COOLING THE INTERNET

How much time do you spend on the Internet or on social media each day? At work or in your spare time? For most of us, these are now vital parts of our lives. With data centres literally running hot to keep up with the demands for smooth traffic and enough storage space, the business for server room cooling is getting very lucrative indeed.

TEXT: **ULF WIMAN** PHOTOS: **GETTY** ILLUSTRATION: **PETTER LÖNEGÅRD**

We see it, we want it, and – in some cases – are dependent upon it. Ever-evolving technology and design updates are incessantly tempting consumers to get the latest gimmicks.

The extraordinarily increasing use of mobile devices has skyrocketed Internet use to completely new stratospheres, as we can now be online 24/7, bringing Internet with us everywhere. Our work life depends on it, as does our personal life. We communicate and connect through e-mail and social media, read news and blogs and get information on every imaginable subject, watch movies and sports, listen to music, do our banking as well as store our pictures and music in the cloud. The list goes on. And on...

After a notable surge in the mid-nineties, there were around 413 million Internet users in the world at the turn of the century according to the often-cited statistics provider Internet Live Stats. World population penetration – though very unevenly distributed – was 6.7 percent. The first billion users was reached in 2005, the second in 2010 and now, in 2015, the number is more than 3 billion and counting. The global penetration has passed 40 percent. In many countries, the penetration rate is getting close to 100 percent.

> **“It is easy to believe that a server room is cool, but in fact it is warm and cosy.”**
>
> MATS CARSELID, GLOBALLY RESPONSIBLE FOR DATA CENTRE COOLING SOLUTIONS WITHIN ALFA LAVAL.

These numbers are stunning, but few of us stop to think about what actually makes it all tick. Behind the scenes, it takes an intricate infrastructure comprising a lot of software and hardware, such as servers, storage, network devices, switches and routers, not to mention cables, to handle the staggering amounts of bytes that we produce and store globally each second.

TO MEET THE GROWING challenge, data centres of all sizes have sprung up all around the world – from small to mega – including flexible/containerized and stationary data centres, and of all data centre tiers, from the simplest tier 1 to the high-safety cutting-edge tier 4.

Managing data centres is a fast-growing niche market, and while the numbers vary greatly, one source mentions a 15-percent yearly growth. The uncertainty is in part a result of the hush-hush nature of the business. Due to the absolutely crucial nature of the operation, security and reliability can never be put at stake. Thus data centres are typically windowless, anonymous and closely guarded secrets. Many major Internet players don’t disclose how many data centres they have or their location. It’s part of the game to just share the lowest level of information.

Did you know that, each second, around the world...

- **2,160** photos are uploaded to Instagram
- **9,300** Tweets are sent
- **49,000** Google searches are done
- **102,000** YouTube videos are watched
- **1.4 billion** people are active on Facebook
- **115** billion emails are sent.

THE OPERATION for example requires fail-safe cooling, humidification, air handling, power distribution and backup systems for the backup systems. On the downside, data centres consume huge amounts of energy. According to the American magazine Time, the digital economy uses a tenth of the world’s electricity and one single data centre may use enough electricity to power 180,000 homes. Consequently, energy efficiency is a top priority for data centre operators. All the electronic equipment generates lots of heat, which makes server room cooling a major energy thief.

WITH AN 18-PERCENT annual growth, the data centre cooling market grows even faster than the data centre market. Some 99 percent of all servers are air-cooled, of which CRAC units (Computer Room Air Conditioning) make up about 80 percent. In-row coolers and heat wheels (Kyoto wheels) are other variants to blow air on the servers. There are also liquid-cooled solutions and while these are currently in minority, some solutions, such as the liquid cooling technology of Alfa Laval partner Iceotope (for more information, see Here 32), has shown great promise and may increase in use in the future.

“It is easy to believe that a server room is cool, but in fact it is warm and cosy,” says Mats Carselid, who is globally responsible for data centre cooling solutions within Alfa Laval. “The ideal temperature for a server rack is between 22 and 25 centigrade. If it is too cold, there will be condensation and static electricity on the components; too warm and you risk overheating.”

Behind the server rack the air is typically 10 degrees warmer after passing the electric components, before the air is returned to the CRAC unit via an upper plenum. It takes a lot of air to cool the servers.

It stands to reason that data centres make money from servers, not coolers, so the demand is for small units that take up as little space as possible. But with a small unit, there is only one way to move all the air needed to cool the servers – you accelerate it. To cool a middle-sized data center of 1MW – equivalent of what it takes to power approximately 1,000 homes – an airflow of 70 m3/s is needed, given a temperature difference (delta T) of 12 degrees.

THIS WOULD BE FINE, if it was not for the so-called Venturi effect. This natural law of physics basically explains that when the air speed is increasing above 1.5 to 1.8 m/s, the air pressure is going down. A good example is the geometry of an airplane wing, where the air is split in front of the wing, making some of the air go above and some below the wing. The air going above the wing will be accelerated and air pressure is going down on the upper part of the wing, giving lifting power.

"This is exactly what happens in a CRAC-cooled data centre," Carselid explains. "Due to the fast-streaming air you get pressure variations in the server room. Consequently, you'll have areas with little or no cooling, so-called hotspots."

This is a well-known issue in the data centre business. In pressurized data centres with CRAC units, the operators are often well aware of where the hotspots are and have come up with solutions that work, but monitoring and control can get very complicated.

THE HOTSPOT PROBLEM is usually solved by creating overpressure in the CRAC unit. However, due to air leakage through, for example, doors and joints, you need to blow more air. And this sets the snowball rolling, and the kW consumption spinning. Another pressure factor is to not design the data centre with too narrow aisles, as this may force the airflow to accelerate, creating overpressure.

Adding to the challenge, servers are dynamic over time. For example, a dedicated financial server is extremely busy at the end of the month, maybe peaking three days each month. In the rack next to it may be a gaming server, which gets busy when people come home from school and work in the afternoon and evening. Next to that, there might be a backup server, which works hard between midnight and three in the morning, but is otherwise idle. A data centre seldom works at full capacity, usually about 60 percent.

To address the hotspot and pressure problems, Alfa Laval and Dutch partner Boersema Installatie Adviseurs, BIA, have come up with an unorthodox server room solution, LSV (Low Speed Ventilation), which contrary to common wisdom uses a larger air-cooling unit, the Alfa Laval Arctigo LSV.

"WITH THE LSV, we size and dimension a heat exchanger that is big enough to handle the task,

SLOWING DOWN TO GET AHEAD

Here met up with airflow mastermind Kees Boersema of Dutch company Boersema Installatie Adviseurs to get the history of low-speed ventilation (LSV) and find out what lies ahead.

How did you come up with the idea for LSV?

"A couple of years ago we noticed that our approach to airflow differed fundamentally from the traditional way, which is to force air through the data centre, typically leading to pressure differences and high energy consumption. We realized that pressure, high air speeds and hotspots were related physical phenomena that could be prevented with a different air circulation pattern."

At what point did you realize that the idea could take off?

"The design with low air speeds and hardly any pressure differences not only decimated the energy consumption – it also increased data centre reliability and improved maintenance, fire suppression, noise control, personnel comfort, tier reliability and IT hardware lifetime."

How and why did you hook up with Alfa Laval?

"We had positive experiences with Alfa Laval and contacted product manager Ad Boiten to discuss our requirements for a robust, industrial-quality low-speed ventilation air cooler with a large cross-sectional area. Together with Ad we specified and designed the air cooler, which is easy to move, has optional filters, step-less control, and is durable and almost maintenance-free."

What is next for LSV?

"Additional advantages often fit in naturally with inherently good designs. The slow-moving air and large cross-sectional area make the heat transfer very efficient. After a year-long study, financed by the Dutch government, we successfully developed steering algorithms to further increase the temperature of the air cooler water side, which defines the effectiveness when reusing heat generated by a data centre. This adds sustainability to reliability, durability and energy-efficiency." ■

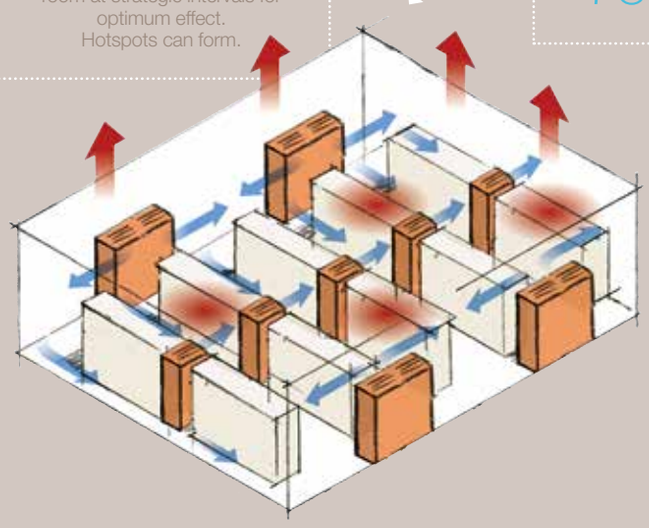
The lowdown on low-speed ventilation

CRAC units

CRAC (Computer Room Air Conditioning) is currently the most common server room cooling technology. The units are placed inside the server room at strategic intervals for optimum effect. Hotspots can form.

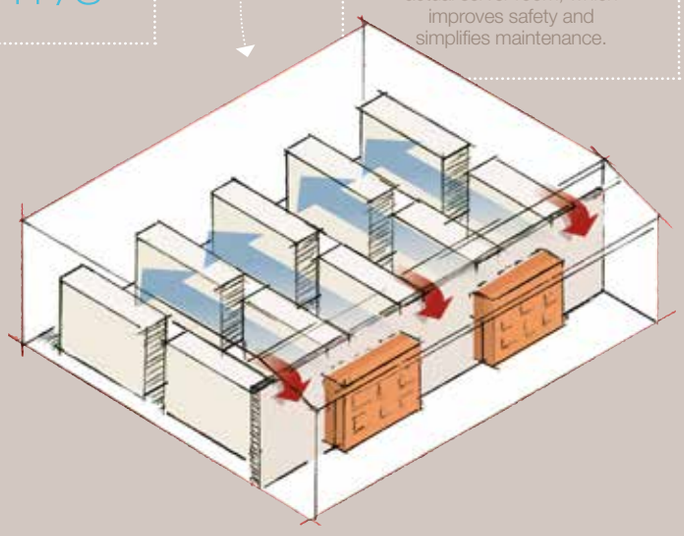
Airflow

70 m³/s



LSV

LSV (Low Speed Ventilation) is a new, competing technology where the air cooler units are placed outside the actual server room, which improves safety and simplifies maintenance.

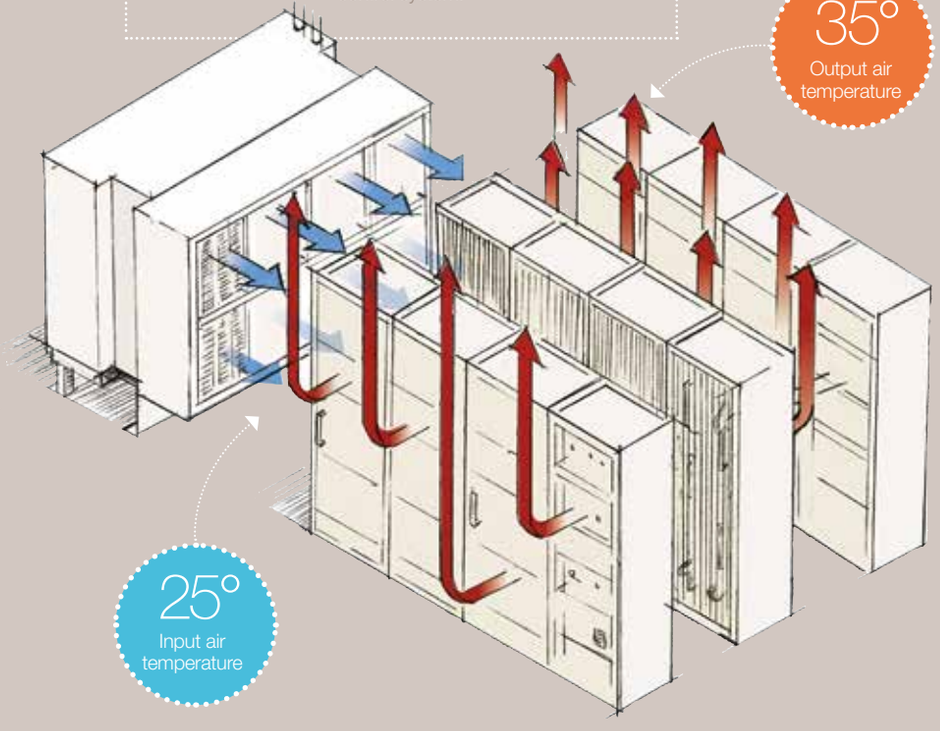


LSV - Low Speed Ventilation

Alfa Laval Arctigo LSV air coolers are specifically designed for server room cooling. They operate with low fan speed, low air velocities and minimal pressure differences along the route of the airflow, providing a simple, stable and reliable climate control system.

The Venturi effect

The so-called Venturi effect explains why an airplane can fly. The geometry of an airplane wing splits the airstream, so that the air going above the wing will be accelerated and air pressure is going down on the upper part of the wing, giving lifting power.



35°
Output air temperature

25°
Input air temperature

Airspeed

1.8 m/s

The threshold above which the Venturi effect kicks in, causing the air pressure to drop.

“The ideal temperature for a server rack is between 22 and 25 centigrade. If it is too cold, there will be condensation and static electricity on the components; too warm and you risk overheating.”

MATS CARSELID, ALFA LAVAL.

without hitting the Venturi effect,” says Carselid. “This way we get a normal pressure in the entire room, still delivering the required amount of air. We don’t have to worry about the pressure at all, which is a totally new way of thinking. In an LSV-cooled data centre, the air availability is controlled, not the air pressure. And that’s a completely different task to do; much easier and cheaper as it requires less controlling equipment.”

With several installations so far the concept is proven, but as in any business, a technology shift within the server room cooling business will take time. But the advantages of LSV are hard to ignore.

Measuring effectiveness in a data centre can be done by the so-called PUE value (power usage effectiveness), which preferably should be as close to 1.0 as possible. “PUE is a rather blunt method, but still a value the data centre industry speaks about,” Carselid says. “It measures the fraction between total facility energy and IT equipment energy. The kW contributors are servers, battery backup systems, cooling, lighting, security, power distribution etcetera.”

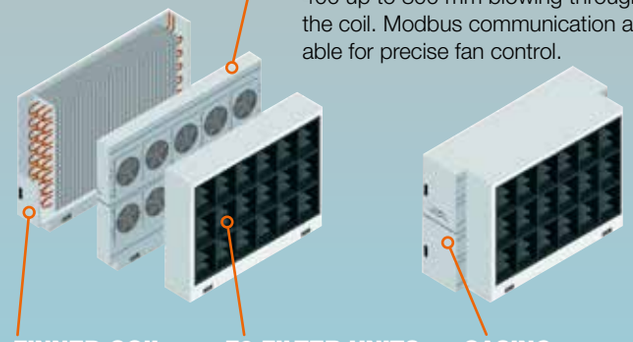
THE COOLING PART is a large part of the total energy, especially if the data centre is using mechanical (chiller) cooling. The effects of using free cooling are great and for that reason some data centres are developed in remote areas with low ambient temperatures.

“The PUE value for the LSV technology is as low as 1.07 with the use of outside air in a Western European installation. This is ground-breaking as the mean PUE value for non-LSV data centres is 1.5,” Carselid explains.

For sure, as the data centre segment keeps growing, the cooling solutions will get more and more effective as well as environmentally friendly. When posed with the questions how much the data centre business can grow and when the curve will break, Carselid is quiet for a moment, then answers thoughtfully: “The server room cooling business is something totally unique,” he says. “The growth curve points right up and the general opinion is that when it breaks we will be in the middle of a complete technology shift – such as when we moved from horses to engine-driven vehicles – where we maybe don’t need servers, or we use another kind of server. No one really knows, but it will be a fantastic journey.”■

Innovative data centre cooling solutions

Alfa Laval Arctigo LSV (Low Speed Ventilation) air coolers are heavy-duty industrial air coolers specifically designed for server room cooling. LSV air coolers operate with low fan speed, low air velocities and minimal pressure differences along the route of the airflow. The units are also placed outside the server room, which simplifies maintenance and keeps security high.
Alfa Laval Arctigo LSV units are available in sizes from 1,115 to 6,515 millimetres (length) and 880 to 2,700 millimetres (height). Refrigerant water. Nominal capacity 7.4 to 311 kW. Air volume 1,865 – 77,750 m3/h.
Alfa Laval also supplies most of the upstream equipment used for data centre cooling systems, regardless of the actual server room solution, including pumps and heat exchangers. The company has a proven track record in free cooling solutions using outdoor air or water. For air these include adiabatic coolers, dry coolers and cooling towers, but an LSV system can even use direct outside air, which reduces the operational costs even further. ■



EC FANS
1 to 10 energy-efficient EC fans, Ø 400 up to 800 mm blowing through the coil. Modbus communication available for precise fan control.

FINNED COIL
Made of heavy-duty industrial-quality corrugated aluminium fins and copper tubes, the modular cooler coil is the heart of the unit.

F9 FILTER UNITS
Easy-to-replace filter units cover the entire coil surface area, which simplifies cleaning and inspection.

CASING
All casing parts are made of corrosion-resistant material with a heavy-duty epoxy finish for easy cleaning and minimal maintenance.

Low speed ventilation benefits:

- Extremely low energy consumption, up to 35–40% lower compared to conventional technology.
- Substantial operational cost reduction
- Simple, stable and reliable climate control system
- No cooling equipment in white space (usable floor space)
- Easier implementation of free cooling
- No “hotspots” caused by high air speeds
- Better white space working environment.