



CASE STUDY  
HOVÅS  
SKOLAN

# Air purification and Heat Recovery in Commercial Kitchens

SAVING ENERGY AT HOVÅSSKOLAN  
THE TECHNOLOGY BEHIND OZONE TREATMENT  
HIGH-PERFORMANCE SYSTEM

 **ozonetech.**

# It Is a Matter of Energy Efficiency, Increased Safety and Cost Reduction

Measurements in the project *Energy Efficient Commercial Kitchens*, co-funded by Belok and the Swedish Energy Agency, indicate that Sweden's municipalities could save almost EUR 60,000 daily if they improved the energy efficiency of their commercial kitchens.

**VENTILATION STANDS FOR** a large portion of each commercial kitchen's energy use, a figure that can be reduced through heat recovery of extract air. This is also something the Swedish Energy Agency's Procurement Group for Commercial Buildings, Belok, recommends in its commercial kitchen guidebook. But in order to be able to recover the heat from a commercial kitchen's extract air, we must first break down the grease in the cooking off-gas. Ozone provides an effective way of breaking down pollutants.

The grease creates other problems too. Grease deposits burn intensely and is hard to put out. The continuous breakdown of grease in extract air reduces the fire hazard and makes your property safer. The Hovåskolan school in Gothenburg has opted for ozone treatment with a system from Ozonetech.

## One of the Toughest Environmental and Energy Requirements in the Country

**THE MUNICIPALITY OF** Gothenburg City has set high objectives for reducing its climate load. Energy use (primary energy) must be reduced by 14 per cent in residential and commercial buildings and 90 % of the carbon dioxide emissions must be eliminated by 2020 compared to 2009.

"We have one of the toughest energy and environmental requirements with regard to buildings – 45 kWh/m<sup>2</sup>, annually including building services", says Johan Gunnebo, energy expert and project manager at Gothenburg City. "And we also calculate energy use more strictly than required in the Building Regulations of the Swedish National Board of Housing, Building and Planning (BBR). An extremely tough goal!"

"Buildings can comply, but we see a potential for improvements in commercial energy use."

**TO REACH** the goals, the City builds as energy-efficient structures as possible and optimizes heating and ventilation on its properties. But energy-efficient construction is not enough. In addition to having Sweden's toughest energy requirements for buildings, the City is under way with the development of Sweden's best system for ensuring that the energy targets are met. It is a package of measures that includes, among other things, early operational optimisation and a completely new energy follow-up system.

"We are working on this at the moment and aim to be ready with it by the middle of 2017", says Johan Gunnebo. "To be sure we are on the right track we need to implement a number of actions including, for example, making continuous measurements. We have great demands on our energy use!"



Photograph: Ingela Qvritist

Johan Gunnebo,  
Energy expert  
and project manager,  
Gothenburg City

### ABOUT MUNICIPALITY OF GOTHENBURG CITY

The City manages, adapts, builds and develops commercial and residential properties for the City of Gothenburg's various operations. With a surface area of more than two million square metres in its care, it is one of Sweden's largest real estate managers. The City takes active part in a number of research and development projects, among other things, in the area of energy efficiency.



Griddles are commonly used for preparing food in commercial kitchens.

## Saving Energy at Hovåsskolan

The City has opted to build a brand new kitchen and canteen at the Hovåsskolan school as the old one did not meet the requirements. The objective is to reduce energy use by 50 per cent compared to the old kitchen.

"Our goal with Hovåsskolan's new kitchen is to generate as much energy savings as possible based on our very tough energy requirements," says Johan Gunnebo, energy expert and project manager. If we achieve this the way we intend to, we can create a new standard based on Hovåsskolan's energy use. This is why we are going all in here.

"At the same time, it is of vital importance that the kitchen staff be completely on board. That they experience that the kitchen works to their satisfaction. We will not reach this objective without their assistance.

Compliance with the tough energy

requirements at Hovåsskolan requires, among other things, a well-functioning ventilation system as well as heat recovery of extract air from the kitchen. The facility management has installed a heat exchanger with very high efficiency (90-95 per cent) along with an ozone treatment system.

The ozone treatment system is here to guarantee the trouble-free operation of the heat exchanger," says Johan Gunnebo. "There are several methods for cleaning extract air, but in our opinion, ozone treatment is the most practical one, and we are also sure that it works."



Tobias Bodén, CEO,  
Andersson & Hultmark  
Photograph: Andersson &  
Hultmark

## Project Dominated by Sustainability Considerations

"There used to be lots of on/off functions in commercial kitchens before, which made recovery of the hot and greasy extract air impossible," says Tobias Bodén, CEO at Andersson & Hultmark. But the project at Hovåsskolan has been dominated by a sustainable way of thinking. "This means, among other things, that we have effected energy optimizations in each kitchen hood individually and have installed a high-efficiency rotating heat exchanger for extract air recovery. But heat recovery here required that we clean the extract air at each hood. We solved this challenge using ozone. The ozone meets the greasy extract air right at the source and immediately eliminates it."

"If we had instead opted to transport the extract air through the ducts to a central treatment installation, the grease would stick to the inside of the duct, generating a greater fire hazard and higher maintenance costs. By scrubbing the extract air at the kitchen hoods, it is also possible to give the ducts a lower fire classification which then makes it possible to lower the material classification and amount of insulation due to the lower fire risk.

### FACTS, HOVÅSSKOLAN

|                              |                                    |
|------------------------------|------------------------------------|
| Kitchen's floor area         | 265 m <sup>2</sup>                 |
| Number of portions per day   | 640                                |
| Number of production days    | 230 days per year                  |
| Pellet heating               | 0.035 kWh per portion (calculated) |
| Operating and property power | 0.35 kWh per portion (estimated)   |
| Hot water                    | 0.03 kWh per portion (estimated)   |

### VENTILATION SYSTEM

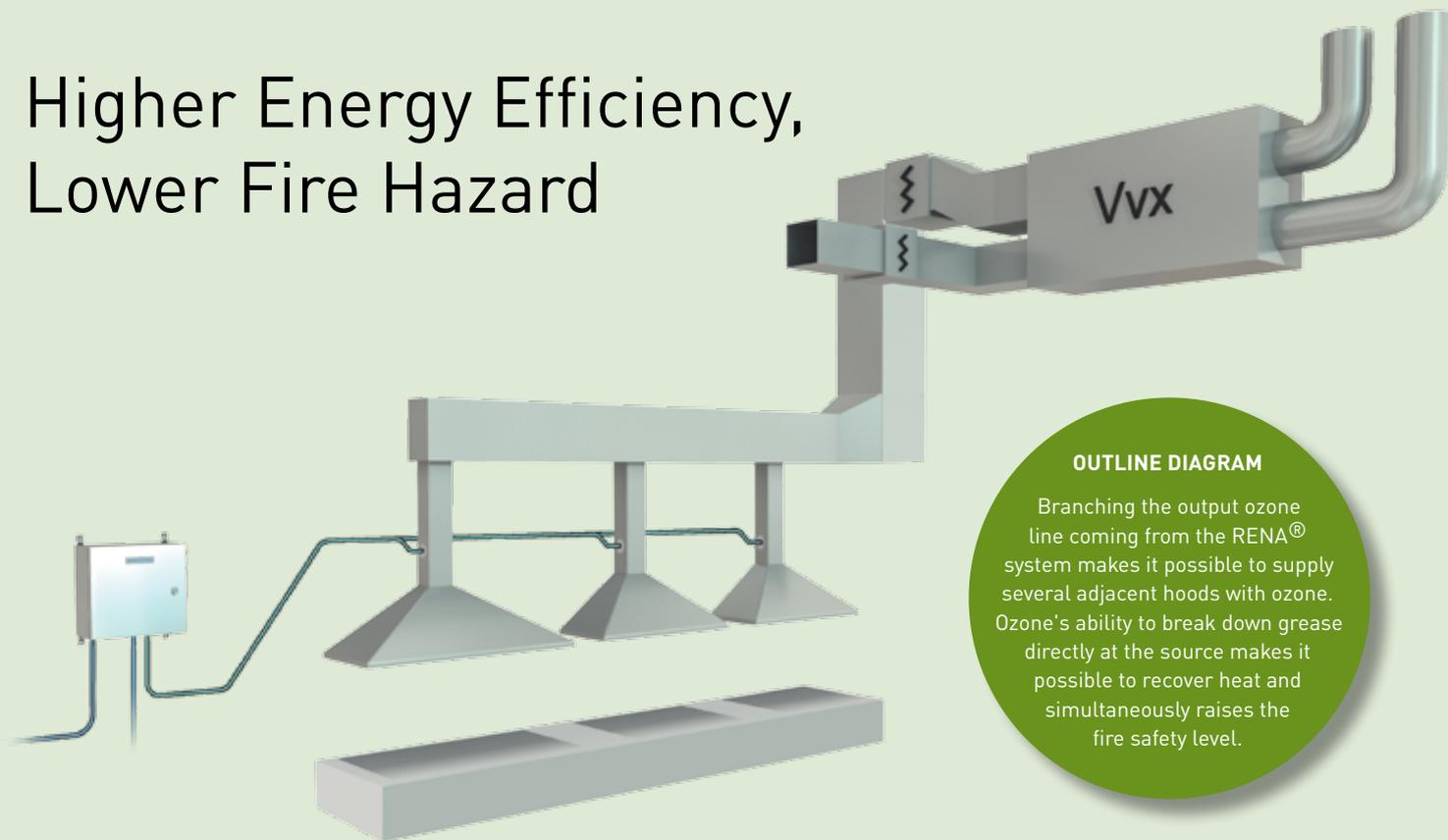
The ventilation system has both air intake and exhaust with a heat exchanger for heat recovery. The ventilation system is equipped with ozone treatment provided by a central ozone system from Ozonetech

"Ventilation in our new kitchen works in a completely different way compared to the old one," says Jessica Bäckström, head chef at Hovåsskolan. "It does not heat so much, and it is so quiet! And we feel confident that it's working! We don't need to give it a thought or worry that it would just pack in one day. And on top of it, we save energy. It is a win-win situation for everyone!"

Jessica Bäckström, head chef  
Hovåsskolan, Gothenburg



# Higher Energy Efficiency, Lower Fire Hazard



### OUTLINE DIAGRAM

Branching the output ozone line coming from the RENA® system makes it possible to supply several adjacent hoods with ozone. Ozone's ability to break down grease directly at the source makes it possible to recover heat and simultaneously raises the fire safety level.

## Belok Recommends Heat Recovery of Extract Air

To reduce energy use in commercial kitchens, the Swedish Energy Agency's Procurement Group for Commercial Buildings, Belok, recommends heat recovery of extract air. This, combined with demand-controlled ventilation, makes it possible to strongly reduce the kitchen's energy needs. Hovåsskolan has installed a heat exchanger that recovers 90 to 95 per cent of the thermal energy in the extract air.

### Ozone treatment guarantees undisrupted operation

Cooking fumes contain grease and odors that accompany the extract air into the extract duct. Without air treatment, the grease is collected in the ducts and on the thin blades of the heat exchanger. To ensure trouble-free operation and high efficiency of the heat exchanger, it is necessary to clean the extract air from grease. Ozone treatment is an efficient and reliable method that is particularly suitable for tough commercial kitchen environments. All components are located outside the ventilation system, and it is only the ozone that is injected into the dirty air stream. The design minimises the need for maintenance and cleaning.



*Extract duct before ozone installation*



*Extract duct after ozone installation*

## Clean Ducts Prevent Fire

Grease has just as much energy as diesel oil; it burns easily and is difficult to put out. Preventing fire is therefore an additional important reason for installing ozone treatment. Cleaning the extract ducts from grease reduces both the fire hazard and the need for chimney-sweeping.

## Ozone Treatment – This Is How It Works

The task of the ozone is to break down pollutants in the cooking fumes. Ozone is produced by an ozone generator and is then injected into the closed extract duct. When it "collides" with the pollutant, the ozone breaks down the grease in the air, immediately scrubbing it. Translated in chemical terms, this is an oxidation process that results in the generation of water vapors and carbon dioxide as residual products. The thermal energy in the purified extract air can now be recovered in a heat exchanger and fed to the cold supply air.



The ozone detector cuts the production of ozone if a fault occurs.



Ozone sensor

## Safe Use

The ozone is guided in behind the grease filter in the duct and then sucked away by the ventilation. Extract air is only cleaned when the ventilation is operational. A pressure switch on the extract duct detects the negative pressure created when the fan is working, which makes it possible for the ozone treatment to start. If there is no negative pressure, the system will not start.

The ozone treatment is therefore only carried in the closed duct system, and there is no ozone

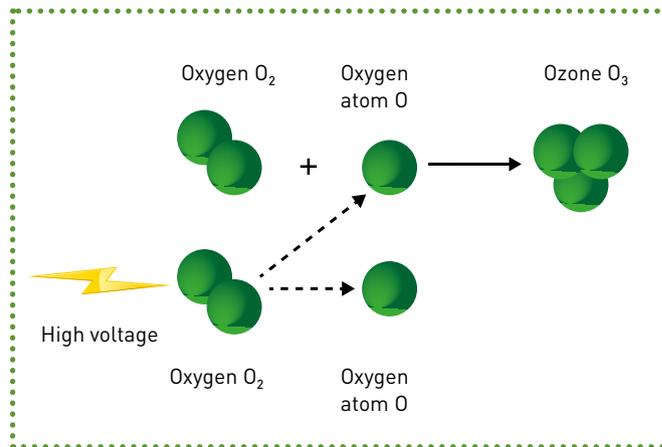
ever in the kitchen. We also recommend the installation of an ozone sensor to detect if there is any ozone in the kitchen air. If an error occurs, the ozone production turns off automatically.

The Swedish Work Environment Authority has developed hygienic limit values for ozone in indoor air or, in other words, acceptable average levels. The limit value for eight hours in a workplace is 0.1 ppm\* (AFS 2015:7).

## Ozone is Formed from Oxygen and Energy

Ozone is a form of oxygen that exists naturally in the environment, where oxygen is made up of two oxygen atoms and ozone of three. If the oxygen atoms are to form ozone, they require an energy input from the sun's UV radiation or a bolt of lightning. On a sunny day, the outdoor air will typically have an ozone concentration of between 0.02 and 0.04 ppm\*. Artificial production of ozone requires either the passage of oxygen through an electrical field (corona discharge) inside an ozone generator or the radiation of air with UV lamps.

\*ppm as a measuring unit is an abbreviation of "parts per million", i.e. one-millionth. Ppm is used as a measuring unit for the concentration of a substance in a food product, water or air.



## Lower Material Requirements

The Swedish industry recommends a stainless grade material in those parts of the extract duct that are affected by high ozone concentrations (Imkanal 2012:2) since 2015. Ozonetech method selected by Hovåsskolan involves the supply of concentrated ozone to the extract duct through a hose made of PTFE. When the ozone reaches the extract duct and meets the air, it is diluted 25,000 times. In other words, ozone concentration in the extract duct is so low that it is possible to lower the material requirements.

# High-Performance System in Hovåsskolan's Kitchen

The City of Gothenburg has chosen an Ozonetech RENA® high-performance ozone system for Hovåsskolan. The high degree of purification of extract air guarantees fire safety, high efficiency as well as reliable operation of the heat exchanger.

Here we will present those components of the RENA® system that have been installed in Hovåsskolan's kitchen. The rest of the products can be found on [www.ozonetech.com](http://www.ozonetech.com).

## ABOUT RENA®

The RENA® system was originally developed for industrial purposes. It meets the industry's requirements for reliability, high purification capacity and as little maintenance as possible. We recommend RENA® for commercial kitchens with medium to high air flows and demands for large purification capacity and low maintenance costs.

## ABOUT THE TECHNOLOGY

The technology used in RENA® is called corona discharge. Ceramic plates connected to high-voltage in an ozone element generate conductive ionised gas, i.e. a corona. Energy is added to the process via micro discharges. Ozone is generated by splitting oxygen molecules into free oxygen atoms in the electric field. The free oxygen atoms then form trivalent oxygen or ozone, as it is more commonly called.

The key to well-functioning ozone treatment is in dealing with the technical, thermal and chemical challenges in connection with ozone production.

- The quality of the raw material, i.e. the purity of the oxygen feed-gas affects the stability of the production process over time.
- The efficiency of the process also depends on the pressure and temperature of the feed-gas. The higher the pressure and the lower the temperature, the more efficient the process.
- Ozone production generates heat – which is why efficient liquid cooling is of vital importance.

## CLEAN OXYGEN AND STABLE COOLING

RENA® uses 93 % dry oxygen, 1 bar g system pressure and max. cooling temperature of 12 °C. This is why RENA® guarantees a constant high level of purification over time, which is unique.

*By producing ozone from clean, dry oxygen, a RENA® system generates pure ozone without any by-products, while the liquid-based cooling maintains a very high treatment capacity.*

## INDUSTRIAL OZONE GENERATOR

Ozone cannot be stored, it is manufactured on site by an ozone generator. The City of Gothenburg opted for an ICT series, ICT 40 ozone generator for Hovåsskolan. Thanks to the PTFE hose used for distributing ozone to the duct, the ozone generator has been placed far away from the kitchen hoods. Ozone is injected via nozzles on the extract duct, straight after the hoods.

The amount of ozone required varies from one kitchen to another. RENA® system's treatment capacity can be adjusted continuously – both manually (as at Hovåsskolan) and automatically.

A treatment system is part of an entire installation. It can remain in contact with its surroundings and be controlled via a RTU, GSM or a web interface.

## A RELIABLE SOURCE OF OXYGEN

One of the key factors for stable ozone production is the existence of a reliable source of oxygen. The RENA® system uses an oxygen generator for producing pure, dry oxygen with low nitrogen content. The equipment separates oxygen and nitrogen from the air, removes all moisture and produces pure oxygen in real time. This makes it possible to increase the quality of the feed gas from 21 % oxygen and 78 % nitrogen (air) to 93 % oxygen and 6 % nitrogen.



## EFFICIENT COOLING SYSTEM

All ozone production generates heat as a by-product.

This heat must be efficiently removed to prevent any damage to the equipment. This is why ICT ozone generators have built-in cooling ducts. Using a liquid coolant makes ozone production more than twenty times more efficient compared to air cooling. This is why the RENA® system employs water cooling. The active liquid-based cooling makes it possible for a single RENA® system to treat up to 12,000 l/s of extract air. RENA® is connected to a central cooling system, to a self-contained closed cooling system or to tap water. The method at Hovåsskolan uses a closed cooling system.

The efficient cooling of the RENA® systems prevents problems with operational disturbances that can affect air-cooled systems, e.g. accumulation of dust on the heatsinks.

## A PRESSURE SWITCH CONTROLS SYSTEM START-UP AND SHUT-DOWN

The treatment system can only start when the kitchen ventilation is operating. A pressure switch on the extract duct gives the system a start and stop signal based on a negative pressure created in the duct when the fan is in operation. This is a very reliable method for control of the treatment system.



*The ozone sensor used at Hovåsskolan is placed in the kitchen. The detector continuously measures the content of ozone in the ambient air and switches the ozone production off if ozone levels exceeds the Swedish National Board of Occupational Safety and Health's limit values for ozone.*

## FOCUS ON SAFETY - OZONE SENSOR

Ozone-based air purification is used to increase safety levels in properties with commercial kitchens. However, care is naturally advised here as with any other equipment. This is why we recommend that RENA® be supplemented with an ozone sensor. The ozone sensor is equipped with a measuring head that is capable of measuring very low ozone concentrations, from 0.00 to 0.100 ppm.



*The ozone meets the greasy extract air right at the kitchen hood and treats it immediately.*

# Ozone Academy

Interest in ozone-based air treatment is just as big as the need for education. We have for over 20 years accumulated knowledge and experience that we now share at our Ozone Academy. We teach about ozone, ozone treatment of air and about how we achieve success with our projects at workshops all around Europe.

We arrange workshops for large groups from individual organisations, but also open workshops for companies with fewer participants. The workshops cover a basic but also available as advanced course and are completely free of charge. Our workshops have now been attended by more than 4,000 colleagues from the industry worldwide.

## Basic Course

The basic course is recommended for those who have no prior experience with ozone-based air treatment. We explain what ozone is, how ozone works as a method of air treatment and what the advantages of ozone treatment are, e.g. a possibility for improvements in energy efficiency, greater fire safety and lowering cost of maintenance of ventilation ducts.

## Advanced Course

The advanced course is aimed at those of you who have a basic understanding and knowledge of ozone treatment and its areas of application. Here we explore and discuss in depth the prerequisites that affect the design, dimensioning and calculation of an ozone-based air treatment system. We also discuss the design of combination techniques, e.g. activated carbon, UV, hydroxyl radicals, scrubber techniques and electrostats.

## Ozonetech at glance

Ozonetech develops and sells products that are based on a unique ozone generation technology. The company was established in 1993, and its core technology was patented in 1996. It has since been in constant development and improvement resulting in several new patents.

We offer our customers air and water treatment products based on an advanced ozone treatment technology. The combination of effective technology, reliability, low energy consumption and low maintenance costs makes our products unique and sought-after.

Ozonetech headquarter is located in Stockholm, and we have sales offices in Finland and Estonia and are in strong development on the European market. All development, manufacture, testing and certification of products takes place in Sweden.

## Lifetime Product Liability

Reduced operating costs, greater real estate safety as well as security are the driving forces behind ozone-based air treatment for extract ducts. This is why Ozonetech offers all of its customers a lifetime Premium Service Agreement. The Agreement covers all wearables and spare parts along with remote monitoring of the installed products using our O<sub>3</sub>Eye™. Our technology makes it possible to monitor the system 24 hours a day, 365 days a year, year in and year out. Any deviations are reported automatically and immediately to our service-centre. We want care-free property owners.

# About Ozonotech

Ozonotech is an award-winning green-tech company that has offered premium products for air and water treatment through the use of ozone since 1993.

Our unique technology and extensive expertise has made us a rapidly growing global company with installations in six continents. All development and manufacturing is located in Sweden. In addition, we have in-house specialists for consultation, planning, installation and service.

As a “Center of Excellence” within air and water treatment, we also collaborate in international efforts to develop global standards for purification solutions.

At Ozonotech, we have a strong incentive to reduce energy waste, health risks and the impact on the environment. Our current solutions provide a multitude of benefits in the processing and food industry, real estate, commercial kitchens as well as in the retail market.

For additional information, visit our website at: [www.ozonotech.com](http://www.ozonotech.com)

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