

viledon[®]
eee.Sy

THE ALL-IN-ONE INLET AIR COOLING AND FILTRATION SOLUTION

USING YOUR WASTE HEAT

FREUDENBERG
FILTRATION TECHNOLOGIES

 **FREUDENBERG**
INNOVATING TOGETHER



INTRODUCING VILEDON EEE.SY

Viledon® eee.Sy is a complete turnkey system for filtering and cooling inlet air to improve the output of gas turbines, engines and compressors in hot and humid climates. Even under current climate conditions, this applies to a big part of the world's entire land mass. eee.Sy stands for "Energy Efficiency Enhancement System". Acting as a filter for the inlet air coming into a turbine plant, eee.Sy simultaneously

filters and cools the air to optimum purity and temperature levels. Viledon® eee.Sy is an entirely unique, patented concept. The advanced eee.Sy technology is available in a single convenient unit, designed for easy and quick integration into any turbine plant. This technology enables increased output by using the waste heat generated by your plant.

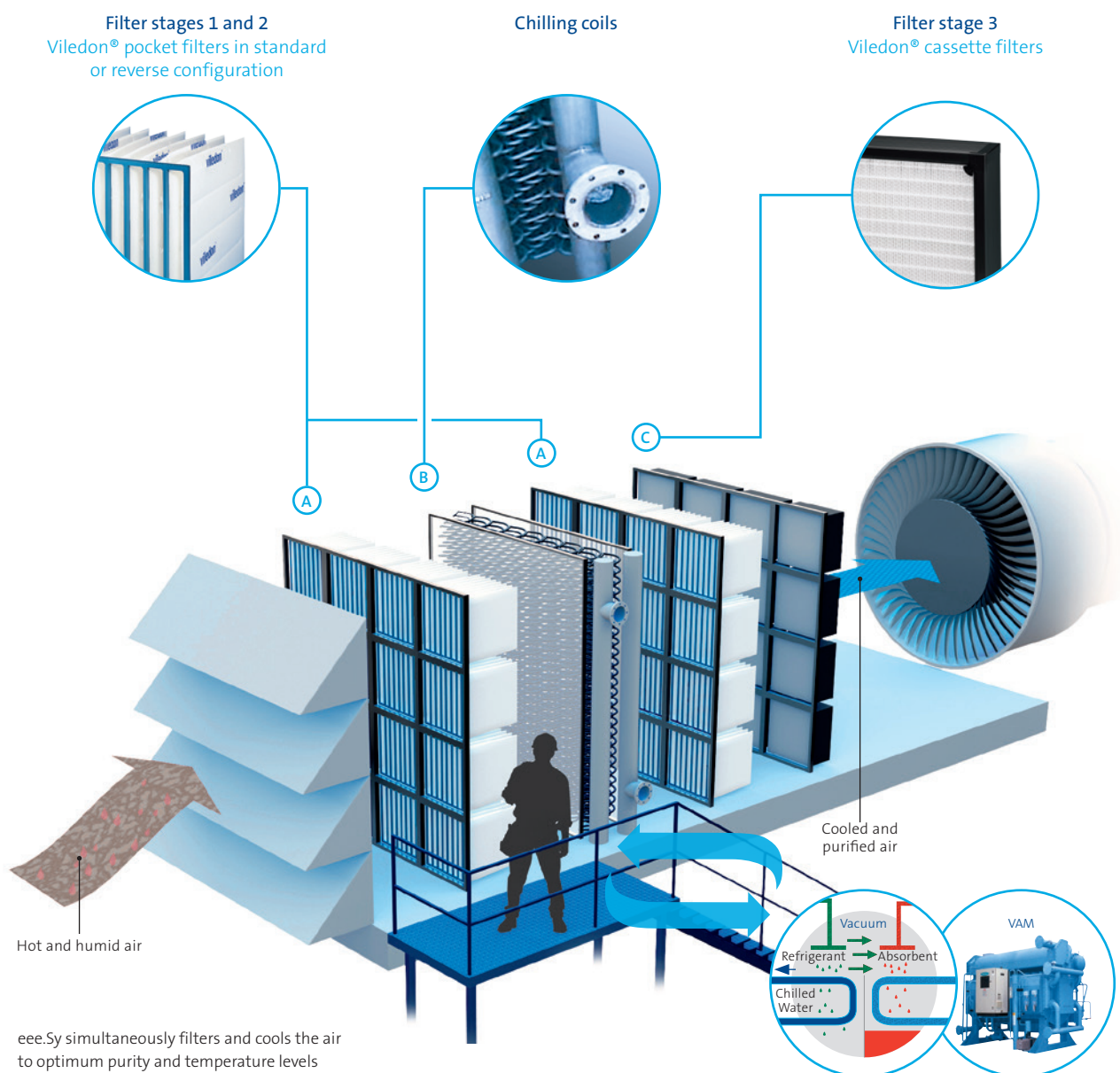
HOW DOES VILEDON EEE.SY WORK?

Viledon® eee.Sy is a fully self-contained inlet air-cooling system, ideally suited to hot and humid climates. It can be delivered in a complete air intake system with the filter stages, the chilling coil, the mist eliminator and the external VAM. Complete waste heat mapping is conducted to analyse the feasibility for the installation of the VAM unit.

Acting as both filter and cooler in one unit, eee.Sy simultaneously filters and cools inlet air to the optimum purity and temperature levels with minimal pressure drop.

This is achieved by placing a chilling coil between the air intake and the turbine or compressor. The chilling coil itself is powered by the VAM unit that uses thermal waste heat generated by the plant.

Viledon® eee.Sy stands for
energy efficiency enhancement System



Viledon® eee.Sy offers you a complete service and installation program, including all construction components and elements for a new-build project or retrofitting of your existing filter house.

Our services at a glance

- Filter house design for desired quality of air
- Energy audit to identify waste heat
- Complete project scheme including engineering, procurement, supply, erection and commissioning
- Project management and service during warranty period



Tailor-made filter house of a successfully realized Viledon® eee.Sy project

INLET COOLING TECHNOLOGIES

AND THEIR SHORTCOMINGS

There are two main methods for cooling intake air: evaporative cooling and refrigeration cooling, each of which offers two options. Although they each have benefits, they also show significant shortcomings. The graph below illustrates the main difference between the two systems.

A. EVAPORATIVE COOLING SOLUTIONS

These work by increasing the humidity of the air to reduce its temperature, at a humidity level close to 100%. This allows the air to be cooled to approx. the wet-bulb temperature. The wet-bulb temperature remains the same throughout the process.

OPTION 1 EVAPORATIVE PANELS

Cellulose or fiberglass panels are inserted into the filter unit. Fresh water falls onto them from above, thus increasing the humidity of the air and reducing its temperature.

Shortcomings

- Limited ability to even approach wet-bulb temperature
- Obstructed air flow leading to higher pressure drop
- Only viable in non-humid climates
- Requires large amounts of water

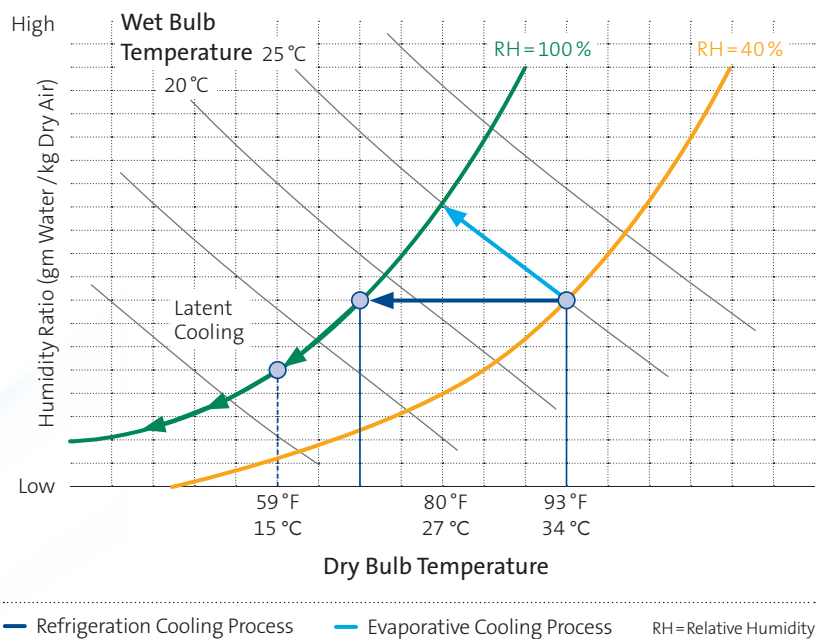
OPTION 2 FOGGING

Multiple metal pipes with nozzles are used to inject very fine water droplets into the air intake. This increases the humidity of the air and reduces its temperature.

Shortcomings

- Cannot go below wet-bulb temperature
- Not suited to humid climates
- Requires the use of expensive demineralised water
- Downstream materials may need to be upgraded to “non-corrosive”

Psychrometric Chart



A SIGNIFICANT IMPROVEMENT

WITH THE BEST AVAILABLE TECHNOLOGY

B. REFRIGERATION COOLING SOLUTIONS

These systems consist of a chilling coil inserted in the filter unit. Chilled liquid circulates through the coil, reducing the air temperature to below wet-bulb temperature, by using sensible cooling and “latent cooling”.

OPTION 1 VAPOUR COMPRESSION

Classic system for air conditioning, equipped with a unit including compressor, condenser, expansion valve and evaporator.

Shortcomings

- High electric power consumption
- Higher parasitic loading than fogging solutions
- Relatively high cost compared to evaporative systems
- High carbon footprint ratio
- High noise from the compressor

OPTION 2 VAPOUR ABSORPTION MACHINE, VAM

System equipped with a unit including condenser, generator, evaporator and waste heat absorber.

Benefits

- Can reach lower temperatures than wet- bulb, easily achieves ISO conditions
- High efficiency, even with high humidity
- Almost no electrical consumption
- Efficiently uses waste heat from the plant
- Significantly fewer moving parts and hence less maintenance
- Silent operation

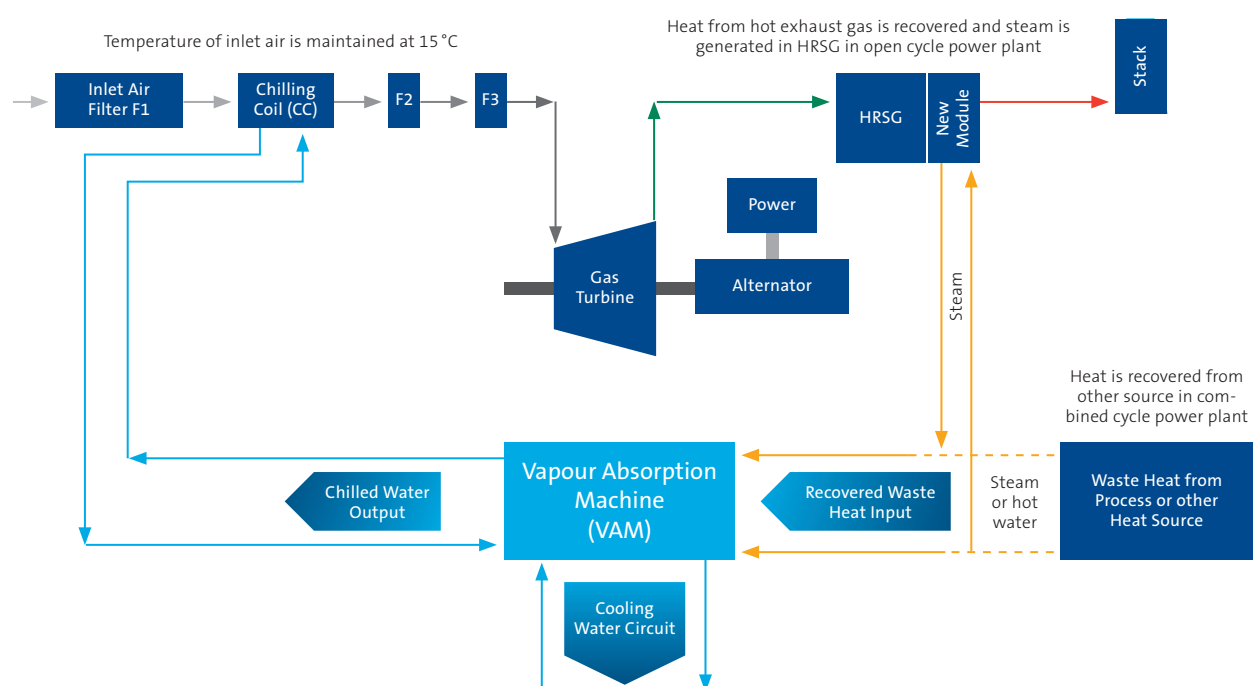
Designed and manufactured by Thermax, the vapour absorption machine (VAM) is the technology chosen for use with Viledon® eee.Sy. It offers significant advantages over existing cooling methods.





THE VAM PROCESS

FOR GAS TURBINE INLET AIR COOLING



HOW DOES VAPOUR ABSORPTION WORK?

A

- Boiling point of the water is a function of pressure
- At atmospheric pressure, water boils at 100 °C
- When maintained at high vacuum, water will boil and subcool itself
- The boiling point of the water at 6 mmHg (abs) is 3.7 °C

B

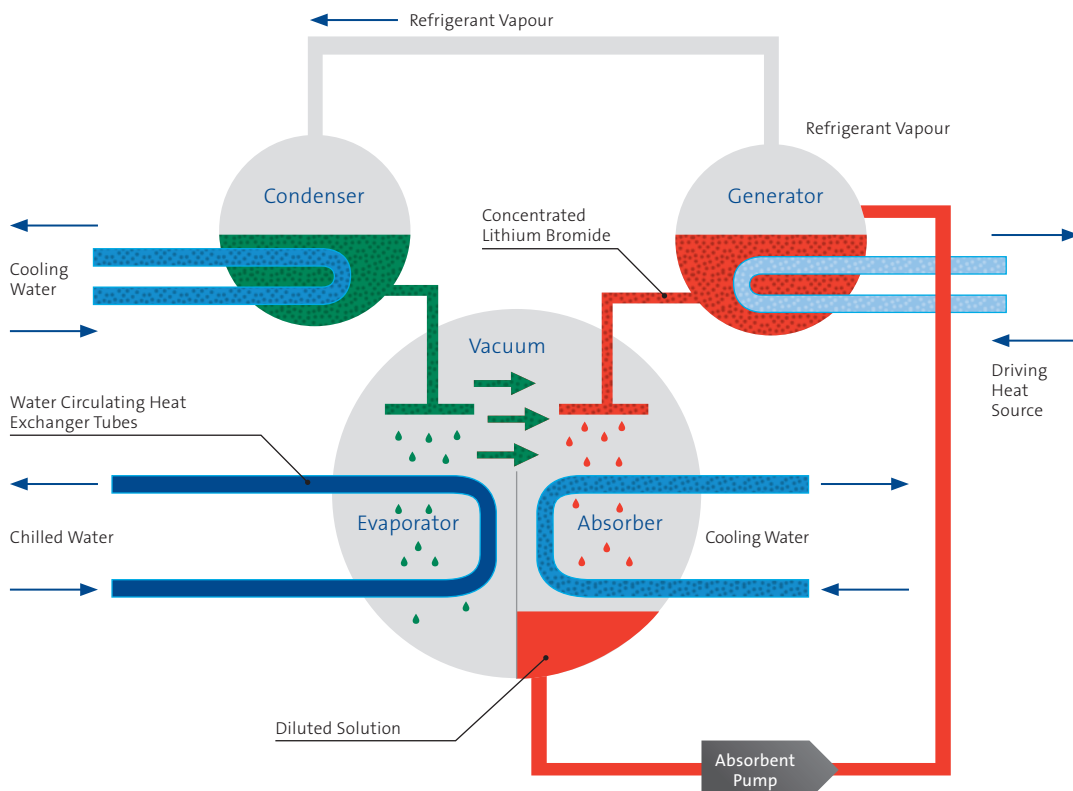
- Lithium Bromide (LiBr) has the property to absorb water due to its chemical affinity
- At higher concentration and lower temperature LiBr absorbs water vapour (refrigerant vapour) very effectively

C

- As LiBr becomes dilute, it loses its capacity to absorb water vapour
- It thus needs to be reconcentrated using a heat source
- Heat source may be steam or flue gases or even hot water

D

- Heating causes the solution to release the absorbed refrigerant in the form of vapour
- This vapour is cooled in a separate chamber to become liquid refrigerant

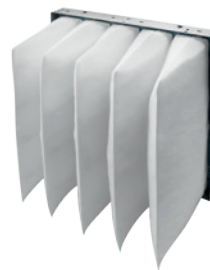


SUPERIOR FILTRATION PERFORMANCE

Viledon® filters meet the highest standards for the protection of people and machinery – even in highly sensitive areas where conventional filters can show deficiencies. Due to their excellent design and construction characteristics, Viledon® filters reduce pressure drop in air filter systems, resulting in energy conservation, lower costs and reduced CO₂ emissions.

Viledon®: the best choice for you

- Low pressure drop
- Long lifetime
- Optimized energy-efficiency characteristics
- 100 % moisture-resistant
- Full inherent stability of the pockets / no contact between the filters and the compartment bottom
- No fiber shedding with pocket filters / no fibers detached from the filter material on the clean-air side
- Glassfiber-free pocket filters
- Reliably leak-proof
- Mechanically stable
- High bursting strength
- Coalescing concepts with “front of filter” drainage function
- Fully incinerable
- EUROVENT-certified fine filters



Reverse pocket filter with water-repellent properties



Compact pocket filter



MaxiPleat cassette filter



THE BENEFITS OF VILEDON EEE.SY

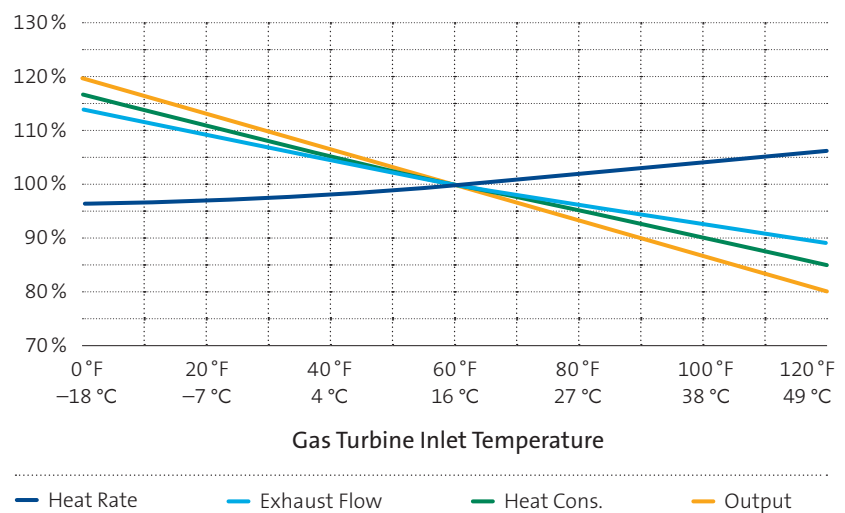
A flexible solution

Depending on requirements, we can either completely retrofit your existing filter house to accommodate Viledon® eee.Sy, or provide a new air inlet system. We will also ensure that the capacity and position of the chilling coil and the various filtration elements are perfectly compatible with your technical specifications.

Our solution allows you not only to achieve optimum power output from your plant. It also means that you can bring your existing turbine up to full ISO standard with minimal investment or downtime.

Viledon® eee.Sy, the integrated combustion air inlet system, offers a modern cooling and filtering solution:

- Increase power output
- Reduce heat rate
- Reduce fouling and damage in the compressor



Viledon® eee.Sy offers major efficiency gains over existing inlet air-cooling and filtration systems, and provides striking performance benefits.

More efficient energy generation

Using Viledon® eee.Sy as your inlet air-cooling solution means that your plant will need less energy to produce the same level of output. What is more, the output will remain stable, no matter how the ambient air temperature may change.

Optimum pressure retention

The ideal combination of a bespoke chilling coil, efficient waste heat energy recycling and state-of-the-art filtration technology results in significantly improved pressure drop performance.

Reducing fouling of the turbine blades

The advanced filter technology employed by Viledon® eee.Sy with high-performance Viledon® filters means that there is less fouling of the turbine blades, resulting in reduced maintenance time and a better turbine performance. Furthermore, by increasing the final efficiency, we also increase overall plant efficiency and give you the potential to generate additional energy, to cope with fluctuating levels of demand.

New mist eliminator system (M.E.S.)

Viledon® eee.Sy's mist eliminator system (M.E.S.) uses progressively structured 100% synthetic fibers based on nonwoven materials. The M.E.S., specifically developed and produced in our own laboratories and factories, has a negligible effect on recommended airflow pressure and thus plays a key role in the overall efficiency of the entire system.

A complete Programmed Logic Control (PLC) system

Developed in partnership with Thermax, suppliers of our VAM units, this unique feature allows the continuous control and regulation of VAM operation, depending on ambient air temperature levels.

filterCair – the complete aftersales service program

Viledon® filterCair is a unique filter management package. It has been designed to ensure that our customers achieve maximum benefit from our top-quality filters installed within the Viledon® eee.Sy project. The flexible, customized package comprises a comprehensive filter program, together with service support and warranties – a cost-effective and sensible completion of your Viledon® eee.Sy program, providing extremely reliable operating and maintenance support.

Key features of the eee.Sy program

- Providing specified air temperature, air quality and pressure drop
- Complete program (design, engineering, procurement, supply, erection, commissioning, maintenance support)
- Single project management point of contact for the entire project



VILEDON EEE.SY HAS ALREADY PROVED ITS EFFECTIVENESS

Since the system was first launched onto the international market in 2000, we have consistently achieved capacity increases of between 18% and 25% across a range of different plants and locations.

A major factor in achieving these results is the system's reliability. With reduced downtime due to blade fouling and excellent overall system performance, less of the technical team's time is taken up by routine maintenance.

The following table gives an indication of real-life results

PREVIOUS CAPACITY	CURRENT CAPACITY WITH VILEDON EEE.SY	PERCENTAGE CAPACITY INCREASE
27.5 MW	33.5 MW	21.82 %
18.0 MW	22.0 MW	22.22 %
19.0 MW	22.5 MW	18.42 %
19.5 MW	23.0 MW	17.95 %
18.0 MW	22.5 MW	25 %

In successful projects in the fertilizer industry, the following factory output increases were achieved

PREVIOUS OUTPUT	CURRENT OUTPUT WITH VILEDON EEE.SY	PERCENTAGE OUTPUT INCREASE
120 K Nm ³ /h	130 K Nm ³ /h	8.33 %
70 K Nm ³ /h	75 K Nm ³ /h	7.14 %
68 K Nm ³ /h	73 K Nm ³ /h	7.35 %

