Vacuum-assisted Quartz Combustion Reactor for 13C-Isotope analysis of Highly-Enriched Protein

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A Quartz Combustion Reactor system was designed and developed to measure overall 13C-isotope enrichment of solids such as biosynthesized protein. This system consists of a batch Reactor, electric tube furnace, gas control manifold, and mass spectrometer. The associated analytical methodology involves vacuum heat treatment (VHT) of solid sample in a Reactor pipe, followed by Reactor loading with di-oxygen, Reactor isolation, thermal combustion, and finally product gas analysis by quadrupole mass spectrometry.

Select design features of the Quartz Combustion Reactor include: 1/ the monolithic Reactor pipe is made of quartz, transition glass, and borosilicate glass; 2/ each end of the central quartz tube is ultimately fused to threaded glass ports; 3/ the quartz region itself extends outside the furnace hot zone, thus polymeric components can be utilized at each end; 4/ one Reactor end is fitted with a PTFE plug for sample loading, removal, and clean-out; 5/ the opposite Reactor end is equipped with a PTFE bushing, PTFE gas valve, and glass barb; 6/ the Reactor barb is flexibly attached to a gas control manifold for vacuum-oxygen supply; 7/ the Reactor is equipped with a small quartz boat for sample loading.

The title Reactor system and associated methodology has the following advantages: 1/ the Reactor pipe has been demonstrated in practice to be re-usable (>100 combustions); 2/ the analytical method does not require catalyst for sample combustion; 3/ the isotope enrichment result for glucose-13C6 combustion (98.9-atom%-13C) compares favorably to its NMR result (99.1-atom% 13C); 4/ isotope enrichment results for >95-atom%-13C protein sample were repeatable to ~0.1-atom%-13C; 5/ the entire measurement system is grease-less; 6/ the VHT technique avoids open-flame heating; 7/ the Reactor and furnace sub-assembly is mobile and thus can be readily attached to an instrument of choice.