

## White Paper



## The Electrode Paradox – solved!

'Intelligent Water Supply' makes electrode steam humidifiers suitable for demineralised water.

Until now, choosing the right steam humidifier for indoor air conditioning systems has been a trade-off for planners: they had to choose between the traditional advantages of electrode steam generation and virtually maintenance-free operation. The reason for this is **water treatment**. Whilst this is the key to longevity and minimal maintenance, it has, until now,

ruled out the use of electrode steam humidifiers for physical reasons. An innovative process now resolves this electrode paradox and, for the first time, combines the best of both worlds.

Efficient. Hygienic. Innovative.



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## Methods of steam generation in steam humidifiers.

In air-conditioning technology and industrial applications, a distinction is primarily made between three methods of generating water vapour in steam humidifiers:

- Electrodes
- Resistance heating elements
- Gas

These methods produce hygienic, germ-free steam, but differ in terms of how they work, maintenance requirements and control accuracy.

The following section focuses on the 'electrode' method and its use in combination with a water treatment system.



## Steam generation using electrodes in steam humidifiers

### Which benefits do electrode steam humidifiers offer?

#### Maximum hygiene (germ-free)

As the water in the cylinder is heated to over 100 °C, bacteria, viruses and other microorganisms are reliably killed off. The steam produced is absolutely sterile and hygienically flawless.

#### No risk of overheating (dry-run protection)

It is physically impossible for the heating elements to burn out or overheat. If there is no water left in the cylinder, the electrical circuit is interrupted and the unit switches off automatically.

#### Precise and rapid control

By specifically raising and lowering the water level, the steam output can be adjusted very quickly and precisely to the actual humidity requirements.

#### Low capital costs

Compared with units featuring resistance heating elements or gas steam generators, electrode steam humidifiers are usually significantly cheaper to purchase.

#### More robust and easier to clean

Due to their surface structure, electrodes are more robust and significantly easier to clean than resistance heating elements.

### How does steam generation using electrodes work?

Steam generation in electrode-based steam humidifiers is based on a **simple but extremely efficient operating principle**. An electrode-based steam humidifier produces germ-free steam by utilising the natural electrical conductivity of water as resistance. This makes it fundamentally different from steam humidifiers with resistance heating elements..

Inside the device is a sealed vapour cylinder, into which several electrodes are embedded. The vaporisation process can be described as follows:

#### | Water supply

The cylinder is filled with ordinary tap water (drinking water).

#### | Electric current flowing through the water

An alternating voltage is applied to the electrodes. This electric current flows from one electrode through the water to the next electrode. This works because ordinary tap water **contains dissolved minerals and salts (hardness-causing substances) and is therefore electrically conductive**.

#### | Heating and vaporisation

Due to the inherent electrical resistance of water, the electrical energy is converted **directly into heat within the water, with absolutely no loss**. The water begins to boil and pure water vapour rises.

### The paradox – the conflict between water quality and conductivity

To understand why the new process represents a genuine paradigm shift in the industry, it is helpful to look at the physical principles of isothermal humidification.

**Electrode steam humidifiers** use the water in the steam cylinder itself as an electrical resistor. The ions dissolved in the water (salts and minerals) conduct the current between the immersed electrodes. This flow of current heats the water directly, bringing it to the boil.

**The problem** is that if ordinary, mineral-rich tap water is used for this purpose, the salts remain in the cylinder when the water evaporates. During operation, they build up as thick limescale deposits on the electrodes. Although automated cleaning processes such as SuperFlush, HighFlush or stub line flushing do extend maintenance intervals and effectively protect the system from damage, they do not, however, eliminate the need for regular maintenance carried out by qualified personnel.

Previous attempts to solve this problem by using **demineralised water** (deionised water / reverse osmosis water) have failed due to the laws of physics, as pure deionised water contains virtually no free ions. The electrical resistance is therefore extremely high, meaning that no current can flow. As a result, planners have so far been forced to resort to significantly more expensive heater type steam humidifiers whenever low-maintenance operation with demineralised water was required.

## The innovation – the 'Intelligent Water Supply' process

A process developed and patented by HygroMatic now resolves this contradiction. Instead of filling the cylinder with **either** tap water containing minerals **or** demineralised water, the system regulates the balance between the two water qualities based on the conductivity inside the cylinder.

At the core of the system is an **intelligent filling management system** that controls two solenoid valves. It continuously monitors the rated current data as well as water level and current readings, and automatically determines which feed water – tap water or demineralised water – is the best option at that moment.

### How it works at a glance

#### Automatic validation of measured values

The system continuously analyses whether the current conductivity value is sufficient or whether the solution needs to be concentrated using tap water

#### Independent decisions on optimisation

Depending on the operating status, the appropriate water source is selected automatically

#### Constant water quality

An optimal blend ensures minimal wear on the electrodes and reduces the build-up of scale-forming substances

#### Increased operational reliability

The 'tank full' error is only triggered once the water level sensor has correctly confirmed the fill level – without the humidifier switching to production stop prematurely

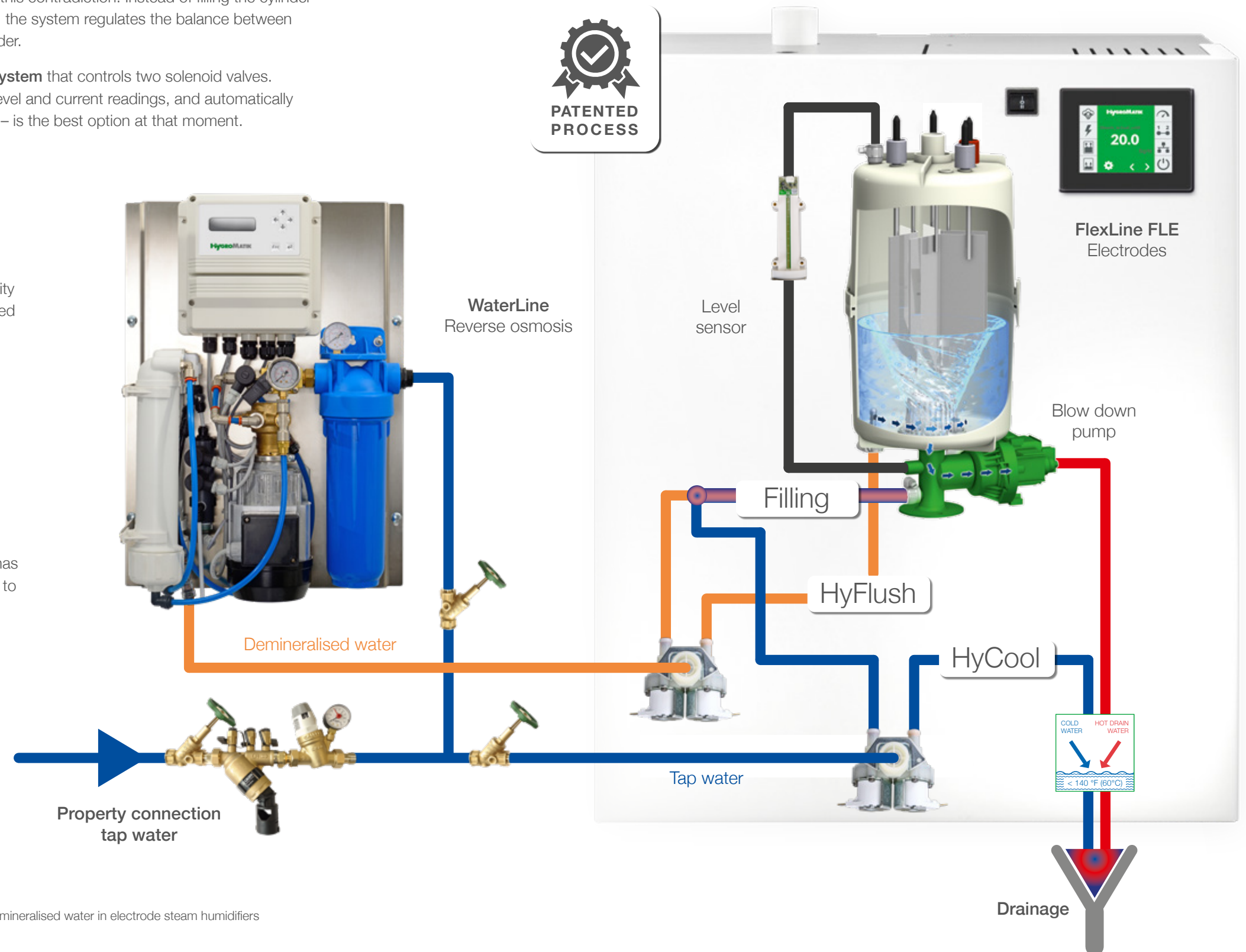


Figure 1. The FlexLine 'Intelligent Water Supply' option enables operation with demineralised water in electrode steam humidifiers

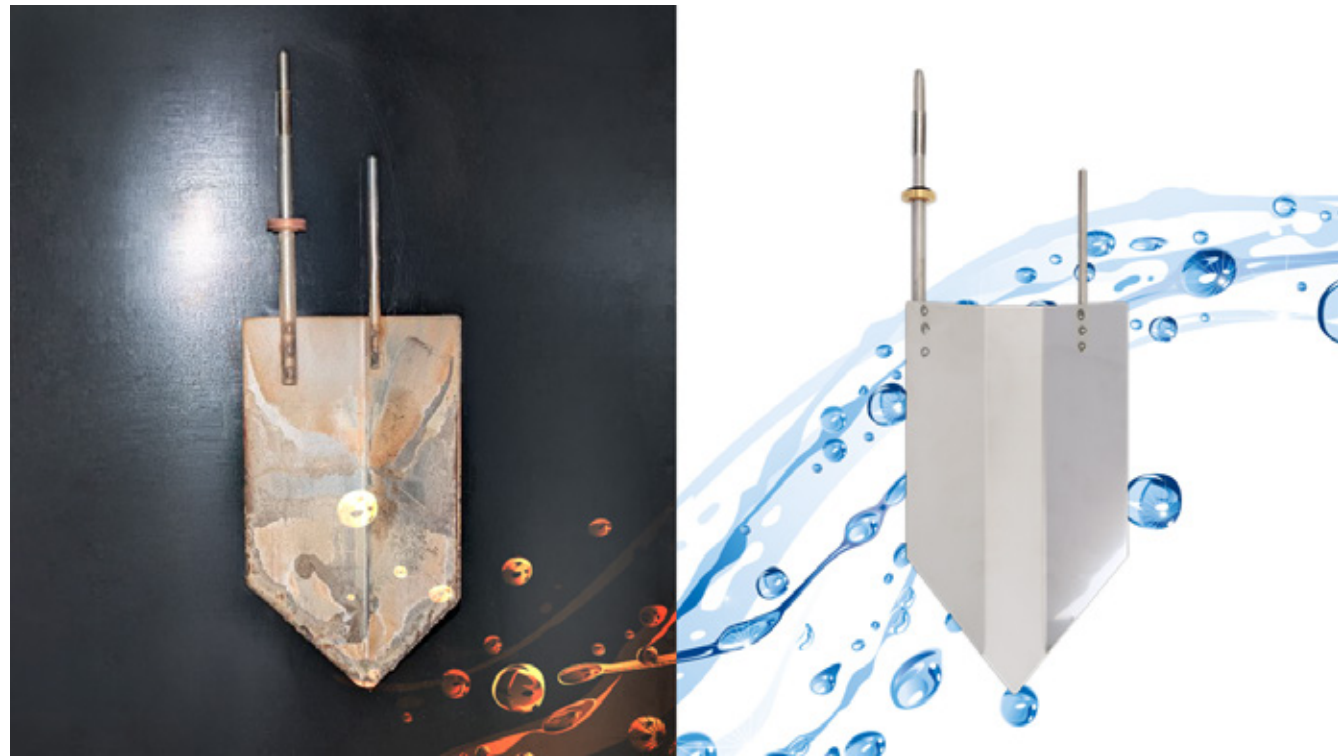


Figure 2. Electrode with a mineral crust vs. preservation of its almost new condition through the use of demineralised water

## The benefits for planners and operators

The electrodes remain free of any significant limescale or dirt build-up at all times, as only very small quantities of hardness-forming substances are fed into the system. The system operates as cleanly and with as little maintenance as a heater type steam humidifier, whilst utilising cost-effective and robust electrode technology. This results in significant benefits for planners and operators of air-handling units.

### Maximum planning reliability and operational reliability

#### No system failures due to limescale build-up

The demineralised water ensures that only minimal limescale deposits form in the steam cylinder. This means that unplanned downtime or losses in efficiency caused by burnt-out or worn electrodes no longer need to be calculated.

#### Genuine, inherent dry-running protection

Until now, planners have had to resort to heater type steam humidifiers when high standards of maintenance-free operation were required. However, these carry the risk of overheating if the water runs out. Thermal protectors prevent the unit from burning out – if triggered, the unit switches to fault mode until the problem is rectified manually. Electrode-type steam humidifiers, on the other hand, possess an inherent, physically based protection against dry running (no water = no current flow = no burnout). They therefore offer interrupt-free operational reliability without the need for additional components.

## Cost-effectiveness & cost savings

### Lower capital expenditure (CAPEX)

Planners can specify electrode steam humidifiers, which are significantly cheaper than heating element systems, without having to compromise on maintenance intervals. This helps keep the operator's budget in check.

### Reduced operating costs (OPEX)

As there is no need for regular cylinder cleaning or expensive spare parts and service calls by specialist staff, the planners can present the operator with a system offering extremely low total cost of ownership (TCO).

### Energy savings by not using desalination

When using tap water, hot, mineral-rich water must be continuously flushed out (desalinated) and replaced with cold water. This consumes energy. When using treated water, however, this thermal loss is almost halved as operating times are effectively doubled, which improves the energy efficiency of the entire system (important for green building certifications).

## Flexibility in system design

### Use of existing infrastructure

If a central reverse osmosis system is already installed in the building (e.g. for laboratories, hospitals or other processes), the planners can integrate the electrode humidifiers into the system.

### Constant power output

As the electrical resistance in the cylinder is no longer affected by progressive calcification, the control characteristics of the humidification system remain absolutely precise and constant throughout its entire service life. This simplifies the design of control and regulation systems (MSR design).

## Better compliance with hygiene standards

### Hygiene safety in accordance with VDI 6022

Although the water is treated, the principle of boiling remains the same. The system effortlessly meets the stringent requirements of VDI 6022, as absolutely germ-free, aerosol-free and mineral-free pure steam is fed into the air duct. There is no risk of particles (lime dust) entering the supply air.

## Conclusion

The patented 'Intelligent Water Supply' process represents a sustainable step towards **greater efficiency and operational reliability**. Thanks to automated control, optimised water quality and a significant reduction in surface fouling of the electrodes, operators benefit from longer maintenance intervals and more reliable operation of their humidification systems.

**Another advantage** is that, in most cases, the technical design of the system also allows for the **retrofitting** of an existing HygroMatik FlexLine electrode steam humidifier.



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