304

Reprinted from the *Soil Science Society of America Proceedings*
Volume 39, no. 2, March-April 1975
677 South Segoe Rd., Madison, Wis. 53711 USA

AN AUTOMATIC SYSTEM FOR SAMPLING PROCESSING WASTE WATER

H. D. FISHER AND J. H. SMITH

AN AUTOMATIC SYSTEM FOR SAMPLING PROCESSING WASTE WATER[1]

H. D. Fisher and J. H. Smith[2]

Abstract

The composition of waste water from food processing and other plants varies with time. A composite sample composed of smaller samples taken at different times will represent an average condition of these flows. The sampling system described in this paper will gather subsamples over a 24-hour or longer period and keep the composite sample frozen until ready for laboratory analysis. This system will work equally well on pressurized pipelines or ponded water. The parts cost per controller is approximately $80.00 plus the price of a freezer, associated plumbing, and a pump if the water sample is not in a pressurized pipeline.

Additional Index Words: **Water quality, biological oxygen demand, chemical oxygen demand.**

FOOD PROCESSING INDUSTRIES produce large volumes of water in which the amounts of suspended solids and concentrations of inorganic constituents including nitrogen and phosphorus vary considerably with time (1, 2). In order to obtain representative samples of the waste water effluent stream, the water must be sampled periodically over an extended period of time. The only feasible way of obtaining this type of sample is with an automatic sampling system such as the one outlined in this paper.

This automatic sampling system was used to sample a pressurized pipeline carrying water from a potato (*Solanum tuberosum* L.) processing plant which was then evaluated for organic and inorganic nutrient content. A report on the first phase of the project was made by Smith. (J. H. Smith. Treatment of potato processing waste water on agricultural land. Invitational paper presented at Pacific NW Pollution Control Ass., Vancouver, B.C., 10 October 1973.)

This sampler collects samples at fixed intervals in time, regardless of outflow rate. This may result in a smaller total sample if effluent is not flowing at the time of sampling. Making the sampling rate proportional to the flow rate may result in more accurate samples, but was too complicated and expensive for the results desired here. The controller can be made to simulate a flow-proportional sampler if enough information is available on the typical flow variations from a source. This can be done by adjusting the sample timer to take more samples during peak flows and fewer during lower flows.

Although the authors used this system on pressure pipelines, the operation of the controller is such that it can also be used with a pump on nonpressurized waste water, such as lagoons or open waterways.

[1] Contribution from the Western Region, Agricultural Research Service, USDA; Idaho Agricultural Experiment Station cooperating. This research was supported in part by a grant from the Potato Processors of Idaho Association, Inc. Received 8 Aug. 1974. Approved 23 Dec. 1974.

[2] Electronics Engineer and Soil Scientist, respectively, Snake River Conserv. Res. Cen., Kimberly, Idaho 83341.

Figure 1 is a schematic layout of the waste water sampling system as used on these pressure lines. At each location where the sampling equipment is used, valve A and one-half of a pipe union are permanently installed on the waste water line. To obtain samples at a particular location, the sampling valve system is installed by attaching the mating half of the pipe union. Valve A is opened and the system cycled manually once. The sampling system is then ready for operation. Solenoid valve B delivers the water to the sampling system; valve C is adjusted to produce enough backpressure to allow flow through solenoid valve D which delivers the actual sample to the sample container.

In operation, solenoid valve B opens at the start of a sampling cycle. This purges water retained in the system from the previous sampling cycle. After a fixed time interval set by a time-delay relay, solenoid D opens and delivers the sample to the sample container. Both solenoid valves B and D then close, deactivating the system until the next water sample is programmed to be taken.

In the authors' application, the outlet in Fig. 2 provided for the motor actually controlled solenoid valve B to supply water to the system. The time delay of relay A controlling the bypass outlet established the flushing time for the system, although a bypass valve was not used. Time-delay relay B controlled solenoid valve D and its time delay established the sampling period.

Because of the variation in pressure in waste water lines between locations, the system is calibrated for each installation by adjusting the backpressure with valve C and the time delay relay controlling solenoid valve D so that the correct amount of water is passed into the sample container at each sampling period.

From the valve system, the water passes into a 4-liter plastic jug inside a small freezer. In the authors' application,

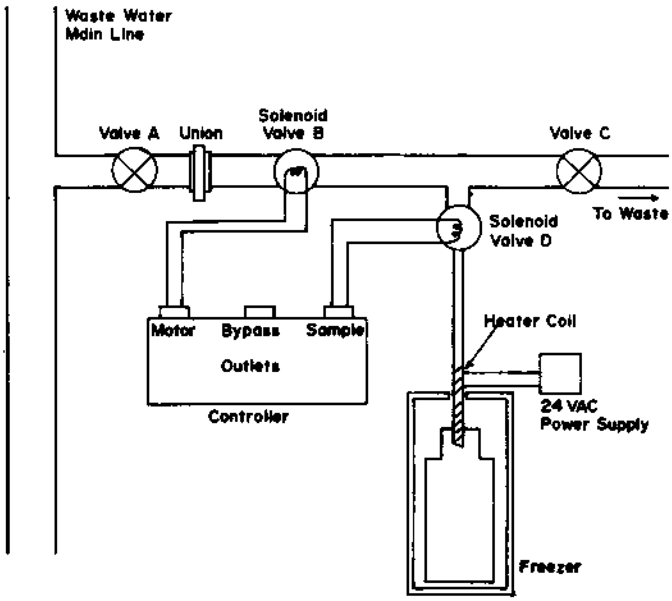

Fig. 1—Schematic of sampling system used on pressure pipelines.

water samples were taken at a frequency of approximately 2 samples/hour for 24 hours to obtain a composite sample. Individual samples usually freeze between samplings and a stratified sample is obtained. The composite sample is kept frozen until analyses are desired, at which time the sample is thawed, mixed, subsampled and analyzed.

An inlet heater prevents freezing of the sample in the delivery tube inside the freezer. This heater consists of insulated nichrome wire (constantan wire can also be used) wound around the delivery tube and powered from a 24-VAC source with a series-dropping resistor so that the

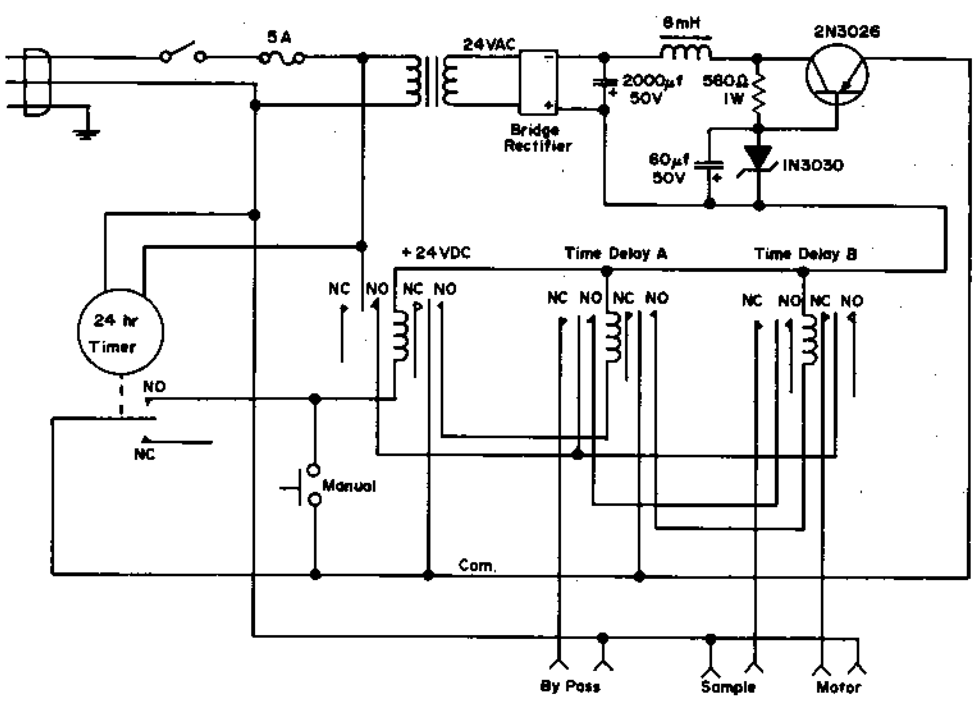

Fig. 2—Electrical schematic of sampling system controller.

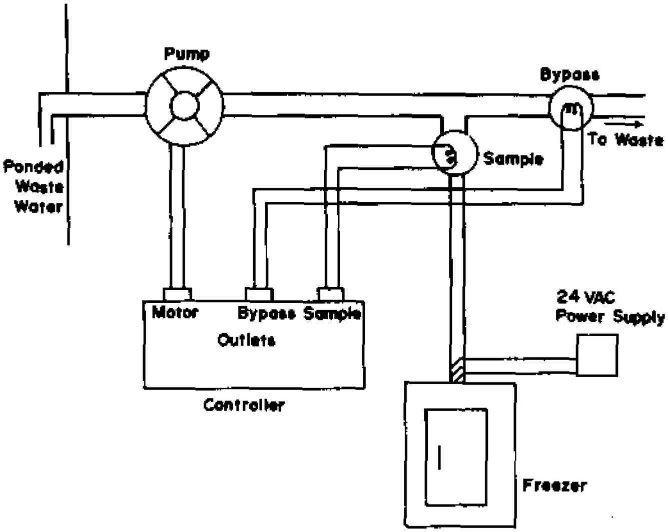

Fig. 3—Schematic of system used on ponded water.

heater dissipates approximately 1 W. Enough resistance wire is used so that the total resistance of the heater is approximately 2 Ω. The delivery tube is a 0.6-cm (¼-inch) diameter brass tube. Glass should not be used for this delivery tube because it will not conduct enough heat from the heater and the water inside will freeze.

The controller for the sampler (Fig. 2) has three electrical outlets that supply 115 VAC for three separate functions. The first outlet from the controller can operate a small motor-driven pump, if required when sampling water that is not under pressure. This outlet is activated continually during the sampling cycle. The other two outlets operate sequentially to control two sampling functions. When the sampling cycle is complete, all three of the outlets are deactivated until the beginning of another sampling cycle. Figure 3 shows all the outlets in operation to sample nonpressurized water.

A modified time switch from which all the electrical contacts have been removed controls sample timing. A 13-cm diam disc attached to the underside of the timer face has a series of holes drilled around the circumference at 5° central angle intervals to accept No. 2 machine screws. This modified timer is mounted on the outside of the box in which the controller is constructed. The machine screws in the disc actuate a miniature snap-action switch with a lever actuator mounted on the box. With screws in each of the holes in the disc, samples can be obtained at 20-min intervals for 24 hours during the day. Other arrangements of screws in the disc will produce samplings at intervals which are multiples of 20 min. The snap-action switch on the timer actuates a 24-VDC relay which supplies both 115 VAC to the points of the next two relays and 24 VDC to the coil of time delay relay A. Relays A and B are delay-on-actuate time delay relays.

When the relay controlled by the time switch actuates, 115 VAC is available to the bypass outlet through this relay and the normally closed (NC) points of time delay relay A. The motor outlet is powered through a set of NC contacts on time delay relay B. When time delay relay A actuates, it deactivates the bypass outlet and applies 24 VDC to the coil of time delay relay B. One set of normally closed points on this relay, in turn, supply 115 VAC to the sample outlet. When relay B actuates, it deactivates both the sample and motor outlets.

Because of the location of these units, voltage fluctuations on the 115-VAC line are quite probable. To eliminate the effects of these fluctuations on relay actuation time, the time delay relays are powered from a 24-VDC regulated supply (Fig. 2) with sufficient storage capacity that short outages can be tolerated without interrupting the sampling cycle.

The parts cost per controller is approximately $80.00. This results in a sample controller which can be programed to sample a maximum of once every 20 min throughout the day, and which has easily adjustable bypass and sampling periods. This enables the user to program the system to fit the type of installation he is interested in sampling, whether it be a pressure system or one in which a pump is required for sampling.

List of Major Components

CONTROLLER

1	Paragon Model 4003–0 time switch,
1	Potter-Brumfield KAP-11DG relay—24-VDC coil,
2	Potter-Brumfield CHD38–30003 time delay relay,
1	Triad F–45X filament transformer,
1	Encapsulated fullwave bridge rectifier,
1 each	2000 μf 50 V, 60 μf 50 V capacitors,
1	2N3026 transistor, and
1	1N3030 zener diode.

SAMPLER AND COLLECTOR

1	115 VAC centrifugal pump and motor,
2	115 VAC solenoid valves in size of pipe used,
2	Gate valves in size of pipe used,
1	5 cubic-foot freezer, and
1	Triad F–45X filament transformer for inlet heater.

Literature Cited

1. Knapp, C. E. 1970. Agriculture poses waste problems. Environ. Sci. Technol. 4:1098.
2. Pearson, G. A., W. G. J. Knibbe, and H. L. Worley. 1972. Composition and variation of waste water from food-processing plants. USDA ARS-41–186. Washington, D.C.