Energy resources and waste management at the Polish Polar Station in Svalbard

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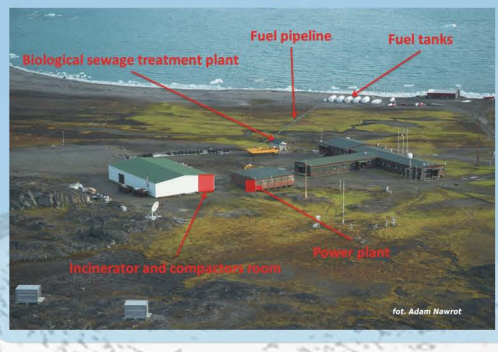
1. Location

The Polish Polar Station is situated in the South-Spitsbergen National Park in Svalbard, in the European part of the Arctic. The unique location of the Station requires a specific approach to energy resources and waste management issues.

The Polish Polar Station general overview



2. Power plant system

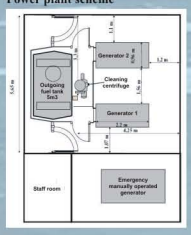
The Polish Polar Station has established a separate power plant building located next to the main building. The power plant is equipped with two Deutz BF4M1013E turbo generators with a 77 kW power engine each. They are electronically protected against failure and have a built-in self-start in case of power loss. The current peak demand for electricity in winter reaches 55 kW, so one of the units operates continuously, while the other is only used in cases of emergency. It remains heated all the time, and is ready for operation in case of failure or during maintenance of the operating one. In case of failure of the currently operating generator, the system automatically switches to the spare unit, starting the process of reaching parameters that allow taking over power supply for the Station. The process takes about 1-2 minutes, so the possible gap in the supply of electricity doesn't exceed that time. Another safety feature is a system informing about phases' overheating. Generators also turn off when values of oil pressure, fluid temperature or frequency exceed specified norms. The generators are inspected every 500 hours (which amounts to almost 20 inspections every year) and are replaced every 20,000 hours. Thanks to these actions failures are minor and sporadic.

The generators are equipped with a special system which recovers heat from the exhaust fumes. This heat (about 90 MJ) is primarily used to melt snow and ice for the needs of the Station's water supply and sewage system. Usually during the summer period (May-September), water for the Station's needs is pumped from a lake located 200 m from the Station's infrastructure and in the remaining part of the year, when the lake remains frozen, water is obtained by placing snow or glacier ice blocks to melt in a 4-tone heated tank. Later, filtered water inflows to the Station's water supply system.

Since the main power supply system is fully automatic, a third generator is used to supply power to special equipment that requires a high temporary demand for energy, such as electric saws or welders. This unit is manually controlled and is not equipped with any security system. It has its own 200 liters fuel tank; the fuel is pumped manually. It has a 40 kW power engine and the voltage is 400V or 3x230V. It is possible to connect it to devices using a separate, direct cable, independent form the main energy supply system.

The Station is also equipped with a special power system (UPS 230) for a safe and uninterrupted electric supply for scientific measuring and recording equipment. The 3x5 LanPro kVA system allows maintenance of the equipment's operation for up to 10 minutes after loss of power supply from the generators occurs. The station is also equipped with 5 portable gasoline, 230V, one-phase electric generators of 2 to 4 kW.

Power plant scheme



3. Fuel installation

The fuel installation at the Polish Polar Station consists of a system of 6 tanks located by the seashore and an outgoing fuel tank in the power plant building connected by a pipeline.

The Station is annually supplied with fuel by supply vessels. Diesel oil is supplied by a tanker and is transferred at sea to smaller tanks with a capacity of 5 m3 installed on floating transporters then to the system of five double-layered tanks with total capacity of 125 m3 (25m3 each) located on the seashore. Shallow waters around the Station and lack of a pier do not allow the tanker to approach directly to the fuel station. Fuel for the power generators is later pumped to and stored in a single-layered, 5m3 outgoing tank located next to the generators' room, equipped with sensors at the lower and upper levels. In order to prevent leakage, a bath is installed under the tank; there is also a second bath located under the fuel cleaning centrifuge. Diesel oil is pumped to the outgoing tank twice a month by a pipeline from tanks located on the seashore using a submersible pump with a capacity of 1.1 kW. The pumping process is carried out under the supervision of an operator. In order to reduce the risk of fuel overflow, the level gauge that controls the filling level has a built-in automatic switch that cuts the power off.

The pipeline transporting fuel between the fuel station and the power room is multi-layered. Its flexible hose (without connections) is reinforced by a steel braid which is overlapped by polyurethane sealed cover. Additionally, the entire structure is placed in steel pipes for protection against bears and accidental collisions with mechanical vehicles used at the Station. Inspection glasses are installed to monitor the space between the internal flexible hose and the external steel pipeline and in case of leakage the fuel can be pumped out. As an additional preventive measure, protective HDPE foil is placed under every tank. Sorbent with diatomic granules is also available and ready for use in case of leakage.

As part of the fuel installation, there is a separate tank dedicated for unleaded petrol located next to the 5 diesel oil tanks. It is used for supplying gasoline to snow mobiles and boat motor engines.

Diesel oil consumption is between 150-200 liters per day depending on energy demand, which in turn is dependent on weather conditions. The average total yearly consumption of diesel oil is approx. 70.000 liters, while the average total yearly consumption of gasoline is approx. 6.000 liters.

4. Biological sewage treatment plant

The sewage treatment plant is the only installation in the Spitsbergen region that operates on the basis of biological decomposition and sedimentation processes.

Sewage is collected in the retention tank that fulfills the following functions: equalizes variable concentrations of sewage, serves as a buffer during size varying inflows of sewage and works as a pump station. Pumps are installed inside the retention tank and pump wastes to two purifying reactors. Reactors function as a separate, biological waste treatment plant. As a result of reactor's aerating, biological decomposition processes (of organic and nitrogen matters) occur: aerobic degradation of organic pollutants and biogenic compounds. The biological process may be additionally aided by dosing small amounts of coagulants (PIX- domestically produced) aimed to remove phosphorus - simultaneous precipitation method. Separation of impurities is a result of sedimentation an effect of air introducing, present in both the reactors.

Processes mentioned above take place cyclically and each cycle consists of the following five phases:

1. Reactor filling - The reactor receives portions of sludge pumped by a retention tank pump and aerates it repeatedly. This phase continues until the complete filling of the reactor.
2. Reaction - The reactor operates in anoxic and aerobic phases with mixing the content providing a reduction of organic and nitrogen compounds.
3. Sedimentation - Aeration process stops and the reactor enters the stationary phase. The separated sludge settles at the bottom of the tank. 4. Outflow - After the sedimentation phase is finished, the excess of active sediment is removed to a separate tank and then the purified waste water outflows through automatic valves.
5. Pause - The reactor enters the waiting phase during which the present sediment aerates.

At the end of the cycle, the reactors are ready to receive a new portion of sewage.

Additionally, the plant is equipped with an installation of grid sacks designed to filter larger pieces of plastic or rubber present in sewage.

5. Waste segregation

The Polish Polar Station puts high emphasis on waste segregation. It is equipped with a system that allows conducting effective and ecological waste management procedures. The system includes two hydraulic compactors and a waste incinerator.

Glass, aluminum and metal are cleaned, washed and segregated into separate barrels and then presses by hydraulic compactors in order to reduce the waste's capacity. Once the barrels are full, they are stored until the summer period when they are transferred out of Spitsbergen. Throughout the entire year, depending on the work carried out and the number of scientists working, the Station produces about 2 tons of scrap, 1 ton of glass and 0,5 ton of aluminum. Batteries and light bulbs are also collected and transferred out.

Paper, plastic and food waste (about 9 tons per year) as well as used oil and petroleum compounds are burned in the waste incinerator located in a separate building. The incinerator is equipped with a combustion chamber with automatic locking doors and a fuel inlet placed on top, which allows an efficient, spiral spread of the flames. Incineration of waste at a temperature of 850 - 1150 °C eliminates the emission of other compounds besides carbon dioxide and water vapor into the atmosphere.

6. Renewable energy sources

The Station also uses renewable energy sources. Solar panels with a capacity of 10 to 50 W are used to power up electric metering equipment, perfectly fulfilling their role during the polar day. During the polar night, selected measuring instruments are powered by small wind turbines with a vertical and horizontal rotation axis.

In the past, the Polish Polar Station attempted to use wind as an alternative source of energy for heating purposes but due to adverse Spitsbergen weather conditions and uneven snow pressure the project was abandoned.

7. Scheduled investments

In the year 2013, the Polish Polar Station plans to make major improvements at the fuel station: replacement of the pipeline and displacement compensators and modernization of absorption tanks protecting the tundra from possible fuel leakage. Also, the power station's interior is going to be remodeled: replacement of the floor and walls' coverings is planned. In order to improve power station's fire safety, installation of water mist fire protection is considered.

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