EDITORIAL

Magnetic Energy Storage

Potential usefulness of Superconducting Magnetic Energy Storage (SMES) has long been recognized. In principle, devices using it can store very large amounts of electrical energy with low rates of decay. Part of the stored energy can be discharged and converted into alternating current in less than 2 milliseconds. Efficiency of a complete cycle of storage and discharge of energy is about 96%. A proposed application to store off-peak energy for use during high demand periods has been delayed because of costs. However, perceptions of the value of SMES are being enhanced by results obtained with small installations. These have achieved reliability and success in improving the quality and stability of electric power supplies.

Energy resides in the magnetic field created when current flows through a conductor. To maximize the effect, a coil with many turns is employed. The energy E that is stored is given by $E = 1/2\ L\ I^2$, where L is inductance of the coil and I is current. To avoid resistive losses while attaining large currents, superconductors are employed. The material of choice is a niobium-titanium alloy. It can conduct large currents at 4 K. For charging or discharging the coil, a power conversion device serves as an intermediary between direct current in the coil and alternating current in a power network.

Power stability has become important in many installations. Computers, office machines, and programmable controllers are particularly affected by power instabilities. Estimates of annual U.S. costs of such fluctuations have ranged from $12 to $26 billion. Most of the disturbances are momentary interruptions or drops in voltage against which the usual computer surge protector is not effective. Electronic controllers on factory machines are especially vulnerable to fluctuations in voltage. Deviations in the frequency of the alternating current also can cause shutdowns. In many instances, duration of the power glitch is only a fraction of a second. Corrective response in a few milliseconds by an SMES device that stores a megawatt-second of energy can forestall a costly shutdown. The first commercial producer of such equipment was Superconductivity, Inc. of Madison, Wisconsin. Only a few of their Superconducting Storage Devices costing about $1 million have been produced, but experience with them has won plaudits. An example was use in an IBM Megatest facility, where voltage sags were causing substantial costs in the form of delays in testing. During the period May 1992 through February 1993, the device successfully minimized 34 voltage drops greater than 10%. Another example was use in a plant in South Carolina where high-quality power was required by sensitive automated and electronically controlled equipment. Between 13 April 1994 and 21 July 1994, the device carried the plant through 142 of 144 potentially disruptive events.

Additional benefits will be attained when a larger SMES unit is incorporated in an Alaskan power network that includes Anchorage Municipal Light and Power. In 1997, Babcock and Wilcox will install a Superconducting Power System capable of delivering 30 megawatts for an integrated time of 1 minute or longer. The system will enable the 600-megawatt maximum load Alaska Intertie network to become a more reliable source of high-quality power. Utilities in general cope with sudden outages of major generating equipment by having spinning reserves, that is, facilities that are generating small amounts of electricity but which can be ramped up to provide needed power. The practical and inexpensive spinning reserve in Alaska is a hydropower source that requires about 1 minute to achieve major production. The new Superconducting Power System, together with the hydropower, will meet the maximum likely emergency needs. Some other benefits realized by the Anchorage utility are enhanced stability, reliability, and quality of its power, including better control of phase angles between voltages and currents. The various components of the system will be shop-fabricated in Lynchburg, Virginia. The storage magnet will have a length of 30 meters, a diameter of 3.5 meters, and a weight of 250,000 kilograms. The operating current will be 16,000 amperes and the maximum field 5.5 tesla. The cost will be about $25 million.

Eventually a substantial demand will arise for intermediate-size SMES devices. We have entered an era in which quality of electric power has become important to many major users. This comes at a time of increased competition among providers of electric power for customers. Utilities will find it necessary to respond to needs for high-quality electricity.

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