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Development of photobioreactor technology for algae cultivation in the International Space Station (ISS)

Stefan Belz
University of Stuttgart, Germany

Life Support Systems (LSS) are an essential subsystem of human spaceflight systems. An LSS allows humans to survive, to live and to work in space. Existing physicochemical technologies used on the International Space Station (ISS) enable water and oxygen generation. Far-distant and long-term exploration missions (e.g. lunar surface habitat or a manned mission to Mars) require a higher closure of the water, oxygen and carbon loop. Especially the carbon loop can only be closed by biological technologies, i.e. food production in space. Higher plants offer an in-situ resource for food. These systems are of a high biological order and require a specific environment to grow. High engineering effort is necessary to provide such an environment in space, especially under microgravity conditions and higher radiation loads. However, microalgae as single-cell organisms compared to higher plants have a higher harvest index, up to 10-fold higher growth rate, a higher light exploitation and need no soil. Microalgae enable an efficient use of photosynthesis in space (conversion of carbon dioxide into biomass and oxygen). Engineering solutions are developed to provide the optimum growth condition of a microalgae species such as temperature, pH value, dissolved carbon dioxide and oxygen concentrations. The Institute of Space Systems investigates cultivation techniques since 2010 in cooperation with the DLR. Knowledge and expertise on cultivation, feeding, harvesting, gas supply and gas extraction are now the basis for the spaceflight experiment PBR@ACLS (Photobioreactor at the Advanced Closed Loop System). The on-going results and development of breadboard testing are presented.

belz@irs.uni-stuttgart.de

Magnetic, geo-electric, and groundwater and soil quality analysis over a landfill from a lead smelter, Cairo, Egypt

Mohamed H Khalil
Cairo University, Egypt

A detailed ground magnetic survey, geoelectric vertical electric sounding (VES), and groundwater & soil quality analysis were conducted in the area of the abandoned landfill of the Awadallah lead (Pb) smelter, Cairo, Egypt. The integration between the applied techniques located successfully the buried solid waste, demarcated the groundwater and its possible contamination, and determined the lead level in soil. Magnetic survey comprised 50 magnetic profiles each 190 m length. Vertical derivatives, wavelength filters, and continuation filters characterized the eastern and central parts of the landfill by high intense magnetic anomalies reflecting metal and lead wastes. The geoelectric survey comprised 16 VES with maximum AB/2 of 100 m. The inverted data demarcated effectively the groundwater aquifer with depth ranged from 11 to 18 m and true resistivities ranged from 96 to 118 Ohm.m. The second layer (Holocene-Q3) of semi-permeable silty and sandy clay cap (true resistivities 29 ~ 51 Ohm.m and thickness 9 ~ 17 m) constituted a considerable role in limiting the possible contamination from the landfill. The analyzed groundwater parameters pH, E_h, TDS, SEC, and DO indicated a good water quality with homogenous aquifer characteristics. Whereas, the lead concentration in groundwater (0.033~0.036 mg/L) was slightly exceeding the safe limits identified by the U.S.EPA (≤0.015 mg/L). Lead in soil samples revealed elevated concentrations (3130 mg/Lit/kg at VES-3) around the Awadallah smelter. Whereas, a gradual decrease in concentrations recorded in the northwestern direction.

moh.hasan.khalil@gmail.com