US Army Corps
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Station

Zebra Mussel Research Technical Notes

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Design of an In-line Backwash Filtration System for Barkley Dam, Kentucky

Background and purpose

The U.S. Army Engineer District, Nashville (CELRN), plans to install an in-line automatic backwash filtration system at Barkley Dam powerhouse on the Cumberland River (river mile 30.6) located in Livingston and Lyon Counties, Kentucky. Barkley's powerhouse has four low-head generating units cooled by pumped water. The purpose of the filtration system is to guard against an expected zebra mussel (*Dreissena polymorpha)* infestation by removing from the cooling water system stages of this organism that are capable of settling and attaching. This technical note describes the planning and design of the Barkley system.

Additional information

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Study phase of backwash filtration design

Backwash filtration uses a self-cleaning strainer to remove suspended solids from flowing water. This filter can be either a single station or a multiplex system. In addition, a basket-type, non-self-cleaning prestrainer can be used to filter large particles and organisms and prevent them from overloading the high-efficiency filter. Specialized filtration capability using a sufficiently fine mesh is necessary to remove the microscopic early life stages of zebra mussels.

The Corps of Engineers enlisted the contractual services of I.C. Thomasson Associates, Inc. (ICT), Nashville, TN, to develop plans and specifications for a filtration system for Barkley's Unit 2. Acres International Corporation, Amherst, NY, was then asked to review the ICT work.

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Final design parameters included the following:

- Filter system capable of continuous backwash cleaning.
- Compatible with various filter media configurations (round, oval, and square).
- Monitoring taps and valved bypass for testing the system effectiveness.
- Local controls with remote interface capability.
- Elimination of 100 percent of zebra mussels (veligers and adults) from plant cooling water piping.
- Noninterference with power plant operations. (That is, the unit must filter, flush, and operate on-line.)
- Provision for constant system flow and pressure of cooling water.
- Sufficient filtration operation time in the event of component failure, to allow for manual repair before problems arise with high temperatures, low flow, or low pressure.
- Equally effective operation under pumped (low-head powerhouse) or gravity flow (high-head powerhouse).
- Administrative controls to prevent low- and no-flow conditions downstream from the filter system.
- Filter shall have interchangeable filter media from 25 to 100 µm and from holes to slits.
- All unfiltered piping (such as the piping leading up to the filter and the backwash piping) shall be provided with cleanouts to allow for mechanical cleaning.
- To ensure adequate pressure to the filter and the backwash system, the cooling water pump will be located upstream of the filter and a backwash booster pump will be added.

Backwash filtration system layout

Generator unit bay 2 was selected for the prototype installation of the filter system (Figure 1). Unit bay 2 includes the auxiliary water intake system, requiring more demanding space constraints. With respect to Barkley Dam, design for the three other unit bays can be adapted from the unit bay 2 design. Both low- and high-head dams can use the system. The existing duplex filter will be replaced with the backwashing filter. An absolute 40-µm filter was chosen to remove all veliger and larger stages of zebra mussels (Dardeau and Bivens 1995). To ensure proper backwashing action, the pump will be relocated upstream from the filter. The existing 8-in. (20-cm) suction line from the scroll case and the generator coolers, header, and discharge piping will not require alteration.

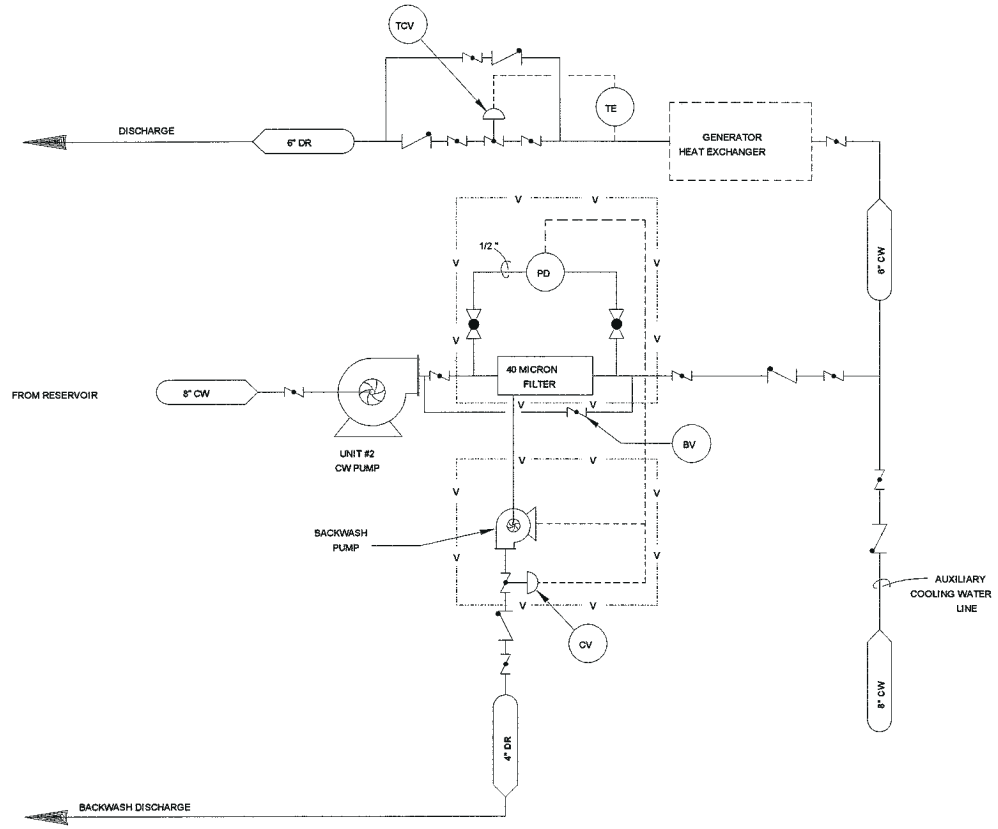
The filter system functions as river water flows from the scroll case and passes through the existing 715-gpm pump. The water then passes through the absolute 40-µm backwashing filter. The filter will support flow rates of 1,350 gpm, filter to size 25 µm, and operate under pressures up to 150 psi and water temperatures of 176 ^{o}F, all of which fall well within Barkley's design criteria. Proper cleaning requires a minimum water pressure of 30 psi. Approximately 1 percent of the intake water will be used in the backwashing procedure and is discharged into the draft tube. The remaining water is filtered, then passed through the cooling water system and also discharged into the draft tube.

Present status of filter system

The backwash filter system is presently in the plans and specifications stage and is awaiting funding for purchase and installation. The estimated cost for one system unit is $90,000, which includes materials and labor.

Reference

Dardeau, E.A., Jr., and Bivens, T. (1995). "Zebra mussel control with backwash filtration," *Waterpower '95; Proceedings of the International Conference on Hydropower,* 25-28 July 1995, San Francisco, CA, American Society of Civil Engineers, New York, NY, 1256-64.



FILTER SYSTEM SCHEDULE

MANUFACTURER	AMIAD (OR EQUAL)
TYPE	SUCTION SCANNER
FLUSHING CYCLE	40-50 SECONDS
GPM (SUMMER)	660
INITIAL RESISTANCE - WATER	0.5 PSI
FINAL RESISTANCE	7 PSI
EFFICIENCY	40 MICRONS WEAVE WIRE SCREEN
POWER TYPE	460/3/60
ELECTRICAL (AMPS)	1.5
DIMENSIONS	6.0'Lx7.75'Hx2.0'W
CONTROL POWER	24 VOLTS

REMARKS:

1. UNIT CONTROLLED BY PRESSURE & DIFFERENTIAL PRESSOSTAT.
2. BYPASS REQUIRED.
3. DISCHARGE PUMP TO BE PROVIDED BY VENDOR.
4. PIPING UP TO FILTER AND THE FILTER DISCHARGE PIPING WILL REQUIRE MECHANICAL CLEANING OR ANOTHER TYPE ZEBRA MUSSEL MITIGATION.

LEGEND

- CONTROL WIRING
- PIPING
- BV — BYPASS VALVE
- PD — PRESSURE DIFFERENTIAL SENSOR
- TE — TEMPERATURE EVALUATOR
- TCV — TEMPERATURE CONTROL VALVE
- CV — CONTROL VALVE
- DR — DRAIN LINE
- CW — COOLING WATER LINE
- CHECK VALVE
- SHUT-OFF VALVE
- GLOBE VALVE
- V-V — DENOTES VENDOR SUPPLIED PACKAGE

Figure 1. In-line backwash filtration system