NREL Business Ventures

Patented (or Patent Applied for) Technologies
Available for License from the
National Renewable Energy Laboratory

Thermal Electric Power Plant Technology Available for Licensing

Advanced-Airfoil Cooling-Tower Fans

As for an airplane wing or a propeller, the geometric shape of a fan blade can make major differences in its performance. Airfoil design, however, is a highly challenging field with only a handful of real experts, and current cooling-tower fan-blade airfoil sections were simply borrowed from the airplane industry. NREL experts previously made significant efficiency gains for wind energy by scientifically designing blades specifically for wind turbines. Now, they have done the same for large fan blades used to draw air through evaporative cooling towers. The new blade design is not as wide and requires nearly 2% less energy to move the same amount of air. Additional savings are likely as a result of lower cascade flow losses and improved airfoil insensitivity to roughness effects. A 280-megawatt coal-fired generating unit with eight cooling towers, for example, uses nearly 1 megawatt to turn the cooling tower fans. Annual fuel cost for this might be about $180,000, so a 2% to 3% energy savings could save about $4,500 per year for each generating unit or $10,000 more revenues from the retail sale of the saved energy.

Simulation of Heat and Mass Transfer Processes in Cooling Towers

NREL has developed a computer code for modeling and predicting the performance of cooling tower packings. The invention provides designers with a tool to assess variations of packing performance with geometrical and configurational parameters. This allows designers to screen design choices to achieve an optimal performance from the packing or fill, without having to make a large number of prototypes. Through such a screening, the designer will arrive at specific potentially unique and possibly patentable hardware after a number of trial and error processes of making prototypes and testing. This code is intended to work in conjunction with a series of tests planned through an accompanying experimental program to identify optimal geometries for specific expected weather conditions for the location of the tower. Towers can be designed taking into account of local variations in weather conditions, with optimal packing designs suited for each application. Such a capability to design custom packings for each specific application is not available in the industry today.

Solar Thermal/ Combined Cycle Power Plant

Kokhala (a Hopi term for heat from the fire or the sun) is a new concept that allows the use of renewable energy to displace fossil fuel supplied to a combined cycle power plant. In addition to a reduction in the consumption of fossil fuels, associated emissions are also reduced. The Kokhala concept provides a means for independent power producers and utilities to offer “green” electricity in an extremely cost-effective manner. The technology risks for the concept are minimized since the combined-cycle plant can operate independently of the solar thermal plant. Financial risks are further minimized by use of a relatively small solar plant, reducing the solar plant capital cost. In the Kokhala plant, high-temperature heat is supplied from a solar central receiver in the form of hot molten salt at 550° C. This hot salt is used to preheat the combined cycled combustion air in a heat exchanger located between the gas turbine compressor and combustor, reducing the need for natural gas. Using today’s demonstrated solar technology, the solar heat can provide up to 30% of the combined-cycle heat input.

Advanced Direct-Contact Condensers

NREL has developed advanced direct-contact condensers (ADCC) that improve efficiency and remove and control non-condensable gases in steam power plants. Co-current and countercurrent sections each employ structured packings for contact media between steam and water. ADCC yielded phenomenal gains in a demonstration installation at a 110 MW geothermal plant at The Geysers in California. The new condenser increased the efficiency of the plant by 5%, allowing a 17% increase in throughput capacity, and cut emission abatement cost in half.

Alstom Energy Systems of Easton, Pennsylvania, has licensed ADCC for geothermal plant installations, but the technology is still available for other uses. For fossil-fuel electric plants, ADCC would be used in conjunction with intermediate parallel-plate exchangers to keep the working fluid separate from the cooling water. The added cost of the intermediate exchangers, however, is more than offset by the ability to clean these modular exchangers one at a time, avoiding shutting down the entire plant for cleaning. This avoids downtime that the Electric Power Research Institute estimates costs the utility industry more than $1 billion per year.

Condensers are also common equipment for any industrial process that generates steam or other vapors, so ADCC could be used in food processing, oil refining, pulp and paper, or other industries. ADCC would be particularly valuable for processes such as concentrating fruit juices, for which maintaining low temperature and low

Hydrogen Sulfide Emission-Control Chemistry for Geothermal Power Plants

One of the most common technologies for controlling emissions of hydrogen sulfide from geothermal power plant spent steam is oxidation of the hydrogen sulfide to sulfur with iron chelates. The iron chelate catalyst is costly, however, and not recoverable. NREL researchers have developed a technology, **Recoverable Homogenous Catalyst Complexes and Methods for Recovery by Capture on Organic Supports or Media**, that allows for recovery and reuse of the catalyst complex. This invention incorporates hydrophobic hydrocarbon chains into the chelate catalyst during original manufacture. The modified complex retains its ability to oxidize hydrogen sulfide, but now will also bind to an adsorption medium such as an organic polymer or silica-based substrate. Treatment with aqueous acid or base recovers the adsorbed chelate for reuse.

A second technology, **Solid-State Renewable Adsorbents for Emission Control of Hydrogen Sulfide**, uses a new adsorbent for hydrogen sulfide treatment. Alkanolamines are commonly used in aqueous solution for removal of hydrogen sulfide and carbon dioxide from natural gas, but have never been used for spent geothermal steam, nor in a solid format. This invention intercalates long-chain alkanolamines in aluminosilicates such as vermiculite, making a solid adsorbent. Important advantages over aqueous solutions include avoiding the corrosion problems and easier, less-energy-intensive removal of the captured gases for reuse of the absorbent by simple washing with dilute bases. This technology could also be advantageously substituted for the aqueous solution process for removal of hydrogen sulfide and carbon dioxide from natural gas.

To discuss licensing possibilities or obtain additional information on any of these technologies, call Ken Touryan of the NREL Technology Transfer Team at 303-275-3008, or send e-mail to technology_transfer@nrel.gov. For a list of other technologies available for licensing from the National Renewable Energy Laboratory, see http://www.nrel.gov/technologytransfer/lic.html on the Web.

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