ENGINEERING TOMORROW

Case story

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

A healthy indoor environment is essential for any recovery process – and creating a reliable HVAC system is a true challenge for any hospital.

Therefore individual control of room temperature and indoor climate is extremely important.

In summer, when temperatures can exceed 30°C, effective air conditioning is especially important in maintaining the comfort of patients and the efficiency of staff.

For these reasons, University Medical Centre (UMC) Ljubljana decided to renovate its cooling system.

The project 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.

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

The hospital specified 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 hospital, 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 hospital 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 technical room.

Additional advantages of using VLT® Low Harmonic Drive:

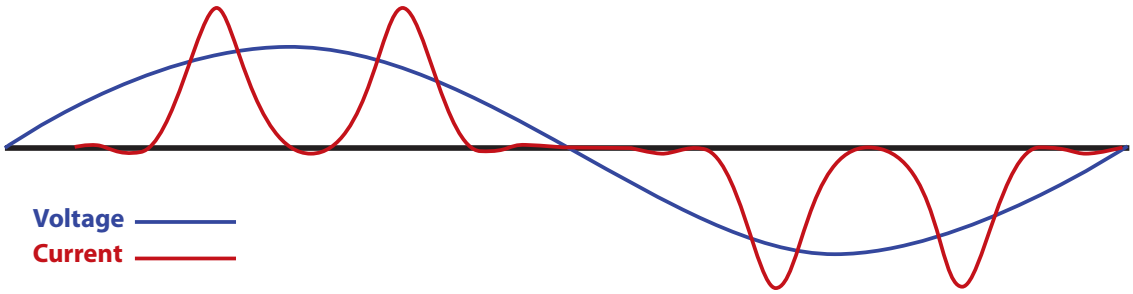
- The voltage on the DC-link of the AC drive is not increased
- Low dU/dt peak at the motor terminals
- 15-20% lower peak voltage
- Low bearing currents
- Low RFI interferences in cables
- Low dissipation field in capacitor banks
- Compliance with dU/dt requirements according to EN 60034 - 17/25
- Compliance with dU/dt requirements according to NEMA MG1- 1998 31.4.4.2.

Hospital 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?

Any non-linear consumers, which draw non-sinusoidal currents from the network, cause harmonic distortions. Practically all modern electronic control devices are source of harmonics. Like any non-linear loads, AC drives might be a reason for harmonic distortions in the network as well.



An example of voltage and current wave forms of non-linear loads. Switching circuit operation is the source of pulse current.

The form of the curve depends on:

- Switching components (for example, SCR diodes)
- The rating of capacitors in the AC drive
- The rating of inductors in the AC drive
- The type of transformer, its rating 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 typical harmonics. The harmonic distortion affects the entire system.

The consequences of current harmonics are:

- Increased energy consumption
- Higher losses
- Higher 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 capacity of the power supply network
- Shorter lifetime 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} current 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 customer 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 of the drive.

The lower the load, the higher the current total harmonic distortion will be. Other solutions are passive, meaning that they also operate in the same way, irrespective of the drive load.

Danfoss Drives, Ulsnaes 1, DK-6300 Graasten, Denmark, Tel. +45 74 88 22 22, Fax +45 74 65 25 80, drives.danfoss.com, E-mail: info@danfoss.com