ASSESSMENT OF A LARGE-CAPACITY FISH PUMP FOR SAMPLING ICHTHYOPLANKTON FOR POWER-PLANT ENTRAINMENT STUDIES

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Plankton nets are the traditional method for sampling planktonic organisms that are sparsely represented in the water column. However, there are situations where nets are impractical. Such is the case for sampling from the intakes and outfalls of electric generating plant cooling water systems (CWS). Recent federal regulations have required power companies to assess the performance of their once-through cooling systems in terms of biological damage. In order to determine the densities and species of ichthyoplankton entrained in the CWS of two power plants in California, we have utilized a commercial bladeless fish pump.

The applicability of pumps for sampling plankton was discussed as early as 1948 (Welch 1948). However, up to the present time there have been relatively few applications of pumps to plankton sampling. Plankton pumps have been designed, used, reported in the literature, and commercially built (Aron 1958, 1962; Beers et al. 1967; Lenz 1972; Icanberry and Richardson 1973), but they all have had a capacity of less than 1.0 m^3, which effectively precludes their use for capturing ichthyoplankton, which is usually present in concentrations of less than one individual/m^3. Therefore, we have utilized a pump that has a large enough capacity to obtain samples containing adequate numbers of larval fish for statistical analyses. This pump exhibits minimal avoidance by larval fish and *Neomysis* sp. It delivers 3.0 m^3 min^{-1} at a 3-m head, and in excess of 4.3 m^3 min^{-1} at lower heads.

The pump is a PACO centrifugal, single-port bucket-type design and is marketed by Neilsen Metal Industries, Salem, Oregon. As adapted by Neilsen, the pump is sold as a fish pump for hatchery and aquaculture uses. According to the manufacturer, the pump can lift 30-cm trout 3 m (distance from water surface to pump) with 99.5% survival. It is powered by a one-cylinder, 12-horsepower Wisconsin engine which is powerful enough to deliver the full capacity of the pump. However, a 24-horsepower Onan twin-cylinder engine, which is also available, would delivery the same capacity with less effort.

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From the factory, the pump comes mounted on a small trailer. We designed and installed a collection box on the trailer (Figure 1; numbers in text refer to portions of pump as illustrated). The inside volume of the box is approximately 2 m^3. A 505-μm mesh net is suspended in the box during sampling operations (Number 10). The net is framed with anodized aluminum, thus preventing the net from being sucked into the discharge ports (Number 3). A bucket collector at the cod end of the net is used to concentrate the sample.

In order to measure the flow rate, we designed a square weir (Number 4) for the collection box. Field calibration tests show that the observed heights on the weir are very close to actual flow rates (Figure 2). A hook-type gage might provide greater precision in flow rate measurements.

Theoretically, with the use of an auxiliary electric vacuum pump (Number 8) the pump can be primed to a 9.0-m head. It is unknown whether the pump can operate at this head; however, we have pumped a 3.5-m vertical lift at this capacity of 3.0 m^3 min^{-1}.

The intake pipe is 15.2-cm diameter aluminum pipe and 4.57 m long. Additional sections 1.5 m long are provided for obtaining greater length if needed.

The discharge pipe (Number 3) from the pump to the collection box is 25.4-cm diameter aluminum pipe. This was designed to reduce the velocity of the water as it enters the net.

Two 20.3-cm diameter discharge pipes drain the collection box. The outlets are located in a smaller box which collects the water flowing over the weir. They insure that the water does not back up and interfere with water-level readings on the weir.

We are presently using the pump to sample larval fish and small crustaceans (i.e. *Neomysis mercedis*). They are collected from the CWS intakes at the circulating water pump suction pits of two different power plants.

Additional studies were conducted to compare the sampling efficiency of the pump to that of a towed 1.0-m 505-μm mesh nylon net. The net was towed across the mouth of the intakes several feet from where the pump

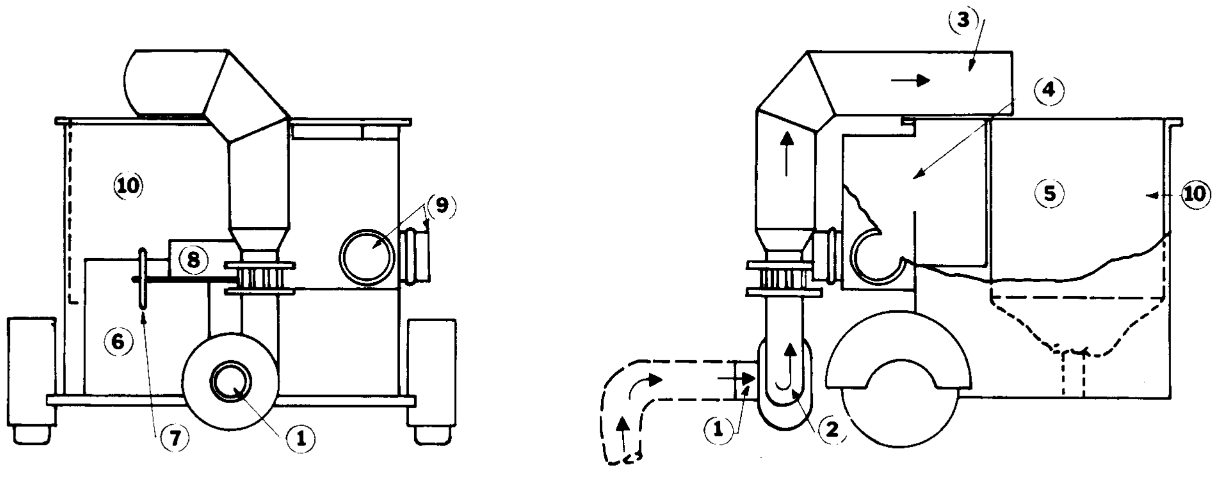

Figure 1. Schematic of pump. 1) intake port, 2) pump body, 3) discharge pipe, 4) weir, 5) tank, 6) engine, 7) gate valve, 8) auxiliary electric vacuum pump for priming, 9) discharge ports, 10) net.

was operating. The results indicate that the pump and net capture statistically similar densities of fish larvae, but the pump was significantly more efficient than the net in capturing *N. mercedis* during 20 paired net and pump samples.

Since the purpose of our ongoing larval fish and *N. mercedis* study is to determine their densities entrained by the power plant cooling systems, we did not address the ability of the pump to capture live organisms. However, the condition of the pumped specimens is such that both larval fish and *N. mercedis* are highly identifiable and in the same physical condition as net-captured specimens.

The pump can be removed from the trailer and mounted on a boat for open-water sampling. Sampling collection is accomplished by discharging the water over the side of the boat into a net suspended in the water.

The fish pump is an excellent sampling tool in situations where mobility required for conducting net tows is absent. It has proven to be a very reliable, easy-to-operate sampling tool. Its sampling efficiency is equivalent or better than that of net tows in the vicinity of power plant intakes. We feel that the pump is an entirely satisfactory tool for assessing the density of organisms entrained in power plant cooling water systems.

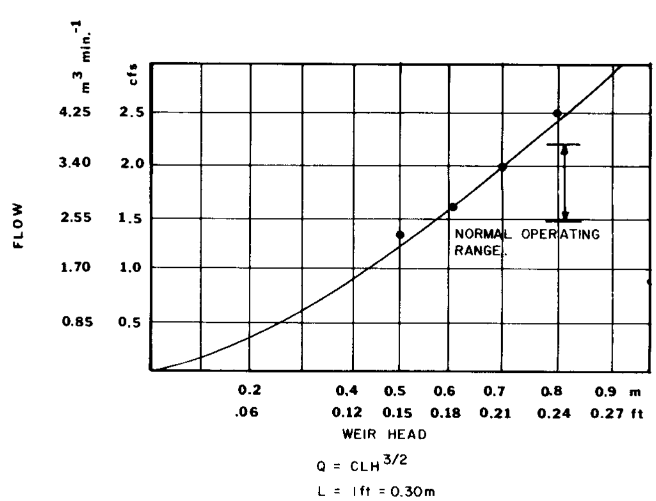

Figure 2. Rated flow curve for weir, Points indicate actual measured flow rate.

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