# Application of artificial neural networks for conformity analysis of fuel performed with an optical fiber sensor

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**Abstract.** The liquid fuel quality control is an important issue that brings benefits for the State, for the consumers and for the environment. The conformity analysis, in special for gasoline, demands a rigorous sampling technique among gas stations and other economic agencies, followed by a series of standard physicochemical tests. Such procedures are commonly expensive and time demanding and, moreover, a specialist is often required to carry out the tasks. Such drawbacks make the development of alternative analysis tools an important research field. The fuel refractive index is an additional parameter to help the fuel conformity analysis, besides the prospective optical fiber sensors, which operate like transducers with singular properties. When this parameter is correlated with the sample density, it becomes possible to determine conformity zones that cannot be analytically defined. This work presents an application of artificial neural networks based on Radial Basis Function to determine these zones. A set of 45 gasoline samples, collected in several gas stations and previously analyzed according to the rules of Agência Nacional do Petróleo, Gás Natural e Biocombustíveis, a Brazilian regulatory agency, constituted the database to build two neural networks. The input variables of first network are the samples refractive indices, measured with an Abbe refractometer, and the density of the samples measured with a digital densimeter. For the second network the input variables included, besides the samples densities, the wavelength response of a long-period grating to the samples refractive indices. The used grating was written in an optical fiber using the point-to-point technique by submitting the fiber to consecutive electrical arcs from a splice machine. The output variables of both Radial Basis Function Networks are represented by the conformity status of each sample, according to report of tests carried out following the American Society for Testing and Materials and/or Brazilian Association of Technical Rules standards. A subset of 35 samples, randomly chosen from the database, was used to design and calibrate (train) both networks. The two networks topologies (numbers of Radial Basis Function neurons of the hidden layer and function radius) were built in order to minimize the root mean square error. The subset composed by the other 10 samples was used to validate the final networks architectures. The obtained results have demonstrated that both networks reach a good predictive capability.

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