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A BIOLOGICAL EVALUATION OF DEVICES USED FOR REDUCING ENTRAINMENT AND IMPINGEMENT LOSSES AT THERMAL POWER PLANTS

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been examined, and thus the true potential of center-flow screens to minimize impingement losses at power plant intakes is as yet unknown.

WEDGE-WIRE SCREENS

The name wedge-wire screen originates from the triangular or wedge shaped cross section of the wire which is welded on support bars to form a screen (Figure 6). Usually a varying size cylindrical basket is constructed from the wedge wire screen material. The size of the cylinder can vary from 2.5 cm to 7.3 m in diameter and up to 24.4 m in length. The screen openings can range from a minimum of 0.25 mm to several centimeters in increments of 0.05 mm. A relatively greater open area can be maintained with these types of screens than with conventional perforated plates or fine mesh screens. The greater open area of wedge-wire screens usually implies that pressure losses through the screen are reduced; therefore approach and through-screen velocities are also lower (Johnson Division 1977). The reduced screen openings of 0.25 mm to several millimeters are adequate to filter out planktonic eggs and larvae of fishes. The reduced approach and intake velocities could prevent the impingement of weakly-swimming or lethargic juvenile fishes.

A disadvantage of stationary screens of all types is that they can clog up very easily with suspended debris and/or can provide an ideal substrate for attached organisms to colonize. In both cases the results are pressure drops behind the screens and increased intake velocities through the remaining open area. While the cleaning of stationary screens is always difficult and costly, the Johnson screens have some practical attributes which aid in their clearing process. If the Johnson screen cylinder is in flowing water, the currents tend to transport debris and eggs and larvae of fish from the face of the screens. If the screens are used in lentic waters or if the screen is clogged or colonized by attached organisms, the cylinder can be back-flushed with a mixture of high pressure air and water, since the end of the cylinder is capped with an end plate. Objectively, however, the effectiveness of back flushing still depends on the amount and particle size of the suspended debris and the rate of colonization by attached organisms. With the possible exception of Corbicula spp. fresh water biota are less likely to colonize these cylinders in nuisance quantities. However, organisms found in the brackish or marine environment may colonize these structures to a degree where back-flush cleaning may not prove adequate. In such cases biocide treatment with back-flushing may be necessary.

Laboratory and field investigations on the performance of the wedge-wire screens are limited. One laboratory and scaled down study is being conducted at the Delmarva Power and Light Company's research facilities in Middletown, Delaware (Hanson et al. 1978). This study is investigating (1) the effects of water withdrawal through wedge-wire screens on various aquatic organisms, (2) the clogging properties of the screen, and (3) methods of back-flushing.

Hanson et al. (1978) described a study in which a cylindrical screen, 30 cm in diameter and 60 cm in length was tested in a flume. The screen openings measured 1.0 mm or less and mean velocities through the screen were approximately 0.15 m/s. In the impingement and entrainment experiments the eggs and larvae of striped bass (<u>Morone saxatilis)</u> were used. Motion pictures taken through plexiglass portholes in the flume indicated that eggs tended to accumulate briefly in relatively small numbers on the leading edge of the cylinder, which was perpendicular to the flow. Evenutally eggs drifted around or were bumped off by other eggs and drifted past the cylinder. As the velocity in the flume was increased, eddies formed on the downstream side of the cylinder. Again, eggs were impinged for a short time but as eddy currents changed they were released and drifted freely downstream. It was estimated that eggs which were impinged for up to 2 minutes with an intake velocity of 0.15 m/s (0.5 ft/s) had mortality rates of less than 5 percent.

1978 Hanson Study.

The susceptibility of larvae to entrainment increased with increasing intake velocities above 0.15 m/s. Only the earliest larval stages were entrained since they were able to pass through 1.0 mm screen openings. However, it was also observed that larvae impinged on the surface of the screens were able to free themselves and swim away from the cylinders. To date, entrainment comparisons between wedge-wire and conventional screens have not been made. Further, there has been no determination made of the long term damage inflicted on larvae which were impinged for various lengths of time.

The limited information presently available on the biological effectiveness of wedge-wire screens does not allow a detailed assessment. However, several general trends can be summarized. It appears that since the wedge-wire screen intake cylinders are stationary and are not amenable to easy removal for cleaning, biofouling may be a serious problem. Consequently, their use in brackish, marine, and possibly in warm freshwater environments may be curtailed. The accumulation of debris, on the other hand, can often be eliminated by a blast of compressed air and water. Therefore, in warm and cold water environments, debris clogging can be controlled. Since the open screen area is greater with the wedge-wire screens than with perforated or slotted screens, approach and intake velocities are also reduced. As these velocities may be proportionately related to impingement, velocity reduction is paramount in fish saving efforts.

It appears from the single laboratory study that in a lotic environment the self cleaning properties of the wedge-wire screens are important, and, along with suspended debris, eggs and larvae of fishes are also transported away from the intake cylinder. Only a fraction of the ichthyoplankton is impinged temporarily on the screens. Eggs impinged on the screens may be rolled off by the current or bumped off by other eggs. Impinged larvae, if they are large enough, can free themselves and drift away from the intake flow.

Because of the greater proportion of open screen available in this design, a smaller mesh structure is feasible which may provide protection against impingement of larger fishes as well as entrainment of ichthyoplankton. Engineering constraints, however, may limit the application of small slot-width wedge-wire screens to power plants with closed cycle cooling systems.