Drives - Trends in the HVAC Market

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Agenda

- Why Drives in HVAC
- Top 5 Trends
- Ecodesign Directive
- USDOE Specification
- Motor Independency
- Dedicated HVAC features
- Summary
Why to use VSD’s in HVAC

The considerable daily load variation in HVAC facilities makes it economical and attractive to install VSD’s on more or less all rotating equipment such as pumps and fans.

The benefits obtain are typically:

- Better Air quality and indoor comfort
- Substantial Energy Savings
- Better asset protection
- Less maintenance cost
- Higher plant reliability/performance
VSD’s energy saving possibilities within HVAC

Control your pump & fans

- Obtain 20-60% energy saving
- Just 20% reduction in pump / fan speed can offer ~ 45% energy savings

The Affinity Laws:

\[
\frac{Q_1}{Q_2} = \frac{n_1}{n_2} \quad \frac{H_1}{H_2} = \left(\frac{n_1}{n_2}\right)^2 \quad \frac{P_1}{P_2} = \left(\frac{n_1}{n_2}\right)^3
\]

The Cube Law

The power consumed = Speed \(^3\)

15Kw pump at 80% of rated speed
Power = 15kW \(\times (0.8 \times 0.8 \times 0.8)\)
Power = 7.68kW (52% nominal)

15Kw pump at 50% of rated speed
Power = 15kW \(\times (0.5 \times 0.5 \times 0.5)\)
Power = 1.87kW (12.5% nominal)
### Product Portfolio for HVAC Applications

| Product type         | Fans | AHUs | Chillers            | Roof Tops | Pumps | Cooling Towers | Burners | Blowers | Conden-
|----------------------|------|------|---------------------|-----------|-------|----------------|---------|---------| sing units |
| FC-102/103/202       | √    | √    | √ Scroll, Screw, Centrifugal | √ Fans    | √     | √ Fans         | √       | √       | √ Fans Pumps |
| VACON100 Flow        |      |      |                     |           |       |                |         |         |               |
| FC-101/51 VACON 20   | √    | √    |                     | √         | √     | √ Fans         | √       | √       | √ Fans Pumps |
| FCM106 VACON 20X/100X| √    | √    |                     | √         | √     |                | √       | √       | √ Fans Pumps |

**Best in Class Product Portfolio for HVAC Applications**
Top 5 Trends in HVAC Market

1 **Energy Efficiency Focus**; Driven by Urbanization, Local Legislations, Energy Price Increases and Green Footprint Aspirations

2 **Integration**; Drives integrated and supplied by Chiller, Fan and Pump OEMs. EC Motors

3 **Quality and Customization**; Generally increased demand for customization and superior quality performance

4 **Enhanced Usability and Communication**; AMA, Smart Commissioning, Cloud Computing, Self Diagnostics, Wireless HMI & Sensors

5 **ESCO & Retrofit**; Increasing “ESCO” & Retrofit market development
Ecodesign Directive

for motors

Scope of EU MEPS


- The requirements apply to most motors fulfilling these criteria:
  - Power range 0.75 – 375 kW
  - Nominal voltage up to 1000 V (3~)
  - Duty types S1 or S3 (duty factor > 80%)
  - 2 to 6 poles

IEC/EN 60034-30-1
IE classes for motors

There is world-wide demand for more efficient products to reduce energy and resource consumption. The EU legislation on Ecodesign and energy labelling is an effective tool for improving the energy efficiency of products. It helps eliminate the least performing products from the market, significantly contributing to the EU’s 2020 energy efficiency objective. It also supports industrial competitiveness and innovation by promoting the better environmental performance of products throughout the Internal Market.
MEPS timeline Europe

<table>
<thead>
<tr>
<th>In effect</th>
<th>Power</th>
<th>MEPS</th>
<th>MEPS Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.06.2011</td>
<td>0.75 – 375 kW</td>
<td>IE2</td>
<td>-</td>
</tr>
<tr>
<td>01.01.2015</td>
<td>0.75 – 7.5 kW</td>
<td>IE2</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>7.5 – 375 kW</td>
<td>IE3</td>
<td>IE2 + VSD</td>
</tr>
<tr>
<td>01.01.2017</td>
<td>0.75 – 375 kW</td>
<td>IE3</td>
<td>IE2 + VSD</td>
</tr>
</tbody>
</table>

European Regulation (EG) No. 640/2009 defines which motors must fulfill Minimum Efficiency Performance Standards (MEPS), and when.

IE2
EU REGULATION 640/2009
USE WITH VARIABLE SPEED DRIVE ONLY!

Starting in 2015, a label on IE2 motors will typically indicate that use of a VSD is mandatory for operation.

IE/IES classes for VSD and VSD+motor defined in EN 50598-2 are NOT relevant for the alternative “IE2 + VSD”
EN50598-2 Standard

Determining
IES classes VSD + Motor

- IES calculating out of IE classes for VSD and motor is NOT possible:
  \( IE_{2\text{motor}} + IE_{2\text{VSD}} \neq IES2 \)

- IES class can be calculated out of motor and VSD losses

- Motor and VSD manufacturer must declare losses in classification point
IES class examples (7.5 kW “System”)  

<table>
<thead>
<tr>
<th>Motor rating</th>
<th>IES0</th>
<th>IES1</th>
<th>IES2</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 kW</td>
<td>&gt; 1138 W</td>
<td>758 W - 1138 W</td>
<td>&lt; 758 W</td>
</tr>
<tr>
<td>4 kW</td>
<td>&gt; 1397 W</td>
<td>931 W - 1397 W</td>
<td>&lt; 931 W</td>
</tr>
<tr>
<td>5.5 kW</td>
<td>&gt; 1754 W</td>
<td>1170 W - 1754 W</td>
<td>&lt; 1170 W</td>
</tr>
<tr>
<td>7.5 kW</td>
<td>&gt; 2161 W</td>
<td><strong>1441 W - 2161 W</strong></td>
<td>&lt; 1441 W</td>
</tr>
<tr>
<td>11 kW</td>
<td>&gt; 2851 W</td>
<td>1901 W - 2851 W</td>
<td>&lt; 1901 W</td>
</tr>
<tr>
<td>15 kW</td>
<td>&gt; 3596 W</td>
<td>2398 W - 3596 W</td>
<td>&lt; 2398 W</td>
</tr>
</tbody>
</table>

- IES losses can be measured or calculated
- Calculation allows to compare “components” supplied from one or two suppliers
Rooftop Units (RTUs) are commonly used in low-rise buildings such as schools, restaurants, big-box stores and small offices.

RTUs cool approx. half of the total commercial floor space in the US.

US RTU Market is estimated to $3.1B in 2016. (70% of Global Market)

In volume US 2016 estimate is 1.2M units (85% of Global Market)
The U.S. Department of Energy (DOE) has finalized new efficiency standards for RTUs.

Standards will occur in two phases:
- First Phase begins in 2018 and delivers 13% efficiency improvement in products.
- In 2023 an additional 15% efficiency increase will be required for new commercial products.

The new standards will typically save building owners $4,200 - $10,000 over the lifetime of the product.

Total Savings will be approx. $167B on the utility bill and carbon emission reduction will be 885 Tons CO2 over the lifetime of the products covered.
US DOE High-Efficiency RTU Spec. Summary

- **Fan Operation:** Supply air fan shall be **variable volume** or have multi-stage operation with, at minimum, three speeds.
  - Minimum Supply (Evaporator) Fan efficiency 60%
  - Minimum Condensor Fan Efficiency 50%
  - Min. Fan Motor Efficiency 70%
  - Direct drive fans
  - Backward curved fans for the condenser fan

- **Control:** Unit shall have a stand-alone Direct Digital Control (DDC) based control system and be compatible with remote energy management control and diagnostic systems.
  DDC controller shall be compatible with external BACnet or LonWorks third party devices or networks.

- **Economizers:** Air economizing shall be required according to criteria defined in ANSI/ASHRAE/IESNA Standard 90.1-2010.

- **Cooling Performance:** Meets or exceeds the CEE Tier 2 performance specification.
Drives Solution for Fanwalls

- Plug Fans and axial fans in parallel are becoming more and more popular in AHU, RTU, condenser and Fanwall applications.
- Use of high efficiency PM Motors has so far required separate drives for each motor.
- Danfoss Drives now take technology development to the next level!

Solution and Advantages:
- Control Several PM Motors in parallel with only one Drive
- Choose best in class motor, fan and drive to reach maximum system efficiency.
- At motor failure only exchange the motor, not the whole fan including the electronics.
Motor Independency

- Depending on motor technology and IE class these factors can differ:
  - motor dimensions
  - start/acceleration/nominal torques
  - nominal speed
  - starting current
  - performance at VSD

- Most common motor technologies:
  - Induction motor
  - Copper rotor motor
  - Permanent magnet motor
  - Line-start PM motor
  - Synchronous reluctance motor
“ONLY” dedicated HVAC drive for HVAC Applications

Fans
- Fire Mode
- Broken Belt
- Skip Frequency

Pumps
- Sleep Mode
- No Flow
- Dry Pump
- End of Curve
- Cascade Control

Special
- Motor Preheat
- Energy log and trending
- Energy Monitoring
- Running hours
- AEO
Fire Mode – Exclusive feature of HVAC Drive

Fire & Smoke Safety Features

- All facilities with requirements for life safety on essential service applications require Firemode functionality for:
  - Stairwell pressurization
  - Smoke extraction
  - Lift shaft pressurization
  - Car-park ventilation for emergency CO evacuation

- Fire override mode prevents the VLT HVAC Drive FC-102 from stopping for self protecting reasons. In this mode it will continue vital fan operation regardless of control signals, warnings or alarms
Why VFDs in HVAC?
- Energy Saving, Comfort..

Top 5 Trends
- EE focus, Integ, Cust, IOT, ESCO

Ecodesign Directive
- IE3 or IE2+VSD

System Efficiency
- IES1

USDE Specification
- VFDs on fans, BACnet, Economise..

Selection – Motor independent drive
- Ind, PM, Sync, Copper..

Selection - Only dedicated HVAC drive
- Firemode, BCAnet, AEO..
Many thanks for your time and attention!