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In aceasta lucrare se propun modele formulate in domeniul frecventei pentru consumatorii neliniari din retelele electrice de joasa tensiune. Aceste modele pot fi utilizate pentru analiza cu metoda balantei armonice implementata in programul ADS (Advanced Design System) si rezulta prin prelucrarea rezultatelor unor masuratori realizate cu un analizor de calitate a energiei.

Modelele unor consumatori neliniari alimentati cu redresoare cu diode (lampi fluorescente, aspiratoare de praf, aparate de aer conditionat, frigidere, cuptoare cu microunde de uz menajer) sunt valabile pentru un interval de tensiuni (0.1 Vn, 1.1 Vn), unde Vn este valoarea efectiva nominala a tensiunii retelei. Un astfel de model caracterizeaza

- valoarea efectiva a fiecarei armonice de curent printr-un polinom de gradul intai in V1 (valoarea efectiva a componentei fundamentale a tensiunii la bornele consumatorului)
- faza initiala a aceleiasi armonice de curent printr-un polinom de gradul inati in φ1 (faza initiala a componentei fundamentale a tensiunii la bornele consumatorului).

Coieficientii acestor polinoame se obtin prin calcule relativ simple.

S-au masurat componentele armonice (caracterizate prin modul si faza initiala) ale curentilor absorbiti de un redresor monofazat si de un redresor trifazat, ambele cu tiristoare. Masuratorile au fost efectuate pentru un numar de valori ale V1 si α1 (unghiul de conductie identic al tuturor tiristoarelor).

A fost elaborat modelul in domeniul frecventei al redresorului monofazat cu tiristoare. Acest model este caracterizat de niste polinoame neliniare de argumente V1 si α1, care exprima atat valoarea efectiva cat si faza initiala a fiecarei armonice de curent. Coieficentii acestor polinoame au fost determinati prin doua metode:

-prima metoda a folosit functia poly45 din MATLAB in care coieficientii polinoamelor ce caracterizeaza modelul au fost determinati plecand de valorile masurate pentru sase valori ale V1 si cinci valori ale

– a doua metoda a folosit, in mod asemanator, polinoame de grad superior celor din poly45 ai caror coieficienti sunt determinati in aceeasi maniera.

O a treia metoda foloseste un algoritm genetic care calculeaza valorile efective si fazele armonicelor de curent plecand de la valorile instantanee masurate ale formei de unda a curentului. Rezultatele obtinute arata ca cel mai bun este algoritmul genetic, urmat de metoda propusa si de poly45. Pentru a verifica consistenta acestor metode, caracteristicile modulelor si fazelor armonicelor de curent pentru α1=70 grade au fost reconstituite cu erori acceptabile cu toate metodle, folosind valorile masurate pentru celelalte unghiuri de conductie.

O lucrare recenta arata ca, cel putin in cazul unui circuit trifazat dezechilibrat cu 150 de condensatoare, 150 de diode, 100 de bobine si 200 de rezistoare, timpul de simulare cel mai scurt se obtine folosond modelele in domenul frecventei implementate in programul ADS. In ordine crescatoare a timpului de simulare urmeaza metoda shooting cu Newton Raphson implementata in CADENCE, analiza tranzitorie din CADENCE, metoda balantei armonice din CADENCE si metoda clasica a balantei armonice din ADS. Cu exceptia metodei dezvoltate in acesata teza, toate celelalte folosesc modele formulate in domeniul timpului.

This PhD thesis proposes frequency domain models for nonlinear loads in low voltage electric power networks. These models are suitable for simulations using the harmonic balance method implemented in ADS (Advanced Design System) software and are computed by processing the outcomes of some measurements made with a power quality analyzer.

These models of certain nonlinear loads with diode rectifiers (fluorescent lamps, vacuum cleaners, air conditioners, refrigerators, microwave ovens for home use) are valid for a voltage range (0.1 Vn, 1.1 Vn), where Vn is the RMS standard voltage value. This kind of model characterizes

- the RMS value of each current harmonic in terms of a 1st degree polynomial in V1 (RMS value of the voltage fundamental harmonic at the consumer's terminals)
- the initial phase of the same current harmonic in terms of a 1st degree polynomial in φ1 (initial phase of the voltage fundamental harmonic at the consumer's terminals).

Coefficients of these polynomials can be obtained using simple calculations.

We measured the harmonic components (characterized by module and phase) of the input current for a single-phase rectifier and for a three-phase rectifier, both with thyristors. Measurements were performed for a set of V1 and α1 values (identical conduction angle in all thyristors).

We established a frequency domain model for a single-phase rectifier with thyristors. This model is characterized by nonlinear polynomials of V1 and α1 variables, which give both the RMS value and the initial phase value of each current harmonic. Coefficients of these polynomials have been determined by two methods:

- the first method used the *poly45* function in MATLAB, where polynomials' coefficients characterizing the model have been computed starting from the measured values of six values of V1 and five values of α1
- the second method used, in a similar manner, higher degree polynomials as compared to those in *poly45*, whose coefficients have been determined similarly.

A third method uses a genetic algorithm which computes the RMS values and phases of the current harmonics starting from the instantaneous values of the measured current. The results we obtained show that the genetic algorithm is the best, followed by the proposed method and by *poly45*. In order to check the consistency of these methods, the characteristics of the modules and phases of current harmonics for α1=70˚ were reconstructed with acceptable errors for all methods, using the measured values for the other conduction angles.

A recent paper shows that, at least in an unbalanced three-phase circuit with 150 capacitors, 150 diodes, 100 coils and 200 resistors, the shortest simulation time is obtained using the HB method employing the frequency domain models implemented in ADS software. Other methods, in the ascending order of the simulation time, are: the Newton Raphson shooting method implemented in CADENCE, transient analysis of CADENCE, harmonic balance method of CADENCE and the classic harmonic balance method of ADS. Except for the method developed in this paper, all other methods use time domain models.