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Project Summary

Field Evaluation of the Land-O-Matic Dry Pellet Chlorination System

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The effectiveness of dry pellet feeder chlorinators to deliver a desired chlorine dose in domestic water systems that would normally receive only occasional monitoring and adjustment was evaluated at four wells near Tucson, AZ.

The Land-O-Matic Dry Pellet Chlorinator* was capable of providing an acceptable average chlorine dose in well water supplied to domestic water systems. The chlorinator proved reliable and easy to operate, but it required regularly scheduled monitoring and maintenance. Finally, data from the three village water systems used in the evaluation suggest that the construction of the well and the configuration of the water system are controlling factors in selecting an appropriate chlorination system.

This Project Summary was developed by EPA's Water Engineering Research Laboratory, Cincinnati, Ohio, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Disinfecting water in small domestic water systems can be difficult. Such systems typically operate with a minimum of operator attention, and their intermittent, on-and-off flow pattern complicates the task of obtaining adequate disinfection. This project evaluated a chlorinator (Land-O-Matic Dry Pellet Chlorinator, Autotrol Corporation, Milwaukee, Wisconsin) designed to dispense chlorine pellets into a well during well pump operation. The evaluation included determination of the equipment's ability to dependably deliver the desired dose of chlorine, as well as observation of equipment operating capabilities in a desert environment.

In a cooperative effort between the U.S. Environmental Protection Agency, the Indian Health Service (U.S. Public Health Service), and the Papago Indian Reservation, four chlorinators were installed at the villages of San Luis, Lower Covered Wells, and Santa Rosa (Santa Rose village well and Santa Rosa clinic well) on the Papago reservation, west of Tucson, Arizona. Information on the wells is given in Table 1. The San Luis well was located next to a stock corral, and water in the well was subject to contamination and had a variable chlorine demand. The deep wells at the other two villages were properly constructed and not subject to surface contamination. During a 2-year period before installation of the chlorinators, coliforms were detected in 11 of 18 well water samples at San Luis, ranging from 1 per 100 mL to 30 per 100 mL. One of 19 samples at Lower Covered Wells was positive (6 per 100 mL). Two of 23 Santa Rosa well water samples were positive (2 per 100 mL and 22 per 100 mL) in the pre-test period.

The chlorinators used in this study consisted of a modular designed thermoplastic device, with a storage bin and motor-driven rotating pellet plate that delivered dry chlorine pellets from the storage bin to a drop tube. The pellets fell through the drop tube into the well casing.

* Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Table 1. *Water System Characteristics*

Component	San Luis	Lower Covered Wells	Santa Rosa Village	Santa Rosa Clinic
	Village			
Well	*Dug, with 8" steel casing*	*8" drilled*	*8" drilled*	*8" drilled*
Depth	*49 ft*	*250 ft*	*400 ft*	*500 ft*
Pump	*Jet*	*Submersible*	*Submersible*	*Submersible*
Capacity	*4-8 gpm*	*12 gpm*	*55 gpm*	*85 gpm*
Storage	*3,000 gal*	*20,000 gal*	*150,000 gal plus 3,000 gal pressure tank*	*23,500 gal*
Daily Water Use Range	*3,200 to 6,500 gal*	*5,000 to 11,000 gal*	*15,000 to 54,000 gal (combined)*	

Each chlorinator was fastened to the well casing with a mounting bracket furnished by the manufacturer. The chlorinators were wired to operate when the well pumps operated. The rate of pellet feed was adjusted by changing the rotating speed of the pellet plate and by opening between 1 and 6 slots in the pellet plate. A schematic diagram of the chlorinator is shown in Figure 1.

The chlorinators were installed in 1983. After an initial 6-month period of operation for break-in and adjustment, a weekly program of sampling was conducted in 1984 and 1985. Chlorine samples were collected on Monday, Wednesday, and Friday. Bacteriological samples were collected on Monday and Wednesday. When samples were taken, the operation of the units was observed, and notes were made on any problems encountered or adjustments made. Chlorine pellets were added as needed. Free and total chlorine residual determinations were made with a DPD test kit. Coliform analysis by the membrane filter method was performed at the Papago Tribal Utility Authority Water Quality Laboratory on the same day that samples were collected

Results

The results of coliform tests at the four wells indicated that the dry pellet feeder chlorinators are most effective when water of uniform quality is treated. Water from the San Luis well, subject to transient contamination, was not easy to treat using a chlorinator that could not automatically change dose in response to changes in chlorine demand. At San Luis, 44 of 150 coliform samples were positive. In contrast, at Lower Covered Wells and Santa Rosa, only one positive coliform test was observed in the 300 tests performed. The wells at Santa Rosa and Lower Covered Wells were designed and constructed to provide a sanitary water supply, and the ground water there was not subject to contamination. Chlorinators at these wells could operate at a steady rate of feed, without requiring frequent adjustment. This situation proved the most appropriate for operation of the chlorinators.

Variability of chlorine dose was also evaluated during the study. The mechanism of chlorination involves dropping solid, 1-gram pellets into the well casing. Wells at San Luis and Lower Covered Wells had stainless-steel pellet catch screens installed in the casing. These caught the pellets and allowed water to flow by as the pellet dissolved. At Santa Rosa, neither well had a catch screen, so pellets dropped to the bottom of the well and dissolved.

In wells having catch screens, chlorine concentrations were above average when pumping began. Pellets that had dropped into the casing near the end of the previous pumping cycle dissolved while the pump was off. Then with a resumption of pumping, the water in the well casing had a chlorine residual higher than desired. In wells lacking catch screens, pellets fell to the bottom of the well. In this situation, chlorine concentrations were lower than desired upon start-up of the pump. When catch screens were used, the high chlorine concentration quickly declined, indicating that the standing water in the well casing had been pumped out. When no screen was used, however, the chlorine concentration increase occurred slowly.

A pumping test was performed at the Santa Rosa Village well (no catch screen used here) after a 24-hour period with no pumping. Chlorine dosing began when pumping started, but the equilibrium chlorine concentration was not reached until pumping had continued for 90 minutes.

The results of this study demonstrate the importance of having adequate storage capacity for pumped water. The storage can provide contact time for disinfection, and it can also provide for equalization of the disinfectant residual. Contact time is best provided in a plug flow regime, whereas dose equalization is best in a complete mixing regime. Accomplishing both purposes in a single tank would involve an ingenious approach to baffle design and hydraulics, but if engineers are aware of the treatment goals desired and of the characteristics of the dry pellet feed chlorinator, they can attempt to meet those goals. The least desirable situation, both in terms of short contact time and wide fluctuations of chlorine residual, was the system with only a small storage volume. When chlorination facilities of this type are designed for small systems, regulatory guidance should be sought to ensure that adequate disinfection is attained when the system is placed in use.

Operating problems were observed during the test period and were associated with the pellet drop tube, the metal pellet plate, metal parts related to the plate drive, and the amount of pellets stored in the chlorinator.

The clear-plastic pellet drop tube supplied originally became dark, and the inside became sticky. Pellets stuck to the drop tube and eventually clogged it. This situation was corrected by use of a gray-plastic drop tube provided by the manufacturer.

The rotating circular plate controlling the rate that pellets dropped into the well sometimes encountered excessive resistance and did not function as intended. Pellets jammed between the housing and the plate, and caused operating difficulties. In 1985, the manufacturer redesigned the pellet plate and fabricated it from a much harder, more rigid, nonmetallic material. The new plate was not tested in this study, but it is expected to be effective in reducing these operating problems.

Chlorine is a very corrosive chemical, and corrosion of metal parts in the pellet housing assembly and the clutch assembly occurred. The significance of the

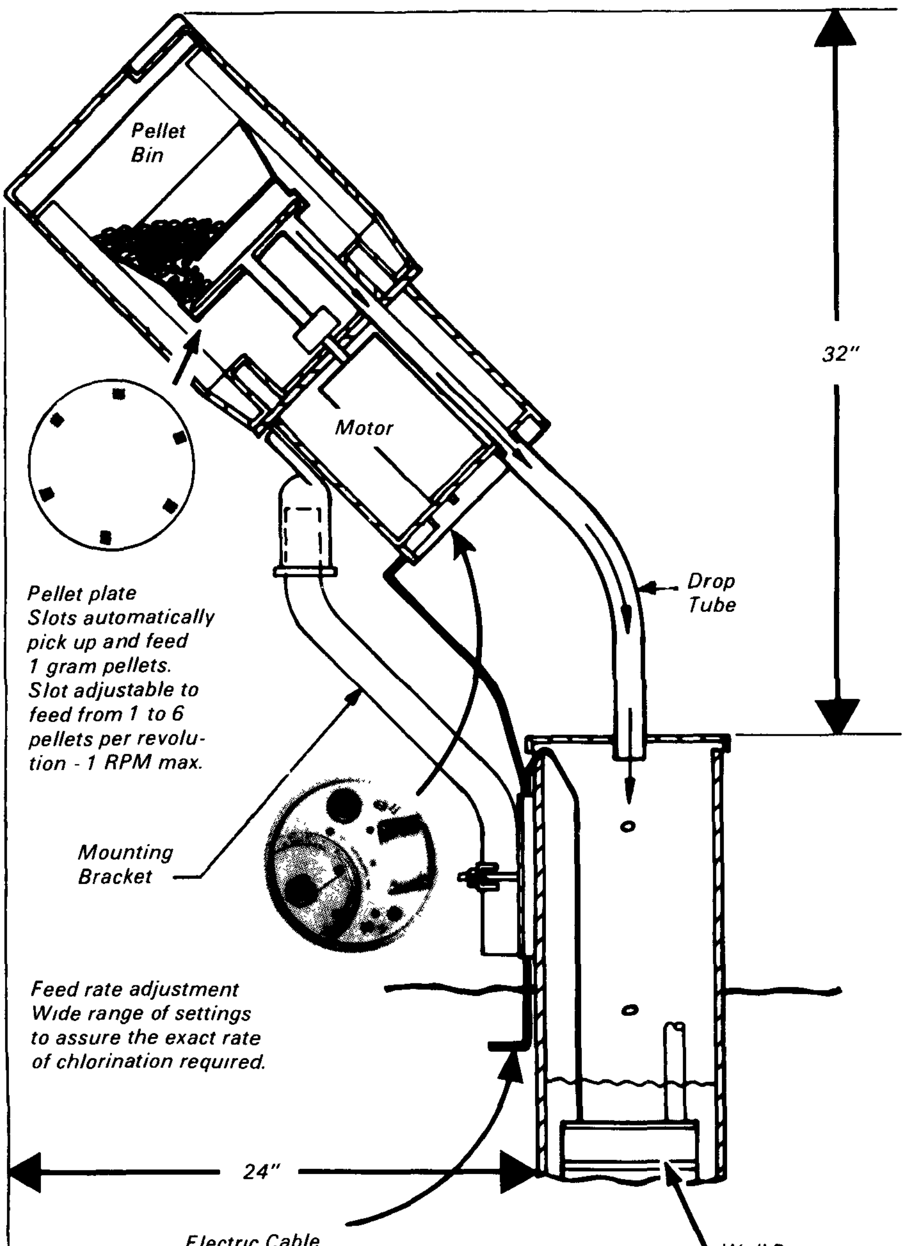

Figure 1. Typical chlorinator system schematic

corrosion was observed when equipment maintenance was carried out. Some screws were so corroded that disassembly of the motor and clutch assembly resulted in damage to screwheads.

Early in the study, investigators noted that the drive motor seemed to labor when the pellet housing was full. This was attributed to flexing of the pellet plate under the weight of a full load of pellets. During the study, the pellet volume was kept about one-quarter full and no more problems were encountered. Changing to a more rigid pellet plate is expected to alleviate this problem.

All four chlorinators were exposed to a desert environment with no shelter or protection. After 2 years, the only weathering problems observed were those of clear-plastic drop tube deterioration and metal parts corrosion. The equipment was not harmed by very high air temperatures or bright sunshine.

Because of the modular design, the units were easy to disassemble and reassemble. No special tools were needed. Except for the oxidized metal parts, no major problems were encountered when repairs were made.

Conclusions

1. The Land-O-Matic Dry Pellet Chlorinator produced an acceptable average chlorine dosage in three water systems of varied configurations.
2. Although the chlorinators produced acceptable average chlorine dosages in the pumped water, they could also produce undesirable high and/or low chlorine levels for short periods of time.
3. High daily temperature and intense sunshine had no apparent effects on the dry pellet chlorinator assembly. However, the clear-plastic pellet drop tubes that conveyed the chlorine pellets from the chlorinator to the well deteriorated rapidly and resulted in improper chlorinator operation.
4. Chlorinator operation was labored when the storage bin was filled to capacity with dry chlorine pellets.
5. The interior metal parts in all the nest and clutch assemblies and 25% of the pellet housing assemblies became badly oxidized and, therefore, difficult to disassemble.
6. The openings in the pellet plates would occasionally plug up with chlorine pellets and/or pellet fragments, which would then cause the pellet plate to bind inside the retainer funnel while the motor continued to turn. This prevented the pellets from entering the well and caused accelerated wearing in or between the clutch assembly and shank of the pellet plate.
7. Operation, maintenance, and repair of the chlorinators was very simple and required no special training or tools.
8. The combination of pellet plate openings, rotation speed adjustments, and drive motor speeds allowed the chlorinators to operate over a wide range of pumping rates.

Recommendations

1. Well construction is an important consideration in the effective operation of dry pellet chlorinators and should be given considerable weight in selecting the proper chlorination system.
2. The dry pellet chlorinators are most effective when used in well water systems that pump directly to large storage tanks, which in turn act to equalize variations in chlorine dosages. Thus, the physical attributes of the

water system should be a consideration in selecting the type of chlorinator used.

3. Dry pellet chlorinators in operation should be put on a maintenance schedule that would allow cleaning of the pellet housing of chlorine dust and pellet fragments on a semimonthly basis.
4. The dry pellet chlorinators should be disassembled at least annually and inspected for signs of excessive wear, oxidation, and/or other associated problems, and questionable operating parts should be replaced.
5. A clear-plastic pellet drop tube was a desirable feature on the chlorinators as it allowed for easy verification of chlorinator operation. A non-deteriorating transparent tube should be substituted for the original tubes or some other means of observing pellet delivery should be incorporated into the chlorinators.
6. The Land-O-Matic Dry Pellet Chlorinator should be evaluated in an area that has both high relative humidities and periods of extreme low temperatures. These factors could influence the effective operation of the chlorinators.

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The complete report, entitled "Field Evaluation of the Land-O-Matic Dry Pellet Chlorination System," (Order No. PB 88-113 667/AS; Cost: $14.95, subject to change) will be available only from:
National Technical Information Service
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