PROJECT facts

Innovations for Existing Plants

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STRATEGIES FOR COOLING ELECTRIC GENERATING FACILITIES UTILIZING MINE WATER: TECHNICAL AND ECONOMIC FEASIBILITY

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Background

As population and economic growth drive the need for more electricity, demands on freshwater supplies for thermoelectric power generation will also grow. However, electric utilities will have to compete with demands from other off-stream-use sectors such as public supply, domestic, commercial, irrigation, industrial, and mining. In addition, the need to leave water in streams and rivers to achieve environmental, ecological, and recreational goals will further complicate the future allocation of the nation's freshwater resources. As such, the availability of adequate supplies of freshwater to produce electricity as well as the potential impact of power plant operations on freshwater quality are issues that are receiving increased attention.

As a result of increased environmental concerns related to power plant water use, research is being conducted to evaluate and develop cost-effective approaches to using non-traditional sources of water to supplement or replace freshwater sources for cooling and other power plant water needs. Water sources that would be suitable for power plant cooling applications must be capable of providing large dependable quantities, thermally stable on a seasonal basis, and cost-effective. In addition, alternative water sources may help to minimize effects on surface-water ecosystems caused by thermal discharge of cooling water and power plant water intakes to insure compliance with sections 316(a) and 316(b) of the Clean Water Act.

Water from flooded underground mines represents a large untapped resource for power plant cooling. These mine water "reservoirs" could serve as a source of water to replace surface water sources. However, mines may not generate sufficient water

Discharge from underground coal mine.

individually to sustain a consumptive use as large as a power plant. In fact, large power plants can evaporate thousands of gallons per minute in order to maintain their operations. Therefore, a number of mines may have to be linked hydraulically, either by direct connection or through the use of mine to mine transfer pumps to obtain an adequate cooling water supply. Water, in sufficient quantity, can then be withdrawn, treated, and supplied to the plant.

Objectives

West Virginia University's Water Research Institute conducted a study to evaluate the technical and economic feasibility of using water from abandoned underground coal mines in the northern West Virginia and southwestern Pennsylvania region to supply cooling water to power plants.

Description

The study included identification of available mine water reserves in the region with sufficient capacity to support power plant cooling water requirements under two scenarios. The first scenario was to provide the makeup water requirements for a 600 MW plant equipped with a closed-loop recirculating cooling water system. The second scenario was to provide the entire cooling water requirement for a 600 MW plant equipped with a closed-loop recirculating cooling water system utilizing a flooded underground mine as a heat sink. If feasible, the second scenario would eliminate the need for a wet cooling tower to dissipate the heat to the atmosphere.

The study identified eight potential sites under the first scenario where underground mine water is available in sufficient quantity to support the 4,400 gpm makeup water requirements for a closed-loop 600 MW plant. Three of these sites were further evaluated for preliminary design and cost analysis of mine pool water collection, treatment, and delivery to a power plant. One site was selected for each of three mine pool water chemistry categories based on "net alkalinity" as measured in mg/L equivalent concentration of $CaCO_3$—net acidic (<-50 mg/L), neutral (-50 to +50 mg/L), and net alkaline (>+50 mg/L). The net alkalinity of the mine pool water determines the water treatment requirements. The mine pool water treatment process includes pre- and post-aeration, neutralization with hydrated-lime, and clarification. A water treatment option using hydrogen peroxide for neutralization was also evaluated. The cost analysis concluded that depending on site conditions and water treatment requirements that utilization of mine pool water as a source of cooling water makeup can be cost competitive with freshwater makeup systems. The following table provides a summary of the capital and operating cost estimates for mine pool water collection and treatment systems at the three sites.

Cost Estimate for Mine Pool Water Collection and Treatment System

Cost	Flaggy Meadows (net-acidic)	Irwin (near-neutral)	Uniontown (net-alkaline)
Total Capital Cost, $	5,740,000	3,770,000	3,464,000
Operating Cost, $/yr	1,367,000	363,000	433,000
Annualized Cost, $/1000 gallons	0.79	0.26	0.29

Based on fluid and heat flow modeling of the second scenario, it was determined that interconnection of two adjoining mines would be necessary to provide sufficient heat transfer residence time to adequately cool the recirculating water flow. As a result, the study identified only one potential site for a closed-loop recirculating cooling water system utilizing a flooded underground mine as a heat sink. Furthermore, that site would be limited to the cooling water requirements of a 217 MW unit. This project was completed in January 2005.

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