BALTIMORE AIRCOIL COMPANY
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Vibrations on VFD driven units

1. General condition of the unit

The first thing to do when experiencing vibrations are making following standard checks and adjust if required:
- Check and make sure the belt tension is according to BAC Operating & Maintenance guidelines,
- Make sure the alignment is within tolerance (check BAC O&M guidelines),
- Verify proper installation of motor & motorbase,
- Make sure the drive system (fan, sheaves) are clean of debris & ice.

2. Parameters VFD

When using a VFD extra attention needs to be paid as vibrations might occur due to several reasons which are mentioned below. In case multiple motors are connected to 1 VFD (parallel) there's a greater chance of creating vibrations because of using incorrect parameters.

First of all make sure following motor data in the VFD correspond with the data on the actual motor nameplate:
- Motor power (kW or HP)
- Motor voltage (V)
- Motor current (A)
- Motor frequency (Hz)
- Motor nominal speed (RPM)

Afterwards it's important to verify the 2 following specific parameters:
Note: the parameters below are an example with a Danfoss frequency drive, other manufacturers most likely also have such parameter but the description might be different.

1. Below you can see the torque characteristics parameter. Make sure this parameter is set on Variable Torque (which is for fans, pumps,...), avoid the use of 'auto optimizer' parameters.

1-03 Torque Characteristics		
Option:		**Function:**
[0]	Compressor	*Compressor* [0]: For speed control of screw and scroll compressors. Provides a voltage which is optimized for a constant torque load characteristic of the motor in the entire range down to 10 Hz.
[1]	Variable torque	*Variable Torque* [1]: For speed control of centrifugal pumps and fans. Also to be used when controlling more than one motor from the same frequency converter (e.g. multiple condenser fans or cooling tower fans).Provides a voltage which is optimized for a squared torque load characteristic of the motor.
[2]	Auto energy optim. compressor	*Auto Energy Optimization Compressor* [2]: For optimum energy efficient speed control of screw and scroll compressors. Provides a voltage which is optimized for a constant torque load characteristic of the motor in the entire range down to 15Hz but in addition the AEO feature will adapt the voltage exactly to the current load situation, thereby reducing energy consumption and audible noise from the motor. To obtain optimal performance, the motor power factor cos phi must be set correctly. This value is set in par. 14-43 *Motor cos phi*. The parameter has a default value which is automatically adjusted when the motor data is programmed. These settings will typically ensure optimum motor voltage but if the motor power factor cos phi requires tuning, an AMA function can be carried out using par. 1-29 *Automatic Motor Adaptation (AMA)*. It is very rarely necessary to adjust the motor power factor parameter manually.
[3] *	Auto energy optim. VT	*Auto Energy Optimization VT* [3]: For optimum energy efficient speed control of centrifugal pumps and fans. Provides a voltage which is optimized for a squared torque load characteristic of the motor but in addition the AEO feature will adapt the voltage exactly to the current load situation, thereby reducing energy consumption and audible noise from the motor. To obtain optimal performance, the motor power factor cos phi must be set correctly. This value is set in par. 14-43 *Motor cos phi*. The parameter has a default value and is automatically adjusted when the motor data is programmed. These settings will typically ensure optimum motor voltage but if the motor power factor cos phi requires tuning, an AMA function can be carried out using par. 1-29 *Automatic Motor Adaptation (AMA)*. It is very rarely necessary to adjust the motor power factor parameter manually.

2. Below the 'automatic motor adaptation' parameter is explained. We advise to switch off this parameter at all times.
Note; In case multiple motors are wired to one VFD it's a certitude this parameter can cause for problems when enabled.

1-29 Automatic Motor Adaptation (AMA)		
Option:		**Function:**
		The AMA function optimizes dynamic motor performance by automatically optimizing the advanced motor parameters (par. 1-30 to par. 1-35) while the motor is stationary.
[0] *	OFF	No function
[1]	Enable complete AMA	performs AMA of the stator resistance R_S, the rotor resistance R_r, the stator leakage reactance X_1, the rotor leakage reactance X_2 and the main reactance X_h.
[2]	Enable reduced AMA	performs a reduced AMA of the stator resistance R_s in the system only. Select this option if an LC filter is used between the frequency converter and the motor.

Due to fact we have no details on all VFD brands, there's the possibility other parameters can also cause vibrations.

Without knowing all parameters it might be possible to identify whether the problem is created by the VFD by performing below tests:

A. If vibrations are at a certain frequency you can also prove this by changing the pulleys to simulate a same fan speed with different frequency at the VFD. When the vibrations remain at the same fan speed (but different VFD frequency) it's shown the vibrations are due to resonance created by a VFD.
B. When more units are installed on site and not all are experiencing a problem: switch a VFD from one motor to another and vice versa.
When the problem shifts from motor A to B it's clear the vibrations are due to the VFD and not the motor or unit.

If the problem is due to the VFD but not due to one of above mentioned parameters, please consult the local supplier or manufacturer.

3. Natural frequencies

Each item & structure has a natural frequency. If this frequency is within the range of the motor speed, this will result in significant vibrations.
When putting a unit in operation equipped with a VFD, we advise to go through all frequencies and check for abnormal vibrations during start-up.
This check means letting the motor run from 15 Hz up to 50 Hz (or if applicable 60 Hz) in steps of 1 or 2 Hz and check for vibrations. Each time the frequency is increased, wait for +/- 20 seconds to verify the unit is running vibration-free.
If a frequency(s) with excessive vibrations is present, it should be blocked in the VFD.
For example if natural frequency equals 32 Hz -> skip frequencies ranging from +/- 30 to 35 Hz.

If the problem persists, contact your local supplier or manufacturer in case of additional problems & questions.

4. Unbalance

When the vibrations increase together with the fan speed there's the chance the vibrations are caused by an unbalance in the drive system (most likely the fan).
In such cases balancing of the drive system is probably necessary; contact your local representative.