

**Corrosion Protection in Waste Water Systems - A new SGK-Recommendation  
Korrosionsschutz in Abwasseranlagen - Die neue Richtlinie C6 der SGK**

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### **Zusammenfassung**

Die von der Schweizerischen Gesellschaft für Korrosionsschutz erstmals 1980 herausgegebene Richtlinie C6 zum Korrosionsschutz in Abwasseranlagen wurde überarbeitet und 2010 neu aufgelegt. Die Erfahrungen mit der alten Richtlinie und die wichtigsten Neuerungen werden vorgestellt und kommentiert.

### **Summary**

The recommendation C6 concerning corrosion protection in waste water systems, firstly published by the Swiss Society for Corrosion Protection in 1980, has been revised and newly issued in 2010. The experiences with the old guideline and the most important innovations are presented and commentated.

### **Résumé**

Les recommandations C6 concernant la protection contre la corrosion des installations d'eau usée ont été publiées pour la première fois en 1980 par la Société suisse de Protection contre la Corrosion. En 2010 il en apparaît une réédition révisée et complétée. Le présent article rend compte des expériences faites avec la précédente version et décrit les nouveautés importantes de la récente édition.

## Introduction

Switzerland can look back on a pioneer role in waste water treatment. Annually two billion cubic meter waste water is cleaned in approximately 900 plants. This is about twice the volume of Lake Annecy. Already in 1980 75% of the population were connected to a central waste water plant. In the year 2005 the connection degree reached 97% [1].

About 50% of the waste water treatment plants were built in the period between 1970 and 1985 (fig. 1). Unfortunately in this boom phase only little attention has been paid to corrosion protection so that in many plants corrosion damages occurred already after three to eight years of operation what caused high economical costs.

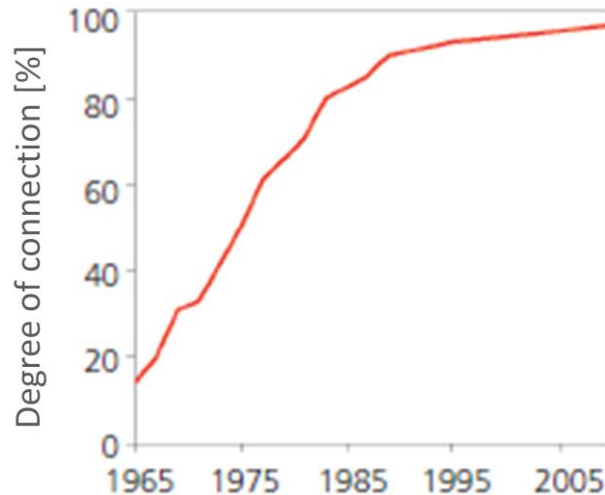


Fig.1: Degree of connection of households to central waste water treatment plant

Although the arisen damages could be attributed to relatively few causes, practically no consequences have been drawn for the repair of corrosion-damaged installations and the building of new plants. Therefore the Swiss Society for Corrosion Protection SGK decided in 1988 with support of the Federal Office for Environment, Forest and Landscape to elaborate a guideline for the corrosion protection in sewage systems. The principal purpose of the guideline was to give the theoretical knowledge to designers and operators of sewage systems, which allows them to recognize possible corrosion dangers in such plants, and to describe the most important preventive measures.

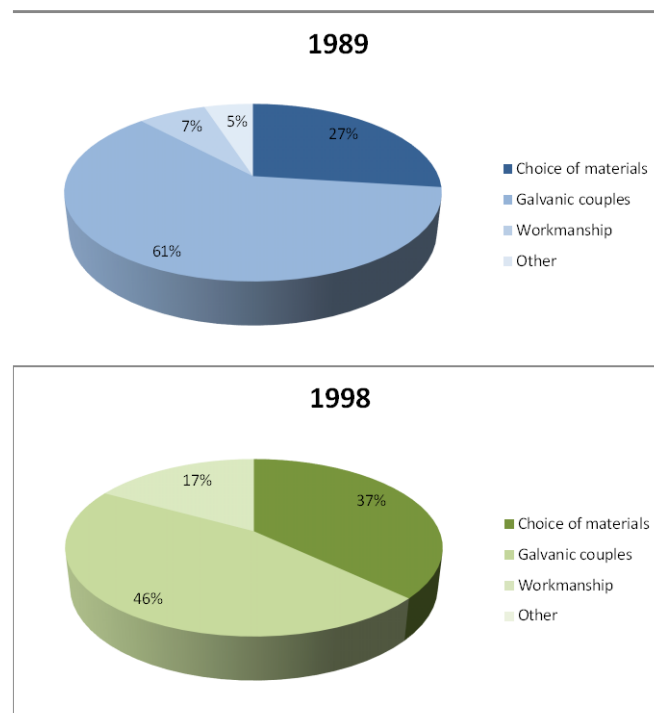
### Experiences with „the old “guideline C6

The guideline C6, firstly published in 1990 and slightly revised in 1995 [2] was a big success. More than 2000 copies have been sold in Switzerland and in neighbouring countries. It was particularly estimated because of its practice proximity and the many examples for concrete solutions.

For the implementation of effective preventive measures a harmonisation of corrosion protection and grounding/electrical concept is of crucial importance. In this context the parallel development of the “directive ARA” by the Federal Inspectorate for Heavy Current installations [3], with many practical references to the electrotechnical aspects connected with corrosion protection, was very substantial for the acceptance and the feasibility of many protective measures. In particular, detailed, at this time partly „revolutionary”, solutions were presented to bring in agreement the requirements for the protection of individuals and the corrosion protection.

From today's viewpoint it can be said that due to the guideline C6 and the directive ARA relevant improvements in corrosion protection were reached for new or modified plants, what affected the number of damages and the maintenance costs very positively.

In several cases it led also to changes in the construction of plants and components. For example practically all installations in clarifiers are made in stainless steel or plastic today and no more in coated C-steel. In the comparison of the frequency of the causes of corrosion damages in the years 1989 and 1998 this circumstance is reflected by the fact that the proportional damage by galvanic couples decreased while those by lack of processing increased due to inappropriate processing of stainless steel (fig. 2).



**Fig.2: Causes of corrosion damages in waste water treatment plants in Switzerland**

For plants built or renewed in the last 10 years larger problems could usually be attributed to the following causes [4]:

- Missing of plant-specific corrosion protection concepts  
The desire for the generalization of corrosion protection concepts is understandable, however not realizable and also not meaningful in practice. Each plant whether new or existing, has its own specific conditions, which have to be considered in the development of the corrosion protection concept.
- Unclear responsibilities and a lack of co-ordination  
The responsibility for the total concept of the plant and thus also for the corrosion protection is with the overall project leader. If necessary he must call in the appropriate specialists and coordinate the work. In the past it manifested that the tasks and responsibilities were often not clearly defined, what led to misunderstandings, duplications or contradicting solution approaches.
- Improper design [5].  
Quite often, components, even standard constructions, with fundamental con-

struction faults (dead corners, non material-conforming processing, mixt constructions with unfavorable surface areas, etc.) were used. In many cases additional protective measures were necessary in order to achieve the desired service life of such parts.

- Missing controls [6]

The effectiveness of preventive measures is ensured only when they are correctly executed. This is valid also for the corrosion protection. Often from cost reasons or due to co-ordination problems no suitable controls were accomplished, which had as a consequence that in individual plants up to 70% of the met corrosion protection measures remained ineffective - an economic nonsense. Since the corrosion problems appear often only after a certain time of use (some months until a few years) a correction is often complicated and expensive, so that in many cases nothing is done and an early breakdown of the component is accepted.

## **The guideline C6 - edition 2010**

### *Motivation*

In the year 2005 the Swiss water association VSA placed an official request for the revision of the 15 years old guideline C6. It wished to have a practical manual with concentrated information on materials, system design, procedures for quality assurance and reception, indication on corrosion dangers and the presentation of standard solutions with examples. The work should concentrate primarily on steel and plastic constructions at waste water treatment units.

Tereupon a working group with corrosion and waste water specialists, planners and a representative of the Federal Inspectorate for Heavy Current installations was formed which started in 2007 with the actualization of the guideline. Previous a possible replacement of the guideline C6 by the CEOCOR guideline [7] was discussed. This was however not judged as meaningful, since the latter is too extensive (over 150 pages) and available only in French. Also it was seen no need for an extension of the guideline towards canalisations.

However, as the corrosion protection concept and the electrical concept of a sewage system must carefully be harmonized, another working group were formed to revise in parallel the directive waste water of the Federal Inspectorate for Heavy Current installations.

### *Structure*

The fundamental structure of the old guideline was maintained for the new edition. It can be essentially divided into 5 sections:

- Basics  
Fundamental Structure of a waste water treatment systems, basic requirements (e.g. service life), responsibilities, legal bases (e.g. security of electrical systems), quality assurance
- Corrosion mechanisms  
Types of corrosion, galvanic couples
- Corrosion resistance of different materials  
Metals, concrete, plastics, influence of processing
- Preventive measures  
Design, material choice, coatings, galvanic separations, cathodic protection (CP)
- Case studies  
Typical errors with different solutions

### Innovations

In the 20 years of the application of the guideline C6 no problems or errors concerning the technical content appeared. It supplied at any time sufficient basic information in order to recognize and solve, with appropriate expert knowledge and/or in cooperation with a corrosion specialist, possible corrosion problems in connection with new developments. Therefore, from the technical point of view only actualizations in connection with process and materials development were necessary.

The actual innovations concern above all those points, which caused most of the problems in practice, as well as changes due to new or changed standards and regulations. Further on in some chapters some complements to the improvement of the understanding were introduced. The following list gives a short overview on the most important innovations:

- Responsibilities

A new chapter was inserted, in which the corrosion protection activities in the different project phases (planning/design, tender, realization and operation) are listed. It is also shown, how the responsibilities can be regulated. In tab. 1 this is exemplarily represented for the planning and design phase.

**Tab. 1: Responsibilities in design phase**

Project step	Activity	Responsibility							
		Owner	Overall project manager	Electro engineer	Corrosion expert	Civil engineer	Process engineer	Contractor	Electrician
Design	Demands of the owner concerning materials and corrosion protection	D	O						
	Definition of goals and requirements for corrosion protection measures	E	D	M	M	M	M		
	Elaboration and approval of the corrosion protection concept and the control plan	E	O	M	D	M	M		

Legend: A: Execution    B: Site engineering    D: Accomplishment    E: Decision    M: Collaboration  
 O: Organization    GP: Overall project manager

- Concrete

The chapters on characteristics and preventive measures for concrete were completely revised. In the past the specification of the concrete took place on the composition, nowadays the concrete is ordered after the desired properties. The tender is therefore based mostly on the exposition classes which characterize the nature and the degree of the environmental influences.

It is made also reference to a recently observed problem, the abrasion of concrete in the biological cleaning in waste water treatment plants [8].

- **Quality assurance/controls**  
Control and inspection plans as well as operating and maintenance concepts contribute to the quality assurance and a trouble-free operation of sewage systems. By different text completions the importance of such documents is pointed out. So it is recommended to provide a control plan where time, kind and extent of controls as well as the responsibility for the execution are fixed.
- If possible it is advisable to accomplish controls in the initial phase of the work, when corrective measures are still possible. It is also important, that clear and mandatory acceptance criteria are specified already in the corrosion protection concept and in the tender phase.
- **Galvanic separations**  
This chapter was restructured for better legibility, the requirements for galvanic separations have been defined more exactly and an overview of the usual types of insulating units (insulating pieces, flanges, ..). are given, as well as indications for checking and monitoring of galvanic separations. The often expressed desire for absolute evaluation criteria is not accomplishable since the measured values depend in practice primarily of the installation conditions and the operating condition of the plant. For a correct interpretation of the measured values therefore appropriate expertise and experience of the examiner are necessary.
- **Reconstruction**  
A substantial difference compared with earlier years is the fact that today the extension and reconstruction of waste water treatment are the center of attention while the construction of new plants is quite seldom. This complicates the development of corrosion protection concepts. It is fundamental that the corrosion of old or re-used installation is not increased in a critical manner. Particularly to consider in this connection are the formation of galvanic couples and the short-circuiting of existing galvanic separations. Since each plant exhibits its peculiarities, no general recommendations or solutions can be presented. Rather the situation should be judged in individual cases by a corrosion specialist.
- **Case studies / Examples**  
The examples were updated and arranged according to causes (construction, aggressiveness of the attacking medium, galvanic couples, operation). This permits a better and more rapid orientation of the reader.
- **Glossary**  
In practice frequently different and often incorrect terms are used, which led quite often to misunderstandings. The introduction of a detailed glossary with clear definitions shall help to avoid such problems in the future.

Many difficulties arisen in the realization of corrosion protection measures since approximately 2000, in particular with galvanic separations, are in connection with developments of electrical, measuring, and control devices, eg. the use of frequency converters for the alimantation of pumps or the integration of (new) Bus-Systems. These require no fundamental deviations of the protection procedures described so far in the guideline C6. However partial adjustments of the detailed solutions are necessary. So, for example, special decoupling or residual current devices must be used in connections with frequency converters. For safety reasons these solutions must be approved by the Federal Inspectorate for Heavy Current installations and becomes therefore part of the directive ARA.

## Final consideration

The SGK guideline C6 "Corrosion protection in waste water installations", published in 1990 received large attention as the first document of this kind in Switzerland and in Europe. With the preventive measures presented therein the number of damages in sewage systems of Switzerland and thus also the maintenance costs could be clearly reduced. Besides many manufacturers realized corrosion-relevant improvements of their products and clear progress in the quality of workmanship, in particular with welded structures made from stainless steel were reached.

With the updated guideline C6 and the revised directive ARA designers and owners will dispose of tools which represent again the newest state of the art for corrosion protection in waste water installations.

Using the guideline in practice it should however be noted that the detailed solutions pointed out in the case studies and examples are always based on an isolated view of a certain problem. Besides for some examples different solutions are described, which are not always compatible among themselves. It is therefore important that in the concrete case a system analysis is done and co-ordinated corrosion protection measures in the context of a plant-specific corrosion protection concept are realized. In view of the complexity of sewage systems it is recommendable to collaborate with an experienced corrosion specialist already in the planning and design phase.

## Literature

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