IRCWD NEWS

WHO International Reference Centre for Wastes Disposal

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Waste Management, Recycling and Environmental Protection

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In recent years, environmental protection has unfortunately become a catchword. Recycling, too, has repeatedly been used when referring to environmental protection and to the threat of raw materials depletion. New patents for recycling procedures, for reutilization and recovery of wastes, shoot up like mushrooms. Many of them are presented under the guise of environmental protection but in most cases they are aimed at earning money.

Wastes are now considered an industrial raw material! Mineral oil and fuel gas are generated from municipal refuse! Building boards, bricks and active coal are made from waste! Refuse slag is turned into building material, beads and glass wool! There is gold in the waste recycling business; one must only look for it!

Slogans of this kind demonstrate the topicality of the saying "Wastes are raw materials in the wrong place". Their frequent use, however, increases the danger of confusing the public, of raising false hopes, of making people believe that recycling measures will straightway solve all the problems of environmental pollution and of raw materials depletion.

1. What is Waste Management?

According to the laws of thermodynamics it is impossible to really destroy wastes; they can only be turned into other materials belonging to various levels of aggregation which ultimately also reach the soil, water or air.

Conversion of wastes, however, results in **environmental pollution loads.** Technical plants such as wastewater treatment plants, refuse incineration plants, shredders etc., all produce emissions. Their quantity, however, depends greatly on the system, design, and type of operation used. The target of waste technology is to accomplish waste conversion in such a way that the secondary and final products will produce a lesser environmental impact than the original wastes. **If this principle is not observed, there is no sense to waste technology!**

The task therefore consists in optimizing waste conversion, environmental pollution loads, resource conservation and the necessary costs. This leads logically to waste management.

By **waste management** we mean **the sum of all measures required for the least harmful treatment, reutilization, recovery and final disposal of all types of wastes, while taking economical aspects into consideration.**

Waste management is therefore part of the economic system and is in itself motivated by the discrepancy between the unlimited consumer demands and the scarcity of available means to satisfy them. The **aim of the economy** is the reduction of the scarcity of nature-given goods by means of cost-benefit analyses.

The **aim of waste management** is to minimize environmental impacts while trying to conserve natural resources reserves as much as possible by means of cost-ecology analyses.

Increasing water, soil and air contamination by solid, liquid and gaseous wastes on the one hand and, the menacing depletion of several natural resources reserves on the other, are the **main springs of waste management.** For reasons of ecology and raw materials economy, the need to recover, recycle and reutilize wastes is now becoming more and more pressing. It is hoped that recycling wastes into the production process or into the consumption cycle will help reduce the amounts of wastes discharged into the environment and, at the same time, preserve natural resources reserves.

Waste management does not solely consist of recycling measures; it also disposes off nonrecoverable waste materials in appropriately located **sanitary landfills.** By this we mean that, at the time of site selection, during operation and when completing a sanitary landfill, water and landscape protection measures must be taken into consideration. **If carefully planned, sanitary landfills can be integrated as new constructive elements into existing or new forms of landscape utilization.**

The most important waste management measures are:

1. Reintroduction of appropriate waste materials into industrial raw materials cycles with a view to producing new products or raw materials.
2. Reintroduction of biogenetic waste materials into natural cycles with a view to producing humic fertilizers and plant nutrients.
3. Integration of sanitary landfills into regional planning with a view to utilizing sanitary landfills as new constructive elements in landscape planning.
4. Causal therapy with a view to producing less waste and then only of a kind that has the least possible side-effects on the environment, i.e. using procedures that cause the smallest possible environmental impacts.

2. Criteria for Recycling Measures: Environmental Impacts

At all times man has striven to reutilize the raw materials contained in wastes. Recycling measures, however, were motivated neither by a raw materials economy nor by ecological factors, but solely by economic considerations; except perhaps in periods of necessity such as wars and economic crises in which recycling measures were even requested and encouraged by governments.

Let us now try, as a result of our study, to explain under what circumstances recycling measures are really effective, without giving priority to profit.

The environmental impacts resulting from the conversion of wastes into new products or raw materials are decisive in determining whether, for reasons of ecology or of raw materials economy, a certain waste material should or should not be recycled or reutilized. By **"environmental impact"** we mean **the sum of environmental pollution loads resulting from waste conversion processes,** i.e. emissions, energy consumption, damages to ecosystems, ecological risks, etc.

Recycling or reutilization methods should be considered doubtful or even wrong if they have a negative impact on the environment. They are suitable only if the recycled wastes, introduced into industrial raw materials cycles or natural materials cycles, help reduce the environmental pollution loads.

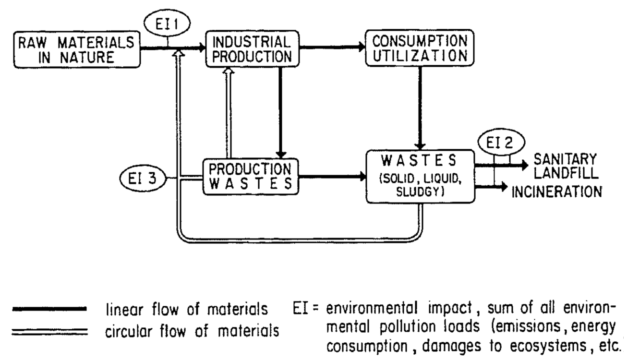
3. Recycling wastes into industrial cycles

The importance of environmental impacts in the linear materials flow, i.e. in the raw materials cycle is shown in Fig. 1.

The materials flow begins with raw materials extraction from nature. Extraction, transport over long distances and raw materials processing for industrial purposes result in:

Energy consumption, emissions, destruction of ecosystems, etc.; all these factors constitute the environmental impact 1 (EI 1).

Fig. 1 Industrial raw materials cycle



The processed raw materials are converted into goods by industry. After consumption and utilization these become wastes which, in the linear flow, are either disposed off in a landfill or incinerated. Landfills and incineration plants themselves produce environmental impacts shown in EI 2.

Wastes resulting from industrial production are mostly dumped in sanitary landfills, thereby increasing the linear materials flow, i.e. the environmental impact EI 2.

With respect to sanitary landfills, the materials flow is perfectly linear. As far as incineration plants are concerned, a partly circular flow may occur if the combustion residues and the heat generated by waste incineration are reused.

Some industrial wastes such as scrap metal, cullets in glassworks, used paper in cardboard factories, have at all times been reintegrated into the production process. This short industrial raw materials cycle is in every respect the most effective, for it causes the least negative impacts on the environment.

Other industrial wastes, as well as municipal wastes can be processed and reused as raw materials, secondary materials or new products. Examples: regeneration of waste oils into new lubricants, conversion of refuse and slag into building material, scrap metal recovery from automobile wrecks, conversion of animal wastes into animal feed, etc. These recycling processes, however, usually consume a great amount of energy and consequently also produce an environmental impact (EI 3).

One might be inclined to say that the reintroduction of greater waste quantities into the circular materials flow, or the smaller the linear material flow, the smaller the environmental impact and the more effective the conservation of resources.

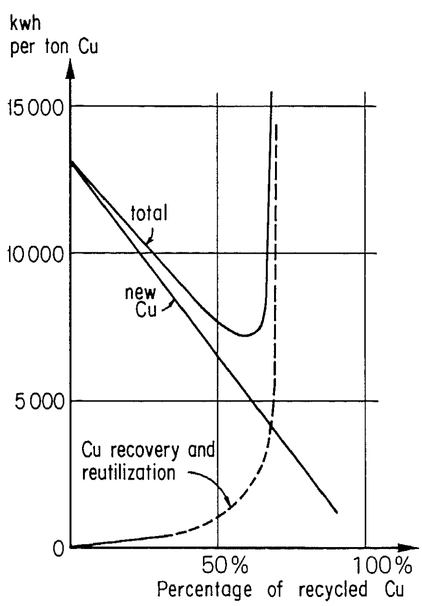
The actual tendency to generalize and simplify makes the above mentioned argument sophistical. **Recycling measures are effective and should be intensified as much as possible only if the environmental impact (EI 3), caused by waste processing, is smaller or at the most equal to the sum of environmental impacts 1 + 2 (EI 1 + EI 2).** Should this not be the case then, the environmental pollution loads are only transferred to another level.

Let us now examine a practical example of copper recovery from wastes (1).

The energy required for producing one ton of copper from ore amounts to approximately 13'000 kwh. On the other hand, the energy needed for recovering copper from suitable copper wastes is about 15 times less. Larger quantities of recycled copper will decrease the total energy consumption required for the production of copper as shown in Fig. 2. However, this is only true up to a certain point: only about 30 percent of the total copper consumption is available as easily recyclable copper wastes (copper scrap, wires, pipes, etc.).

Other copper wastes such as alloys, industrial sludges, i.e. wastes in which copper is mixed with other metals and which can be found in small concentrations, are not only far more difficult to recycle but also consume large amounts of energy. Approximately 25—30 percent of the total copper consumption is composed of this type of copper waste.

Fig. 2 Energy required for the production of one ton of copper as a function of the percentage of recycled copper (according to Stumm and Davis, 1974)



Consequently, not more than 60 percent of the copper waste can be recycled. The remaining 40 percent are in such a diluted form in solid and liquid wastes, in pigments and dyes, or in the soil and water, that it would be pointless to try to recycle them. An enormous amount of energy would be needed to extract them.

The same applies also to all the other raw materials.

Due to environmental impacts therefore, a limiting factor is imposed on the recovery of raw materials from wastes.

The difficulty now lies in **quantifying** the environmental impacts because they constitute the decisive criteria for all waste management measures. Quantifying energy consumption is relatively easy because it can be measured or calculated. On the other hand, long term effects and synergisms of various emissions on organisms and materials, nature degradation and damages to ecosystems, are part of the environmental impacts which are not yet totally discernible, let alone quantifiable. This, however, should not hinder our attempts to quantify them, for future developments in waste management will depend to a great extent on the quantitative definition of environmental impacts.

4. Recycling biogenetic wastes into natural materials cycles

Considerations similar to those mentioned above may be also applied to the recycling of organic, biodegradable wastes into natural materials cycles.

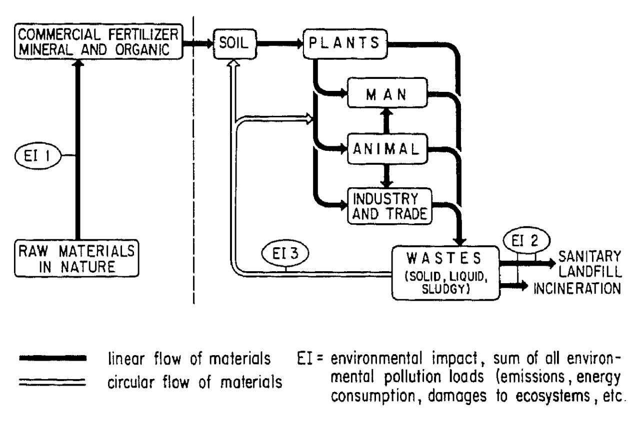
The materials cycles and the most important environmental impacts are shown in the simplified Fig. 3.

Before the appearance of fertilizers it was relatively easy to reintroduce wastes, generated by human society, into natural materials cycles (to the right of the broken line in Fig. 3). Natural resources products and plants were used as food by humans and animals or as raw materials by simple industry. Most biogenetic wastes produced by plants, humans, animals and industry went either directly, or after a long humification process, back into the soil as natural fertilizers (white arrows in Fig. 3), thereby replacing nutrients and humus. Consequently, only a relatively small quantity of waste entered the linear materials flow (black arrows in Fig. 3), i.e. was dumped or incinerated.

Since the victory of the fertilizer industry, the materials flow has changed decisively. For the production of fertilizers raw materials are exploited, transported away and processed into mineral and organic commercial fertilizers. This results in an environmental pollution load expressed as environmental impact EI 1.

Ever increasing quantities of commercial fertilizers entered the linear materials flow. Being easy to handle and much more economical than natural fertilizers, they ousted the latter from their position. This decisively strengthened the linear materials flow and not only increased the environmental impact EI 2 (damage to water, soil and air caused by sanitary landfills and incineration plants) but also the already mentioned environmental impact 1, while making inroads on natural resources.

Fig. 3 Natural materials cycle



This leads us to the following conclusion: the more biogenetic and other appropriate domestic, industrial and agricultural wastes are removed from the linear materials flow and introduced into natural materials cycles, the lesser the environmental pollution load and the more effective the conservation of natural resources.

However, this conclusion is also sophistical. Most biogenetic wastes must be processed before they are used as plant nutrients or humic fertilizers. The processes used are for example: waste composting, sewage sludge conditioning into spreadable fertilizers, processing of appropriate industrial and commercial wastes into organic fertilizers, etc. These processes consume a lot of energy and are by no means free of emissions; they are the cause of environmental impact EI 3.

Biogenetic wastes recycling into natural materials cycles is only effective if the environmental impact EI 3, caused by the processing of wastes into fertilizers, is smaller than, or at most, equal to the sum of EI 1 + EI 2.

Even though some municipal wastes may today no longer be integrated into natural materials cycles, due to their composition, we should still try to feed as much wastes as possible back into the soil in the form of fertilizers and humification agents. Suitable wastes are:
- sewage sludge (liquid or conditioned)
- refuse compost or refuse sewage sludge compost mixture
- composts made from industrial wastes
- wastes from livestock industry
- organic wastes from trade, industry, forestry and agriculture

The nutrient and humus potential in biogenetic wastes should not be neglected, not even for economic reasons.

5. Future prospects

Waste treatment technology is able to offer us today many reliable processes, some of which have already been in use for a long time, i.e. sanitary landfills, thermal and biological treatment methods, reuse and recovery processes. However, no attempts have been made so far to optimize these processes from the ecological point of view or to compare their respective environmental pollution loads.

The chief objective of waste management should be the control of materials and energy flows which result from our civilisation. In this way, we can reduce their detrimental effects to a degree that guarantees fairly optimal environmental conditions for men, animals and plants.

This objective can not be reached if the environmental protection measures go on treating the symptoms (this also applies to waste disposal practices). Priority should be given to the **therapy of the causes.** In other words, production processes should be modified in order to produce the least possible wastes and, most important, only of a kind that can be processed without causing an important environmental pollution load. Below are listed a few thoughts that require careful consideration:

1. Is it really inevitable that, while decontaminating and neutralising industrial wastewaters rich in metals, sludges are produced in which various heavy metals are mixed in such a way as to render their recovery almost impossible? The dumping of these sludges is an unsatisfactory solution and means choosing the easiest way out.

2. Is it really inevitable that industrial wastewaters containing heavy metals be treated jointly with municipal wastewaters, thus contaminating municipal sewage sludge to such a degree that it can no longer be used in agriculture? (The agricultural use of sewage sludge is the best and most economical disposal method).

3. As a result of increasing energy and chemosynthetics production, larger quantities of refractory (non- or not easily decomposable) organic hydrocarbon compounds are released into the biosphere and, consequently, also into sewage sludge and other wastes. The quantitatively largest components are the petroleum hydrocarbons, followed by synthetic pesticides and herbicides and surfactants (2). At present, very little is known about the ecological effects of these substances and their long-term synergisms. The logical conclusion from the point of view of causal therapy would be: synthetico-organic industrial and domestic products should not be made of refractory substances since their detrimental effects on the ecosystem would assume alarming proportions.

4. The intentional short life of products and consumer goods causes a specific waste increase. From the point of view of causal therapy it is therefore imperative to extend the durability (improve the quality) of commodities. Moreover, it is necessary to combat the "throw away" mentality.

Conclusion

Apart from the limits imposed on recycling possibilities by environmental impacts, even the most appropriate recycling measures, taken **alone,** are unable to drastically reduce the environmental pollution load, or to effectively prevent raw materials depletion. **However, recycling measures give us the possibility to gain time!** It is only in combination with other measures, especially causal therapy, that this objective will be reached.

Another alternative would be to wait until the exhaustion of cheap fossile energy. At this point, the impossibility to switch in time to other sources of energy will have solved the whole problem.

References

(1) **Stumm, W.** und **Davis, J.**
Kann Recycling die Umweltbeeinträchtigung vermindern?
Brennpunkte (gdi-topics) Nr. 2, 5. Jahrg., Deutsche Verlagsanstalt Stuttgart (1974).

(2) **Wuhrmann, K.**
Belastung der Gewässer mit refraktären Verbindungen,
Symposium Föderation Europäischer Gewässerschutz FEG, Versailles (1971).

News from WHO

New WHO publications

Food hygiene in catering establishments: legislation and model regulations, published under the joint sponsorship of the Food and Agriculture Organization of the United Nations and the World Health Organization, in collaboration with the United Nations Environment Programme, Geneva, 1977, 16 pages, available through WHO sales agents, price: Sfr. 6.–.

The World Health Organization, through its Food Safety Programme, which is aimed at ensuring the safety of foods for the consumer, has conducted a survey of legislation relating to food hygiene in catering establishments in a representative cross-section of the countries of the world. This information is summarized in this new WHO publication which deals briefly with such topics as the construction, lighting, and ventilation of premises, their registration and licensing, equipment and utensils, washing and sanitary facilities, food protection, and food handlers. The basic principles of food hygiene legislation are also discussed.

The last part of the book contains a model code of food hygiene regulations that sets out in detail, but in simple terms, the various points which should be legally enforceable in any country and should be embodied in the legislation. It is intended in particular for the guidance of developing countries wishing to build up an effective organization for the control of standards of hygiene in catering establishments. The subject, however, is one of universal concern and this book should be of interest not merely to health and food control authorities but also to catering organizations, consumer associations, and the like.

Guide to Hygiene and Sanitation in Aviation, by James Bailey, Geneva, World Health Organization, 1977, 170 pages, French and Spanish editions in preparation, available through WHO sales agents, price: Sfr. 28.–.

The World Health Organization published a first **Guide to Hygiene and Sanitation in Aviation** in 1960. Although the basic principles of hygiene have not changed since then, the conditions of their application have altered vastly with the tremendous growth in the volume and the speed of air traffic, with the introduction of new aircraft and of air routes into new areas, and with the adoption of new practices, particularly in flight catering, both on the ground and in the larger aircraft of today. All these factors may strain wastes disposal, water supply and catering services and facilities, thus increasing the risk of the international spread of diseases. It has never been more vitally necessary to safeguard the health of air passengers and air crew.

A revised and considerably expanded second edition of the **Guide to Hygiene and Sanitation in Aviation** has therefore been published. It is intended for the use of health administrations and authorities, aviation administrations, airport authorities, air transport operators, airport and airline employees, airport and airline caterers and concessionaries, airport designers, and aircraft manufacturers – in a word, for all those directly or less directly concerned with ensuring the health of those who fly.

Detailed information pertaining to the health and hygiene aspects of aviation is presented under the following broad headings: food, water, toilet sanitation and liquid wastes disposal, solid wastes, aircraft interior cleaning, cargo, and vector control. A series of annexes is included dealing with such subjects as the characteristics of common foodborne diseases; questionnaires for eliciting information on cases of food poisoning on board aircraft; guidelines for the sanitary inspection of airports, for reports on drinking-water quality, and for the disinfection of water-vehicle tanks; and, finally, suggestions for vesting national administrations with the necessary powers to enforce health and hygiene measures at airports.

Management of Solid Wastes in Developing Countries, by Frank Flintoff, 1976, WHO Regional Publications: South-East Asia Series No. 1, 245 pages. This publication was prepared under the sponsorship of the Government of India and is available at a price of Sfr. 20.– from the WHO Regional Office for South-East Asia, World Health House, Indraprastha Estate, Ring Road, New Delhi - 110002, India.

It is intended to provide a reference source for engineers, municipal officers, administrators and other interested persons, and to fill a need for a training manual for technicians in a field of universal and growing importance.

New IRCWD publications

Methods of Analysis of Sewage Sludge, Solid Wastes and Compost, published by the WHO International Reference Centre for Wastes Disposal, CH-8600 Duebendorf, Switzerland, 1978, 44 pages, available through the above mentioned centre, price for non-collaborating and private institutes: Sfr. 50.–.

These simple methods, which are quite common in experimental chemical laboratories, have been especially adapted to the problems of sewage sludge, municipal solid waste, and compost. Part I, which covers the analysis of sewage sludge, is based on the Final Report of the Management Committee of the COST-Project 68 (European Cooperation and Coordination in the Field of Scientific and Technical Research). Part II deals with municipal solid waste and compost and was originally prepared by the Solid Waste Dept. of the Swiss Federal Institute for Water Resources and Water Pollution (EAWAG) in 1961.

Compost – An Annotated Bibliography on Compost, Compost Quality and Composting (1971–1977), published by the WHO International Reference Centre for Wastes Disposal, CH-8600 Duebendorf, Switzerland, 208 pages, available through the avove mentioned centre.

This bibliography contains 415 annotated references on compost from the IRC Solid Waste Documentation, and covers current American and European literature from the year 1971–1977.

Abstracts

The following abstracts have been taken from our documentation on solid wastes which contains over 2900 publications.

Anonymous: IVL: Nitrogen fixation in industrial process waters, 1976, 2, IVL Bulletin.

A desire to increase world protein production without concomitant problems of eutrophication caused by leaching of soluble nitrogenous fertilizers has focussed increasing attention on biological nitrogen fixation. We have been concerned with the occurence of nitrogen-fixing bacteria in paper mill process waters and in sludge samples from biological treatment plants. The investigation has involved examination of water samples from 8 localities and sludge samples from further 4 localities. We took advantage of a medium specially developed for isolating nitrogen-fixing members of the Enterobacteriaceae and showed that the capacity for fixation was widely distributed among 6 taxa of this family and occurred in about 50% of all isolates. Specific activities of the nitrogen fixing enzyme system were uniformly high and most isolates which we examined were relatively insensitive to deactivation of nitrogen fixing activity by oxygen. A wide range of carbon compounds (especially sugars) were shown to be suitable carbon substrates and the regulation of enzyme synthesis followed patterns already indicated by studies on a much more restricted range of bacteria.

The data suggest that nitrogen fixation by Enterobacteriaceae will be important under field conditions and experiments, carried out on a laboratory scale activated sludge process, have shown that the nitrogen requirement can be met entirely through the fixation of atmospheric nitrogen. This is probably also of primary importance in supporting the growth of other organisms which are unable to fix atmospheric nitrogen.

Curds, C.R., Hawkes, H.A.: Ecological aspects of used water treatment: The organisms and their ecology, 1975, 1, 414 p, Academic Press Ltd, London.

This volume presents a series of accounts concerning the general biology and ecology of the plant and animal life inhabiting the various aerobic and anaerobic treatment processes. Lists of all major species of organisms and references to the taxonomic literature are given. In each case the role of the individual groups of organisms is discussed in detail and suggestions for further research are made. The content of this volume (which is the first of the serie) is the following: aerobic bacteria, anaerobic bacteria, fungi, algae and bryophytes, protozoa, nematoda, rotifera, annelida, insecta, arachnida, crustacea and mollusca. The work which is written for those with a training in the biological sciences, will be of interest to biologists and microbiologists. At the same time it will be of use to all concerned with used water treatment and the water industry. Volume 2 in preparation is headed: The processes and their ecology.

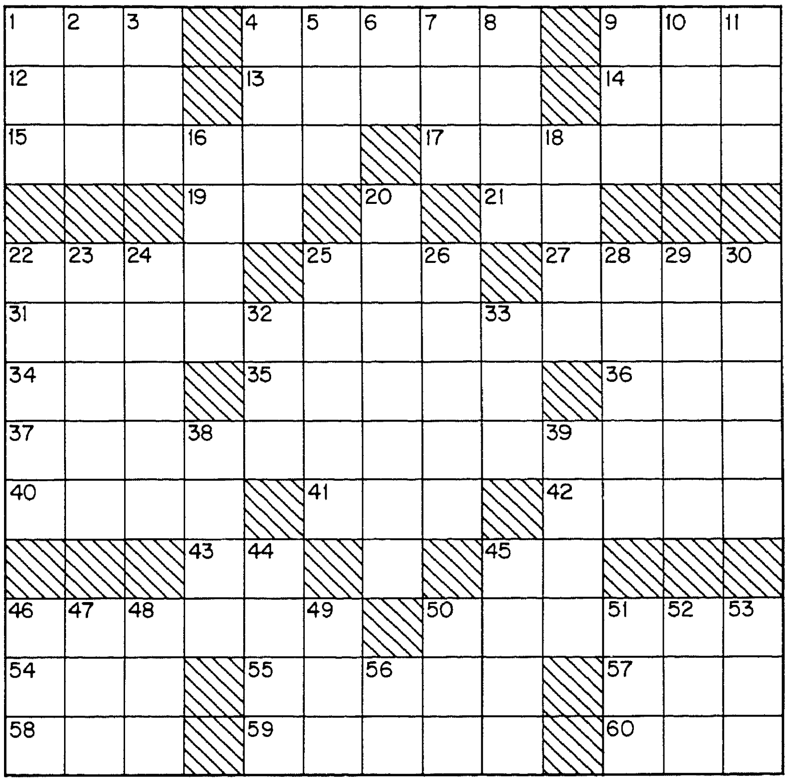
Matula, R.A.: Present status and research needs in energy recovery from wastes, 1977, No. H 00091, 452 p, Proceedings of the 1976 Conference, The American Society of Mechanical Engineers.

This volume is a report on an Engineering Foundation conference held in September 1976 to isolate basic and applied research problems which must be solved in order to permit wide-scale application of systems for energy recovery from wastes. This conference proceedings volume includes the keynote address, the papers presented in the eight technical sessions, and summary statements covering the presentations and discussions. The session topics were: emissions and pollution control in municipal scale incinerators; corrosion in waste fired systems; waste separation and preprocessing; practical operating problems of energy recovery from municipal wastes; production of fuels from waste; characterization and properties of industrial wastes; anticipated trends and needs in industrial waste utilization; and energy release characteristics and controls. A postconference review resulted in the identification of the following high priority research needs in the area of energy recovery from wastes: development of methods for the measurement, characteristics and control of effluent stream pollutants; development of methods for sampling; analysis; and classification procedures for waste fuels; examination and elucidation of the mechanisms of corrosion of materials-o-construction of waste fuel fired systems; development of a uniform and equitable energy and resource recovery system economic analysis procedure; development of materials handling, processing, and separation systems specific to waste fuel utilization; establishment of a mechanism for the acquisition and dissemination of technology relating to waste energy systems.

Adams, P.J.: Modern bark-burning methods are making this an attractive fuel, Apr. 1977, 51, No. 4, 104–106, Pulp and Paper.

Rising prices for fossil fuels have caused industry to reexamine the potentials of waste wood and wood bark as fuel. Advantages of this method are low cost, non-pollution, and very low ash content. While disadvantages include high moisture content and sand or salt content. The basic process of burning wood refuse requires the evaporation of moisture, the distillation of volatile components, and combustion consisted of hand-fired fixed grates in refractory furnaces. As installations became larger, applications included Hofft inclined grates, which permitted the wood to slide into the furnacy by gravity. The outgrowth of this method is the modern inclined water-cooled grate installed in fully Monowall welded-wall water-cooled furnaces. Later improvements include the use of hydraulic-sluicing systems with fly carbon return to the fuel feed, special upper-furnace overfire air systems, and factory-assembled package units for the burning of hogged fuel. Various test installations covering such applications as fluidized beds, gasification, and pulverized firing of hogged fuels are now in service.

Pollution Puzzle



Across:
1. Kinship
4. Useful waterway
9. . . . flow
12. Fish eggs
13. Oxygen compound
14. Fury
15. Opposed to outgo
17. Bright flower
19. Rhenium (symbol)
21. Doctor of Engineering (abb.)
22. Limited surface
25. Droop
27. Feminine name
31. Contraction of a volume
34. Lymph . . .
35. Conforming to ethical standards
36. Verein Deutscher Ingenieure (abb.)
37. Sensitivities – not quite!
40. Brief statement
41. Substitute natural gas (abb.) (g=e)
42. Unproductive
43. Laboratory equipment (abb.)
45. Fluorine (symbol)
46. Isolate
50. Screen
54. Used as scarlet dye
55. Natural source of energy (adj.)
57. Edible shoots
58. Extract of wood ashes
59. Negative ion
60. Biochemical oxygen demand (abb.)

Down:
1. Hindu title of address
2. Electrically charged atom
3. A stake
4. Used as fuel
5. Not only a weapon
6. Nickel (symbol)
7. Increase a quantity
8. Contained in car exhaust gases
9. Ocean pollutant
10. Canton of Switzerland
11. Beverage
16. Small town north of Ankara, Turkey
18. Form of energy
20. Night soil container
22. Oak nut
23. Hero of a Shakespearean tragedy
24. Pass a law
25. Contemptible person (pl.)
26. Somber hole
28. . . . . . with rage
29. Small copy
30. Seed used as flavoring agent
32. Empire (abb.)
33. Fourth caliph of Islam
38. Snakelike fish (pl.)
39. Boulder clay
44. Feminine name
45. Glacier snow
46. Arm's length
47. Refusal
48. Form of water
49. Eternity
50. Food and Agriculture Organization (abb.)
51. Bathing vessel
52. Former name of Tokyo
53. Bacilliform
56. Lithium (symbol)

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