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HTS Turns 25

Twenty-five years ago, high-temperature superconducting (HTS) compounds were discovered, and the race to commercialization began. Much research has been expended to perfect engineering applications using HTS materials. In thin film superconductor devices and wires, the most progress has been made via an oxide superconductor composed of yttrium, barium, copper and oxygen in the well-known basic composition of $YBa_2Cu_3O_7$, or more commonly, YBCO.

YBCO wires, now referred to as second-generation (2G) HTS wires, are in commercial production and are a preferred material for many high-tech applications.

The most recent superconductor power cable demonstration was commissioned in September when Korea Electric Power Corp. (KEPCO) energized the world's longest distribution-voltage superconductor cable system at the I'cheon substation near Seoul. Powered by American Superconductor's (AMSC's) Amperium 2G superconductor wire and fabricated by LS Cable & System Ltd., the 22.9-kV alternating current (AC) cable system is rated at 50 MW. It is the longest HTS cable in the world using 2G superconductor wire. KEPCO also has in process two other superconductor cable projects: a 1-kilometer, 154-kV AC cable system, and a 500-meter, 80-kV DC cable system. Both cables are expected to be placed into service in KEPCO's grid on South Korea's Jeju Island.

Earlier this year, a major HTS demonstration got underway in China. The installation at the Baiyin substation in Gansu Province, China, illustrates the multifaceted capabilities of superconductors in substation equipment. This substation includes a superconductor power cable system; a superconductor fault current limiter (FCL), which is a high-voltage surge protector for the power grid; a superconductor magnetic energy storage (SMES) system that provides backup electric power; and a superconductor transformer that minimizes energy losses. All of these technologies at the Baiyin substation rely on HTS wire.

Among other notable superconductor projects is Long Island Power Authority's (LIPA) half-mile-long, 574-MW capacity, 138-kV power cable system that was energized in 2008. It is the world's first in-grid deployment of a transmission-voltage superconductor cable system

American Electric Power Co. Inc. (AEP), one of the largest U.S. utilities, energized superconductor cable at its Bixby Station near Columbus, Ohio, in August 2006. The 200-meter cable uses a novel concentric phase design. The cable system has reliably served some 8,600 customers carrying more than 50 MW of power for more than five years. The field experience at AEP follows the successful six-year operation of a separate superconductor cable that carried all of the power to Southwire Co.'s Carrollton, Ga., manufacturing and world headquarters complex.

In New York, Consolidated Edison Co. (Con Edison) has been involved in a project to showcase a proprietary superconductor power cable with inherent fault current limiting capability. In Project Hydra, Con Edison, AMSC, Southwire Co. and the the U.S. Department of Homeland Security (DHS) have combined efforts to demonstrate how HTS wire's ability to carry much power can be combined with superconductor's dual-impedance characteristic to suppress fault currents automatically.

The Tres Amigas interconnection in New Mexico could be the first application of HTS cables in a more traditional HVDC application. The HTS cables proposed for this project will be used as part of a high-power DC bus.

HTS wire is being used in the development and commercialization of products and applications including superconductor power cables, FCLs, rotating machines and transformers. Superconductor cables have numerous advantages when applied to the utility grid, including high-power transfer capability, minimum right-of-way requirements, no interaction with the environment and the ability to limit fault currents.

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