Reforming electrolytic capacitors in frequency inverters

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Electrolytic capacitors are integral parts of frequency inverters. These inverters are sometimes are stored as spare parts. In case the inverter is switched on without any preparation after several years of inactivity, it might get damaged; or worse, the capacitors might even explode, which leads to extensive damage of the inverter.

This happens due to ongoing chemical processes taking place in switched-off capacitors. These processes cause the growth of leakage current when connected to voltage. What immensely influenced the power of the chemical processes is the temperature during storage; the higher it is, the more powerful the chemical processes and the worse the consequences of connecting the inverter to voltage without preparation. Luckily, these processes can be reverted, and the capacitors can be put into an ideal state again if the right method is used. These problems accompany only electrolytic capacitors, used usually in low voltage inverters. The foil capacitors used in higher voltage inverters do not suffer from the chemical processes mentioned above.

However, not all electrolytic capacitors get damaged during storage, it depends on the specific type and the declared lifetime. Some capacitors can be connected to voltage even after five years of inactivity. Others suffer from such advanced chemical processes that the leakage current of the capacitor is extremely high when voltage is applied. That causes the capacitor‘s temperature to go rapidly up, which is followed by its destruction. Therefore, the so-called reforming electrolytic capacitors must be done preceding the voltage being applied. This reforming causes slow restoration of electrolyte and prepares capacitors for normal usage with full voltage applied full power.

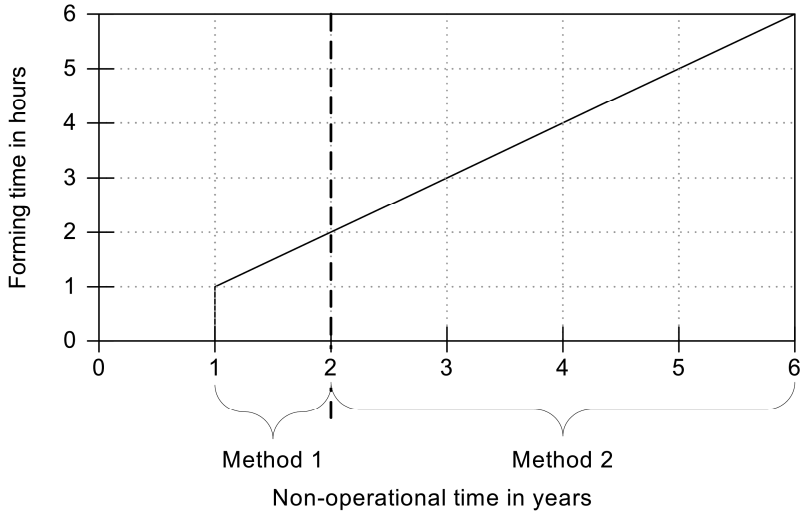
Picture 1 Examples of electrolytic capacitors by EPCOS TDK

Reputable manufacturers of frequency inverters highlight the necessity of reforming capacitors in their manuals and enclose instructions how to do it. The individual methods are slightly different, but same in principle. Generally, capacitors are reformed by gradual increase of voltage; the duration of reforming depends on the duration of inactivity of the inverter. Several specific recommendations can be found below; the ways of reforming (applicable to all types of inverters, depending on the equipment) are also mentioned.

The recommendation from the ABB company, applicable to their inverters

1) The procedure for inverters inactive for less than 2 years

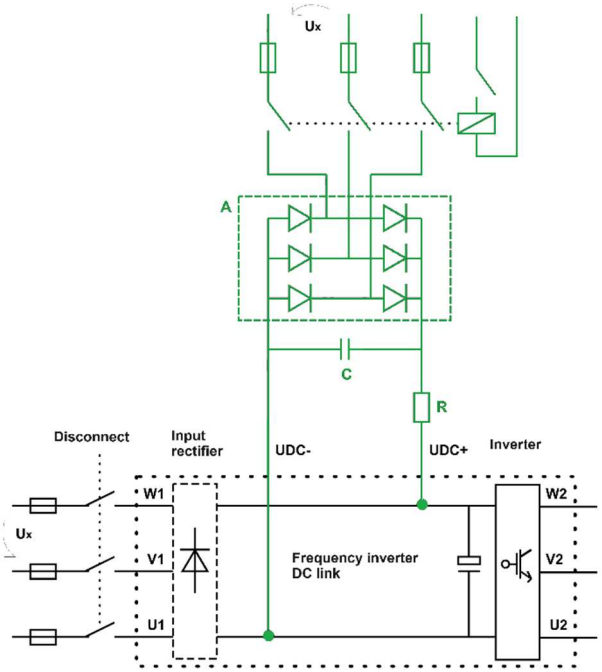
Switch the inverter on for the time given in Figure 1 (Method 1).
The converter turns the capacitors automatically on. Supply the power to the multidrive inverter units and the inverter modules once a year to keep the capacitors active.



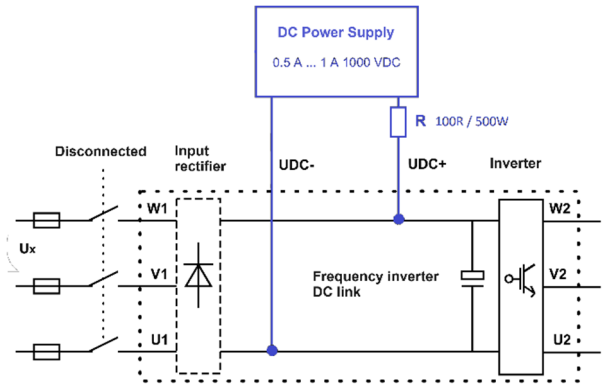
Picture 2 The duration of reforming capacitors

2) The procedure for inverters inactive for 2 years and more

Use method 2 depicted in picture 2 – the voltage is applied on converter DC link either from diode rectifier through limiting resistor (method 2A), or from regulated DC power supply (method 2B), as can be seen in the pictures below.
Concerning the limiting resistor (picture 3), the recommended value for the supply voltage of 400 V is 220 Ω / 700 W. The ideal voltage for both methods √2 x rated AC supply voltage, eventually even the capacitor rated voltage. Max. recommended current is 500 mA. In case it is not possible to limit the current, it is needed to increase the voltage gradually, for example 100 V at the time; in this way, the max. voltage shall be reached in the time depicted in picture 2.



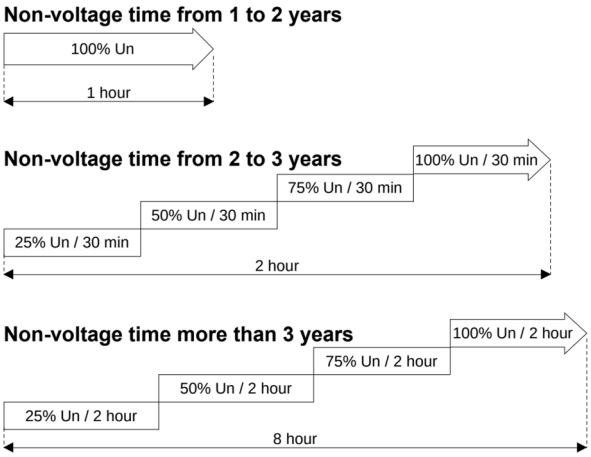
Picture 3 Reforming circuit for method 2A



Picture 4 Reforming circuit for method 2B

The recommendation from the SIEMENS company

When they are to be used, the inverters by SIEMENS must be reformed following inactivity longer than 2 years. In case of long-term inactive inverters, it is recommended to apply voltage to them regularly for one hour at the time. When taken care of in this manner, they may be used immediately shall the need arise. The right way of reforming the inverters (picture 5) is recorded in the manual. Once again, the duration of reforming depends on the duration of inactivity; the voltage applied shall be gradually increased.



Picture 5 Reforming capacitors in inverters by SIEMENS

The recommendation from the YASKAWA company

The YASKAWA company recommends this procedure for inverters inactive for more than 1 or 2 years:

1) Connect the inverter input to a three phase variable voltage transformer.
2) Make sure it is set to zero output voltage and connect the power supply
3) Slowly increase the voltage to 100 V. Observe any abnormal actions of the inverter for 5 to 10 minutes.
4) Gradually increase the voltage 100 V at the time, wait 5 to 10 minutes between every increase. After achieving the final voltage, apply it for another 15 minutes. If there are any abnormalities during the reforming, it is recommended to repeat the procedure.

The service technicians generally choose reforming with a three phase variable voltage transformer and gradual increase of voltage, similarly to what both the YASKAWA and the SIEMENS companies recommend. This method is universal and can be used for any type of inverter in need of reforming. There are, however, also some disadvantages. It is a time-consuming procedure, the current flowing to capacitors is not actively limited and the equipment needed is heavy and bulky. The ideal procedure is thus to use specialized power supply, designated specially for reforming capacitors. Such power supplies usually enable automatized execution of the procedure; according to the pre-set voltage, current and duration of reforming. They are equipped with current limiter and in some cases also with controlled discharging of capacitive load after power supply shutdown. They are mobile and the power may be supplied from a common socket (230 V).

Sources used:

1) *https://en.tdk.eu*
2) *https://en.wikipedia.org*
3) *Publicly available materials from companies YASKAWA, SIEMENS a ABB*