

ABKAT[®] Method

The method for industrial waste water treatment is suitable also for treating underground waters, stagnant infiltrating waters and other problematic waters and at the same time new standards have been determined. The cost of the treatment can be reduced drastically in this case.



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Industrial waste waters resulting from the production in pharmaceutical and chemical industry or during treatment and purification processes are very often loaded by an extremely high content of organic compounds, salts or colouring agents.

Unfortunately, such load show also underground waters in localities of large chemical plants in new federative countries or new EU member states. This load represents in general a negative factor for new investor at construction new plants. Even 15 years after overthrow of Communist regime in the former GDR many workplaces in eastern part of Germany have problems with such load of subsoil waters. Therefore, in new EU member states this method gives a potential for concrete specified tasks and projects certainly as a minimum up to 2020. In an example given in Table 1 it is presented the existing load of underground waters in different localities of extremely loaded chemical workplaces.

	pH value	TOC in mg/l	CSB in mg/l	AOX mg/l
Underground water 1	8	1.548	5.288	1.580
Underground water 2	7	77	247	20
Underground water 3	10	16.937	40.968	890
Underground water 4	9-10	1.813	3.863	560

Tab. 1: Data of the not treated ground water samples

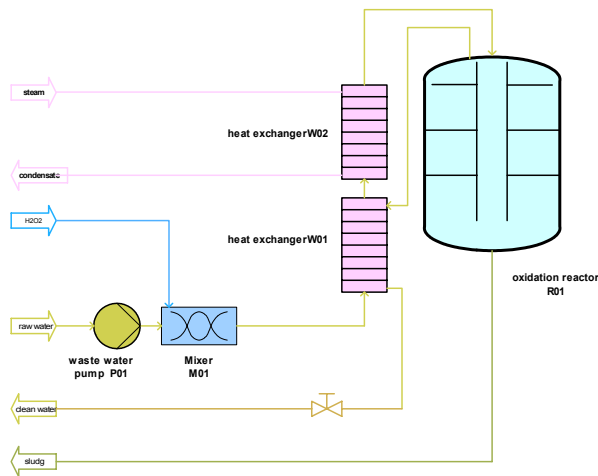
On the basis of the present state of the art they are used for treating underground waters in general multistage processes consisting of the following technological stages:

Pre-treatment	Iron and manganese separation
	Separation of solid substances
Purification	Stripping with subsequently connected TNV/KNV
	Adsorption

In case of complicated underground waters it is necessary to choose combined methods for treating taking into consideration the fact that many substances can not be separated by stripping and adsorption. Therefore, a wide spectrum of harmful substances when using usual technological processes for water treatment results in extremely high costs of treating processes. These costs may attain an amount of up to about 10 to 30 €/m³ treated water. If the underground water treatment is realized by means of an user's model these costs are increased as a consequence of cost of financing and cost of personnel and analyses carried out to an amount of 20 to 40 €/m³.

Above all, multiply chlorinated halogen hydrocarbons such as tetrachloroetane can not be separated from water at all or with many difficulties only when using present methods. For the reason of a very low vapour pressure it is very difficult to separate chlorine hydrocarbons by stripping. Adsorption can not be used effectively for the reason of an adverse position of equilibria of activated carbon / water separation. The oxidation method used up to this time consisting in the use of hydrogen peroxide and/or ozone as oxidizing agent have been used and tested only in cases of negligible portions of harmful substances in an amount of less than 100 mg/l.

**Basic flow sheet ABKAT-process
one stage process**



With the use ABKAT[®] method shown in Fig.2 developed by firm DGE GmbH the majority of harmful organic compounds is degraded by wet oxidation. Using this method they are degraded above all problematic harmful substances as anilines, highly chlorinated aliphatic hydrocarbons with space and time yield. The ABKAT[®] method represents a new technical development because it is under design of a new control of the process of wet oxidation with a new utilization which has not been realized up to this time.

Figure 1:
The basic flow sheet of one-stage ABKAT[®] system

Technical realization of the process at the same time makes it possible in this way to maintain for a long time pH value of the treated waste water in the range between 6 and 9, therefore, it is possible to omit neutralization. In addition, it is possible to omit fully also a pre-treatment stage.

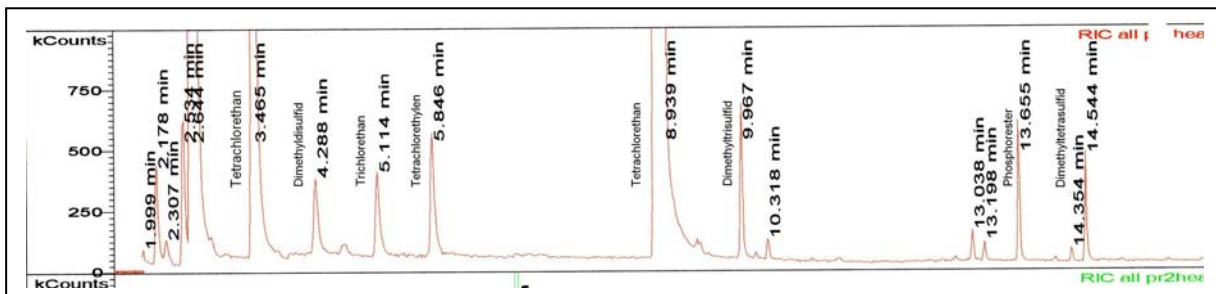


Fig. 2: Chromatogramme of problem waste water

Tests carried out both with underground water as presented in Table 1 and with different waste waters have shown that it is possible to decrease markedly a value of CSB and AOX using wet oxidation. A detailed kinetic model of the oxidation process is not possible for the reason of complex reaction processes. For kinetic simplification of data obtained by measuring during waste water test the CSB and AOX degradation has been taken into consideration as the first order reaction. In the limits taken into consideration it is permitted at maintaining certain preconditions. Thermodynamic data found in the course of this process are in the following range:

	pre-exponential factor k_0 1/min	activation energy EA kJ/mol
Degradation of CSB	1,5 to 3	10 to 20
Degradation of AOX	$(4-8) \cdot 10^8$	60 to 100

Theoretical conversion computed show the fact that for degrading CSB it is possible to control the process of degradation in a small range by means of temperature. However, it is possible to ensure the requested degradation at low temperatures by a delay time.

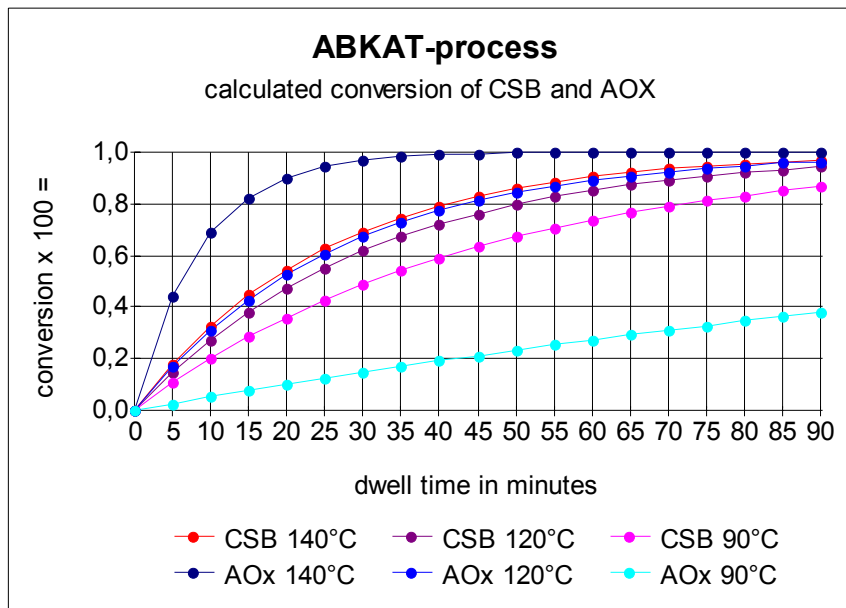


Fig. 3: Computation of conversion on the basis of reaction kinetics developed

A markedly higher dependence on temperature exists at AOX degradation when compared to CSB degradation. As surprising it has been found that particularly such substances as hexachloroethane, chlorbenzol, chloroform etc. have been decomposed already after a short time of the reaction. It is possible to utilize this connection advantageously at technical realization for the process control (Figure 3, Computation of conversion). In case of waste waters with extremely AOX portions also a spontaneous shift of pH value occurs as a consequence of their fast decomposition.

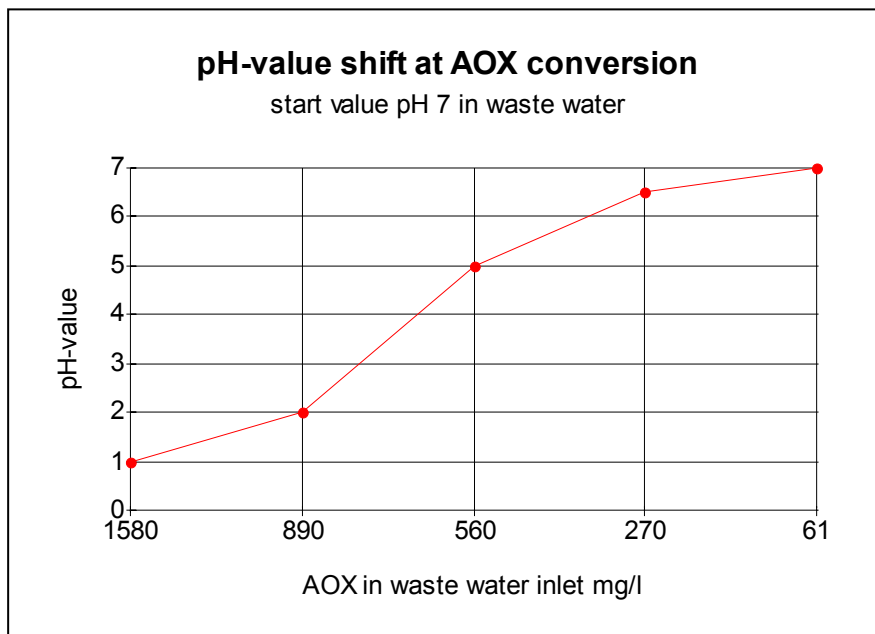


Fig. 4: Course of pH value shift

In Figure 4 it is shown a dependence of pH value with a starting value pH value of 8. From this it is possible to deduce that it is very advantageous to connect more reactors in series. By installing neutralization after the first stage it is possible to prevent from corrosion at high temperatures. In this way it is possible to use a graduated quality of material for single reactors. Therefore, other advantage consists in additional acceleration of CSB degradation in neutral medium. Knowledge obtained up to

this time allow us to compute in advance pressure and temperature conditions and also a necessary size of the reactor, therefore, to estimate well prepared capital and operating costs. For ensuring guaranties and warranty, however, laboratory tests and tests on our pilot equipment on site for a time period of 1 – 2 months are considered to be an advantage.

In case of underground water with a rate of flow of 100 m³/h, which has to be treated they will be attained the values in table 2, for example when using a 3-stage ABKAT[®] method:

Underground water composition:

Inlet		Outlet		Degradation	
CSB in mg/l	AOX in mg/l	CSB in mg/l	AOX in mg/l	CSB in %	AOX in %
2.500	135	390	10	84,4	92,6

Tab. 2: Reduction of CSB and AOX value at the wet oxidation with the ABKAT[®]-process



Waste water samples
On the left: before treatment
On the right: after treatment

The following utilities are necessary only for cleaning:

Steam	1.600	kg/h	20 bar
Electric power	30	kW	
Hydrogen peroxide	0,7	m ³ /h	50 %

Taking into consideration the fact that process and technical realization of this method does not require any stage of a pre-treatment it is possible at an agreed immediate treatment to treat the underground water with a cost of 3-4 €/m³. Therefore, it is possible to decrease operational expenses by 50 % in comparison with conventional methods. The advantage of this treating method consists in the fact that it is possible to increase the degradation rate by using a simple modification of the process conditions, i.e. by modifying temperature and quantity of oxidizing agent. A fluctuation of the raw water feeding can be always compensated according to design of the equipment in the range between 1 and 50 by immediate accommodation of operating conditions and without any reduction of the degradation capacity. The utilization of the new method can be applied successfully also as an equipment with a divided flow.

Summary

The new method of waste water treatment is a process fitted with a simple instrumentation. This process shows an operating reliability and is in operation without any high cost of control and maintenance. The other known methods of electrochemical treatment of waste water or ultrasonic treatment of waste water or a combination of these methods shows markedly high cost of maintenance when compared to the new method. It results from the fact that at electrochemical treatment of waste water for example the process velocity is limited by a boundary layer of electrode surface. The process is deteriorated additionally by the existence of sediments on the electrodes. Nothing about these problems which occur certainly in practice is mentioned very often in literature. In case of highly contaminated waste waters containing also suspended particles it is not possible to use the electrochemical method of waste water treatment. The ABKAT[®] method developed by us makes it possible; therefore, to be utilized in wide extent from soaking through water treatment up to