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DOI: http://dx.doi.org/10.4322/apa.2015.025

ANTARTICA'S NEW BUILDINGS: WASTEWATER AND ENERGY SYSTEMS

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Abstract: *After the historical period characterized by the search for constructive solutions that allow safe permanence in Antarctica, currently one observes a greater concern with environmental aspects and an explicit claim to undertake the occupation so as to cause minimal or no environmental impact at all. In this scenario, the technologies employed in energy systems and sewage treatment play an important role and contribute with the development of more efficient and sustainable buildings. The aim of this research was to identify and systematize the technologies adopted by referential buildings for energy systems and wastewater treatment plants. The adopted methodology started from the previous selection of six buildings located at sites environmentally differentiated and built in the last decade. As a result, summary charts were prepared with the main features of the systems adopted, being noticeable a trend for the reuse of grey water and adoption of energy from renewable sources concomitant to traditional systems with fossil fuel generators.*

Keywords: Scientific Stations, Wastewater Treatment, Energy, Sustainability

Introduction

Energy plays a key role in Antarctica, since it enables the permanence of the researchers and the operation of equipment in buildings. There are countries currently expanding efforts in area sources of energy, opting for systems based on renewable sources in order to promote greater efficiency and energy self-sufficiency in buildings (Tin *et al.*, 2010; Pacheco *et al.*, 2012). One of the main concerns in the context of environmental preservation is sewage, (Tarasenko, 2009), which has also received special attention because it is a risk factor to the preserved environment of Antarctica, (Ministério do Meio Ambiente, 1995). Thus, the aim of this research was to identify and systematize the technologies adopted by referential buildings concerning to energy systems and wastewater treatment plant.

Materials and Methods

The methodology used in this work considered the need for a literature review and research of the most relevant Antarctic Programs. From a timeframe of 10 years, and considering the availability of reliable information as an additional criteria, the following stations were selected, classified as references for the subject of study: Amundsen-Scott South Pole Station (U.S.), Bharati Antarctic Research Station (India), Halley VI Research Station (England), Juan Carlos I Research Antarctic Station (Spain), Neumayer Station III (Germany) and Princess Elisabeth Antarctic (Belgium). It is highlighted that the information, mainly related to the values of the works and construction areas, although from trusted sites, were not confirmed by official programs of the countries of origin. From the cut point, the six referential buildings were analyzed on aspects of wastewater treatment and energy systems. The information, after confirmation of the reliability of the source, were selected and systematized in the form of a summary chart.

Results

The data surveyed were organized and summarized in Chart I, with general information, and Chart II, with sewage treatment systems and energy.

Chart I. General Information

Station/Country	Inauguration	Localization	Area (m²)	Capacity		Useful Life (Years)	Cost (US$)
				Summer	Winter		
Amundsen-Scott South Pole Station (U.S.)	2008	High Plateau	6,100	150	50	25	150 mi
Bharati Antarctic Research Station (INDIA)	2012	Larsemann Hills	2,400	40	15	25	42 mi
Halley VI Research Station (ENGLAND)	2010	Brunt Shelf	1,858	71	16	20	52 mi
Juan Carlos I Antarctic Research Station (SPAIN)	2013	Livingstone Island	1,280	24	no inf.	no inf.	16 mi
Neumayer Station III (GERMANY)	2009	Atka Bay Island	3,300	40	9	25-30	51 mi
Princess Elisabeth Antarctica (BELGIUM)	2007	Queen Maud Land	700	40	25	25	11 mi

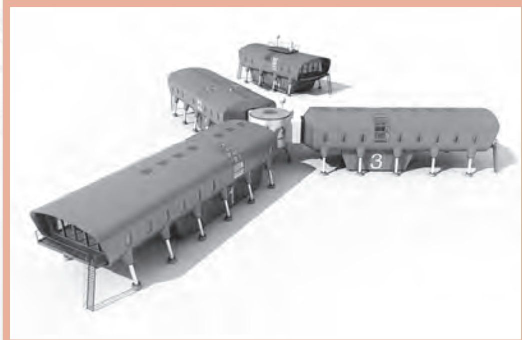
Source: Hugh Broughton Architects (2013); Bof Architekten (2013); British Antarctic Survey (2013); Alfred Wegener Institute (2013); International Polar Foundation (2013) and Berte (2010)

Chart II. Sewage and energy

	Wastewater	Energy
Amundsen-Scott South Pole Station (U.S)		
	• No treatment; • Waste generated is packed and transported to McMurdo station, with the exception of domestic liquid waste, which is disposed in deep Wells in the ice.	• Diesel generators AN-8 + photovoltaic matrix (30 kW).
Bharati Antarctic Research Station (India)		
	• Physics + Biology; • Adoption of MBR (Membrane Bio Reactor) bound to an aerobic biological reactor; • After treatment, the water is reused.	• Diesel generators + Wind; • CHP System (Combined Heat and Power).
Halley VI Research Station (United Kingdon)		

Source: A3 Water Solutions GMBH (2013); Alfred Wegener Institute (2013); Berte (2010); Bof Architekten (2013); British Antarctic Survey (2013); Brooks & Ferraro, J (2010); Hugh Broughton Architects (2013); International Polar Foundation (2013); Japanese Inspection Report (2010); Tarasenko (2009); Metcalf & Eddy, Inc (2009)

Chart II. Sewage and energy

	Wastewater	Energy
	• Physics + Biology; • Microbac bioreactor with cleaning once a year; • Treated wastewater dumped in the ice; • Treated sludge is incinerated and their ashes are removed from Antarctica	• Diesel generators + photovoltaic (summer).
Juan Carlos I Antarctic Research Station (Spain)		
	• Physics + Biology; • The principle of operation of the purification system used is the biological digestion of organic matter carried out by bacteria already present in the wastewater	• Diesel generators + Wind + Solar; • CHP System (Combined Heat and Power).
Neumayer Station III (Germany)		
	• Physics + Biological + UV Sterilization; • Wastewater is clarified and sterilized by UV rays and pumped through a pipe to the dump in an ice shelf, located about 100 m from the station.	• Diesel generators (4 x 150 kW) + Wind (30 kW supplemental); • Heat generators used in the system of heating and snow melt; • CHP System (Combined Heat and Power).
Princess Elisabeth Antarctica (Belgium)		
	• Physics + Biological + Disinfection; • • The sewage and liquid waste from the kitchen and showers treated with bioreactors, filtered and recycled for use; • The processed water is normally reused five times and later released in a crack in the ice.	• Wind + (9 x 54 kW) Photovoltaic (9 kW, 90m²) + Solar Panels (20 kW, 200m²); • Integrated Systems = near-zero emissions; • Diesel generators (safety); • "Smart Grid" system of energy management.

Source: A3 Water Solutions GMBH (2013); Alfred Wegener Institute (2013); Berte (2010); Bof Architekten (2013); British Antarctic Survey (2013); Brooks & Ferraro, J (2010); Hugh Broughton Architects (2013); International Polar Foundation (2013); Japanese Inspection Report (2010); Tarasenko (2009); Metcalf & Eddy, Inc (2009)

Discussion and Conclusion

From the analysis of the information, it is observed that the types of sewage treatment systems used are varied, but usually based on systems of bioreactors coupled to membrane filter modules, which can also contemplate the use of sterilization of waste by UV rays, as in the case of the Princess Elisabeth station. Eventually, it also makes separate treatment of greywater for its re-use in secondary activities of the building.

In general, the power generation systems employ diesel generators and seek to match other sources of energy and heat such as photovoltaic panels and wind turbines associated with energy converters and systems of accumulation, especially in tanks of water. Contemporary stations, like Princess Elisabeth and Neumayer III, adopt the concept of *smart grid*, adjusting to the minimum the consumption of the stations, addressing consumption demand management and choice of sources of energy with excellence.

Acknowledgements

This work is sponsored by the National Institute of Science and Technology Antarctic Environmental Research (INCT-APA) that receives scientific and financial support from the National Council for Research and Development (CNPq process: n° 574018/2008-5) and Carlos Chagas Research Support Foundation of the State of Rio de Janeiro (FAPERJ n° E-16/170.023/2008). The authors also acknowledge the support of the Brazilian Ministries of Science, Technology and Innovation (MCTI), of Environment (MMA) and Inter-Ministry Commission for Sea Resources (CIRM).

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