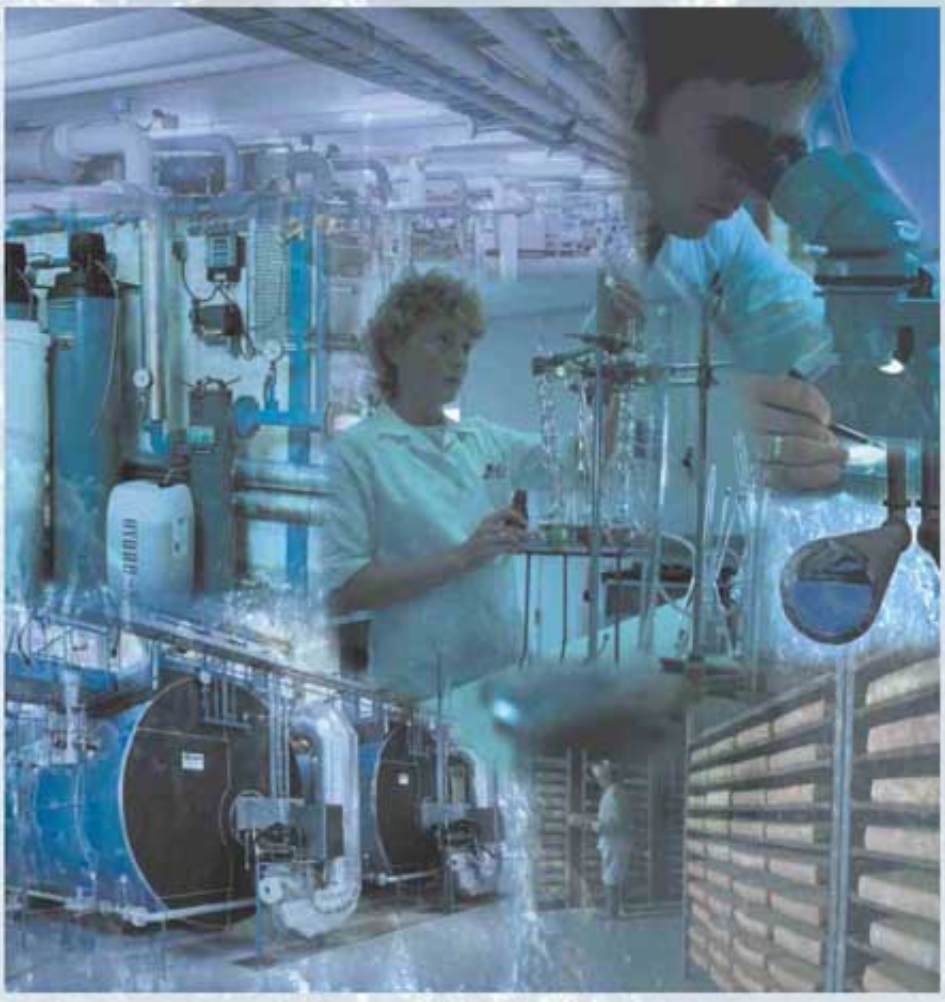
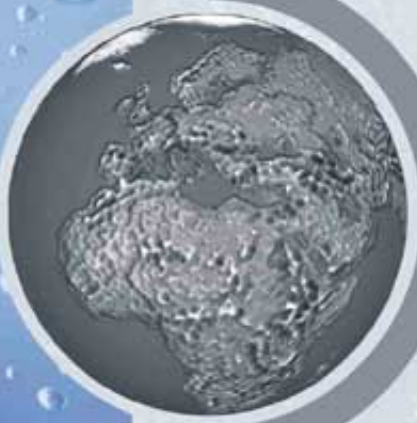
The function principles of the Hydro-X method

And the advantages of a physical-chemical treatment of boiler water





Boiler Water
District Heating
Cooling Water
Dosing Pumps
pH-Control
Filtration
Neutralization
Analysis equipment

Hydro-X

The method for boiler water conditioning in steam and district heating plants

A unique method and product

Hydro-X is a method and product for conditioning boiler and district heating water. Hydro-X is simple to use and gives complete protection against corrosion and scale along with an assurance of efficient and harmless dissolving of existing scale.

Hydro-X applied in steam plants guarantees the production of 100% pure and neutral steam.
The Hydro-X method distinguishes itself from all other methods of boiler water conditioning or purely chemical or mechanical principles.

Thus it is important that any decision maker knows about the general physical-chemical conditions behind the advantages of the Hydro-X method.
The purpose of the present publication is to give the necessary insight into the Hydro-X boiler water conditioning process.

Over 60 years with the Hydro-X method

Water treatment methods can generally be based on the following,

- purely chemical principles

- chemical-mechanical principles

- physical-chemical principles

The physical-chemical principles provide a very wide safety margin to variations in the feed water's chemical composition.
The purely chemical conditioning principles however create an artificial environment in the water which always necessitates a later correction.
This was the starting point for the Danish engineer A. Johansen, who in the late 1920s started the research which forms the background for the development of Hydro-X. Around 1940 the development work was complete and production could begin. It was only after the war that the marketing of Hydro-X could begin. Today the Hydro-X method is used in a variety of places to a very large extent.

For example Hydro-X is used by more than 300 of Denmark's approximately 450 district heating plants. The conditioning of more than 50% of the Danish district heating water is done using Hydro-X. Hydro-X is also used in several thousand steam boilers.

However most of the production is currently exported to more than 40 countries.
Water is different from place to place and the composition of water can even vary from season to season. Water must therefore be conditioned using principles that consider both a great deal of flexibility and precision, despite individual variations in the water quality. This is why water should be conditioned using the Hydro-X method, and this is the background for the widespread adoption of Hydro-X to this day and in the future.

The founder of Hydro-X Albert Johansen

The head office of Hydro-X located at Ravnstrup near Hjallerup

The principles of Hydro-X provide good operating economy

The effects of using Hydro-X

To prevent the formation of scale

To dissolve existing scale and convert this to sludge to be removed by a blow-down

To condition sludge into a freely mobile mass, that does not clog valves and gauges, but can be collected and removed

To stop any working corrosion in the entire system and prevents the corrosion of steel, copper, zinc, stainless steel and brass

To ensure the production of 100% clean and neutral steam

To safeguard steam plants against carry over

The effects of the seven individual substances

Hydro-X contains seven different substances. This includes organic substances with the physical effect and inorganic substances with the chemical effect. The combined effect of the substances is complex, but the following explains the effects in a simplified manner.

Organic substances	- Sodium alginate	Prevents scale formation
	- Sodium tannate	Forms a corrosion protecting passivation layer of tannins. Adsorbs oxygen. Acts to prevent formation of deposits
	- Lignin	Loosens scale deposits
	- Starch	Conditions sludge
	- Glycol derivatives	Inhibits formation of foam
Inorganic substances	- Sodium hydroxide	Complexes the salts in the water and controls the pH value. Conserves the magnetite membrane
	- Trisodium phosphate	Prevents formation of deposits and protects the iron surfaces

The chemical treatment of boiler water

Hydro-X works according to different principles than those traditionally used in chemical boiler water treatment. These products are often of a simple composition. The boiler water treatment using purely chemical methods addresses the salts that are dissolved in the water. I.e. the effect is based on the laws of Stoichiometry.

The risk of overdosing

So the addition of chemicals must occur in exact relation to the amount of impurities that are currently dissolved in the water. And so overdosing may lead to unwanted effects such as corrosion, foaming, or carry over.

The Hydro-X method is based on entirely different principles. The combined amount of basic products - NaOH and Na_3PO_4 - is small in water conditioned with Hydro-X: Only about one tenth of the amount necessary for softening according to stoichiometric principles.

Hydro-X boiler water treatment

The composition of Hydro-X leads to reactions in the water that are more of a physical nature than chemical. The organic and the inorganic substances each perform their own functions, while each of the substances also complements the effects of the others. The inorganic substances serve a number of specific purposes:

Sodium alginate
Is used in combination with catalytic components. It facilitates the formation of molecules with particular form and function: to precipitate calcium and magnesium salts.

Tannin
Efficiently adsorbs oxygen and contributes in the building of a corrosion protective coating of iron tannate.

Lignin
Has properties similar to tannins. These provide the scale removing effects of Hydro-X.

Starch
Contributes to separating the sludge and making the sludge particles easily mobile.

Glycol derivatives
Have an efficient effect on foaming and carry over.

Sodium hydroxide and Trisodium phosphate
The inorganic components of Hydro-X both have several secondary but important effects. They maintain a weak alkaline pH-value, which is beneficial to the reactions of the organic components.
They are indicators for the concentration of the solution, and facilitate safe measuring by simple hydrochloric acid titration (with n/10 HCl).
The forte of the Hydro-X method is the combination of physical and chemical effects.

The function and advantages of the Hydro-X method in preventing corrosion and scale formation

No increase in salts
The organic components of Hydro-X perform a critical role. They are only present in minimal weight amounts, but they are finely divided and highly dispersed so that they exhibit the surface active properties of colloids. The enormous surface area of the organic mixture is thus present without noticeably increasing the total amount of dissolved salts.

Physical effect
The comminuted organic components have a very high molecular weight and thus attract molecules from any impurities in the water. The effect can be compared with the mutual attraction of two masses. I.e. there is no chemical reaction at this stage of the water treatment.

Neutral adsorption of salts
The absorbed molecule is neutral, so it can absorb all salts in the water. Both those that occur due to temporary and permanent particles and salts such as iron-, chloride- and silica- compounds, etc.

Precipitation of sludge
The absorbing molecules ensure that all the impurities are precipitated as sludge. This sludge is highly mobile, amorphous and completely disjointed. This way any chance of scale formation anywhere in the plant has been eliminated.

Ion neutralization
The neutral molecule components of Hydro-X absorb both the positive ions cations as well as the negative ions anions. Cations and anions neutralize each other through mutual adsorption.

Instantaneous adsorption
The adsorption of any ion formation during the dissolving of impurities in the water is instantaneous.

Corrosion is stopped
The neutralization of ions has a direct and immediate effect against electrochemical corrosion. The corrosion process rests on the exchange of ions between points of different electrical potential. This electrochemical process is stopped.

Hydro-X is also efficient against gases such as oxygen (O_2) and carbon dioxide (CO_2). A concentration of 1‰ in the feed water will be sufficient to prevent corrosion in any part of the plant through which water and steam pass.

Minimal risk of Caustic embrittlement
Caustic soda can make iron brittle. Caustic embrittlement occurs proportionately with the amount of free caustic alkalinity in the boiler water.

When Hydro-X is used the concentration of caustic alkalinity is very low and consequently the risk of Caustic embrittlement is reduced to a minimum.

No zinc
Hydro-X prevents corrosion according to different principles from zinc. Furthermore the scale dissolving effects of Hydro-X are reduced by this metal. The basic components corrode the zinc producing zinc oxide and sodium zincate. These substances close up the pores in the scale, and the effect of the Hydro-X molecules is reduced. Consequently zinc plates should be removed before initiating the Hydro-X treatment.

How Hydro-X dissolves existing scale

No production stop
The Hydro-X method facilitates complete removal of old scale from steam boiler and economiser without interruptions to normal production.

Dissolving the scale
Hydro-X contains components that originate from lignin and which expand as the temperature increases. When the lignin particles enter the pores of the scale, they expand and break the scale away from the metal. The loosening of the layers of scale happens in several phases and is strongest in the area of the heating surface with the highest temperatures.
The effect can be observed when the steam boiler is opened after the first period of the Hydro-X treatment.
Very thick layers of scale are cheaper to remove during production stops by chemical cleaning. Doing so significantly reduces the amount of Hydro-X needed.

Conversion of scale to sludge
The scale is broken down to fine, loose particles. If the scale remains in the steam boiler it will eventually be converted to a freely mobile sludge which can easily be removed by blow-down. Also in this case, the Hydro-X method works according to quite different principles compared to the orthodox methods of removing old scale by chemical solution.

Purification of steam using the Hydro-X method

Hydro-X for all steam plants
Regardless of which purpose the steam is used, the Hydro-X method can be used to condition the water of the steam boiler plant. In this case the physical-chemical treatment of the boiler water not only ensures the optimal operation of the plant, it also ensures a 100% pure steam.

100% pure steam for all purposes
The steam can be used directly for any purpose. For autoclaving in a hospital environment or in production of foods, including export authorized meat production.

Only very few chemicals
Hydro-X removes the need to add the usual large quantities of sludge forming chemicals such as carbonates or phosphates. This reduces the total volume of sludge to a minimum, and eliminates the risk of foaming due to excessive alkalinity.

No carry over regardless of plant type
Even carry over due to the chemical composition of the water is prevented using the Hydro-X method. For some forms of softening plants this advantage is particularly of value, and also in these cases the glycol derivatives in Hydro-X will effectively eliminate the risk of carry over. The glycol derivatives absorb on both sides of the steam bubbles' liquid surface. They further discharge the water thus causing the steam bubble to break.

Optimal sludge precipitation
Impurities, whether in solid form or in gas form, are absorbed and neutralized. Precipitation occurs in the form of sludge that is easily mobile and disjointed. The sludge is easily removed by blow-down or filtering.

The consistency of the sludge prevents impurities from being absorbed in the steam and leaving the system with the steam. For this reason, the steam is 100% neutral and clean. The pH-value is 7.0. The Hydro-X method neutralizes and absorbs all the impurities that were formerly contained in the steam.

Quick effect
The effect can be seen within a few hours after adding Hydro-X start dose. The characteristic purification has started, and the steam is ready for direct application.

Protection of the whole plant
This process also ensures an effective protection of all the components of the plant that are in direct connection with the boiler, e.g. pre-heater, turbine, condensate pipes.

Hydro-X for steam plants with operating water treatment systems

Efficiency improvement
Even in steam plants with optimal ion exchange systems using the Hydro-X method will result in a substantial efficiency improvement. Most often the economics will be very simple to compare as the cost savings in maintenance are greater than the costs of using Hydro-X.

The problems can be solved
Despite use of ion exchangers, operation losses, production stop costs and maintenance costs are often considered unavoidable and accepted.
Not least in advanced plants where solutions to the problems are sought through the technical construction. But scale formation, electrochemical corrosion, carry over and other problems are still familiar. And periodic mechanical boiler cleaning, dismantling and cleaning of the economiser, replacement of corroded parts, etc. are still necessary in plants where Hydro-X is not applied.

In all plants including during operation
The advantages of the Hydro-X method can be exploited in all kinds of water treatment plants: calcium/sodium, cation-exchange, cation-anion-exchange, reverse osmosis plant, etc.
Regardless of the construction principles in the water treatment and deaereation plants, the chemical development has not yet created a plant so perfect that the use of Hydro-X has become obsolete.

Fluctuating and optimal operation
Problems occur with the highest frequency in plants with large and sudden changes in the steam use, and in plants where the utilization is near capacity. In both cases the Hydro-X method's characteristic properties will be fully utilized.

Constant effect with changing water quality
As already mentioned, Hydro-X works by physical means more than by chemical means.
This means that the method is constantly effective, not effected by very large changes in the quality of the feed water. In existing water treatment plants Hydro-X will therefore have the same necessary function that the shock absorbers fulfill in a car with otherwise perfect suspension. The requirement for a wide safety margin can be fulfilled without unintentional consequences and new areas of risk.

Constant safety with changing loads
When the water treatment plant is operating with irregular operating loads, the formation of scale, corrosion and pollution of the steam will all increase. This is why the Hydro-X method has an especially important effect. A dosing will immediately absorb all impurities that pass from the softening equipment, condensate container and on to the boiler, economiser, overheater and condensate pipes. For this reason the entire plant can work constantly with maximum capacity, and the daily maintenance can be reduced to a minimum.

The dosing of Hydro-X has a wide safety margin

Minimum dosing
Just a small amount of Hydro-X is necessary in the feed water treatment. The minimum dose is determined by the purpose of the treatment: to obtain a complete precipitation of the impurities in the water.

Treated water
When treated water is used, the minimum dose is so sufficient that impurities larger than those actually contained in the boiler during the treatment can be absorbed.

Increasing hardness
This is why the minimum dose is fully effective, even when the hardness of the water increases. Variations in the quality of the water from one bore to another or from season to season are most often without any practical consequence to the effect of Hydro-X. Only in few places the limits for hardness are exceeded that necessitate a larger dosing of Hydro-X or where it will be necessary to supplement the treatment.

Safety margin always optimal
An overdosing of Hydro-X carries no risk. Both when the overdosing occurs due to error whether human or technical and when it occurs deliberately as a way to accelerate the decomposition of scale. An overdosing will not harm the boiler - and the steam quality will remain pure.

Optimal use of the Hydro-X method

Dosing, blow-down, filtering

Automatic dosing

Due to the simple control and the wide safety margin, Hydro-X is well-suited for automatic dosing even when used with simple dosing equipment. The illustrations show a water treatment plant where the dosing of Hydro-X is done by pH-controlled dosing equipment. The plant maintains a constant pH-value on the circulating water - in this case a pH-value of 9.8. In other types of plants such as steam plants and smaller central heating plants, proportionately controlled dosing equipment can be chosen so that the dosing pump runs in parallel with the fresh water supply or feed water pump.

Blow-down

On steam plants there is a concentration of salts and other impurities. To ensure optimal production using Hydro-X this concentration cannot exceed a certain level. Thus it is important that the plant has blow-down equipment, which ensures blow-down from the boiler when the maximum concentration has been reached.

Filtering

At district and central heating plants it is important to install filtering equipment on the systems. When the water is treated with Hydro-X, residual hardness and other sludge products are stabilized and dispersed in the circulating water. To avoid the accumulation of these products in the plant they must be filtered out. In many installations this is done best and most economically using a part stream filter of the bag/magnet type. Typically a continual stream of 5-15% of the water is circulated through the part stream filter.

Norms for dosing Hydro-X

Control norms
The dose rates listed below are for normal dosing. In an actual use situation consultants from Hydro-X A/S will adjust and control the feed and boiler water. The analysis results determine the exact dosing optimal for each individual case.

Delivery
Hydro-X is delivered as a ready-to-use liquid in cans, drums, or plastic containers.

Storage
Hydro-X can be stored for an unlimited time and will not change provided it is stored in a sealed container.

Steam plants

- Normal dosing
  Daily or continual addition of Hydro-X to the feed water.

- Start dosing
  Hydro-X treatment is initiated by adding 1,0 liter Hydro-X per m^3 of boiler water.

- Raw water
  Add 0,2 liter Hydro-X per m^3 of make-up water.

- Treated water
  Add 0,04 liter Hydro-X per m^3 of make-up water.

- Condensate
  Add 0,04 liter Hydro-X per m^3 of condensate.

District heating plants

- Normal dosing
  Hydro-X is added to the circulation water.

- Raw water
  Add 1,0 liter Hydro-X per m^3 of added water.

- Treated water
  Add 0,5 liter Hydro-X per m^3 of added water.

Control of the conditioning

- Simple control
  The Hydro-X method also simplifies the control of boiler water. p-value, m-value, hardness, pH-value and conductivity provide all the necessary information for the majority of boilers.

- Analysis equipment
  Analysis is easily performed using the special Hydrotest kit sold by Hydro-X A/S. It is recommended to perform analyses daily.

- Norm values for steam boilers
  Residual hardness: 0 dH°
  p-value, mval/l: 10-20
  Conductivity µS/cm: below 7000 (3500 ppm).

- Norm values district heating plants
  Residual hardness: 0 dH°
  p-value, mval/l: 1-3
  pH value: 9,8 +/- 0,2
  Appearance: clear and free of sludge.

Co-operating with Hydro-X consultancy services optimizes operation and profitability

Operation safety
Hydro-X is not just a means for more efficient protection of boiler plants and conditioning of boiler water. Our organization backs up the product with service, consultancy, analysis of plants and all the necessary equipment and education necessary to ensure smooth operation at our customers' facilities.

Constant control
When you receive delivery of Hydro-X you can enter into a service agreement giving continuing control of the boiler and feed water quality. This service is your extra safety. The work is performed on a regular basis by our local consultants.

Immediate fault finding
The Hydro-X A/S consultants use sophisticated measuring equipment when checking for faults. Examples are breaks in heat exchangers, corrosion, pollution of the condensate, or other faults, that require precise localization and maybe urgent repair. The consultants are ready for immediate site visits in case of operation problems.

Operation economy
Any economically optimal solution is based on a total overview of the situation.

Clear cost-savings
The present costs of operation, maintenance and production stops will be substantially higher than the costs of using the Hydro-X method. Thus, the net result of switching to Hydro-X is a substantial benefit.

An effective assurance
Other plants require - careful consideration of the risks and costs of production stops and failure to deliver. This must be the basis for evaluating the objective advantages - of switching to Hydro-X.
Hydro-X can supply - a safe solution with no future risks for any plant, even when operating under the strictest demands for production assurance.
After having read the information in this material, you will know the basics of the Hydro-X method.

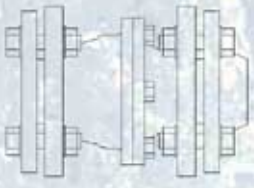
Certified quality management
Hydro-X A/S is certified according to the ISO 9001 quality management system, and the ISO 14.001 environmental management system.

Call Hydro-X
After speaking with one of our consultants you will be able to evaluate the specific economic and operation safety of using Hydro-X in your plant. So call us and set up an appointment with one of our technical consultants.

Hydro-X is Danish technology and know-how that has been exported to more than 40 countries for over 60 years

Our work areas

Chemicals for: Steam plants, district heating plants, cooling water systems. Within these areas Hydro-X A/S supplies products, services, know-how and consulting along with electronic instruments for monitoring, controlling and dosing in water treatment.



Our other products

Products in the series: Hydroplex, Hydrocor and Hydrocid are chemicals for cooling water treatment. Along with our electronic instruments these products provide dosing control and monitoring of cooling water treatment. We can also supply inhibited acids for any kind of acid cleaning.

C.E.O.
Ole Kristensen

Hydro-X A/S

Hydro-X A/S markets all the products from the factory in Hjallerup, Denmark as well as from factories under licensed production in countries such as Spain, The Philippines, Thailand, China, Egypt, Tanzania, Bulgaria and Indonesia. In Hjallerup we also perform extensive analysis work for the company's customers. The experiences from this work form the basis for regular seminars for customers and other interested parties. Approximately 70% of the production at Hydro-X A/S is exported to more than 40 countries worldwide.

KING FREDERIK IX'S AWARD
FOR EXCELLENCE
IN EXPORT

DS CERTIFIED Environmental Management System DS/EN ISO 14001

DS CERTIFIED Quality System DS/EN ISO 9001

Hydro-X A/S
Tylstrupvej 50
P.O. Box 30
DK-9320 Hjallerup
Tel.: +45 98 28 21 11
Fax: +45 98 28 30 21
E-mail: info@hydro-x.com
www.hydro-x.com
CVR nr. 29207518

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