suction device. It must be possible to suck very large quantities of air at a time to ensure that the entire surface of the bath is sucked off properly.

If the quantity of air that is sucked in is not high enough, the aerosols in the middle of the bath may escape without being captured by the air stream. While values do improve significantly when this method is used, the desired value is still not achieved! The quantity of air must therefore be increased until the flow rate is high enough to capture the aerosols in the middle of the bath. This is realistic in the case of very narrow tanks.

Anyone who has ever received a quotation from a serious provider will have been shocked by the high prices. Other firms will offer a fairly low price but fail to achieve the promised values.

Another point needs to be checked in advance: Is there enough room between tanks for installing the suction channels?

But this is not the only unsolved problem. What if the aerosols are released into the open air? After all, we are talking about sulphuric acid aerosols here. There may be a car park in the vicinity, or the environmental authority may demand that a separator is installed from the start.

As I said, the quantity of sucked air is high – you will not find yourself complaining about the quality of the air in the factory hall. Depending on the number of anodising baths, the voltage applied and the size of the factory hall, the hall may well be emptied of air 1 to 3 times every hour. The extracted air must be replaced. The vacuum causes outside air to enter the hall.

In warm climates this is not a problem.

However, if the outside temperature sinks, so does the temperature in the factory hall. You can easily imagine the amount of heating energy required if the outside temperature goes down to, say, freezing-point.

Often, covers are suggested as a solution for improving suction or reducing the quantity of air sucked off. When considering the installation of covers, you also need to bear in mind the major disadvantage they have: A great amount of the sulphuric acid aerosols which are not sucked off condense in the form of sulphuric acid underneath the cover - and not only there but also on the goods carriers. Later, drops of sulphuric acid will drip from the goods carriers onto the finished goods.

There is another solution that has already been employed in numerous cases, i.e. the use of foaming agents. These foaming agents produce a foam blanket on the surface of the bath which inhibits the aerosols. They then remain in the foam blanket for a certain period of time. During that time, the colloidal system disintegrates so that the greatest part of the sulphuric acid is retained and "only" the hydrogen escapes from the foam. This method helps to significantly reduce the number of sulphuric acid aerosols.

However, the foam blanket keeps tearing due to air movement. The resulting holes in the foam blanket allow sulphuric acid aerosols to escape. If the utilisation of the baths is very high, this method is no longer enough to comply with the required value.

Another problem is the exact dosage of the foaming agent. If an inadequate amount of foaming agent is used, there won't be enough foam, which in turn means the effect is insufficient. Overdosage of foaming agents creates undesired mountains of foam. A further problem is the formation of oxyhydrogen. Oxyhydrogen, or detonating gas, is a mixture of oxygen (or air) and hydrogen – a spark may be enough to cause an explosive detonation.

At Alufinish, solutions for this problem have been discussed for years. Again and again, the idea came up of separating the cathode compartment from the rest of the bath. The idea was that separation would make it possible to reduce the extracted quantity to a minimum.

The first trials were carried out in the Alufinish laboratory. The cathodes were covered with the type of anode bags known from electroplating technology. Since we are dealing with cathodes in this case rather than anodes, we will use the term "cathode covers" in the following.

The success was apparent immediately. The hydrogen produced was limited to the inside of the anode bags! The anode compartment was no longer milky, as is usually the case, but clear so that the bottom of the bath was visible!

The emission of obnoxious odours was also significantly reduced by this measure. Because of the small size of the laboratory bath and the low amperage, it was by no means certain yet if values of below 0.1 mg/cubic metre would be achieved in practice.

But even at that stage it was possible to say that significant improvements could be expected in the field. If that value was not achieved, there was still the option of adding a small suction device in the area of the cathodes.

The practical tests showed that the cathode covers alone were not sufficient to ensure compliance with the workplace limit value.

When we considered installing a small suction device, we were confronted with the problem that the medium to be sucked off mainly consisted of hydrogen and air, i.e. in the worst case scenario it could form an explosive mixture in the form of oxyhydrogen.

Therefore, it only made sense to make the suction device explosion-proof. Furthermore, the exhaust air could cause the same problems as in the aforementioned case. If, on top of everything else, the environmental authority demanded that a separator be installed, the overall investment would turn out to be quite high after all.

We therefore decided that removal by suction was not quite the ideal solution.

At the same time as Alufinish was carrying out its own tests, the company Over Eloxa GmbH commissioned a thesis to be written on the subject of "Aerosol Minimisation". The company Over did not want to accept the huge cost of implementing a suction device.

In summer 2004, the German national environment agency and the trade association informed the company Over of the required reduction of the workplace limit value and granted Over a transitional period of one year to meet the new values.

The thesis initially dealt with foaming agents. However, it did not produce any satisfying results. The disadvantages of the method have already been described in greater detail.

After some reflection, the conclusion was reached that the problem needed to be solved where it was generated, i.e. at the cathode. The cathode compartment was separated from the anode compartment by cathode covers, confining the disturbing components to a small area.

Now the only problem left was that of separating hydrogen and sulphuric acid in the cathode compartment. We had to try to achieve the separation of hydrogen and sulphuric acid by using strictly physical means.

Thanks to their joint know-how, the companies Over and Alufinish managed to improve the field plant after rebuilding it several times, thus ensuring that even under severe conditions the required values would be achieved.

These values have been confirmed by repeated tests carried out by the respective trade associations.

The company Over has applied for a patent for the procedure and owns the exclusive rights to it. Anodising plant operators may, if they are interested, use the procedure against a small one-off charge.

According to Over, the one-off amount charged depends on the voltage applied and equates to €220.00 per 1000 A.

Payment of this one-off charge settles all costs incurred by the user from using the patent application or the patent, if applicable.

In addition, there are also the costs required for the technical equipment. These costs depend on the size of the baths, the type of cathodes etc. The company Over requires a questionnaire to be completed before drawing up its proposal.

If an order is placed, comprehensive installation instructions will be supplied so that the device can be installed by internal staff.

As an example for fitting out a 5000 A anodising bath with a length of 7.50 m and a depth of 2.00 m, Over gave us a guide price of

€ 2000.00–3000.00.

If you are interested in this procedure, please contact

Mr xxxxxxx, xxxxxxx company, phone xxxxxxx.

He will be happy to give you the planning questionnaire and help you to fill it out, if necessary.

Finally, I would like to point out that this is a simple physical process. Not only does it offer the benefit of meeting the values prescribed by law but your staff can literally breathe freely again and you will have no extra energy costs. Other benefits: on your next walk through the factory, take a look at your craneway and other steel parts within the area of the anodising baths. The corrosion you will see has been caused by the sulphuric acid aerosols.

Those who find the price high at first should obtain an offer for extraction in order to compare prices. The follow-up costs should also be included in the calculation.

Finally, I would like to add that the company Over is responsible for the information supplied here. Alufinish merely wishes to introduce its customers to a good and cost-effective method of meeting the required workplace values in a safe and cost-effective manner.

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