Usable Water from Raw Sewage

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Introduction

Water is becoming an ever increasing critical commodity to man. Yet today, man is continuing to waste it. Present day conventional sewage treatment plants are examples of this wastefulness. Chemical treatment of waste water only exchanges one type of pollution for another. Chlorine used in sufficient quantities to kill large percentages of bacteria also pollutes the water so that it stunts plant growth, kills oysters and other shellfish, and in general makes the effluent far less useful.

It is predicted that by the year 2020, or about 50 years from now, the United States' demand for fresh water will greatly exceed its present supply. The present wasteful methods of sewage treatment cannot be allowed to continue if our children and grandchildren are to have the water they will need.

With these considerations in mind, Energy Systems, Inc. of Melbourne, Florida, started to investigate the usefulness of nuclear irradiation in treating sewage more than four years ago. As a result of these investigations a pilot irradiation sewage treatment plant has been in operation at the University Center for Pollution Research (U.C.P.R.) of Florida Institute of Technology (F.I.T.) for the past three years, and a small commercial plant has been in continuous operation at Palmdale, Florida for over a year.

Irradiation Processes

In considering the type of irradiation to be utilized it was necessary to choose between particulate radi-

*Footnote: Energy Systems, Inc. has licensed to Tampa Bay Engineering Company of St. Petersburg, Florida, the sales, engineering, and construction rights for the Irradiation Sewage Treatment System for 40 states and the Caribbean. International Purification Systems, Inc. of Atlanta have the sales, engineering and construction rights for the state of Georgia.

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ation or non-particulate (electromagnetic) radiation. Gamma rays are of the latter type and are suitable for the treatment of sewage because of the lack of residual radioactivity left in the material irradiated. Irradiation of the effluent with gamma photons from Cobalt-60 results in zero residual radioactivity. This condition is well established by the many patients who have received Cobalt-60 gamma ray treatment for cancer. Other types of nuclear irradiation either do not penetrate the liquid sufficiently or possess the capability of producing a radioactive effluent.

Both Cobalt-60 and Cesium-137 produce gamma photons which could be used for the treatment of sewage. However, at the present time Cobalt-60 appears to be the most practical source when considering costs, energy emitted, the physical and chemical properties, and the availability. Cobalt-60 can be easily obtained in small or large quantities from at least three commercial suppliers in North America.

Effectiveness of the use of Cobalt-60 irradiation results from two causes, both of which result from gamma photons. The gamma photons activate chemical molecules and typically cause ionization to occur by the interaction with the orbiting electrons. As a result, small molecules are ionized, and long chain organic molecules may be broken up into shorter chains and/or so activated that the potential for chemical reactions is increased. In connection with this effect, the gamma photons also produce ozone, peroxide, hydroxide ions, and oxygen ions in even pure water. These products of irradiation are very strong oxidants. The result of the ionization and absorption of energy into the molecular chain structure in the presence of the production of the oxidants produce possible synergistic effects that result in a breakup of the chemical molecular structures and the killing of bacteria and viruses.

Irradiation of the effluents from conventional secondary sewage treatment plants is not a "cure-all". The irradiation does assist in and provide an important step in the processing of secondary effluent to produce usable water. The three years of operation of the pilot irradiation sewage treatment facility at U.C.P.R. and the one year operation of the small commercial irradiation sewage treatment plant at Palmdale, Florida have shown that six effects result just from the irradiation process.

1. Of primary importance is the effective reduction in the suspended organic solids in the fluid as it passes through the irradiator, because

filtration is required for highly treated water. The irradiation produces a wet-oxidation process that reduces the plugging characteristic of effluent inherent in conventional secondary sewage treatment plants. Filtering processes at the Palmdale plant have shown an order of magnitude longer run-time than normally expected if the effluent from the extended aeration plant were directly filtered.

2. The reduction of both bio and non-bio degradable detergents is also an important factor of the irradiation process. During the three years of operation of the pilot irradiation sewage treatment facility at U.C.P.R. it was found that different degrees of degradation of detergents could be obtained as a function of the energy input into the fluid. At the nominal energy use for the other results (approximately 50,000 rads) it was found that approximately 90% degradation occurred and that nearly the entire foaming action was destroyed.

3. One of the very vital results of irradiation of sewage is the killing effect on viruses. Irradiation is the only economically practical way of treating a fluid to kill viruses and have the fluid remain usable. Gamma irradiation is one of the principal methods in use today for the sterilization of surgical instruments.

4. Of course, another result of the irradiation process is the killing of bacteria. However, if this were all that was accomplished the cost could not be justified. Chlorine is cheaper, but then all that chlorine addition accomplishes is the substitution of a chemical pollutant for a bacteriological pollutant. Consistent results from both the pilot facility at the U.C.P.R. and the commercial plant at Palmdale have shown that a 99.9% kill of coliform bacteria have been obtained by the irradiation. A consistent 100% kill of E-Coli bacteria has been obtained at the Palmdale irradiation sewage treatment plant during the past year.

5. One of the interesting effects of the irradiation process is that the effluent from conventional secondary plants will support a large algae growth within a couple of days, while the effluent from the irradiator remains algae free for months unless algae are placed in the fluid. If a piece of bark or wood is placed within the fluid, algae already on the object will grow, but the algae do not "bloom" throughout the fluid.

6. Tests run by a student showed that concentrations of the pesticide parathion were reduced when passed through the irradiator at the U.C.P.R. Normal dosages of irradiation resulted in a reduction of up to 30% in the concentration of solutions of parathion. Higher dosages resulted in additional reduction in the pesticide.

Commercial Plant Operations

After considerable testing of the effectiveness of irradiation of sewage, Energy Systems, Inc. of Melbourne, Florida contracted with Lykes Brothers, Inc. of Tampa, Florida to construct a small continuously operating commercial irradiation sewage treatment plant. The plant was built at the Fisheating Creek Campground in Palmdale, Florida. The plant consisted of a wet well, used as a collection basin, a conventional aeration package plant, a nuclear irradiator, and a filter system shown in Figure 1. In the lower right-hand part of the picture is the wet well which is used as a holding tank to smooth out the large fluctuations in usage typical of a campground. On top of the wet well are two pumps used as a lift station. All flow through the system from the package plant through the irradiator and until the fluid reaches the filters is by gravity. Immediately behind the wet well are the three concrete sections of the extended aeration package plant. To the left of the package plant is the irradiator. Behind the package plant is the filter building.

The irradiator itself is a 14 ft. by 14 ft. by 9 ft. concrete block surrounded by a 10 ft. high cyclone fence. Inside the concrete block the irradiation chamber or core is approximately a right circular stainless steel cylinder. Eight pencils of Cobalt-60 are suspended within the core. Core design is arranged so that 90% of the energy of the Cobalt-60 is absorbed within the chamber and the fluid is completely mixed so that every drop receives the correct total absorption of energy. These last two parameters are critical for the successful treatment of waste water by irradiation.

Figure 2 shows a block diagram of the Palmdale Plant. Numbered points are locations from which samples were taken for testing. Table I shows the numerical results of the analysis of the samples obtained from locations 1, 3, 4, and 5, as indicated by Figure 2.

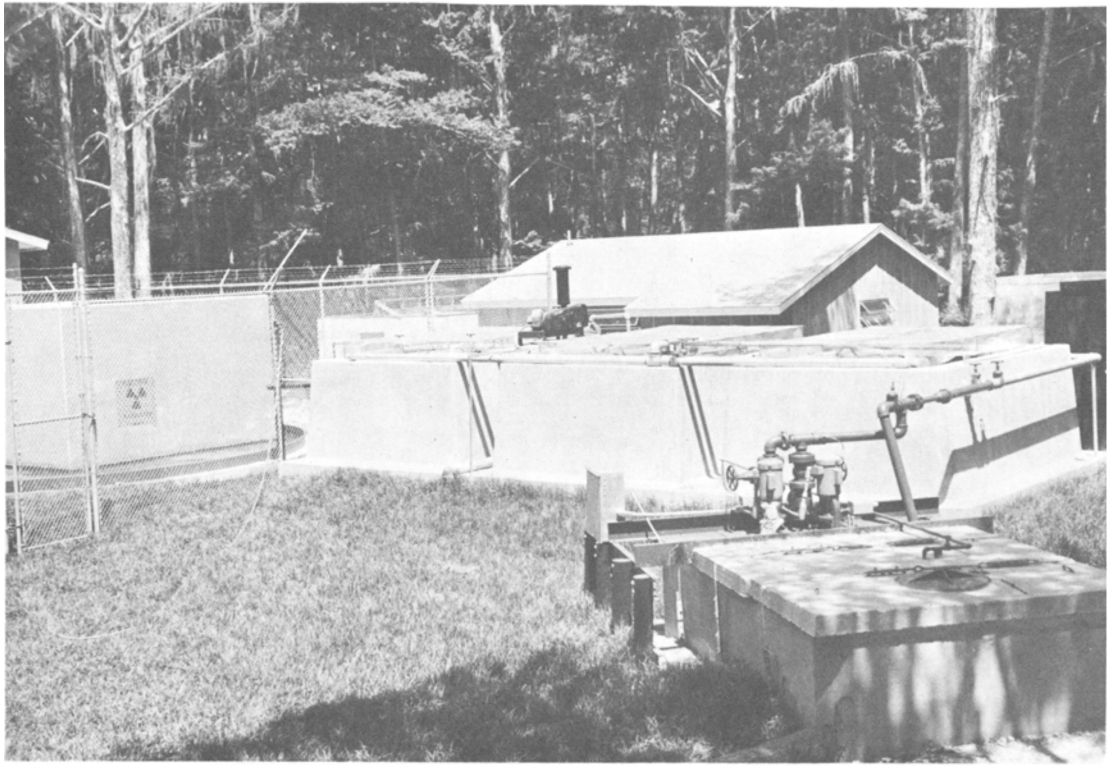

FIGURE 1

Photograph of Palmdale Plant

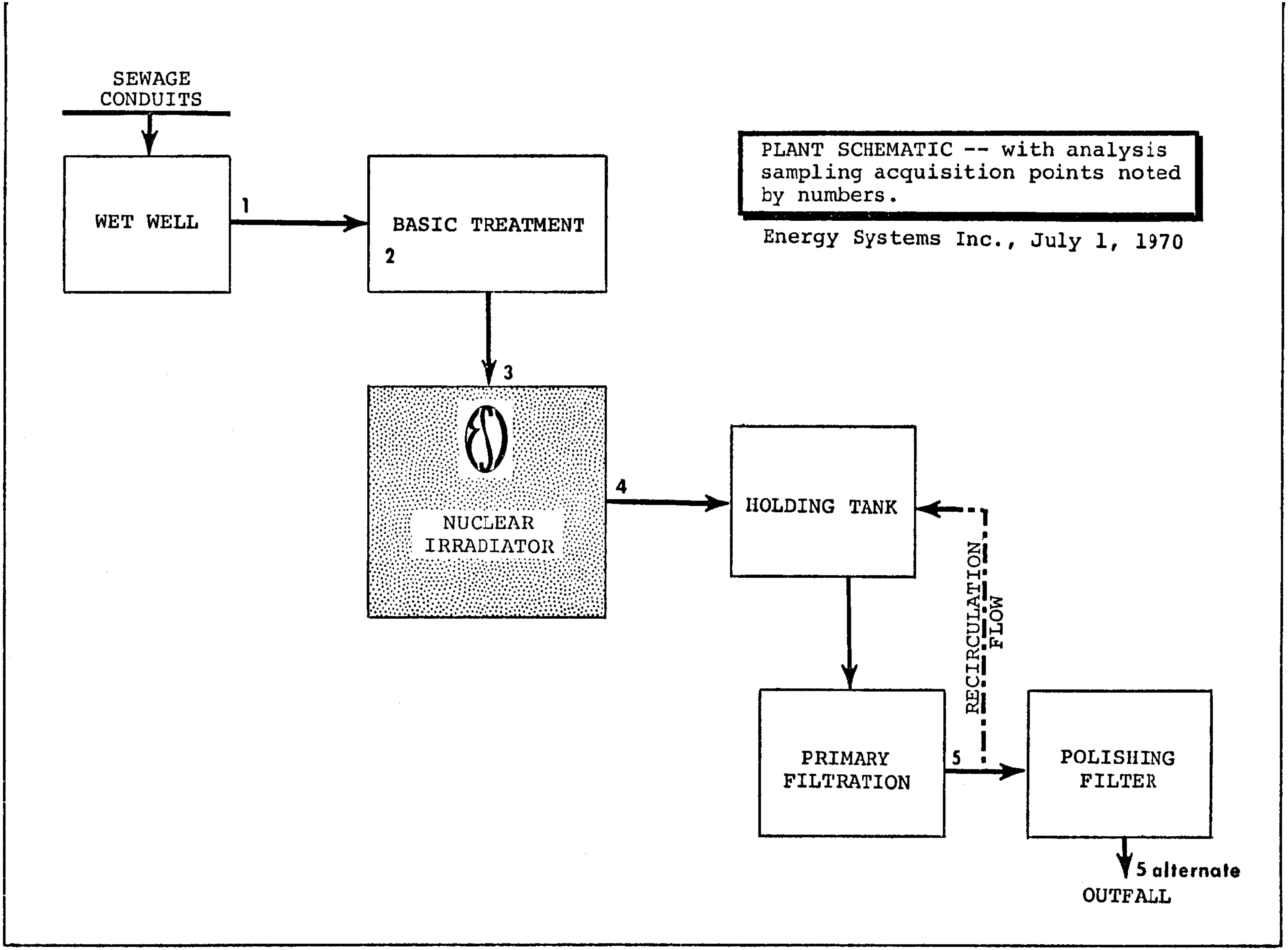

Figure 2. Schematic Flow Diagram of Palmdale Plant.

TABLE I
Data From A Representative Test Run

	W.W.*	IRI*	IRO*	OF*
Settleable Solids (mg/l)	20.5	2.0	0.2	0.0
Turbidity (Jackson Units)	42	20	15	12
BOD (ppm)	360	120	40	3
Suspended Solids (mg/l)	390	110	16	4
Dissolved Oxygen (ppm)	6.0	7.0	3.0	6.35
pH	6.9	5.9	6.9	7.0

*W.W. - wet well
IRI - Into irradiator
IRO - Out of irradiator
OF - Outfall

Conclusions

Usable water can be obtained just by the irradiation process. Irradiated unfiltered effluent could be utilized directly as irrigation water because:

1. Effluent possesses no residual pollutants that could harm or stunt growth.
2. Effluent is odorless.
3. Organic materials in the effluent have been broken down.
4. Many bacteria and viruses have been killed.
5. Detergents have been greatly reduced.

These advantages make an irradiation sewage treatment plant desirable in parks and other camp areas where the effluent can be effectively used for irrigation. Usage of sewage effluents for industrial purposes would require some type of filtering following the irradiator. Water to be returned to a source stream should be filtered. Filtration treatment can be obtained so that the fluid will meet potable water standards. Thus, technically, sewage waste can be cleaned up and the water made usable.

Streams and lakes do not have to be polluted. However, clean water cannot be obtained at the price of dirty water. The cleaner the water required the more it will cost the public. It is not a question of technical capability to clean up the waterways; it is question of the economic demands and desires to pay for the required task. A little thought will convince the reader that dirty effluent will eventually cost more than clean water because of eventual clean up costs.