



March, 2013

„Cryogenic refrigeration is matching small heat loads of superconductors with small refrigeration budgets. What it takes is diligent engineering.“

Facts:

- Operating HTS magnets means operation at 30 K to 40 K
- Closed loop refrigerators and good thermal insulation enable these temperatures efficiently
- Heat loads to the cryogenics e.g., in a wind generator are very small: Just some 10 W in Ohmic losses and some 150 W in radiation and conduction.



Example of an Installed Cold-Head.

Superconductors are Cool – But How to Keep Them Cold?

For superconductors to maintain their impressive properties, they have to be cooled to their operating temperature. Superconducting magnets based on high temperature superconductors (HTS) operate at about 30 K to 40 K. To achieve such low temperatures, cryo refrigerators are needed. The most wide spread system consists of a compressor and a cold head which are connected to each other via a piping system.

These commercial units use modified air conditioning compressors with gaseous helium as working gas. The expansion of the compressed gas in the cold head provides the cool at a metallic connection plate. The expanded helium gas is then returned to the compressor and the loop is closed. Since the cycle is hermetically sealed, no helium is lost. Typical maintenance intervals are beyond 10,000-20,000 hrs.

To make efficient use of the cooling power, good thermal insulation by using vacuum jackets and reflecting insulation foils are a must. In power engineering this practice is not very common, but in other industrial areas widely used. Examples are food processing, LNG tankers, MRI scanners and semiconductor fabs.

Eventually, the heat load to the cooling system is determined by the complete design and allows the economic use of HTS.

Expertise in Cryogenics

Reliability and ruggedness are the core elements of industrial standard components. This is no difference in HTS based systems.

Large thermal inertia due to their big thermal mass characterize superconductive systems. They need days for a cool-down—same for warm-up. Even after complete failure of refrigeration the system typically remains at or near operational temperatures for hours. Not even copper based systems can do this normally.

Maintenance concepts are part of the support including the design of components allowing scheduled maintenance of the active components with lowest impact on operation.

The ECO 5 Team has leading expertise in integrating a simple to use and robust cooling system. Using metallic conduction wherever possible allows for a simple and easy to use system. Superconductive magnets itself are maintenance free.

„Cryogenics is certainly not a new art. The benefit of the ECO 5 Team is that we are able to take this technology and bring its spectrum of advantages to arrived power engineering.“

ECO 5 Team: Engineering Services for Highly Efficient Power Systems

- Rotating Machines
- Coils and Magnets
- Inductive Heating Systems
- Cryo Technology
- Materials Science
- Grid Expansion and Protection.

Why ECO 5?

The ECO 5 Team has a strong strategic and operational heritage; our engineers worked extensively for operating companies and understand the priorities that clients have in the development and delivery of projects.

Within one compact organization, we have an unrivalled range and depth of knowledge and expertise of all aspects that are vital in delivering a sound project.

For further information please contact:

Dr. Jürgen Kellers

ECO 5 GmbH

Bornheimerstraße 33b, Innenhof

53111 Bonn, Germany

Tel: +49 228 62961770

Fax: +49 228 62961774

E-Mail: juergen.kellers@eco-5.de

<http://www.eco-5.de>

As an engineering provider, the ECO 5 Team is specialized in the development of high-efficiency power systems. Our focus is on renewable energy generators for wind, hydro, and wave power. Beyond these fields, core competencies lie also in fault protection of high-voltage grids and inductive metal heating. In these areas we contribute highly specialized know-how in the application of industrial-grade superconductors as well as in more conventional copper and permanent magnet solutions. Strategic and marketing competencies complement the technical expertise.

We manage customer projects from strategic line up, feasibility analysis up to prototyping. In technical expertise and tools we cover materials science aspects, multiphysics FEA, and 3D CAD. Supporting these activities, we offer our competence in the areas of cryo technology, plant and process safety, and the analysis of IP rights pertaining to a technological development.

Disclaimer and Copyright

While we make every effort to keep the information on our Fact Sheets current, we accept no liability whatsoever for the content provided. The content and works provided herein are governed by the copyright laws of Germany. Duplication, processing, distribution, or any form of commercialization of such material beyond the scope of the copyright law shall require the prior written consent of its respective author or creator.