ABSTRACT

Power quality improvement has a positive impact on sustained profitability of the distribution utility on the one hand and customer satisfaction on the other. In distribution systems, the current harmonic distortion should be limited to an acceptable limit to avoid heating, losses and malfunctioning of power system components. The Total Demand Distortion was introduced in IEEE Std. 519-1992 to measure the current distortion level instead of the total harmonic distortion that was introduced in the earlier version of the IEEE Std. 519-1981. Although the value of the total demand distortion index can quantify the current harmonic distortion level, it cannot reveal whether this distortion level is within or outside permissible limits. Therefore there is a need for an index that can evaluate the current harmonic distortion and reveal whether this distortion is within or outside the allowable limits.

An Adaptive Neuro-Fuzzy Inference System based Total Demand Distortion Factor (ANFIS-TDDF) is proposed in this thesis work to evaluate the current harmonic distortion. From the results obtained when applying the proposed ANFIS method into different distortion cases in sinusoidal and non-sinusoidal situations, it is found that the ANFIS-TDDF is able to convey two important information: it can give an indication on how much free is the current waveform from distortion or how much near the sinusoidal wave
shape and also decide whether the distortion contained in the current is within the acceptable limit or not, which cannot be obtained from the TDD alone. Also the ANFIS-TDDF proves to be very sensitive to any changes in the TDD values or short circuit values. In addition ANFIS TDDF values are affected by any distortion in the voltage waveform which already affects the current waveforms.

In sinusoidal situations, power factor definition is unique and expressive. However in non-sinusoidal situations and/or nonlinear load different power factors are proposed to express these situations. New definitions of electrical quantities in non-standard situations are needed because of the changes in the situation in power systems. Power factor is fundamentally an index of the quality of power that allows a user in a deregulated market to select an electricity provider on the basis of level of quality of the delivered power. As a result, there is a need to evaluate the quality of the power delivered through evaluating a power factor index.

In this thesis work, an ANFIS based Representative Quality Power Factor (RQPF) is introduced. The proposed ANFIS-RQPF represents the existing different power factors - displacement power factor, transmission efficiency power factor (TEPF) and oscillation power factor (OSCPF). The ANFIS-RQPF can represent an essential module for evaluating and amalgamating the three power factors. The ANFIS-RQPF was applied in linear/non-linear loading conditions and supplied from sinusoidal/non-sinusoidal sources, considering lagging and leading power factor cases. It is found that this factor is very expressive and accurately represents these power
factors in all cases. The power of the ANFIS-RQPF is to characterize qualitatively and, at the same time, quantitatively the degree of electric power system utilizations by a single index while carrying all of the characteristics of the three power factors that it represents.

The ANFIS based approach is also used to calculate the ANFIS-RQPF in three-phase unbalanced systems. In three-phase systems the ANFIS-RQPF is a single value index that represents a blend of the three recommended power factors, fundamental positive-sequence power factor (FPSPF), TEPF and OSCPF, each having three linguistic variables assigned as inputs. THE ANFIS-RQPF represents the three recommended power factors FPSPF, TEPF and OSCPF more accurately in three-phase systems.

The proposed ANFIS based Power Quality Assessment methods will be very useful for billing purposes since it has proven to be very sensitive and suitable for all operating conditions. Therefore, customers will be charged the correct penalty, under all conditions. The ANFIS based methods also have the advantages of being simple, easy to be implemented, flexible, easily altered, adjusted and contains its knowledge base. So there is no need for an expert after the designing stage.