IRCWD NEWS

WHO International Reference Centre for Wastes Disposal

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No. 10/11

October 1976

An Algal Regenerative System for Single-Family Farms and Villages

In addition to the description of a bio-gas plant as realized in India (IRCWD News No. 8) we are publishing now a system developed by U.S. Scientists C.G. Golueke and Prof. W.J. Oswald, University of California, Berkeley. This system promises the development of a family living unit that embodies a maximum of self-sustenance and yet is in complete harmony with its external environment. The feasibility of such a system is greatest in tropical countries.

Introduction

During the past few years, considerable attention has been directed towards the development of a living unit that embodies a maximum degree of self-sustenance and be in complete harmony with its external environment. The rationale for developing such a unit is that of placing a minimum burden on the environment and on available resources, especially energy sources, through the integration of human habitation with the environment. The integration involves the development of localized systems in which residues are directly recycled into the individual living unit which generated the residues. In other words, the ideal would be a series of "closed" systems. Obviously, the systems could not be completely closed, in that energy and certain materials would have to come from outside the unit such as structural materials, utensils and certain equipment. Rather, the aim is that once a unit is set up, to make it self-sustaining.

In the course of their research on the utilization of algae for the reclamation of nutrients and water from municipal and agricultural waste waters, and on the development of photosynthetic life-support systems for extraterrestrial applications, the authors of this paper arrived at the design of a self-contained living system which they feel merits attention. Their system, an algal regenerative system, has the advantage of providing for the utilization of solar energy. Thus, it incorporates addition as well as preservation, namely external (solar) energy is brought into the system to augment that which is conserved within the system. Bringing in external energy is essential, because short of the mythical perpetual motion machine, no system can operate without a net loss of energy. In the authors' system, solar energy supplies the energy needed to keep the system functioning, just as solar energy is the ultimate source for the earth as a whole. It has in miniature, the features of the living part of the earth as a whole, namely, photosynthesis (crop production), aerobic and anaerobic bacterial decomposition (carbon and nitrogen cycles), recycling of water, plus the use of the chemical energy of methane. The system is beyond the conceptual state because its components have been demonstrated individually and integrally by the authors as being technologically feasible in laboratory and pilot scale studies.

A description of the system is the subject of this paper. It is based upon material contained in Appendix A of the final report *Photosynthetic Reclamation of Agricultural Solid and Liquid Wastes.* (The report is being published by the U.S. Environmental Protection Administration.)

Overall description

A schematic diagram of a typical small-scale algal regenerative system as envisioned by the authors is shown in Figure 1. Aside from the people and the animals, the principal components of the system are an anaerobic digester, a series of algal growth chambers, a sedimentation chamber, sand beds, a solar still, and a gas exchanger. Inasmuch as it is combined with a residence needing gas for cooking, the anaerobic digester is covered to permit combustible gas to accumulate under the cover at a pressure sufficiently above atmospheric to force the gas from the collector to the stove. Excess gas, which is rich in methane (i.e. 55 to 65%), is conveyed from the gas dome through conduits into the residence, where it is used for household purposes. Periodically, digested solids are drawn from the digester for use as soil conditioner or fertilizer in the growth of vegetables on a nearby soil plot.

At its minimum practical size, the algal regenerative system would provide waste disposal and nutrient recycle for four persons, one cow and fifty chickens. This size was arbitrarily regarded as being the most elementary that could be operated. The bases upon which the size of the components of the single-family unit were estimated, are described in the paragraphs which follow. Within as yet to be determined size limits, design data proven satisfactory for the single-family unit could be directly extrapolated to fit larger populations.

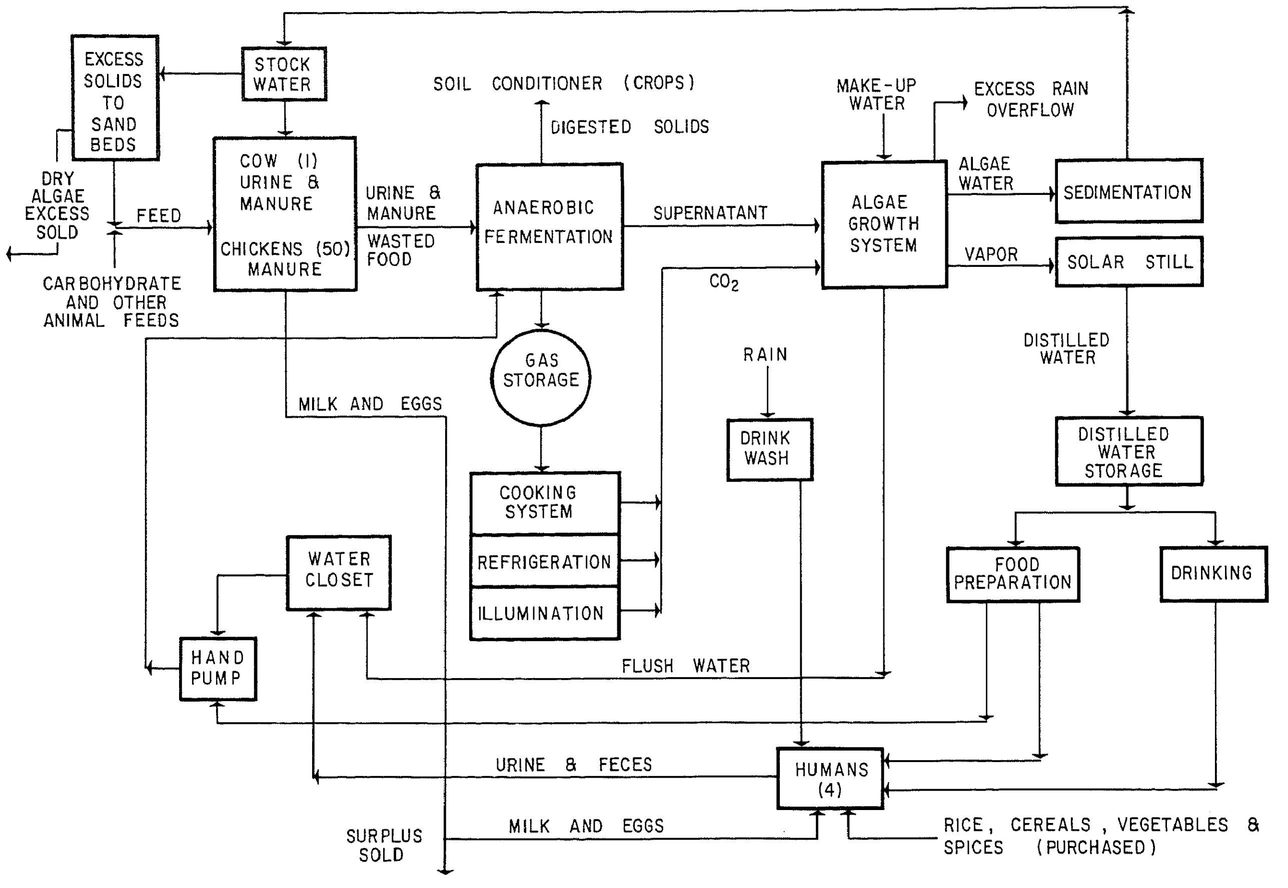


Fig. 1 Schematic diagram of single-family microbiological organic waste recycle system

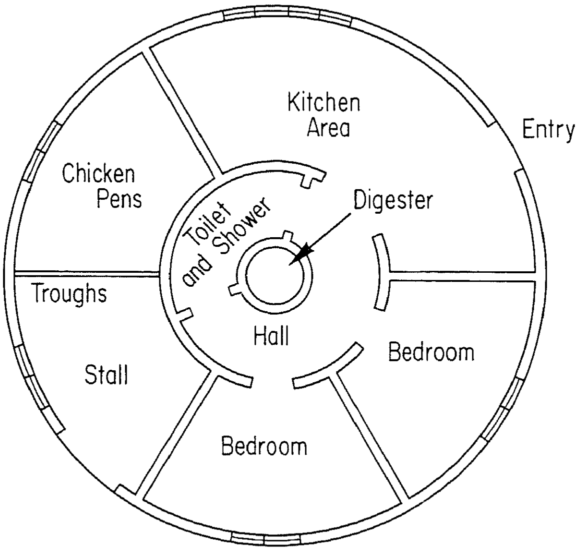
Components of the system

Digester: The size of the digestion element of the system is based upon an established microbiological minimum per capita criterion of 0.028 m^3 (1 ft^3) for humans, 0.28 m^3 (10 ft^3) for cattle, and 0.07 m^3 (0.25 ft^3) for chickens. Therefore, the minimum aggregate volumetric digester requirement for a population of four persons, fifty laying hens, and one milk cow is 0.736 m^3 (26 ft^3). However, experience has shown that to be manageable under practical conditions, the minimum size of the digester should be 1 meter in diameter and 2.5 meters deep. The active volume of such a digester would be 1.56 m^3 (55 ft^3), or almost twice the computed minimum requirement. Oversizing the digester would not be a waste, because benefits resulting from the additional volume will be a superior fermentation and an excellent gas conversion.

The digester is equipped with an inverted dome-type cover for gas pressurization. It also has a charging chute through which the manures and night soil and food and feed waste are introduced into the digester culture *below* its surface. Wastes are introduced below the culture surface lest digester gas escape or oxygen enter by way of outside air. The latter could be disastrous if enough oxygen entered to result in an explosive mixture of methane and oxygen. Proper entry is assured by constructing recharge chutes with a side entrance below the water line. For most efficient use, the digester is positioned at the center of the ponding system and living area. Such an arrangement permits overflow supernatant to move directly into the pond system, and thereby conserve heat and minimize piping.

Algae Production Unit: The algae production unit is the most crucial part of the system. It is sized on the basis of the amount of waste nitrogen available from the contributing population. For example, an efficient milk cow may process 120 grams of nitrogen daily, of which 20 grams are excreted as milk, and 100 grams as feces and urine. An efficient laying hen may process 3 grams of nitrogen daily, of which 0.6 grams are excreted as eggs and 2.4 grams as feces. Thus, with one cow and fifty chickens, the nitrogen contributed in the form of wastes from the animals would be 2 220 grams (4.9 lbs) per day. Since each human excretes about 12 grams of nitrogen each day, four persons waste about 48 grams of nitrogen per day. The aggregate amount of waste nitrogen would then be 268 grams daily. Past experience has shown in an algal system based upon the use of animal manure as a nutrient source, nitrogen, phosphorus, and other elements are always in excess with respect to carbon. It also indicates that the composition of most unicellular algae grown under such conditions may be assumed to be 10% nitrogen. (Algae growing in less nitrogen rich waters usually have a nitrogen content of 6 to 8%.) Thus, if all waste nitrogen were to be recycled, the amount of algae grown each day would be 2 680 grams (5.9 lbs). If the production rate is assumed to be 0.33 grams of algae per day, the standing biomass of algae required would be 8 130 grams (18 lbs). Assuming a concentration of 500 mg per liter, the culture volume required would be 16 250 liters (4 294 gal.).

The design depth of a culture is based upon the fact that experience has shown that an adequately mixed algal culture attains a concentration which permits light to penetrate it to one-third the culture depth. Since light of daylight intensity penetrates about 12 cm into a culture having a concentration of 500 mg per liter, the depth of the culture should be 36 cm. Although the algal culture itself is only 36 cm deep, the walls of the pond structure should be 0.5 meters high so as to provide freeboard. Inasmuch as a 36-cm deep culture occupies 28 cm^2/liter, the surface area requirement for a 16 250-liter culture would be 58 m^3 (623.5 ft^2), and a small factor of safety is provided. In summary, the dimensions of the circular pond should be 64 m^2 in area and 36 cm in depth. Under warm, sunny conditions, a culture of this volume and dimensions will produce between 1 and 2.5 kg dry weight of algal protein per day.



The entire pond system consists of three concentric ponds operating in series. This arrangement ensures protection against transfer to or survival of pathogens in the final pond. Moreover, the provision of three or more ponds in series guarantees an excellent degree of treatment.

A collector hopper 1/2 meter wide and 1/3 meter deep is installed in the outer final section of the pond system to serve as a sump in which settleable algae are collected. The settled algae make up a 2 to 3% algal slurry. Periodically, the slurry is drawn through a valve into a watering system for the cow or is discharged on sand beds for drying. A total of 8 m^2 of sand beds, divided into four beds of 2 m^2 each are required. The sand beds should be underdrained so that water can be collected and returned to the system as the need arises.

The human occupants in any system require potable water, i.e. fresh and having a low solids content. In the system as designed, potable water is provided through the use of a 1.86 m^2 (20 ft^2) solar distilling apparatus mounted in such a manner as to entrap vapor from the algal culture. Under the conditions to be met in the use of the system, a 1.86 m^2 solar still would yield about 37.85 liters (10 gallons) of distilled water per day—an amount sufficient to meet the drinking and cooking needs of four humans. During rainy periods, the solar still can be used as a catchment area for rain water to be used in lieu of distilled water. During the dry season, evaporation from the algal culture surface would be quite extensive; and on the hottest, windiest days when the ambient relative humidity is low, it could be as

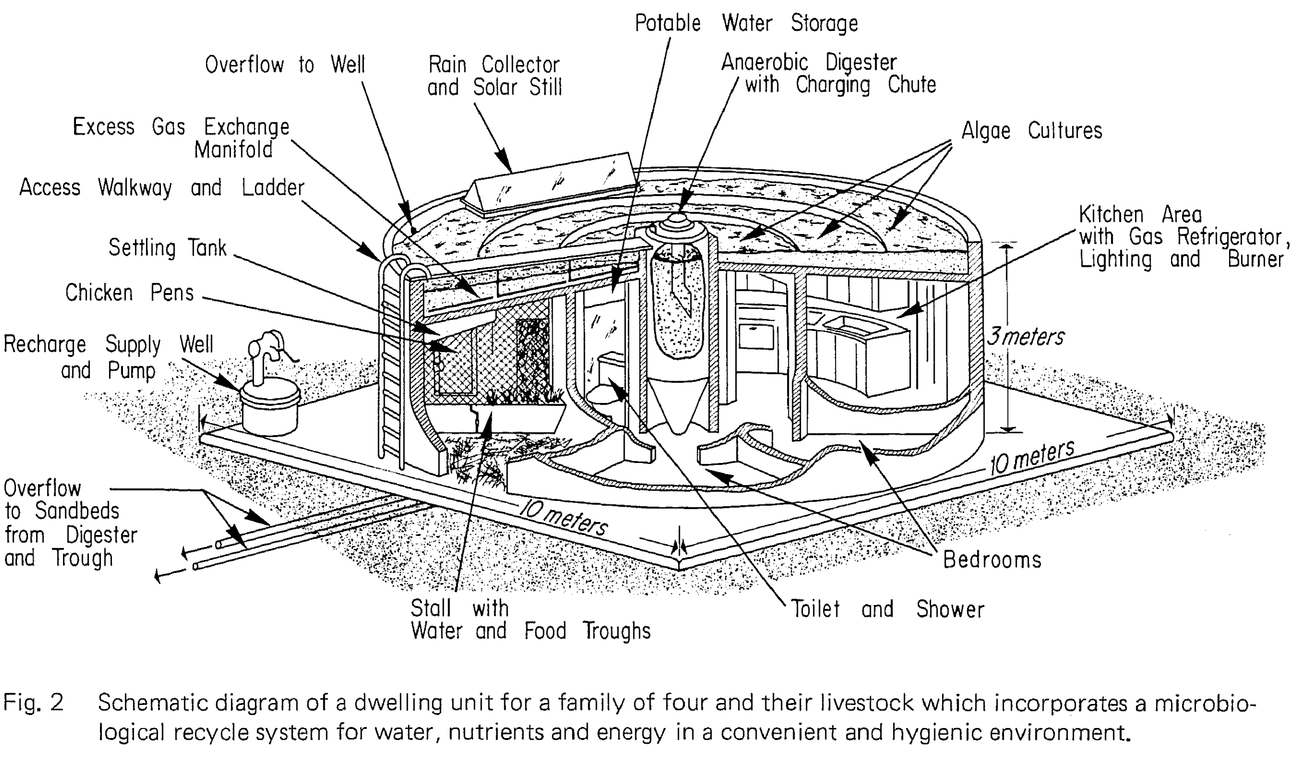


Fig. 2 Schematic diagram of a dwelling unit for a family of four and their livestock which incorporates a microbiological recycle system for water, nutrients and energy in a convenient and hygienic environment.

much as 757 liters (200 gallons) per day from the 64 square meters of pond surface. Consequently, provision must be made for a source of makeup water. Ground or surface water may be used to supply the deficit. The makeup water is used for bathing, for drinking water for the chickens (chickens are not tolerant to salt and hence can't be given the pond water), and for cleansing purposes. The quality of this water must be carefully controlled because otherwise the chance spillage of excess water could lead to the development of unsanitary conditions. If the system were covered with transparent materials to prevent evaporation, excessive heating of the culture probably would occur. However, the possibility of utilizing the high-temperature strains of algae in a system equipped with a transparent cover should be investigated, since such a covering would reduce the need to import large amounts of water. During heavy rains, the overflow from the final pond of an open system would be suitable for disposal to surface or ground waters.

To maintain peak performance of the ponds, it is essential that they be mixed once each day. Mixing may be accomplished in myriad ways ranging from high velocity recirculation (2 ft/sec) through the use of a pump to manual stirring with brooms or paddles. In all cases, the bottom of the pond should be constructed to have sufficient strength to withstand the rigors arising from the mixing system employed. Any type of firm surface should do so long as it is not disintegrated or suspended during mixing, as would be the case if a pond has a dirt bottom. The pond floor should slope slightly outward from the center so that settled algae are moved away from the digester during mixing.

If the algal culture were placed above the house, the entire digestion and algal growth system could be located on a plot of land 10 meters by 10 meters. Supporting the algal culture above the ground, if it should prove to be feasible, would provide shelter and living space beneath it for the animals and for the humans as well.

Although from the standpoint of management, it would be economically advantageous to have larger than single-sized family units, individual units would have the advantage of enabling each family to take personal responsibility for its own system.

The Integrated System: A diagrammatic sketch of a typical family unit having the dimensions given in the preceding paragraphs and combined into a shelter complex is presented in Figure 2. The operation of the system involves the charging of all manure, urine, wasted food, night soil, and clean-up water into the digester shortly after they are produced, or at least once daily. In the digester, fermentation once established continues on a steady basis, as does gas production. Particular care would have to be exercised to avoid unnecessary loss of useful components. Therefore, all solids, liquids, and gases must be recycled or consumed. Complex substances are decomposed in the digester. Products of this decomposition are organic acids, ammonia, CO_2, and methane. The methane is stored for use as needed. The addition of the nutrients to the digester displaces soluble substances into the algal culture, where the latter serve as a substrate for algal growth. The methane, under slight pressure, is used as fuel in cooking. Carbon dioxide formed by the combustion of the methane is vented by convection to the algal culture, where a part of it is used as a carbon source by the growing algae. Algal slurry is fed to the cow and constitutes its sole course of drinking water, thereby forcing it to consume algal protein in the wet form. Algal slurry not consumed by the cow is removed from the trough and is spread over sand beds. The dewatered and dried algae can be used on the site for chicken feed or to augment the algal slurry feed for the cow, or it can be sold.

Using the space below the culture as living quarters serves to shelter both the humans and the animals from the elements. The algal culture and digester provide a buffer against rapid change in temperature for the occupants; and the metabolic heat given off by the occupants would, in turn, supply some warmth to the algal culture and digester during cool periods.

On the basis of past experience, the system, as diagramed in Figure 2, can be expected to provide an ample and hygienic environment for a family and its essential livestock. The unit can be constructed of local materials, or perhaps can be prefabricated for import. Because it is largely powered by sunlight energy, the feasibility of such a system is greatest in tropical regions of the world, although it can be of use in other areas during the summer period.

The advantages accompanying the use of the system are: 1. the provision of a highly livable system for its occupants; 2. the establishment of an efficient and hygienic waste management; and 3. the recovery of valuable nutrients from wastes. A major disadvantage is the need for a rather substantial capital investment. However, through experimental studies with prototype units, functions and materials can be experimentally tested, and if required, modified in such a way that costs can be minimized, and operations perfected to a point at which the system would be self-supporting. If this were possible, an economic incentive would exist for investors or for governmental agencies to provide such units on a long-term loan basis. The economic basis for repayments of loans would come from maximizing the production of milk, eggs, vegetables, and algae, and minimizing the cost of essential inputs to the system such as supplementary feeds. Surplus eggs, milk, vegetables, and algae would be sold, and a portion of the money used to repay the capital investment for the system. A preliminary economic analysis indicates that a gross income of between \$250 and \$1,000 per year could be realized with the system. Operation costs are estimated to range from \$50 to \$100 per year. If only the lower income level were reached, the use of such a system probably would require a substantial subsidy. On the other hand, if the higher income level could be attained, the unit probably would be economically attractive.

Reprint from Compost Science, May—June 1973, 14, No. 3

Compost from Blowroom Cotton Dust

By A.D. Bhide, National Environmental Engineering Research Institute, (NEERI), Nagpur, India.

"There are vast quantities of cotton stocks which have to be burnt annually to control pests and diseases. Research should be initiated to find new ways of controlling pests and diseases without burning so that this material could be utilized as a source of organic fertilizer or mulch."

This reference of the FAO/SIDA Expert Consultation (Soils Bulletin 27, Rome 1975) has no direct connection with the following paper on cotton dust compost. Nevertheless it shows new ways of utilizing fractions of cotton residue.

COTTON TEXTILE MILLS, especially in their blowrooms, produce a large amount of cotton dust which is found to average at the rate of 20—50 tons/year/25 000 spindles. The textile mills in India are expected to produce 30 000—33 000 tons of this waste every year, nearly 20% of which is produced in Bombay and 15% each in Ahmedabad and Coimbatore.

This waste is presently being disposed of along with other sweepings from mill or used as fuel in boilers or sometimes a portion of it is used as a cheap filling in quilt blankets. Studies were undertaken at CPHERI, Nagpur, to see if this material could be gainfully utilised[2].

Nature of the Waste

The waste essentially consists of unrecoverable cotton fibres and broken cotton seed coats. Sieve analysis of the waste showed 54% of the material to be finer than 0.707 mm, 13% to be between 0.707 mm to 2 mm while the remaining was of a size more than 2 mm[2]. Chemical analysis of the waste (Table 1 and 2)

Table I

Chemical Analysis of Raw Cotton Dust

Item	*% by weight*
Moisture	8.0
Organic matter	70.0
Carbon	41.0
Nitrogen	1.40
Phosphorous as P_2O_5	0.60
Potash as K_2O	1.20
C/N Ratio	29.28
pH	6.2

showed that the waste has NPK values much higher than city refuse. The C/N ratio is also quite favourable indicating faster rate of decomposition. The waste was also more or less uniform in composition and hence the costly operations of segregation and shredding were not necessary.

Table II

Item	*Cotton dust*	*Usual city refuse in India*
Total Nitrogen %	1.4	0.4—0.7
Phosphorous (as P_2O_5) %	0.6	0.3—0.5
Potash (as K_2O) %	1.2	0.3—0.7
C/N Ratio	29.28	30—35

Field Studies

Full scale field trials were hence carried out to compost this material using piles 4 m long x 2 m wide and 1.5 m high. Various turning intervals such as daily, alternate day, every third day and every fifth day were tried. Throughout the work moisture content was maintained within the usual optimum range of 50—60%. Continuous measurement of temperature was done as well as the samples were regularly collected from the decomposing mass and analysed[1, 3, 4] for various criteria such as pH, % ash, C/N ratio and moisture content. On the basis of these observations, the time of completion of the process was judged. Similar trials were also carried out on composting of raw cotton dust seeded with previously prepared compost.

Economics

As cotton dust is homogenous in nature, it does not need any separation. Also the size of material is such that grinding of the material is not necessary. Hence, cost estimates were prepared for a small unit receiving 20 tons of waste per day to produce 13 tons of compost from it. Cost for various items, such as land, water, civil works, transport and labour was calculated for Nagpur conditions. For this plant size, manual labour was felt to be cheaper than use of mechanical equipments. These cost estimates showed that the lowest cost of production of Rs. 6.36/ton was required when the material was composted in 20 days after turning it on alternate days[2].

Application

Compost prepared from city refuse containing much less nutrients, sells at Rs. 8.50 per ton at Nagpur. Hence this compost, with its higher nutrient content will definitely sell at a higher price, thus yielding a sizeable profit.

The demand of compost around Nagpur is so much that one of the textile mills in Nagpur sells, cotton dust which has simply been dumped and kept moist for 6 months, at Rs. 15/- per ton at the mill premises. The farmers are observed to cart away the material up to 50 miles for use on their orange farms.

As the textile mills are mostly located in big cities, the cotton dust compost can also be easily sold to city dwellers for use on their kitchen and terrace gardens provided it is neatly packed and retailed. The clean nature of the raw material will obviate aesthetic objections and will help find better acceptance.

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Reprint from Compost Science, Nov.—Dec. 1974, 15, No. 5.

News from WHO

WHO/WPRO News Release on Solid Waste Seminar in Manila, February 1976

Improper Garbage Collection and Disposal a Danger to Public Health and Environment.

Improper collection and disposal of waste results in dangers to public health and contributes to a deterioration of the environment.

Management of solid wastes is therefore an important part of environmental hygiene. It should be integrated with total environmental planning.

Solid wastes management should provide a hygienic, efficient and economic system of collecting and transporting wastes to treatment plants. It should also render the solid wastes harmless, not simply transferring the harmful substances to the water system or the atmosphere.

The seminar formulated proposals and/or guidelines for a plan of action in solid wastes management at regional and national level.

Fifteen participants attended the Seminar.

Bangladesh

This is an article from the WHO Journal, No. 22, April 1976 on Basic Sanitation in Bangladesh.

The absence of facilities for the sanitary disposal of human excreta continues to be a major contributory factor in the high incidence of enteric diseases among rural people. A project underway in this country provides for the construction of simple water-seal latrines and concrete rings for lining privy pits. These units, manufactured in the Thana workshop, are sold at cost to the villagers who install them under the guidance of a government sanitarian.

Cost Reduction by the Use of Modified Sewerage

The following is a summary of a report on a modified sewerage system for N'Djamera, Chad, by Dr. R.C. Ballance, WHO Geneva, Switzerland.

In 1963, Marais was faced with the problem of installing sanitation facilities in Zambian housing estates. The local population had the cultural habit of using sticks, stones or corncobs for anal cleansing and this precluded the use of a standard water seal type of privy slab, even though ample water was available for flushing purposes. The aqua privy would avoid this problem since it is virtually free from blockage. Local experience with aqua privies had not been good because it had not been possible to convince people of the need to add water and thus maintain a water seal at the bottom of the drop pipe. The eventual solution to the problem was to install aqua privies but to have household drainage discharge directly to the privy tank for replenishment of the water seal. Effluent from the aqua privy was then discharged to a conventional system of street sewers.

Experience with this type of system showed several advantages. Blockages were eliminated in the sanitation units as well as in the sewers. The aqua privies acted as sedimentation and digestion tanks and consequently reduced the strength of the sewage which was ultimately subjected to treatment prior to final disposal. Since solids had been removed in the aqua privies, self-cleaning velocities in the sewers could be lower than in conventional systems. This permitted the use of smaller pipes and flatter grades which resulted in reduced excavation of trenches. Operating experience has shown that aqua privy cleanout is necessary with a frequency of about once every seven years.

Although the overall experience in Zambia has been favourable, this type of system has not been adopted elsewhere and even in Zambia was confined to small housing estates.

The concept was suggested by WHO to the consulting firm which had been retained to carry out feasibility studies on sewerage in N'Djamera, Chad in 1974. Careful cost estimating of the various alternatives revealed that the use of this system was a feasible alternative to conventional sewerage even taking into account the capital cost of the aqua privies and the cost of periodic cleanout. Savings accrue from the use of smaller pipe, lowered excavation costs, the elimination of several lift stations, reduced maintenance to relieve blockages and smaller facilities for treatment. Furthermore the system is totally compatible for connexion to existing septic tanks. New areas, as they are developed, can adopt the entire concept or if conventional sewerage is used within the area it is only necessary to discharge area sewers to a tank prior to the connexion with the modified system. Yet another advantage of the modified system is a substantial reduction in water supply requirements as compared with flush toilets and conventional sewerage.

Periscope

India

The following is a summary of the report "Studies on Refuse in Indian Cities" Part III-Cost Economics by A.D. Bhide, et al. of the National Environmental Engineering Research Institute (NEERI) in Nagpur, India.

This report was published in Indian Journal of Environmental Health, Vol. 17, No. 3, July 1975. The study presents a survey of 33 Indian cities and points out the following:

- Municipal agencies were observed to incur on an average 10% of their total expenditure on refuse collection and disposal.
- The expenditure on an average was found to amount of Rs. 5 to 7 per person per year.
- The cost of refuse transportation was found in a majority of cases to lie between Rs. 0.3–0.9/km/ton.
- Manual composting of city refuse was being practised extensively and the concerned cities did not face any problem in the sale of compost produced.
- In a large majority of the cities practising composting, the compost was being sold at a rate of less than Rs. 10/ton.

It was seen that the composting operations yielded revenue in excess of the money spent on it.

International Course

The Institut national de recherche chimique appliquée (IRCHA) is organizing an *International Course* for engineers on *"Design of Wastewater Treatment Plants, Economy and Re-Use in Biological and Physico-Chemical Treatment Processes"* in *Paris,* France from November 30 to December 3, 1976.
The course will be held in English and in French.
For further information write to:
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91710 VERT LE PETIT
France

Abstracts

The following abstracts have been taken from our documentation on solid wastes which contains over 2600 publications.

Rosich, R.S.: Resource recovery from solid wastes, 1975, 6, No. 4, 120–126, Search.

New techniques for treatment and materials and energy recovery from solid wastes are examined. Special attention is given to the development of systems for the production of reduced carbon as alternative sources to natural gas, petroleum and coal, and the development of new approaches to complete separation of the constituents of the inorganic fraction of wastes. With particular reference to the situation in Australia at this time the author suggests that demonstration plants should be constructed to evaluate the pyrolysis process (preferably near a petrochemical facility to allow evaluation of the pyrolysates as feedstocks for the industry).

Knuts, A., Albertsson, V., Sanberg, S-O.: Environmental protection in kraft pulp mills, 1975, 47, No. 783, Jour. Water Poll. Control Fed.

A short survey is given of the general methods of environmental protection techniques in the pulp industry. The applications of these techniques are exemplified by a thorough description of two kraft mills at Munksjö AB. The description includes pulping in a completely closed liquor system, treatment of condensates, systems for handling temporary discharges, chemical treatment of wastewater in a clarifier, sludge handling, and cross recovery.

Nordstedt, R.A., Baldwin, L.B., Rhodes, L.M.: Land disposal of effluent from a sanitary landfill, 1975, 47, No. 1961, Jour. Water Poll. Control Fed.

An unproductive, low-lying area was reclaimed for pastureland by sanitary landfill on a sandy soil in a high water table area. Effluent from the trench method landfilling operation consisted of groundwater and leachate from previously filled trenches. The effluent was dispersed on nearby established pasture with a sprinkler irrigation system. No adverse effects on the soil or shallow groundwater were measured. Visual evaluation of the pasture grasses indicated an improvement in growth rate and appearance.

Bayer, U., Rockstroh, S.: Utilization of textile waste, 1975, 30, No. 8, 523–525, Technik.

In the light of the necessity of utilizing secondary raw materials, the possibilities of exploiting textile waste products are described as they are applied in the DDR and other socialist countries. In addition to the familiar materials such as cleaning rags, waste cotton, crude felt, and fiber waste, the possibilities of applying fiber waste to nonwoven materials for coating chipboard and as a base for PVC floor coverings and for formation of wet produced non woven materials are reported.

Answers to Pollution Puzzle

1 P	2 I	3 P		4 C	5 Y	6 S	7 T	8 S		9 B	10 O	11 D
12 U	D	O		13 L	E	E	R	Y		14 U	R	E
15 S	A	L	16 M	O	N		17 E	N	18 E	R	G	Y
			19 O	2		20 G		21 E	T			
22 A	23 L	24 O	L		25 G	A	26 T		27 C	28 L	29 A	30 W
31 B	A	C	T	32 E	R	I	O	33 P	H	A	G	E
34 I	T	H		35 O	U	T	R	E		36 W	A	I
37 D	I	S	38 I	N	F	E	C	T	39 A	N	T	S
40 E	N	E	Z		41 F	R	H		42 L	Y	E	S
			43 B	44 E		S		45 S	L			
46 D	47 O	48 S	A	G	49 E		50 F	L	Y	51 A	52 S	53 H
54 E	R	A		55 I	N	56 D	I	A		57 I	R	E
58 W	E	N		59 S	O	O	N	G		60 R	A	W

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