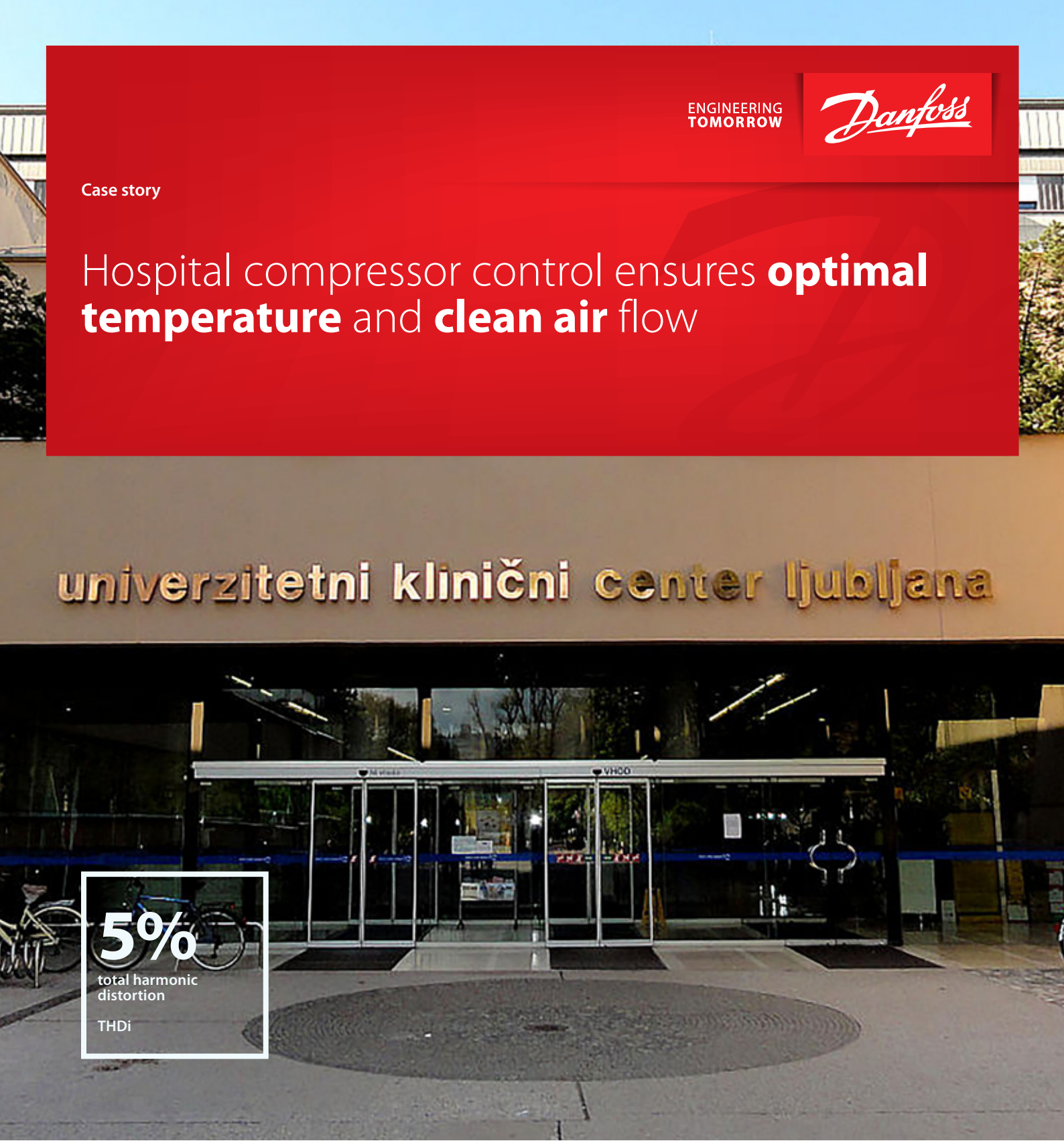
ENGINEERING TOMORROW

Case story

Hospital compressor control ensures **optimal temperature** and **clean air** flow



Air-conditioning and ventilation systems are crucial in hospitals. Optimal temperature and fresh air flow are important factors when treating patients. During treatment, patients spend most of the time in hospital rooms, especially those who are sickest and cannot go outside. Recovery is faster and more efficient in rooms with adequate temperature control than in overheated and unventilated spaces.

In rooms without air conditioning the temperature can exceed 30°C in summer, which even the healthy find difficult to bear, let alone those who are unwell. The efficiency of health-care personnel is also significantly reduced in such conditions.

For these reasons, University Medical Centre (UMC) Ljubljana decided to renovate its cooling engine room. A part of the project also involved the replacement of and regulation of two cooling compressors which had been in operation for more than 40 years. Two 19 XR compressors with 2245 kW of cooling power and 375 kW of electrical power were engineered. The investor requested a THDi harmonic distortion level never exceeding 5%.

Zero interference, **high safety and high efficiency**

For this site, the investor requested low harmonic distortion, with THDi level no higher than 5% irrespective of the load. Additionally, the supplier was expected to deliver a reliable system with a high level of redundancy and security, a zero level of interference with the primary hospital equipment, a high level of safety for maintenance personnel, service and technical support, and savings in energy consumption.

In agreement with the designer and the investor, Danfoss suggested the active solution VLT® Low Harmonic Drive (LHD), where the AC drive and active filter are combined in one unit. The active filter is assembled parallel to the AC drive input; therefore, the AC drive operates normally in the event of filter malfunction and provides operation of the cooling system. Important factors taken into account by the investor when adopting the decision were the list of spare parts, 24/7 service support, and smooth commissioning.

These VLT® Low Harmonic Drives control the new compressors in the machine room.

Additional advantages of using VLT® Low Harmonic Drive:

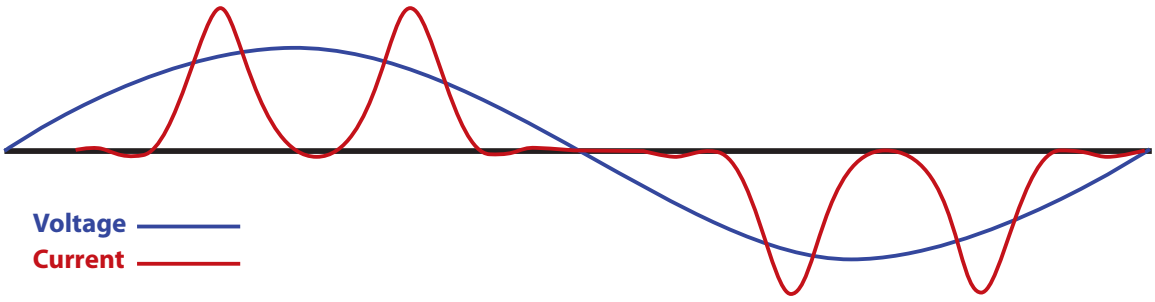
- The voltage on the DC part of the AC drive does not increase
- Lower dU/dt peak at the engine input
- 15-20% lower peak voltage
- Lower bearing currents
- Lower RFI interferences in cables
- Lower dissipation field in condenser banks
- Compliance with dU/dt requirements according to EN 60034 - 17/25
- Compliance with dU/dt requirements according to NEMA MG1- 1998 31.4.4.2.

Investor representatives, their supervisors, main contractor, compressor supplier, and Danfoss as the drive supplier and CNS programmer were all present at the system start-up. All contractors had to demonstrate an extremely high adaptability and consistency in order to provide optimal operation of the system and ensure that it performs its primary function – which is optimal temperature and ventilation of hospital rooms, resulting in higher comfort of patients and healthcare personnel.

Two 19 XR compressors with 2245 kW of cooling power and 375 kW of electrical power now service the cooling system.

What exactly are harmonic distortions?

Harmonic distortions are a by-product of non-linear loads that draw non-sinusoidal current from the network. They are a by-product of all modern electronic control devices. Like all non-linear loads, AC drives generate harmonic distortion in the network as well.



Timing demonstration of voltage (blue curve) and current (red curve). Switching circuit operation is the source of pulse current.

The form of the curve depends on:

- Switching components (for example, SCR diodes)
- The size of condensers in the AC drive
- The size of inductors in the AC drive
- The type of transformer, its size and impedance
- The type, cross-section, length and impedance of the cable
- Other electrical devices

For AC drives, the fifth, seventh, eleventh, thirteenth, (and so on) multiples of nominal frequency are the most distinctive. The harmonic distortion affects the entire system. The consequences of current harmonics are:

- Increased energy consumption
- Greater losses
- Greater resonance currents in the network
- Transformers with a high percentage of non-linear loads connected are more loaded and heat up more than those with mostly linear loads connected
- Cable heating.

Current distortion affects the voltage, resulting in distortion of the power supply voltage as well. If the network is "polluted" with harmonics, then no device connected to this network can operate optimally or at its full capacity. This leads to:

- Lower yield of the power supply network
- Shorter lifespan of connected device.
- Transitional phenomena, "flickers"
- Uneven motor operation (pulsations on the shaft)
- Power supply and production failure
- Significantly increased electromagnetic interference

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Solutions for low harmonic distortion

How can harmonic distortion be reduced? Most AC drives have 6-pulse rectifiers at the input. THDi can reach over 100% of nominal I_{rms} signal here. With the installation of DC or AC inductors the harmonic distortion can be reduced to approximately 40% Irms, which is acceptable for most applications. All Danfoss drives come with integrated DC inductors. Drives without integrated inductors usually have AC inductors added at the input.

When the investor requests a lower level of harmonic distortion, Danfoss offers the following solutions:

- AHF filters
- 12-pulse AC drives with two 6-pulse rectifiers
- 18-pulse AC drives with three 6-pulse rectifiers
- AAF – Active filters
- LHD – Low Harmonic Drive
- AFE – Active Front End

AAF, LHD and AFE are active solutions for reducing harmonic distortions. This means that they actively adapt their operation according to the drive load. It is well known that harmonic distortion changes depending on the load, where the lower the load, the higher the harmonic distortion will be. Other solutions are passive, meaning that they always operate in the same way, irrespective of the load.

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