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ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT, BETTER SOLID AND HAZARDOUS WASTES MANAGEMENT, AND SUSTAINABLE DAF LANDFILL LEACHATE PRETREATMENT: UNIDO EFFORTS

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ABSTRACT

This publication introduces the United Nations Industrial Development Organization (UNIDO) and its international leadership role in promoting industrial ecology (IE) and ecologically sustainable industrial development (ESID) and improving solid and hazardous wastes management in industrial and developing countries. The subjects covered in this publication are: ESID definition, criteria, activities and programs directly or indirectly related to solid waste and hazardous waste management. The patterns of industrialization should enhance our economic and social benefits for present and future generations without impairing basic ecological processes. The 3-E criteria of ESID are: (a) eco-capacity and biosphere protection; (b) efficiency of using man-made and natural capital; and (c) equity promotion. Important ESID activities are: (a) pollution prevention and cleaner pollution prevention; (b) international environmental conventions and protocols; (c) environmental soundness of industrial technologies; (d) integration of environmental considerations into industrial strategies and policies; (e) identification of financial resources for developing countries; (f) technical and policy information dissemination; and (g) provision of assistance upon request by the UNIDO member states. The major UNIDO's ESID programs directly and indirectly related to solid waste and hazardous waste management are: (a) integrating environment and development in decision-making processes; (b) protection of the atmosphere; (c) protection of water resources, oceans and fresh water resources; (d) environmentally sound management of biotechnology; (e) environmentally sound management of toxic chemicals; hazardous wastes and solid wastes; (f) strengthening the role of business and industry; (g) environmentally sound technology, cooperation and capacity-building; (h) information for decision-making; (i) national mechanisms and international cooperation for capacity-building in developing countries; and (j) additional ESID programs. A sustainable process system involving the use of modern coagulation, dissolved air flotation (DAF), ozonation, nitrification, denitrification, and final clarification for treating landfill leachate is reviewed and introduced as a typical example of ESID activity.

KEYWORDS: United Nations Industrial Development Organization (UNIDO). Ecologically sustainable industrial development (ESID). Solid wastes. Hazardous wastes. Industrial ecology (IE). Landfill leachate treatment, Dissolved air flotation (DAF), ClearFox..

ACRONYM

BAT	Best available technology
DAF	Dissolved air flotation
ESID	Ecologically sustainable industrial development
ICGEB	International Centre for Genetic Engineering and Biotechnology
ICPIC	International Cleaner Production Clearinghouse
IE	Industrial ecology
ILO	International Labour Organisation
IPCS	International Program on Chemical Safety
UN	United Nations
UNEP	United Nations Environmental Program
UNIDO	United Nations Industrial Development Organization
UNESCO	United Nations Educational, Scientific and Cultural Organization
WHO	World Health Organization

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1. INTRODUCTION

1.1 Summary

This publication introduces the United Nations Industrial Development Organization (UNIDO) and its international leadership role in promoting industrial ecology (IE) and ecologically sustainable industrial development (ESID) and improving solid and hazardous wastes management in industrial and developing countries. The subjects covered in this publication are: ESID definition, criteria, activities and programs directly or indirectly related to solid waste and hazardous waste management. The patterns of industrialization should enhance our economic and social benefits for present and future generations without impairing basic ecological processes. [1-5]

The 3-E criteria of ESID are: (a) eco-capacity and biosphere protection; (b) efficiency of using man-made and natural capital; and (c) equity promotion. Important ESID activities are: (a) pollution prevention and cleaner pollution prevention; (b) international environmental conventions and protocols; (c) environmental soundness of industrial technologies; (d) integration of environmental considerations into industrial strategies and policies; (e) identification of financial resources for developing countries; (f) technical and policy information dissemination; and (g) provision of assistance upon request by the UNIDO member states. [4-5]

The major UNIDO's ESID programs directly and indirectly related to solid waste and hazardous waste management are: (a) integrating environment and development in decision-making processes; (b) protection of the atmosphere; (c) protection of water resources, oceans and fresh water resources; (d) environmentally sound management of biotechnology; (e) environmentally sound management of toxic chemicals; hazardous wastes and solid wastes; (f) strengthening the role of business and industry; (g) environmentally sound technology, cooperation and capacity-building; (h) information for decision-making; (i) national mechanisms and international cooperation for capacity-building in developing

countries; and (j) additional ESID programs.

A sustainable best available technology (BAT) system involving the use of modern dissolved air flotation (DAF), coagulant, and membrane filtration for treating landfill leachate is described and recommended as a typical example of ESID activity.

1.2 The United Nations Industrial Development Organization (UNIDO)

The United Nations Industrial Development Organization (UNIDO) is a specialized agency of the United Nations (UN) with about 170 member states. The member states regularly discuss and decide UNIDO's guiding principles and policies in their sessions of the Policymaking Organs. The UNIDO's mission is to promote a new humanity science of industrial ecology (IE) and accelerate inclusive and sustainable industrial development (ISID) in Member States. Natural resources recovery, environmental sustainability, and proper management solid, liquid and gaseous wastes are emphasized within ISID. The UNIDO's programmatic focus is structured, as detailed in the UNIDO's Medium-Term Program Framework 2018-2021, in four strategic priorities: (a) Creating shared prosperity; (b) Advancing economic competitiveness; (c) Safeguarding the environment; and Strengthening knowledge and institutions. [1-5]

It is important to note that UNIDO is mainly assisting developing countries, so some industrialized countries which are the UN member states have refused to pay the UNIDO membership fees becoming the UNIDO member states.

2. ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT AND SOLID AND HAZARDOUS WASTES MANAGEMENT

Efficient solid and hazardous waste management is always needed due to continuous industrial development, while continuous industrial development can be sustained only if it preserves the balance of nature. Industrial ecology (IE) is a branch of science for sustainability, or a humanity framework for designing and operating industrial systems as sustainable and interdependent with natural systems. It seeks to balance industrial production and economic performance with an emerging understanding of local and global ecological constraints. [1-18]

Ecologically sustainable industrial development (ESID) which is a part of IE is a necessary approach to industrial development that will allow us to reconcile the demands of population growth, the desire for continued industrial development and the need to preserve the environment at the same time. The authors and coworkers have conducted many research concerning sustainability activities. [19-29]

There has been a good deal of debate on the meaning of the term “sustainable development”. The UN World Commission on Environment and Development has offered several definitions of sustainable development. The one that is most often repeated is that sustainable development “meets the needs of the present without compromising the ability of future generations to meet their own needs”. According to a document from the United Nations Industrial Development Organization (UNIDO) [4-5], ESID is defined as “those patterns of industrialization that enhance economic and social benefits for present and future generations without impairing basic ecological processes”. On the basis of the growing scientific evidence in support of the strong definition of sustainable development, UNIDO proposes a definition of ecologically sustainable industrial development (ESID) that tends to preserve natural capital and allows a low degree of substitutability by man-made capital. ESID may also be defined as those patterns of industrialization that enhance economic and social benefits for present and future generations without impairing basic ecological processes. It follows, therefore, that any significant degradation of ecological processes by industrialization, as well as by other human activities, is unsustainable over long periods. Any definition of sustainable development ought to address three issues: (a) the explicit contribution of ecological processes to living standards; (b) the access by future generations to as effective a resource

base as that enjoyed by the present generation, if living standards are not to decline over time; and (c) the resource base, which must include a mix of man-made and natural capital.

3 CRITERIA OF ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

To achieve the Ecologically Sustainable Industrial Development (ESID), industrial development must meet "3E" criteria: (a) eco-capacity: any industrial development must allow the capacity of ecosystems to continue to function despite pollution and must protect the biosphere; (b) efficiency: any industrial development must have the most efficient conversion of human, material and energy resources into industrial outputs and must make the most efficient use of man-made and natural capital; and (c) equity: any industrial development must have the equitable distribution of environmental burdens as well as of the outputs of industrialization across nations, across segments of society and across generations, and , in short, must promote equity. [1-5]

3.1 Eco-capacity and Biosphere Protection

The concept of eco-capacity has two aspects. On the one hand, it refers to the capacity of an ecosystem to be resilient, that is to maintain its patterns of behaviour in the face of external disturbance. On the other, it refers to the capacity of the system to remain stable, that is to maintain its equilibrium in response to normal fluctuations in the environment. It is the first aspect of the concept that is of interest here.

Protecting the biosphere from industry-related activities is a fundamental criterion for sustainable development. It is also a very difficult one to measure because it is multidimensional. It includes stabilizing the biosphere in the face of the threats from greenhouse gases and ozone-depleting substances, maintaining the carrying capacity of natural resource systems (forest, fisheries and agricultural land) and protecting the absorptive (assimilative) capacity of air, water, and soil from emissions and waste discharges.

3.2 Efficiency of Using Man-made and Natural Capital

Even if the overriding concern of sustainable development is the preservation of the natural environment, this should be done in an efficient manner. Thus, if there are alternatives for maintaining eco-capacity, the

idea would obviously be to choose those that minimize input (of energy, for example) per output produced or that maximize output per input needed. This follows from the fact that the notion of development is central to ESID, and development, in turn, implies rising living standards, at least in the broad sense. As attested by economic history, economic development by means of industrialization (the transformation of raw materials into products) has long been the path to higher standards of living. Hence industrialization policies have to be consistent with achieving the most efficient conversion of raw materials into outputs.

3.3 Equity Promotion

There is one further criterion that needs to be applied, namely the promotion of equity. The issue of equity takes a number of forms: (a) equitable distribution of environmental burdens as well as outputs; (b) equitable consideration of industrialized countries and developing countries; (c) equitable consideration of present and future generations; and (d) further equity issues. [4-5]

3.3.1. Equitable Distribution of Environmental Burdens and Outputs

The very first is the equitable distribution of environmental burdens as well as outputs. The solution of this issue may have important repercussions for their preservation of the environment. If the costs of meeting environmental standards are considered to be too high, sizable segments of the population, many of the already poor, will suffer the consequences of this decision, i.e., a degraded environment, and this will make them poorer. The cycle spirals downwards because poverty per se breeds some of the worst forms of environmental degradation, i.e. deforestation, over-exploitation of marine resources, unsanitary living conditions etc., as discussed later.

3.3.2. Equitable Consideration of Industrialized Countries and Developing Countries

On a global scale, the issue of equity arises in another way. One argument is that industrialized countries, which have benefited the most from the exploitation of natural resources and the waste assimilative capacity in die biosphere, now have a moral obligation to permit the developing countries to follow similar growth patterns. This argument implies that industrialized countries should pay the excess costs

incurred by the developing countries to protect the environment. However, this moral argument is not necessarily accepted by those who would have to pay the excess costs. A more effective argument might well be based on interlocking mutual security and economic interests. This was the argument that justified the Marshall Plan after the Second World War. At present, a number of West European countries have found it cost-effective, i.e. in their own interests, to assist Poland and the other Eastern European countries to reduce air pollution. Such arguments can be applied on a global, as well as regional scale.

3.3.3. Equitable Consideration of Present and Future Generations.

A third aspect of the equity issue is intergenerational equity. The present generation is clearly paying for the degradation of natural resources, such as deforestation, overgrazing and erosion, caused by earlier generations. Future generations will, however, have to pay not only the costs of current environmental degradation of the same kind (only accelerated) but also the costs of accumulations of atmospheric gases and toxic heavy metals and the loss of tropical rain forests and biological diversity. One implication of this understanding is that the needs of future generations should be taken into account even if this places an additional strain on political institutions, which are normally geared to achieving short-term targets and not to satisfying future generations.

3.3.4 Further Equity Issue

Two further aspects of the equity issue are especially relevant to industry: (a) first, all countries need to participate in the shift to cleaner production processes, which are at the core of ESID; besides cleaner production processes could maximize this potential; and (b) secondly, unless employment opportunities are created for marginalized populations, they will continue to resort to environmentally unsound farming, grazing and fishing, giving rise to environmental disasters such as deforestation and top-soils depletion, and showing little sign of diminishing.

4. LEADERSHIP ROLE AND ESID ACTIVITIES OF THE UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

The United Nations Industrial Development Organization (UNIDO) has lent its support, on a coordinated

basis, to the activities of many member states active in the field of ESID, and has worked in close cooperation with national institutions in implementing ESID. The following subsections introduce some past, present and future major directions for UNIDO action in achieving ESID. [1-5]

4.1 Pollution Prevention and Cleaner Pollution Prevention

The first and the most important UNIDO activity is assisting developing countries, upon request, in building the technical and scientific institutional capacity to develop, absorb and diffuse pollution prevention techniques and cleaner production processes essential to making the transition to ESID. This could be done by: (a) demonstrating the financial and economic advantages and environmental benefits of ESID by working cooperatively with industry and other technical experts, and with Governments, to undertake a program of site-specific, country case studies; (b) providing technical support for the design, establishment, operation, evaluation and monitoring of pollution prevention techniques and cleaner production processes and technologies; and (c) assisting demonstration and training centers at new or existing industrial facilities, and providing support to centers of excellence;

4.2. International Environmental Conventions and Protocols

To play the UN's international leadership role, UNIDO has frequently assisted developing countries in the implementation of international environmental conventions and protocols related to industrial activities because this is what UNIDO can do the best. This kind of activities can be done by: (a) providing technical assistance to those countries to identify and implement the actions needed; and (b) helping those countries to locate expertise and funding for projects that contribute to the implementation of those conventions and protocols;

4.3. Environmental Soundness of Industrial Technologies

Assisting developing countries in determining the environmental soundness of industrial technologies is the third UNIDO activity which can be accomplished by: (a) preparing guidelines on environmentally sound industrial practice for selected sectors; (b) promoting, in selected sectors, technical procedures to evaluate and to test processes, products and services; and (c) providing assistance for the development of

assessment techniques for the identification and measurement of environmental impact.

4.4. Integration of Environmental Considerations into Industrial Strategies and Policies

Assisting developing countries in integrating environmental considerations into their industrial strategies and policies is the fourth activity which can be done by: (a) identifying sectoral and subsectoral priorities for environmentally sound industrial activities; and (b) specifying the techniques available to rehabilitate existing industries so that they could operate in an ecologically sustainable manner, assessing the costs of such a transition and estimating a time frame for achieving it.

4.5. Identification of Financial Resources for Developing Countries

Underdeveloped countries are not ready for industrial development. Developing countries are ready and willing, but do not have adequate financial resources for their desired correct and sustainable industrial development. Since UNIDO is not a financial organization, its responsibility is recommending and assisting developing countries in identifying appropriate and available financial resources, where possible on concessional terms, that would enable them to take necessary steps to achieve ESID;

4.6. Technical and Policy Information Dissemination

Dissemination of any UNIDO information to its member states is a continuous effort. Strengthening the UNIDO's existing database and its capacity to coordinate the dissemination of technical and policy information on ESID, *inter alia,* is accomplished by cooperating with the United Nations Environment Program in its work on the International Cleaner Production Clearinghouse (ICPIC).

4.7. Provision of Assistance Upon Request by the UNIDO Member States

UNIDO also assists its member states, upon request, in achieving ESID in accordance with the provisions of the UNIDO Constitution and relevant decisions of the General Conference and Industrial Development Board. In implementing its programs and projects UNIDO has established and/or strengthened internal procedures for appraisal and approval of activities that ensure compatibility with the concept of ESID.

5. UNIDO'S ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT PROGRAMS DIRECTLY AND INDIRECTLY RELATED TO SOLID AND HAZARDOUS WASTES MANAGEMENT

The United Nations Industrial Development Organization (UNIDO) plays a key role in the implementation of the Ecologically Sustainable Industrial Development (ESID) program areas and chapters of the United Nations (UN) Agenda 21. The relevant chapters elaborated below are directly or indirectly related to solid and hazardous waste management.

Most of the UNIDO program areas are accorded high priority within the Organization, based on the its specific strengths as developed over the past 60 years. UNIDO regards these program areas as the its primary concerns, as they are based on a clear delineation of its role and on an efficient division of labor within the United Nations system. These program areas are introduced in below. [1-5]

5.1 Integrating Environment and Development in Decision-Making

The UNIDO strategic management approach is based on a process of consultations and cooperation between the Government and the private sector for the development of flexible and demand-driven technical and financial support programs that enhance productivity and secure sustainable growth. Furthermore, the policy studies, System of Consultations and technology acquisition and negotiation programs are all instruments geared to effecting a proper integration of environment into the decision- and policy-making process. Typical successful examples of solid and hazardous waste management in both industrialized countries and developing countries are: (a) recycle of lead car batteries; (b) government's plastic bags ban in New York State, USA; (c) establishment of recycle centers and development of single stream solid waste treatment technologies for separation and recycle of waste plastic bottles, aluminum cans, glass bottles and waste papers in USA; (d) government incentive program for waste papers recycle and marketing; (e) establishment of recycle centers for recycling waste rubber tires and other rubber materials, (f) international collaboration of solid/hazardous waste treatment and disposal chains; etc. (g) legislation for proper management, treatment and disposal of solid and hazardous wastes; (h) government incentive program for reuse of agricultural solid waste as raw materials for production of synthetic fuel; (i) establishment of the solid waste Best Available Technologies (BAT) and

the Best Available Management (BAM) for the municipalities and industries to follow. [30-33]. Figure 1 shows how the recycled rubber is successfully reused as the children play ground's floor, road, rectangular protection pad, fall protection tires, and foot rods.

Figure 1. Recycle and reuse of waste rubber and tires in a children play ground as the floor, road, rectangular protection pad, fall protection tires and foot rods. ,

5.2 Protection of the Atmosphere

UNIDO addresses this issue in three ways: by developing alternative clean fuel programs (cleaner coal and oil, mission control); by stimulating greater efficiency in incineration/combustion processes and energy conservation; by supporting alternative clean energy sources (solar, hydropower, hydrogen, methane gas, bio-synthetic gas). Both environmental and energy considerations are being increasingly integrated into UNIDO activities, stressing the development of sustainable energy systems. Typical solid

and hazardous waste management issues in both industrialized countries and developing countries are: (a) selection of cleaner fuels, such as low sulfur coal, natural gas, for incineration/combustion processes; (b) installation of air pollution control units, such as fabric filtration, cyclones, electrostatic precipitation, wet scrubbing, dry scrubbing, condensation, thermal oxidation, catalytic oxidation, gas phase GAC, desulfurization, and/or gas phase membrane process, for purifying the stack effluent from incineration/combustion facilities [30-33]; (c) collection of methane gas from landfill sites for air pollution reduction; (d) treatment of landfill gas using flare process, gas phase biofiltration, etc.; (e) purification of landfill gas and recycle of the purified landfill gas as a fuel; (f) proper siting of incineration/combustion, composting and landfilling facilities for reduction of air pollution; (g) odor pollution of composting gas using gas phase biofiltration; (h) capture, separation and storage or reuse of carbon dioxide gas from incineration and combustion facilities' stack gaseous effluents by carbon sequestration process system. [26]; and (i) regional or international atmospheric modeling and dispersion of gaseous effluent from solid and hazardous waste facilities. [30]

5.3. Protection of Water Resources, Oceans and Fresh Water Resources

An integrated approach to water management can ill afford to ignore industry, and the efficient use of water was thus emphasized at the ESID Conference. Over the years, UNIDO has been endeavouring to minimize the impact of industrial activities on the aquatic environment. Its objective is to improve industrial efficiency by reducing the quantity of water used, the waste water produced, and the extent of water-borne pollutants. Complementing such efforts, manuals, guidelines and technological information on the management of waste water will be prepared and disseminated. . Typical solid and hazardous waste management issues in both industrialized countries and developing countries are: (a) regional or international groundwater modeling of flow and water quality affected by sanitary landfill leachate; (b) investigation and reduction of plastic wastes and other solid/hazardous in rivers and oceans; (c) proper treatment of sanitary landfill leachate for water resources protection; (d) reduction or total ban of ocean disposal of any raw or treated biosolids; (e) improving old landfill sites using modern liners and leachate collection technologies; (e) proper siting of landfill facilities to avoid or reduce water pollution; (f) application of advanced processes, such as dissolved air flotation (DAF) and membrane processes for treating leachate or decontaminating groundwater. [34-40]

5.4. Environmentally Sound Management of Biotechnology

UNIDO has recognized the enormous potential that biotechnology^ offers both industrial

development and environmental protection and is currently enhancing the biotechnological capacity of some developing countries so as to enable them to take advantage of that potential. Appropriate mechanisms and centers, such as the International Centre for Genetic Engineering and Biotechnology (ICGEB), have been set up.

Efforts have and will continue to concentrate on studies and capacity building, enabling countries to identify and capitalize on opportunities in biotechnology, based on their own comparative advantages, as well as on direct technical assistance in applying biotechnology to industrial activities in health care, chemical production and environmental protection; and to promote biosafety through inter-agency collaboration aimed at developing a biosafety information network and advisory service. The examples of environmentally sound management of biotechnology related to solid and hazardous wastes are: (a) development and application of biodegradable plastics; (b) development, improvement and application of bioreactor landfilling technology for replacement of conventional landfilling technology; (c) improvement of vermicomposting process for disposal of biodegradable solid wastes, such as restaurant food wastes and other agricultural solid wastes; (d) application of advanced DAF, sequencing batch bioreactor, biological nitrification-denitrification, membrane bioreactor, etc. for leachate treatment.; (e) prevention of pharmaceautical pollutants from entering the solid waste streams by implementation of effective pollution prevention or waste minimization programs. [40-43]

5.5. Environmentally Sound Management of Toxic Chemicals; Hazardous Wastes and Solid Wastes.

Solid and hazardous industrial wastes can be reduced through improved process efficiency. This involves promoting cleaner technologies, minimizing waste at source, developing alternatives for erstwhile waste and promoting recycling. In UNIDO priority is given to safety in chemical production, especially with regard to hazardous operations and toxic chemicals. This approach covers operational, occupational and environmental safety in chemical production, and contributes to the sound management of toxic chemicals, thus complementing the work initiated by the World Health Organization (WHO) in collaboration with UNEP and the International Labor Organization (ILO) of the International Program on Chemical Safety (IPCS). UNIDO is currently negotiating to join IPCS. The examples of environmentally sound management of toxic chemicals, hazardous wastes and solid wastes may include: (a) recycle of metallic lead from automobile batteries; (b) recovery of toxic precious metals from e-wastes; (c) recovery of ferrous metals from appliances and automobiles; (d) recycle of plastic solid wastes for manufacturing outdoor furniture, construction materials, etc. ; (e) recycle of toxic mercury from e-wastes for reuse; (f) solidification of incinerator ashes that contain toxic heavy metals for reuse as

bricks; (g) recovery of solid glass waste for reuse as glass products; (h) development of technologies for minimization, separation, treatment and disposal of hazardous solid wastes; (i) separation and treatment of hazardous radioactive wastes and long-term storage of the treated radioactive wastes in underground or deep ocean. [31-33].

5.6 Strengthening the Role of Business and Industry

UNIDO will analyze increasingly the role of business and industry with a view to advocating either the short- or long-term profitability of environmental protection through the use of dean or energy-efficient technology and energy conservation in industry. UNIDO will build on its prior experience of pollution prevention through product and process improvement, including plant modernization and rehabilitation. Business and industry in developing countries will be assisted in the adoption of processes and procedures that reduce demand on resources by industry and generate less industrial waste, inter alia by devoting particular attention to environmental considerations in the operation and development of small and medium-scale industries. Through demonstration activities such as Cleaner Production centres, UNIDO will foster the reduction of industrial waste in the production process. The investment promotion activities of UNIDO will play a major role in providing enterprises in developing countries with the means to approach sources of financing required for diversification of their products and services into environment-related areas.

5.7 Environmentally Sound Technology, Cooperation and Capacity-Building

Inherent in all efforts to promote sustainable industrial development is the need to select appropriate technologies based on social, technical, economic and environmental criteria and to develop the absorptive capacity for these technologies. Support is also provided in the negotiation of technology transfer contracts in order to ensure that the transfer mechanism matches the needs and capabilities of the recipient. The efforts of UNIDO to assist developing countries in effective technology transfer will strengthen the ability of those countries to meet the obligations of international agreements relating to environmental protection, as outlined in the recommendations of ESID. For example, the transfer of appropriate technology reduces dependence upon technologies using chemicals damaging to the ozone layer; it is thus in accordance with the aims of the Montreal Protocol on Substances that Deplete the Ozone Layer. Similarly, appropriate technologies can minimize the quantities of hazardous wastes produced by industry, which supports the principles of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.

5.8 Information for Decision-Making

Adequate decision-making for industry is directly related to the adequacy of information available. UNIDO is working at three interrelated levels to provide information to developing countries: collection and dissemination of industry-related environmental information to developing countries through a referral/clearing-house system; data and information collection, analysis and modeling as a basis for policy formulation and decision-making; inclusion through the UNIDO feasibility study program of environmental considerations in the calculation of the costs and benefits of potential investments. The UNIDO's activities also take on a further dimension in enhancing public awareness, with the public information program advocating sustainable industrial development through the print and audio-visual media, among other approaches, and by promoting closer and continued linkages between UNIDO and developing-country counterparts, donors, the media and the public at large. The United Nations Educational, Scientific and Cultural Organization (UNESCO) is frequently assisting UNIDO in publication and information dissemination. [1-3]

5.9 National Mechanisms and International Cooperation for Capacity-Building in Developing Countries

Capacity-building permeates the many different layers of the UNIDO’s response to the UN Agenda 21. Its support to national capacity building concentrates on three fundamental aspects of sustainable industrial development: enhancing national capacities to incorporate environmental considerations into industrialization policy and strategies; enhancing capacities to disseminate and analyze technological information; improving capacities to analyze and exercise choices among technological options. Closely linked to technology cooperation, UNIDO’s experience forms a substantial base upon which to continue, in cooperation with Governments, the United Nations system, NGOs and the private sector, to strengthen and amplify those activities.

5.10. Other UNIDO's Ecologically Sustainable Industrial Development Programs

The United Nations Industrial and development Organization (UNIDO) has many other Ecologically Sustainable Industrial Development (USID) Programs which may not be directly related to the solid and hazardous wastes management. They are: (a) global action for women towards sustainable and 'equitable development; (b) combating deforestation; (c) combating poverty; and (d) promoting

sustainable agriculture and rural development.

6. Sustainable Process Systems for Treating Landfill Leachate

6.1 Ecological Landfill Problems and the Needs of Sustainable Best Available Technology (BAT)

Industrialization will pollute the ecosystem of the Earth. Knowing the concept of ecologically sustainable industrial development (ESID), an environmental engineer will naturally become an industrial ecologist who will take a scientific approach to solve an environmental pollution problem that will allow us to reconcile the demands of population growth, the desire for continued industrial development and the need to preserve the environment at the same time. Let us take sanitary landfill as an example. Landfill is one of most important solid waste treatment and disposal processes. Landfill is not a sustainable process unless its problems of gas emission and leachate discharge are solved. There are more problems if the solid waste stored at the landfill site is of hazardous. Collection, treatment, or recycle of landfill gas is discussed elsewhere [40, 43] . This publication introduces an existing process system using mainly dissolved air flotation (ClearFox) for leachate treatment in Germany, and then discusses other unit processes which may work with dissolved air flotation (DAF) together to form an ecologically sustainable (i.e. meaning technically feasible and economically affordable) process system for leachate treatment.

6.2 Full Scale Operation of A Germany Landfill Using Dissolved Air Flotation

The composition and the hydraulic flow of landfill leachate depends on: (a) the type of solid waste which was stored in the landfill; (b) the annual precipitation; and (c) the age of the landfill.

AVE-Alte Schanze is an old landfill in Paderborn, Germany, filled with the solid wastes consisting of production residues (i.e electroplating, fuel ashes), urban, oily and construction wastes. The landfill annually drains about 200,000 m^3 leachate, which is collected for proper treatment. [36]

Since it is an older landfill, it drains a leachate containing less biodegradable organic matter (BOD/COD

ratio is extremely low and may be zero). Typically the leachate has a strong smell, low turbidity, light color, very high COD, low BOD, and high nitrogen concentrations (NH_4, NO_2, NO_3), various hydrocarbons (often organic halogens), chlorides, sulphates, and different toxic heavy metals (i.e. Zn, Cu, Ni, Cr, Cd, Hg, Pb, etc.).

A possible sustainable BAT system with a capacity of 600 m^3/d, or 25 m^3/h has been chosen by the landfill owner and approved by the government. It is a combined physicochemical-biological system consisting of : (a) dissolved air flotation (DAF; ClearFox), (b) ozonation, (c) fixed-bed biological reactor (FBR) for nitrification and denitrification, and (d) final clarification (lamella separator). Entire process system is fully automatic and the daily flowrate which is depending on the rainfall can be adjusted manually. Manufacturing time of this possible sustainable BAT process system was 12 weeks.

All process steps can be bypassed, and the flow can be reversed manually using switching valves (for instance, if more nitrate in raw leachate wastewater, then first denitrification treatment can be ahead of nitrification treatment).

The complete landfill leachate treatment system using dissolved air flotation or ClearFox as the work-horse has been operated since November 2018. The average characteristics of the landfill leachate wastewater are: over 4000 mg/L COD, over 100 mg/L BOD_5, over 400 mg/L total nitrogen, over 200 mg/L ammonia nitrogen, over 200 mg/L nitrate nitrogen, and over 100 mg/L AFS.

Dissolved air flotation (ClearFox) removes 85% of COD, 50% of total nitrogen, 65% of ammonia nitrogen and 95% of AFS from raw leachate wastewater.

The effluent from the complete physicochemical-biological system (including DAF, ozonation, biological nitrification-denitrification, and final lamella clarification) consistently meets the effluent standards of German, European and International standards of : 400 mg/L COD, 70 mg/L total nitrogen, 10 mg/L ammonia nitrogen, 3 mg/L phosphorus, 20 mg/L AFS, and 1500 mg/L chloride. For further full scale operational results, the readers are encouraged to contact the manufacturer of this Germany landfill leachate treatment system, PPU Umwelttechnik GmbH. [36]

Glossary

Ecologically sustainable industrial development (ESID): (a) It is a part of industrial ecology science, or a scientific approach to industrial development that will allow us to reconcile the demands of population growth, the desire for continued industrial development and the need to preserve the environment at the same time; (b) ESID is defined as "those patterns of industrialization that enhance economic and social benefits for present and future generations without impairing basic ecological processes"; (c) On the basis of the growing scientific evidence in support of the strong definition of sustainable development, UNIDO proposes a definition of ecologically sustainable industrial development (ESID) that tends to preserve natural capital and allows a low degree of substitutability by man-made capital; (d) ESID may also be defined as those patterns of industrialization that enhance economic and social benefits for present and future generations without impairing basic ecological processes.

Industrial ecology (IE): It is a branch of science for sustainability, or a humanity framework for designing and operating industrial systems as sustainable and interdependent with natural systems.

United Nations Industrial Development Organization (UNIDO): It is a specialized agency of the United Nations (UN) with about 170 member states. The member states regularly discuss and decide UNIDO's guiding principles and policies in their sessions of the policymaking organs. The UNIDO's mission is to promote a new humanity science of industrial ecology (IE) and accelerate inclusive and sustainable industrial development (ISID) in member states. Natural resources recovery, environmental sustainability, and proper management solid, liquid and gaseous wastes are emphasized within ISID. The UNIDO's programmatic focus is structured, as detailed in the UNIDO's Medium-Term Program Framework 2018-2021, in four strategic priorities: (a) creating shared prosperity; (b) advancing economic competitiveness; (c) safeguarding the environment; and Strengthening knowledge and institutions. Since UNIDO is mainly assisting developing countries, so some industrialized countries which are the UN member states have refused to pay the UNIDO membership fees becoming the UNIDO member states.

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INTRODUCTION TO THE E-BOOK SERIES OF THE
"EVOLUTIONARY PROGRESS IN SCIENCE,TECHNOLOGY, ENGINEERING, ARTS AND MATHEMATICS (STEAM)"
”

The acronym STEM stands for “science, technology, engineering and mathematics”. In accordance with the National Science Teachers Association (NSTA), “A common definition of STEM education is an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply science, technology, engineering, and mathematics in contexts that make connections between school, community, work, and the global enterprise enabling the development of STEM literacy and with it the ability to compete in the new economy”. The problem of this country has been pointed out by the US Department of Education that “All young people should be prepared to think deeply and to think well so that they have the chance to become the innovators, educators, researchers, and leaders who can solve the most pressing challenges facing our nation and our world, both today and tomorrow. But, right now, not enough of our youth have access to quality STEM learning opportunities and too few students see these disciplines as springboards for their careers.” STEM learning and applications are very popular topics at present, and STEM related careers are in great demand. According to the US Department of Education reports that the number of STEM jobs in the United States will grow by 14% from 2010 to 2020, which is much faster than the national average of 5-8 % across all job sectors. Computer programming and IT jobs top the list of the hardest to fill jobs.

Despite this, the most popular college majors are business, law, etc., not STEM related. For this reason, the US government has just extended a provision allowing foreign students that are earning degrees in STEM fields a seven month visa extension, now allowing them to stay for up to three years of “on the job training”. So, at present STEM is a legal term. The acronym STEAM stands for “science, technology, engineering, arts and mathematics”. As one can see, STEAM (adds “arts”) is simply a variation of STEM. The word of “arts” means application, creation, ingenuity, and integration, for enhancing STEM inside, or exploring of STEM outside. It may also mean that the word of “arts” connects all of the humanities through an idea that a person is looking for a solution to a very specific problem which comes out of the original inquiry process. STEAM is an academic term in the field of education.

The University of San Diego and Concordia University offer a college degree with a STEAM focus.

Basically STEAM is a framework for teaching or R&D, which is customizable and functional, thence the “fun” in functional. As a typical example, if STEM represents a normal cell phone communication tower looking like a steel truss or concrete column, STEAM will be an artificial green tree with all devices hided, but still with all cell phone communication functions. This e-book series presents the recent evolutionary progress in STEAM with many innovative chapters contributed by academic and professional experts.