

Application of Respirometric Techniques to the Biological Stabilization Process of Organic Waste

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The aim of the research performed by the candidate was the development of tools and analytical methods for the measurement of the biomass respiratory activity in organic solid waste. The knowledge of the respirometric index during the composting process allows investigating and quantify the presence of biomass and its metabolic activity. This information give some indications for the process development. It is also essential for both complete understanding of the system evolution and for highlighting the problems or deficiencies of the composting process (stabilization).

The aim of the respirometric method was to evaluate the degree of stability of the material both during the composting process and in the final product.

In the first period of the research a new type of dynamic respirometer was developed and constructed. This tool is characterized by a forced air flow through the composting layer (for this reason is called dynamic) and represent the adaptation for solid matter of the typical water respirometer. In the same period, a second static (manometric) respirometer was optimized, in which the operational procedure and especially the data processing have been changed. During the development of the analytical method the tools were further changed in order to solve many problems that had been encountered during the experimentation period. The development of the analytical method, based on 481 respirometric analysis, was developed in collaboration with the Agricultural Institute of San Michele all'Adige (IASMA) and the Regional Agency for Protection of the Environment of Veneto (ARPAV). Experimental data was used to define the effects of the various parameters directly involved in the definition of standard conditions on RI. The principal parameters that where considered were: humidity, temperature, quantity of the sample, effect of pretreatment (freezing, sieving, etc...). The respirometric method was based on two different type of respirometers, one with a fixed amount of oxygen (AIR L) and the second with no limitation of oxygen supply (AIR NL). The analytical method is flexible in such way that it can be easily applied to various commercial tools and is reliable to give similar results using different instruments. The research was divided into three main sections, the first involved the building of the respirometers and the development of the analytical method; the second part dealt with the practical application of the method. In this study the respirometric assay in association with different chemical analyses and fitotoxicity assay were used to monitor and analyze five different composting processes. Using the experimental data a relationship between RI (respirometric index) and GI (germination index) was evaluated. The experimental phase was suitable for making a reliable diagnosis of the composting process. This research showed the lack on the process management in many Italian composting plants. In the final part of the research an application of cytometric techniques to measure the amount of active biomass in the organic matter was developed. This allowed the determination of the specific oxygen uptake rate (for a single cell) and the results were in agreement with those reported in literature. Cytometric analyses allowed to quantify the biomass present in the treatment plants, this gave new information to the knowledge of the process and to the understanding of the respirometric tests. Currently we are involved with the Italian EPA in a study for the definition of an analytical method and standard limits for respirometric index measurement.