Possibilities of Diminishing the Distortions Introduced by Superior Harmonics of Electric Current

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Abstract – **The purpose when commanding electric engines of alternative current, is to limit the level of the disturbances in the charge network by using some filtration devices coupled in series or parallel with the charge network.**

The superior harmonics filters illustrate the limits of the superior harmonics which can be provided by static converters of frequency or by static converters of continuous current. The types of filters are described due to their capacity to reduce the disturbances of tension or current under the values of the superior limits admitted. There are presented a few filters of power for the command of electric machines.

The study exemplifies the need of interconnections between the charge system, the converter and the filter of superior harmonics.

Keywords – **Charging sources / compensators / static converters / cyclic converters / power filters / harmonic interfering.**

1. Types of filters for electric current harmonics

In the practical applications of electrical actions using the command of electric machines, the static converters, it may be distinguished different types of superior harmonic filters of the electric current, as shown in fig. 1, fig. 2, fig. 4.

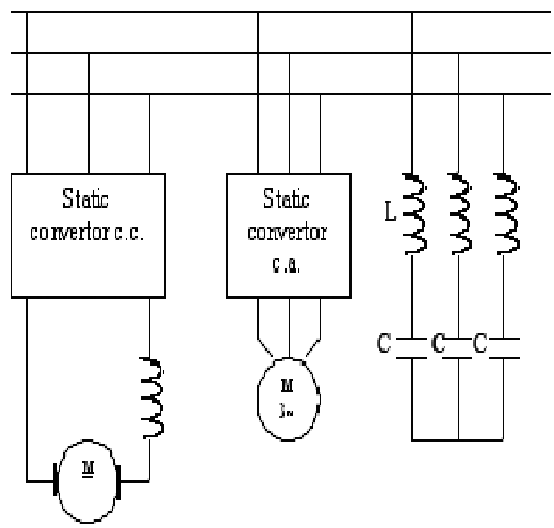


Fig. 1. Harmonic filter - type A

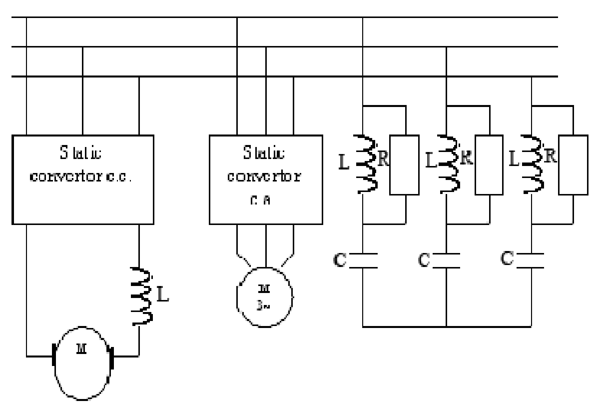


Fig. 2. Harmonic filter- type B

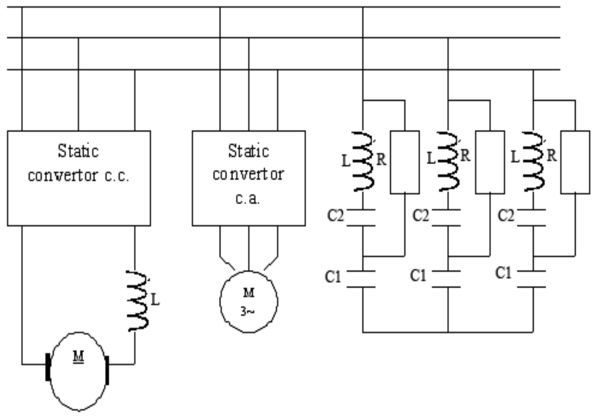


Fig. 3. Harmonic filter - type C

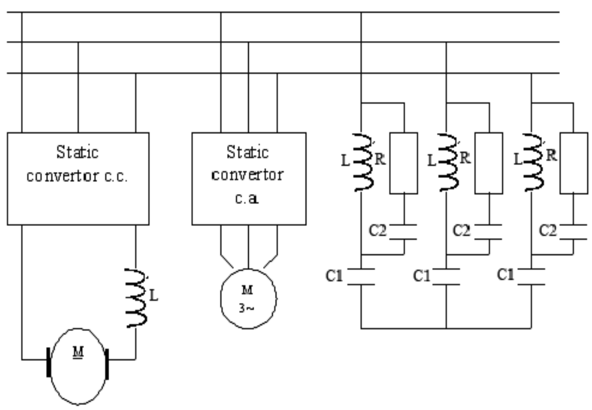


Fig. 4. Harmonic filter - type D

A-type filters are generally used in the case of electrical actions of continuous current, filters of type B and C are used in the networks where the superior harmonics are completely diminished with the parallel resonance effect; for this reason these filters have to be completed also with other possibilities of diminishing the superior harmonics (connections of the transformers).

D-type filters are not recommended in the case of commands with static converters of alternative current where the frequency is reduced under the nominal value, because of the fact that the filtration is disturbed by the presence of the non unitar current harmonics.

Filters of type B and D may be used in the case of electrical actions of alternative current for powers that exceed 100 KW, in order to eliminate the disturbances of finite power electric networks.

Filters of type B and D are made in order to reduce the frequency harmonics if they are higher than their frequency of tuning, being also called filters of high band or go up filters. Filters of type C have a fabulous importance in cyclomotors applications and can also be used in charging networks of electric arc furnace at a voltage of 35 kV.

For C-type and D-type filters, the important role of the capacity C2 is to prevent the excessive overcharge of the resistance R, because of the current harmonics of fundamental frequency.

This phenomenon becomes important at low frequencies of tuning (accord) of the filter, which leads to important wastes of energy.

The economies realized in the presence of the capacity C2 have to be interpreted near the expenses of installation and the low price of the resistance.

The C-type filter is considered to be useful for the harmonics of order 2, when the resistor will reduce the variations of the capacitive voltage to a higher amplitude (three times higher) than the amplitude of the network voltage.

These types of filters need a strict value of the capacitor, because otherwise the functioning duration of the condenser is reduced.

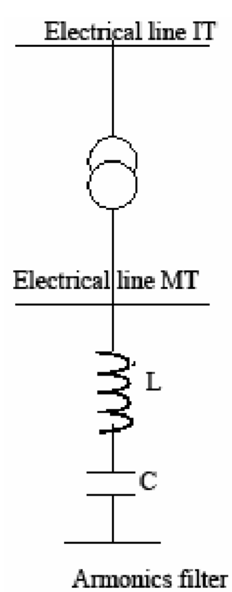
2. The harmonic resonance of filters

Besides the condition that harmonic filters have to realize filtration, they can also realize functions that are in opposition with their destination, becoming incompatible with the characteristics of the charging network.

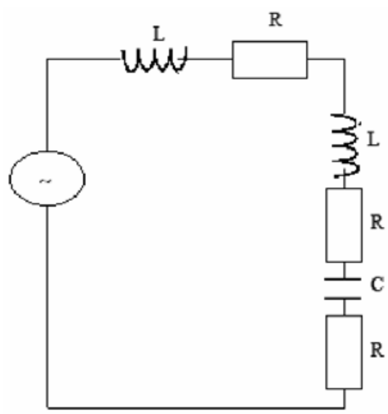
There are 2 types of harmonic resonance: harmonic parallel resonance and harmonic series resonance.

2.1. The parallel resonance of superior harmonics currents produced in the filter's interior

The parallel resonance is the most used type in practical applications.



a)



b)

Fig. 5. Electric scheme of an electric network with a LC filter (a)
Equivalent electric scheme (b)

In the electric scheme and the equivalent electric scheme in fig. 5 there are taken in consideration the resistances and the equivalent inductivities of the respective line of the filter.

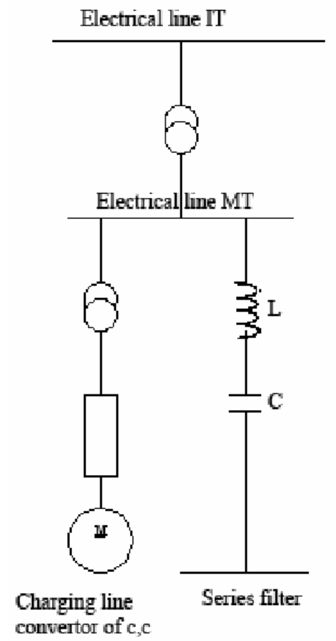
At tuning frequency of the filter, the equivalent impedance of the filter is practically 0. At lower frequencies than the resonance frequency, because of the coupling between the inductivity L and the capacity C, it results a larger impedance. In this case, the current of the harmonic is injected in the interior of the filter, producing high voltages with the effect of increasing the currents both on the charging line and on the filter line.

In the case of transitory range, the harmonics of order 1, produce dangerous over voltages which can destroy the converter, which leads to configuration measures of the charging network with 2 transformers in parallel or other measures concerning the magnetic coupling between the circuit elements, so that the transitory range can be diminished.

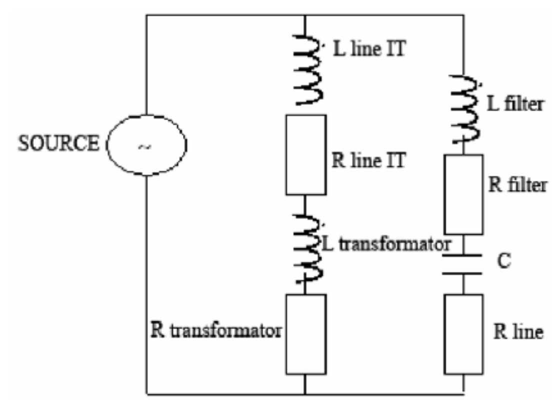
2.2. The series resonance

In transitory ranges, the tuning of the filters of the superior harmonics is realized out of first order harmonics or emit their accord for frequencies from the neighborhood of the fundamental harmonic.

The tuning of the harmonic filters for frequencies under the fundamental frequency, should have the effect of destroying the period of the resonance phenomenon. The series resonance appears at the same frequency as the parallel resonance.



a)



b)

Fig. 6. Electric scheme of a network with a LC series filter (a)
Electric scheme of the series filter (b)

The consequences of the charging system scheduled with a LC series filter in the case of the resonance at fundamental frequency are estimated to be of at least 10 times higher than in the case of parallel filter.

3. Conclusions

Static converters may perturb or not the appropriate functioning of other receivers coupled on the same charging line. Nevertheless, the quantitative and qualitative estimation of the perturbation level can be realized only after an analysis of the case.

This is even more important as the electric actions are of higher powers and the power of the charging lines is not considered to be infinite.

The minimal information that has to be presented by a case study is:

– the demand of reactive power of high state and the adjustment of high voltages, to evaluate the limits of the system and if necessary a filtration study SVC;

– the active medium power, the reactive power and the power factor to evaluate whether the network needs a system to correct cosφ;

– the capacitive compensation at the exit of the correction equipment of the power factor;

– the decomposition of the compensation of the power factor on one or more filters of superior power harmonics;

– minimal and maximal levels of the spectrum of superior harmonics of the current so that the compensation system is compatible to the electric network;

– the calculus of the maximal distortion of the superior frequency voltage in the bars of the static converter and then a precise evaluation of the distortions during the functioning of the converter;

– improvement of the filter's characteristics until the parallel resonance phenomena are omitted;

– improvement of the characteristics in such way that the distortions of voltage and current are under the admitted limits of the society which supplies the electric energy;

– improvement of the performances until series resonance phenomena are eliminated.

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