Methanol from sunlight and air: A guide towards the embodiment design of the micro plant

The carbon emission of fossil fuels contributes to global warming. The start-up ZEF develops a sustainable alternative to create fuel. By capturing CO2 and H2O from the air, the energy from PV solar panels, and the right technology, they create methanol. Methanol can, among other things, be used as a fuel or to create plastics. This product is called a micro plant. With the development of large PV solar farms with 40.000 solar panels and 13.000 micro plants, methanol will be produced on a large scale.

The micro plant is a small chemical factory with about 50 different parts. These parts are individually, or within one of the four subsystems developed at TRL level 4. However, these parts are only developed at a technical level; the integration of these parts into a micro plant suitable for the mass manufacturing of 100,000 pieces has had little thought. Therefore the purpose of this graduation project is to guide ZEF towards an embodiment design for the micro plant. The four main design drivers that influenced the choices are price, functionality, environmental impact, and flexibility.

To get to an embodiment design the influence of maintenance, the architecture design, the insulation and the casing where researched.

Maintenance: The micro plant requires maintenance about every 2 to 5 years. The chosen maintenance strategy is preventive predetermined scheduled maintenance. The two extreme options for maintenance were maintenance at the micro plant's location or automated maintenance in a garage. Option one was chosen because this allows for the flexibility to make changes in the maintenance schedule. This resulted in the requirement to have access to all maintenance interfaces and six control buttons for the micro plant.

Architecture design: Architecture design is about how the different parts are positioned relative to each other. Size of the parts, their heat and cooling requirements, their maintenance requirements, and their place in the system diagram determined their position.

Insulation: The material used for insulation is stone wool. Stone wool is cheap, durable, and has the proper thermal properties. It can be manufactured in different ways; for this project, the solution of a box made with stone wool plates, placed around the insulation parts and filled with stone wool flakes will be used. The insulation gets a plastic protective layer.

Casing: The core function of a casing is to keep all the parts stiff together and transport the air from the air filter to the air fan. It is unnecessary to have a casing that encloses the whole micro plant because most parts do not require an enclosed to ensure a 20 years lifetime. This design chooses a blow-molded air duct with a steel frame to embody this 'naked' casing.

In the end, the total costs of the micro plant was more expensive than the target price. The micro plant needs to be suitable for more PV solar panels, cheaper, or is not feasible.

This project was only a starting point for product design, recommend is to continue the development on the product level, because the product level does influence the technical level. Also, getting from a concept to a product requires time and collaboration with multiple stakeholders.

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