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Chapter 1

Waste Water Management Systems

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Additional information is available at the end of the chapter

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1. Introduction

As mankind eventually adopted a more settled, non-nomadic way of life, people become increasingly involved in the technical aspects of water. To a large extent, the primary concerns in the beginning were utilization and improvement of existing water resources, together with protection against the hazards and potential harm associated with uncontrolled natural water. It was only toward the end of the nineteenth century that wastewater become an issue in science, technology, and legislation, specifically, its production and treatment, in terms of both municipal and industrial sources [1]-[5].

As early as 4500 years ago the first prerequisites were met for urban and agricultural water management. This encompassed irrigation and drainage systems, canals, and sewage facilities. Even so, the treatment of waste water in formal waste treatment plants by means of the microbial degradation of wastewater components was reported for the first time 1892. It was municipal wastewater, including that from artisans, craftsman, and small factories, typical for larger cities of that time. Much earlier, in Greco- Roman times extensive facilities were erected and maintained for supplying drinking water to cities. Waste water in those days presented no major problems, and sewage systems were regarded less as a means of collecting water for reuse than as way of draining off potential sources of hazard and preventing pollution of the streets, with the attendant risk of a spread of vermin and epidemics.

Development of the organized utilization of water as an essential resource for human beings, animals, and plants led to further technical strides, such as dams against flooding or for storage purposes, waterways designed for transport, and harbors on the sea coast and along inland waterways. Problems of wastewater arose gradually during the same period in conjunction with the increase in urban population as the natural self purification capacity of surfaces waters proved no longer able to keep pace with development. Risks related to groundwater contamination are associated not only with emissions in the form of wastewa-

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ter, the ground -air cycle plays a role as well via atmospheric deposition. The state of a particular body of water can be described by a set of code numbers, but the core of the problem is in fact a sum of all the processes leading to the observed state. In this case, the essential element is the kinetics of two opposing processes the rate of pollution, and the rate of cleansing. Each of these is in turn a combination of natural and anthropogenic phenomena applicable to the site in question. Most of the problems are derived not from absolute numbers, but rather from population densities, production densities, or productivities, in the various urban centers of the industrialized world, all of which actually have access to an adequate supply of natural water.

In the terminology of water economics, consumption of water refers to a loss of quantity, not a decrease in quality. In this sense, consumption represents that part of the water supply that is lost in the course of use, primarily through evaporation. This fraction of the water is permanently withdrawn, at least from the local water cycles, and is thus no longer available for further utilization, so it must be replenished with water from precipitation, springs, or wells.

As industrialization proceeded, two unique characteristics of water acquired rapidly increasing importance, its high specific heat capacity, and its rather high solvent power with respect to many inorganic and some organic substances. The consequences of these factors in the context of the production and disposal of wastewater are quite different, however. Water that is intended to serve as a heat reservoir, cooling agent, steam source, must be cleaned before use in order to prevent corrosion and erosion in turbines and heat exchangers, and it is subsequently returned to the environment in a purified state, albeit at a higher temperature. On the other hand, water in its function as a reaction medium, or even a reaction partner, has now developed into the most significant source of wastewater in industry. Entire branches of manufacturing are based on production processes carried out in the aqueous phase, where water is used as a solvent, dispersing agent, transport medium, and reagent. This is perhaps most evident in the case of breweries, in sugar, paper, and pulp factories, in dye works, tanneries, and the like where the teal problem is one not only of the actual content of the wastewater, but also its quantity [6].

Water in drawn by industry from many different sources. It may be taken directly from a river, a lake, a well, or from a privately impounded supply, or it may be obtained from a neighboring municipality. Both the amount drawn by the industry and the degree of treatment accorded the water so withdrawn varies widely from industry to industry and from plant to plant. The quality of treatment may vary considerably within a given plant depending upon the particular uses to which the water is put. the amounts of water withdrawn by various industries for different uses, and the quality of water s that have been used by different industries before being subjected to various degree of treatment are varied.

Water has been used in abundant quantities by chemical, petrochemical, petroleum refining and other process industries. However, in recent years, the increased cost of wastewater treatment to meet environmental requirements and the scarcity of less expensive industrial water have provided process industries with strong incentive to minimize the amount of water consumption and wastewater discharge. The major concern is to emphasize the im-

portance of water reuse and a number of effort have been made towards achieving the goal of extensive water reuse in various process industries [3].

There have been presented many ideas for wastewater recovery and reuse in the in industries[5]-[9]. These paper have exclusively described wastewater treating systems for the realization of zero discharge. As for the optimal design methods for wastewater treating systems, several attempts have also been made by using system approaches. Much information on the optimization studies on process units for waste water treatment can be acquired from this survey [10]-[50]. In addition, a method of utilizing the system structure variables is considered to be useful to eliminate difficulties due to combinatorial problems. The studies presented so far, however, only cover wastewater treating systems. The amount of wastewater was given beforehand and its reduction was not taken into consideration. As far as the authors know, the optimal design problem including water reuse for the total system consisting of water-using system and wastewater -treating system has not yet been solved.

2. Basic principle

In the last decade, a number of studies, on wastewater reuse or optimal designs of waste water treating systems have been presented. Though those studies have received much attention, they have been carried out exclusively on wastewater treating systems without paying attention to water using systems. However, the authors extensive survey on the present status of water use in a industry has shown that there is enough room to reduce a large amount of both fresh water and wastewater. The reduction can be accomplished by optimizing water allocation in a total system consisting of water using units and wastewater treating units. The problem of maximizing water reuse can be considered as a problem of optimizing water allocation in a total system. Furthermore, the problem of determining a system structure is defined as a parameter optimization problem by employing structure variables. Due to the approach, the difficulties associated with combinatorial problems are resolved.

For the year 2000, a global balance of quantities and fluxes shows an overall water supply of 2500 km^3 and water demand 6000 km^3, representing 24% of the directly usable supply [6]. When this allocated among the major consumers and account is taken of the corresponding levels of specific water consumption (evaporation), several trends with regard to quantities and types of wastewater are discernible. (Table 1)

Consumption category	Percentage of total demand (6000 km^3)	Consumption (evaporation) as a percentage of demand
Domestic	8	20-30
Industry	29	15-20
Agriculture	59	75
Storage losses	4	100

Table 1. Types of wastewater.

Water circulation through the atmosphere contains 13000 km^3,ca. 0.02% of the overall liquid, global water reserve of 1.3 x 10^9 km^3. The annual quantity subject to evaporation, which is equal to the annual amount of precipitation, is estimated at 475000 km^3. This corresponds to a 35-fold annual turnover of the atmospheric content, which means water exchange between the atmosphere and the surface of the earth is complete every 9.5 days. In some cases local circumstances lead to considerable deviations from these global values.

Waste water treatment becomes especially important in times of water scarcity. This is particularly true when agriculture, domestic water needs, and industry find themselves in vigorous competition. the greatest increase by far is anticipated for agriculture assuming for the year 2000 a world population 6-6.5 x 10^9 (Fig.1).

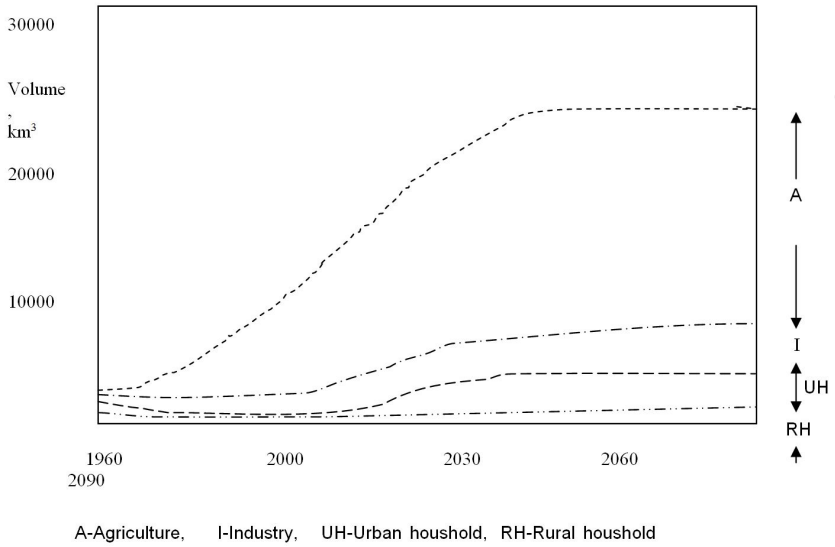

Figure 1. The increasing worldwide demand for water.

Water as regarded as chief raw material problem of the future, elevating wastewater treatment to the status of a recycling technology. This involves substance protection in the sense of sustainable development, together with the maintenance of an adequate supply of drinking water, an emphasis that goes beyond the earlier concern directed almost exclusively toward environmental protection, especially the protection of natural waters.

Each of the processes described below has its place in the broad spectrum of technical possibilities. The question of what is the best process should thus be replaced by a search for the most suitable process in a particular circumstance, taking fully into account the nature of certain definable problem cases. Modern technological development of wastewater treatment has occurred largely in and with the aid of the chemical industry. However, the waste water problem and its treatment is of interest not only to this particular aspect of industrialized society. Numerous other branches, often to an even greater extent (Fig.2).

There is no shortage today of diverse international experience in the construction and operation of waste- treatment plants. In fact, in some places this has developed into its own separate branch of process engineering. It is still worth noting with respect to terminology, however, that some of the reasoning applied to wastewater concepts and standards of evaluation has been borrowed from neighboring disciplines, especially biology.

3. Industrial water treating systems

The authors have carried out an expensive study on the present status of water use in a typical industry. As the result it has been shown that there enough room to reduce a large amount of wastewater by maximizing water reuse and waste water recovery. Further increases in the efficiency of water use can be expected by the change of process conditions. In solving such large complex problems, it has been found more methods.

Water is drawn by industry from many different sources. It may be taken directly from a river, a lake a well, or from a privately impounded apply, or it may be obtained from a neighboring municipality. Both the amount drawn by the industry and the degree of treatment accorded the water so withdrawn varies widely from industry to industry and from plant to plant [10]-[36]. The quality of treatment may vary considerably within a given plant depending upon the particular uses to which the water is put. Table 2 shows the amounts of water withdrawn by various industries for different uses[37]-[40].

In the chemical industry, economic factors usually dictate the inclusion of a wastewater separation system. Thus, wastewater that is not in need of treatment, clean water, especially cooling water, is separated from that which does require treatment. Clean water can be discharged directly into the receiving stream. If the wastewater requiring treatment fails to meet the quality specifications for biological waste treatment it must first be subjected to decentralized chemical-physical pretreatment, after which it can be fed into the central wastewater treatment plant for purification as shown in Fig.2.

Specific wastewater loads can be reduced or even avoided through measures of the type recommended in conjunction with process integrated environmental protection.

The entire wastewater regime is also reflected in the approach taken to wastewater decision making. For each type of wastewater, all the following questions must be rigorously addressed to ensure consistent and disposal (Fig.3).

Can be amount and contamination level of the waste water be reduced or even eliminated by process integrated means?

Does all the wastewater in question in fact require treatment?

Is the waste water suitable in its present form for biological treatment, or should it be subjected to decentralized pretreatment?

These considerations apply, for companies that have their own central wastewater treatment plants, and indirect discharge, for companies that dispose of their wastewater via a public wastewater facility.

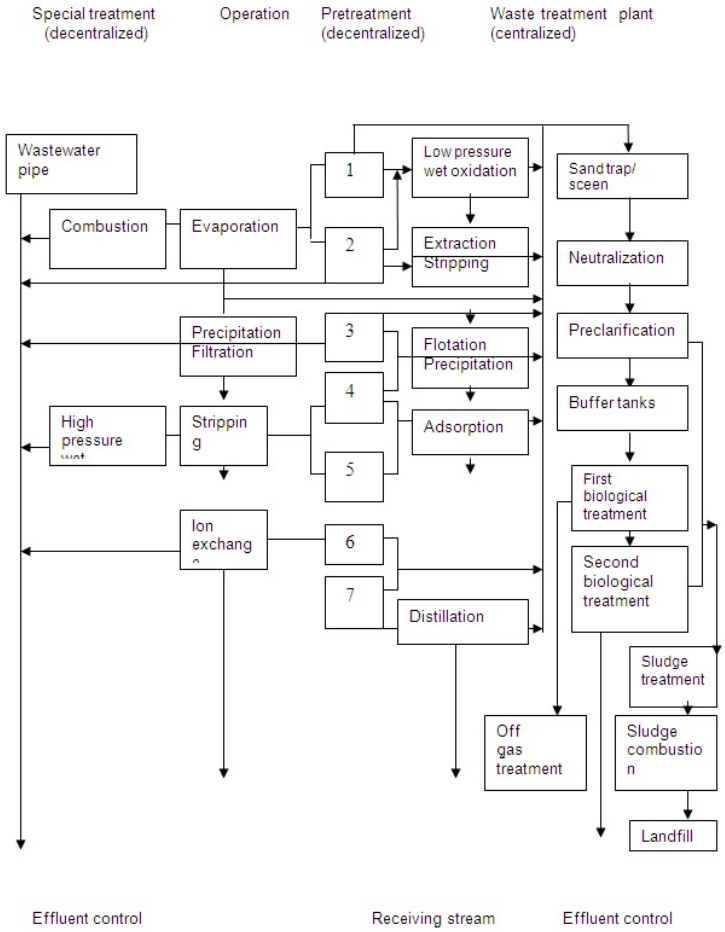

Figure 2. Decentralized and centralized aspects of waste water treatment.

Suspended solids removal, particularly of the coarser materials from 5μ up, such as sand and heavy silt may be removed in sedimentation basins. Such basins usually serve a dual purpose, preliminary removal of suspended solids, and storage to balance variations in supply with the relatively constant demand of the plant processes. In these basins, detention time is measured in days, the amount depending upon the likelihood of interruption or reduction in the supply. A 30th-day detention is not uncommon in some circumstances. Particles smaller than 1μ are generally not affected by the detention. The effect of continued aeration and sunlight in oxidizing organic peptizing substances may cause a certain amount

of flocculation. Algal growth, particularly of the free floating type, occurs in warmer climates and may indeed contribute to the total turbidity emerging from the basin. Control of algal growth is usually accomplished by the addition of copper sulfate sprayed in aqueous solution on the water surface from a boat or spread by solution from solid material in burlap bags towed behind power boats that traverse the surface of the reservoir in a pattern. In the warmer climates, addition of copper sulfate every several months in the amount of one ppm, based on the top one foot of water, may be employed. In some exceptional circumstances in very arid regions with short water supply, evaporation control may be practiced by the addition of fatty alcohols which form a monolayer on the surface.

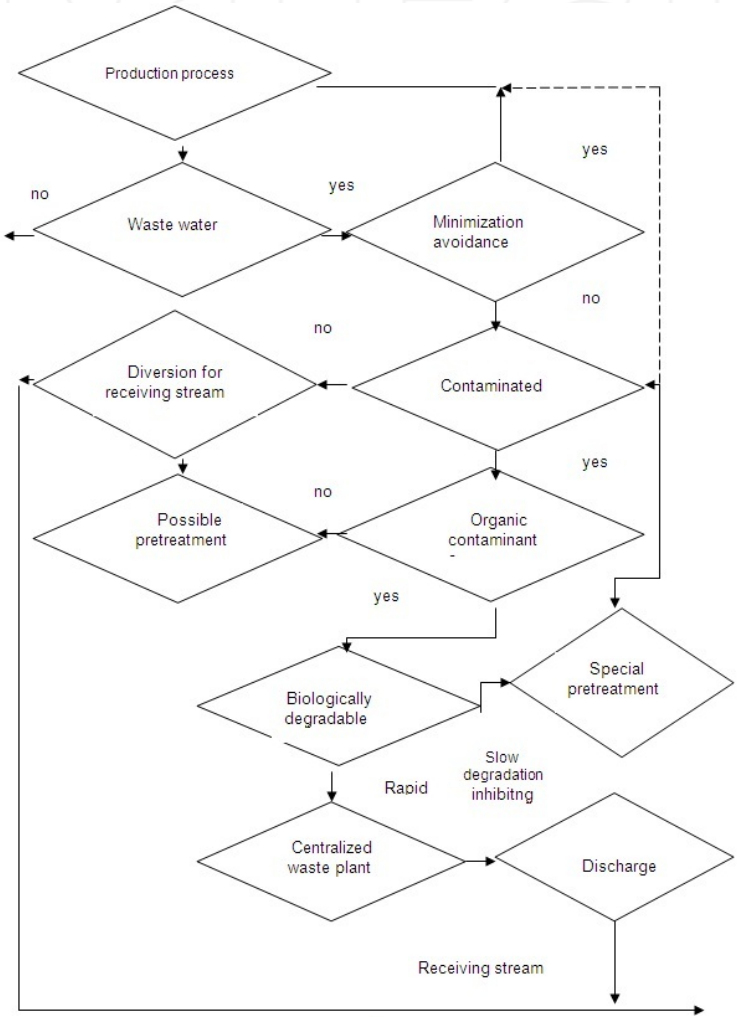

Figure 3. Decision diagram dealing with for waste water formation, avoidance, separation and treatment.

The degree of clarification applied to the water from the source of supply is governed both the intended use of the water and by the level of turbidity that is to be removed. Two processes, singly or in combination, are generally employed for clarification. The first of these is filtration where turbidities are generally less than 50 ppm, and clarification can be accomplished simple by passing the water through a filter. Filters may be of three configurations, the most common being a single granular medium such as sand, typically of effective particle size of 0.4 mm at flow rates ranging from 1 to 8 gal/minft$^{2.}$

A small amount of a coagulant such as alum may be added ahead of the filter amounts varying from 5 to 15ppm. Such rapid sand filters may either be operated by gravity, relying solely on a head of water over the filter medium to force the water through, or they may be completely enclosed in a cylindrical tank with pump pressure used to force the water through the medium. Pressure drops typically range from 1 to a maximum of 8 ft of water. The depth of bed employed is commonly from 2 to 3 ft. Finely divided anthracite coal of effective particles size of 0.6 mm may be used instead a sand. When anthracite is used, the addition of coagulation chemicals is usually required. The coagulation chemicals added serve the purpose of agglomerating the colloidal dispersed solids and aid in their adherence to the filter media and hence their removed. Clarification efficiencies measured as the ratio of suspended solids entering are commonly 0.90-0.99. The sand or anthracite coal in earlier designs was supported on a bed of graded gravel, but in current practice is more commonly supported directly on the filter bottom which is provided with strainers sufficiently fine to prevent sand or anthracite from passing through.

Previously most filters, both pressure and gravity, were of a single medium, sand or anthracite. Currently, many new installations are being designed with a mixed media or graded density filter. In this case, filter media of different types such as sand and anthracite are employed together, with the anthracite, being the more coarse and lower density medium, appearing on the top of the filter, 49 mm (20 in) of 1.0 mm anthracite coal may be placed on top of 14.7 mm 6 in (6 in) of 0.4 mm sand. When the filter backwashed to remove the suspended impurities that accumulate during the run, the less dense medium, the coal, is washed to the top by the upward flow of water and the heavier medium, the sand, even though finer, remains on the bottom. The suspended solids that have been removed, being much lighter than, either medium and in flocculated form, are carried out by the up flowing water and washed to waste. In both types of filters, single medium and mixed media, the amount of backwash water required is approximately three percent of the total throughput of the filter during a run, the end of which is controlled by a given limit on the quality of the effluent. The advantages of the mixed media filter are that the coarser material on top causes removal of a large percentage of the suspended solids in the entering water and allows the solids removed to accumulate in the depth of the bed rather than forming a mat on the top. The remaining amount of suspended solids is removed on the finer media. The net results is an ability to handle an influent water with a much higher suspended solids content, and to process a greater quantity at higher flow rates without deterioration of effluent quality than is possible with a single medium filter. Where mixed media filters are employed, flow rates

vary from 3 to 6 gal/minft^2. Total head loss is limited to approximately results in a penetration of suspended solids through the filter medium into the effluent.

Industrial Group	Water intake, billion (gal /year) [b] -cooling and condensing	Water intake, billion gal/ year -boiler feed sanitary service etc.	Water intake, billion gal/ year -proc Ss	Water intake, billion gal/ year -total	Water intake, billion gal/ year -water recycled	Water intake, billion gal/ year -gross water use, including recycling	Water intake, billion gal/ year -water consumed	Water intake, billion gal/ year -water discharged
Food and kindred products	392	104	264	760	520	1280	72	688
Textile mill products	24	17	106	147	163	810	13	134
Lumber and wood products	71	24	56	151	66	217	28	123
Paper and allied products	607	120	1344	2071	3045	6016	129	1942
Chemicals and allied products	3120	202	564	3880	3688	7574	227	3650
Petroleum and coal products	1212	99	88	1399	4768	6162	81	1318
Leather and leather products	1	1	14	16	2	18	1	15
Primary and metal industry	3387	195	995	4578	2200	6778	266	4312
subtotal	8814	762	3432	13008	15347	28355	817	12191
other industries	571	197	271	1039	1207	2246	71	968
Total industry	9385	959	3703	14047	16554	30601	888	13159
Thermal Electric Plants	34849	c		34849	5815	40665	68	34781
Total	44234	959[d]	3703	48896	22869	71265	956	44940

[a] [37]).a Source census of manufactures [37], b gal means British gallon 1gal= 4.54 L, c Boiler feed water use by thermal electric plants is estimated to be equivalent to sanitary service, in industrial plants etc., d Total boiler feed water(excluding sanitary service in industrial plants).

Table 2. Industrial plant and thermal-electric-plant (Water intake, Reuse, and Consumption, 1964.

4. Adsorptive, chemical and incineration systems in waster water treatment

Adsorption processes have been successfully applied in the chemical industry for the purification of water generally, as well as for various solutions and individual wastewater streams.

In the chemical, physical, and biological purification of wastewater dissolved constituents are eliminated not only by use of special absorbents, but also in many cases by adsorption on the surface of undissolved substances already present. Elimination occurring by the latter mechanism cannot be examined separately, so it is simply described to the treatment process as a whole.

The deliberate application of adsorption is always in competition with other chemical, physical, and biological approaches to the purification of wastewater. Ecological and economic considerations are decisive in the choose of any particular process or process combination [10]. The question as to whether adsorption is technically and economically feasible, either alone or in combination with other processes, must be examined separately in each individual case. To this end it is necessary to consider the adsorption phenomenon itself in conjunction with the preparation and regeneration of the adsorbent, since from a process engineering stand point the two processes constitute a single entity. In addition, reuse or disposal of material arising in the course of the process should be taken into account as appropriate.

Adsorption causes dissolved organic wastewater constituents to accumulate at the surface of one or more adsorbents. Adsorption must there fore be regarded as a physical concentration process taking place at a liquid solid phase boundary, one that competes with other concentration processes occurring at liquid-liquid [11]-[13] (extraction or membrane processes) and liquid-gas boundaries (evaporation, distillation, stripping)[34]. In the unified examination that follows, it was necessary that some attention also be devoted to such oxidative processes as aerobic biological treatment, chemical oxidation, wet oxidation, and combustion, treated elsewhere in this contribution in detail.

In general, it may be assumed that adsorption processes have already established themselves as valuable for dealing with fairly small wastewater streams containing low concentrations of adsorbable substances. Adsorption is especially common in decentralized waste water treatment, both alone and in combination with other processes.

Dissolved waste water constituents are potentially subject to attachment at the surfaces of solids. An accumulation of this type is known as adsorption, and it is attributable mainly to van der Waals forces, particularly dipole-dipole interaction, though columbic forces also often play an important role. The fixing of dissolved substance to a sorbent can sometimes lead to an enrichment factor of 10^5 or greater. In most cases the adsorbent–adsorbate mixture must then be worked up in a second processing step. Regeneration of a contaminated sorbent frequently takes advantage of the reverse counterpart to adsorption-desorption.

The equilibrium state that is established after a sufficient amount of time has elapsed defines the equilibrium concentration of a solute in a liquid and the loading of an adsorbent. This

state can be described in terms of so called adsorption isotherms. An isotherm is applicable only to a specific, defined temperature, although the influence of temperature is very small in liquid-solid systems in contrast to gas-solid systems. The curves themselves are usually determined empirically, but their shape can also be described mathematically.

One of the first attempts at developing an isotherm equation was reported by Langmuir, who was concerned originally with the adsorption of gases, basing his work on methods of statistical thermodynamics. The Langmuir equation assumes the presence of a adsorbent surface, and it is therefore valid only to the point of a monomolecular covering of the relevant surface. In general, Langmuir homogenous isotherms are described by the equation:

$$X = X_m \frac{c}{b+c} \tag{1}$$

where X is equilibrium loading, X_m is loading for monomolecular coverage, c is residual solution concentration remaining after establishment of the adsorption equilibrium, and *b* is *a* constant.

The isotherm equation proposed by Freundlich as early as Langmuir was established empirically. Because of its relatively simple form it is an excellent device for describing adsorption from an aqueous solution:

$$\frac{X}{M} = kc^n \tag{2}$$

where X is amount of adsorbed substance, M is weight of adsorbent used, c is residual concentration remaining after establishment of the adsorption equilibrium, and k and n are constants specific to a given adsorbent-adsorbate mixture.

Plotting this equation in log-log function, $\log(X/M) = \log k + n\log c$, produces a straight line, which greatly facilitates practical application of the method (Fig.4 and Fig. 5).

The Langmuir equation is clearly limited to low degree of loading, whereas in the case of the Freundlich equation there is no formal concentration-dependent limitation to the expression's validity. In practice, however a flattening of the Freundlich isotherm does become evident with increasing concentration, which means that the Freundlich exponent (n) increases with decreasing concentration. Thus rigorous application of the Freundlich equation is limited to a rather narrow concentration range.

Multicomponent mixtures are the rule in practical waste water treatment, and these can be characterized only by such cumulative parameters. Individual substances included in a collective analysis compete for occupation of the available adsorption sites.

Since different substances usually have very different adsorption behaviors, the Freundlich isotherms actually obtained in such cases are curved, or even bent at sharp angles as shown in Fig.5.

Despite the complications created by isotherms whose course is not straight, the Freundlich isotherm method is frequently used as a way of rapidly acquiring information regarding absorbability on adsorbents. Moreover, such isotherms make it possible to estimate adsorbent consumption rates as well as the achievability of particular concentration targets.

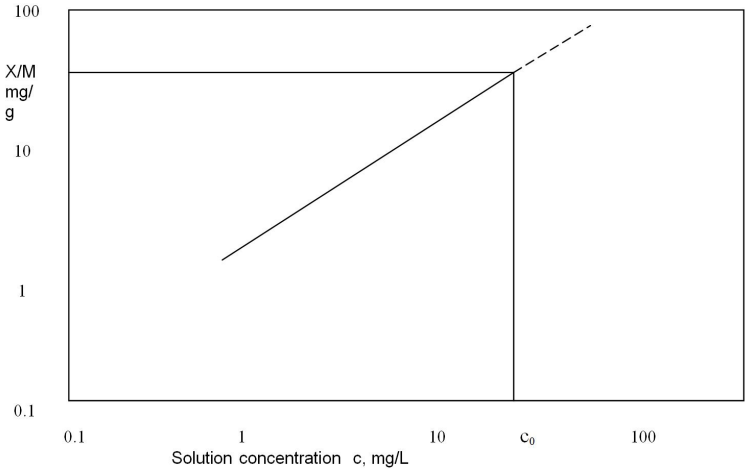

Figure 4. A well behaved Freundlich isotherm.

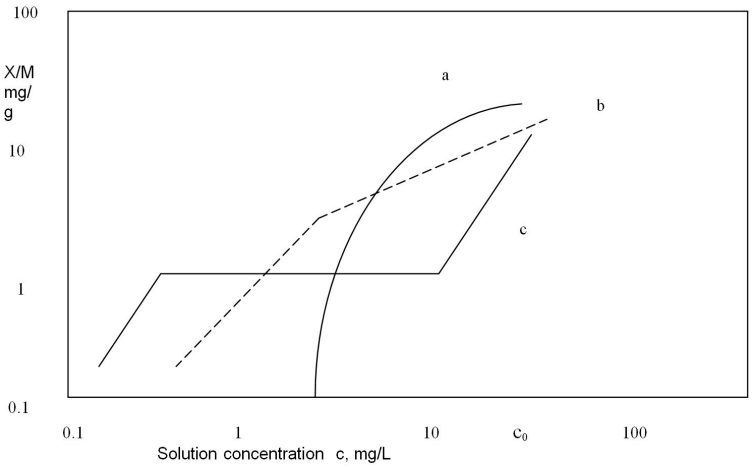

Figure 5. Typical non-linear Freundlich isotherms (a,b,c) obtained with different mixtures of solute.

In the last twenty years special processes have been developed to utilize chemical reactions directly for the degradation of water contaminants. Some have been developed to the point of technical maturity, and without exception these are oxidative processes. The methods for the oxidative and reductive elimination of wastewater components are old.

The active oxidizing agents are oxygen containing radicals in the vast majority of cases the radical H-O. The oxidizing agents actually introduced are usually air, oxygen, hydrogen peroxide, or ozone. Process engineering characteristics distinguishing the individual methods vary quite considerably. What differentiates one process from another. and distinguishes all of these approaches from the microbial route, is a consequence largely of the nature of the wastewater itself and the extent to which its components should or must be degraded. It should also be noted that advantage is sometimes taken of several either direct chemical or biochemical methods, as well as combinations of the two together.

The generally more drastic reaction conditions or more aggressive reactants associated with a purely chemical method, and the often higher degradation rates achieved, lead easily to the impression that direct chemical methods are inevitably superior to biochemical methods. This is not necessarily the case, however. Material degradation is the first and

foremost a kinetic problem, and reaction mechanisms and catalysis play decisive roles. To describe a substance as "not degradable" is basically an unwarranted oversimplification, because it implies that "degradability" is a fixed property of a substance, whereas it is in fact matter of behavior, i.e., some degradation will indeed occur, but at a rate that is unacceptably low. In drawing any methodological comparison, various direct chemical methods must be taken into account, and especially from the following points of view [41]-[45].

1. Energy costs and not only with regard to requisite temperature levels, but also the required duration of action and any energy expenditures associated with separation and enrichment steps, especially in the case of dilute wastewater.

2. Irregular waste from and how to cope with peak volumes or concentration. Microbial processes function best when volumes and concentrations are relatively constant. Large fluctuations, especially toward higher values, can often be managed with the aid of subsequent or parallel chemical process steps.

3. Mixed wastewater and the separation of partial (split) streams containing slowly degradable of interfering wastewater components [41],[42]. Major grounds for the separation and individualized treatment of specific production wastewater streams include the following:

   a. A certain partial stream is characterized by high volume and the presence of contaminant amenable to degradation by means of the simple and inexpensive low pressure wet oxidation process, resulting in a secondary wastewater suitable for introduction into a control biochemical wastewater-treatment plant.

   b. A partial stream contains wastewater components that degrade only slowly, suggesting that high-pressure wet oxidation. This process is quite elaborate and involves relatively high operating costs, so a more economical alternative might be to pursue chemical degradation only up to the point of suitable fragmentation, assigning the responsibility for further degradation, as above, to a central biochemical wastewater-treatment plant.

c. A partial stream contains such a high level of salts that a cell culture would no longer be capable of functioning. Wet oxidation on the other hand might not be feasible either if in the case of certain salt-like companion substances the threat of corrosion rules out both low-and high-pressure oxidation. Such a case could be dealt with only by strictly thermal oxidation based on combustion, after appropriate concentration.

Generally, speaking, chemical treatment is restricted to special wastewaters characterized by components that are degraded too slowly in conventional waste-treatment plants or that interfere with the biochemical degradation of other substances. Chemical waste degradation processes listed in order of increasing operating temperature and pressure.

1. Atmosphere pressure wet oxidation by means of hydrogen peroxide, ozone, or air, with iron oxide or titanium dioxide as catalyst.

2. Low-pressure wet oxidation with air, based on an iron/quinone catalyst.

3. High-pressure wet oxidation with air, using copper as the catalyst.

4. Thermal oxidation, i.e., evaporation of water and combustion of the residue.

There is no such thing as a single best process, one clearly characterized by an ecological maximum and economic minimum. What is instead required is extensive experimental investigation to establish the limits and possibilities associated with each individual case, thereby providing a sound basis for meaningful comparisons. The question of how one should proceed with a particular wastewater source can then be answered reliably.

Thermal processes must generally ruled out in cases involving low concentrations of degradable substances because of excessively high specific energy costs per unit volume. The use hydrogen peroxide is often advantageous here, especially if the substances in question accumulate on an irregular basis. With higher contaminant concentrations, either high-pressure or low-pressure wet oxidation can be implemented. Evaporation followed by combustion becomes the method of choice if there is the added complication of high concentrations of inorganic salts. Wastewater of this type is derived largely from the chemical and materials industries.

The direct oxidation of organic compounds by hydrogen peroxide under acidic conditions is a well-known but relatively seldom-employed process. The oxidation potential of H_2O_2 can be increased above that of ozone through catalysis, usually with Fe^{2+}. Oxidation with hydrogen peroxide was investigated in the second half of the 20th century in conjunction with the treatment of municipal sewage[42] and waste water from industrial production, especially effluents containing sulfur and phenols [10], [43]. Successful hydrogen peroxide treatment of wastewater from hardening plants and tanneries has also been described.

In special advantage of this process is that the technological effort required is small, an especially positive factor in the case of dilute wastewater (<10 g COD /L). Non biochemical treatment is of special importance for wastewater fractions with low concentrations of contaminants, because the corresponding large volumes determine the size of the required

treatment facility, and thermal processes are excluded because of the enormity of the associated energy requirement.

Oxidation with H_2O_2 proceeds at atmospheric pressure and room temperature within 60-90 min. Hydrogen peroxide is not toxic, is easy to handle, and decomposes into the environmental products oxygen and water. Large scale use of this otherwise virtually universal oxidizing agent is restricted by the high price of H_2O_2 itself, together with the fact that although self–decomposition proceeds with the formation of oxygen, the resulting oxygen contribution almost nothing to the oxidation process.

Hydrogen peroxide is not merely an oxygen-transfer agent that facilitates work in a homogenous aqueous phase, indeed, one should make every effort to avoid conditions favoring the self-decomposition of hydrogen peroxide:

$$H_2O_2 \Rightarrow H_2O + \frac{1}{2}O_2 \tag{3}$$

More the point is the fact that catalysis by iron (molar ratio H_2O_2 : Fe^{3+} = 15 : 1, pH= 3.0), leads-as in the reaction of the Fenton reagent-to the formation of the H-O′ radicals, and it is these that constitute the actual oxidizing agent.

The redox potential E_0 for the reaction sequence:

$$H_2O_2 \Rightarrow HO^+ + OH^- \tag{4}$$

$$Fe^{3+} + HO^+ \Rightarrow Fe^{3+} + OH^* \tag{5}$$

$$OH^* + H^+ + e \Rightarrow H_2O \tag{6}$$

has been determined to be 2.28 V. For the analogous reaction with ozone the redox potential is 0.21 V lower:

$$O_3 + 2H^+ + 2e^- \Rightarrow H_2O + O_2 (E_0 = 2.07V) \tag{7}$$

In the case of substance that oxidize only slowly even under these conditions, or via oxidation chains starting from them, it has been observed that self-decomposition of H_2O_2 - which is of no value for COD degradation-becomes appreciable. It is therefore necessary to establish the extent of utilization of introduced H_2O_2, and to complete this with the applied dosage in that particular case. The dosage should then be decreased until a utilization of nearly 100% is achieved [44]. If a dosage is calculated based on the stoichiometry corresponding to complete oxidation all the way to CO_2, an almost equivalent COD degradation can usually be achieved with 60% of the calculated dose, resulting in almost 100% utilization of the added H_2O_2.

The heat of reaction has also been determined under these conditions, leading to the following values established with a flow calorimeter, isothermal [45]:

$$\begin{aligned} Q_1 &= 4.59 cal / mgCOD \cong 19.22 J / mgCOD (\pm 3\%) \\ Q_2 &= 2.48 cal / mgH_2O_2 \cong 10.39 J / mgH_2O_2 (\pm 4\%) \end{aligned} \tag{8}$$

The extent to which different classes of substances differ in their behavior is illustrated by the data in Table 3. From an economic stand point, the selected conditions in this study were appropriate only for the last two substances listed. The process can be regarded as non-specific with respect to the various classes of organic substances typically encountered in wastewater. It also shows little dependence on the salt load.

The degradation of more than 100 individual compounds as well as authentic industrial wastewater has been described [46]. As a results of adsorption on flocculated material during the neutralization step the process leads to an effective reduction of COD roughly 10-15% greater than the level of true degradation.

The process can be operated continuously in the form of a cascade. On a pilot-plant scale (≤ 500L) the residence time is 60-90 min with a dosage of 20-80% H_2O_2/COD. Partial oxidation with maximum utilization of H_2O_2 is pursued only to the point at which the wastewater can be subjected to subsequent degradation in a biological wastewater-treatment plant without impairing biochemical processes there. The type and level of salts present is of some importance, even though the actual oxidation with H_2O_2 is largely insensitive to salts. Considering only the COD value of the wastewater, partial oxidation with H_2O_2 is still technically feasible with dilute effluent in the concentration range 0.5-10g COD/L, where thermal processes must be excluded because of the associated energy demand.

Radical formation based on hydrogen peroxide has also been achieved by UV irradiation for wastewater-treatment purposes [47].

Use ozone for the oxidative elimination of wastewater components has also been known for a long time. Ozone was used even earlier for the sterilization of air and the treatment of drinking water. Its effectiveness is highly dependent on the pH and is based essentially on two mechanisms.

1) So-called direct oxidation occurs under acidic conditions. This is fairly slow process, but the conversion can be accelerated greatly if the energy necessary for radical formation is provided in the form of UV high from a Hg low pressure radiation source.

$$\begin{aligned} &O_3 \Rightarrow^{h\nu} O^* + O_2 \\ &O^* + H_2O \Rightarrow^{h\nu} H_2O_2 \\ &H_2O_2 \Rightarrow^{h\nu} 2HO^* \end{aligned} \tag{9}$$

2) Alkaline oxidation also takes place via the intermediate formation of hydroxyl radicals:

$$
\begin{aligned}
&O_3 + HO^- \Rightarrow \ HO_2^- + O_2 \\
&HO_2^- + O_3 \Rightarrow^* O_2^- + O_2 + HO^* \\
&H_2O \ + O_3 +^* O_2 \Rightarrow HO^- + 2O_2 + HO^*
\end{aligned} \tag{10}
$$

Ozonization of organic halogen compounds leads to both inorganic halides, from dehalogenation at C-Cl, and the ensuing formation of new organic halides.

The formation of organic halides has also been detected in wastewater containing a combination of chlorine free organic materials and inorganic halides originating from the accompanying salt load. Compounds formed in this way generally reflect the presence of oxidizing agents, especially ozone or hydrogen peroxide.

In this system, oxidative degradation of C-H and C-C bonds and the formation of the new C-Halogen bonds in the presence of the appropriate salts is strongly pH dependent. Radical reactions produce the intermediate hypochlorite, which in alkaline medium also acts as an oxidizing agents. Chlorination at carbon is clearly apparent under acidic conditions, as implied by an equilibrium shift in the system

$$Cl_2 + H_2O \Leftrightarrow HOCl + HCl \tag{11}$$

This effect is even more pronounced in the case of the higher halides as shown by the following Data on C-Halogen formation in conjunction with oxidation (Table3).

Halide	Threshold pH
Chloride	<5
Bromide	<10
Iodide	<15

Table 3. Halogen formation vs. treshold pH.

Oxidative cleavage predominates in all three cases at a pH>4.

The oxidative treatment of wastewater containing salts requires the prevention of simultaneous and persistent halogenation. A high chloride content must be anticipated in seepage water from landfills and in certain effluent streams derived from product ion lines in chemical processing plants.

Bromide in drinking water leads to the formation of organobromine compounds upon ozonization. Special measures must be instituted in dealing with bromide- and iodide-containing wastewater derived from the processing of color negative films and the production of printing plates. In the case of iodide containing wastewater it is useful to remove the iodide prior to oxidation of other constituents. With bromide–containing wastewater it is possible

to degrade the adsorabable organic halide (AOX) formed in situ during the course of oxidation by introducing an excess of oxidizing agent.

Radicals derived from natural ozone, and from natural, extracellular sources of hydrogen peroxide in the soil, especially the hydroxyl radical H-O* [48], also produce halogenated intermediates in the presence of ubiquitous salts, including halogenated metabolites. Some of the latter are intermediate products with a limited lifetime in the mineralization process, whereas others are persistent excretion products in the form of humid acids with halogenated aromatic groups. Similar processes are observed in the ocean and in inland waters.

Corresponding process in industry, i.e., oxidative degradation reactions with the simultaneous formation of intermediate organic halogen derivatives, has so far not been reported, although oxidative degradations in the formed natural decomposition and decay induced by natural oxygen sources together with biochemical catalysts: oxidizes, peroxidases have been simulated in the laboratory [49]. Specific proposals were developed in conjunction with this study for the industrially very important degradation of lignin in the wastewater released from paper and pulp mills.

Semiconductors catalysts such as the oxides of titanium, iron, or zinc, together with atmospheric oxygen as the oxidizing agent and sunlight as a source of the requisite activation energy, constitute systems for the treatment of dilute wastewater. These systems have already been investigated in the context photochemical degradation of organic substances in the atmosphere [48],[49].

Apart from studies involving individual substances, the behavior of actual wastewaters has also been investigated in a thin film fixed-bed reactor (Fig.6), including groundwater, seepage water, influents to biochemical wastewater-treatment plants, and the corresponding effluents.

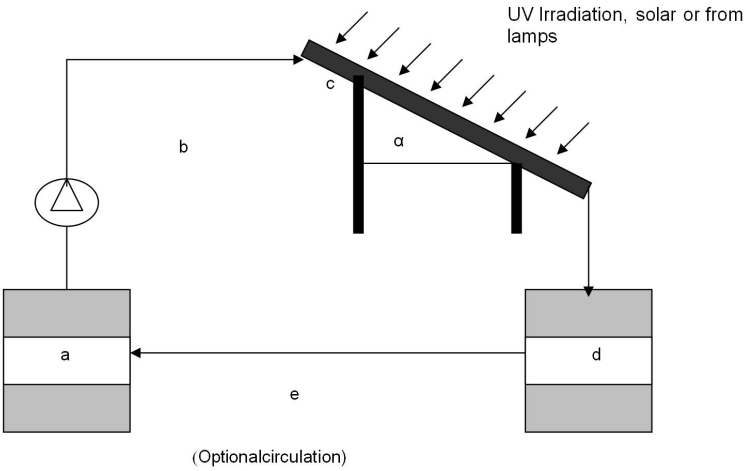

Figure 6. A thin-film fixed- bed reactor for solar detoxification.

A consideration of the associated energy factors shows that titanium dioxide absorbs light only at wavelengths below 390 nm because of its relatively large band gap of 3.2 eV. Accessible sunlight with a radiant power of 20-30 W/m^2 in the wavelength range 300-400 nm makes available 0.2-0.3 photons per m^2 per h. Quantum yields of 0.1-10% have been reported at TiO_2 surfaces. Assuming an average quantum yield of 1%, this energy source would suffice for the degradation of 2-3 mmol of wastewater compositions per square meter of surface area per hour. For substances with molecular masses of ca.100 present in concentrations of ca. 1mg/kg, the potential wastewater throughput would be 200-300 L/h for an absorption surface area of one square meter. Lamp panels equipped with standard fluorescent lamps of the type developed for tanning benches have also been used as sources of near-UV radiation. The corresponding degradation reactions proceed more rapidly with hydrogen peroxide as a sole or supplementary source of oxygen.

Variants such as parabolic channel reactors have been found to be much less effective than thin-film fixed-bed reactors. Such chemical variants as hydrogen peroxide in conjunction with mixed oxides based on Fe (III)/Ti(IV) have led to better utilization of the available visible light, because *a*-Fe_2O_3 absorbs at wavelengths under 540 nm.

Photo-reactivity has been found to increase in the presence of mixed oxides of this type as a result not only of photo-oxidation but also photo-addition, which may prove to be of some importance in the context of degradation intermediates.

Wastewater for which biological, chemical and physical purification processes either fail or prove too expensive can, if necessary, be purified by combustion of their organic constituents. In principle, all organic substances can be oxidized in a flame, and volatile inorganic substances formed can be separated in a flue-gas scrubber. Oxidation in a flame and the associated breakdown of organic materials depends on temperature, residence time, oxygen content, and turbulence in the combustion chamber.

The incineration of organic constituents is a specialized process for treating those industrial wastewater in which the organic constituents, and under some circumstances the inorganic constituents as well, are chemically utilizable at high temperature with the aid of atmospheric oxygen, the accompanying water matrix "gas phase oxidation" is also used in conjunction with this type of combustion to distinguish it from processes such as wet oxidation.

5. Waste water management system

Waste water management involves analysis of elements, their attributes, behavior and parameters estimation, real time optimization and safety. Optimization provides optimal working conditions, services, troubleshooting, advanced control and hazard minimization. However, these will support people decision to prevent abnormal situation, not replace the people.

Waste water treatment operation makes history data base of manipulates entity variables. Supervision can make different service databases model. A model manager, which shows how does seek out a new way to create optimal waste water policy and how does model pretreat-

ment and post treatment waste water network life cycle, and how does make management history was developed. Management systems will be available to analyze environment requirements and performed information processing in the aim objective achieving [51]-[58].

There is no safety reason to discontinue operation, when monitoring devices respond at the boundary between normal operating and admissible error ranges of waste water variables. Damage minimizing systems come into action when the waste water system is in no specified operation and when an undesired event occurs.

To use models to support decision making is proliferating in both the public and private sectors was the aim of this chapter. As powerful decision aids models can be both beneficial and harmful. At present, few safeguards exist to prevent model builders or users from deliberately carelessly data, or recklessly manipulating data to further their own ends. Perhaps more importantly few people understand or appreciate, the harm can be caused when builders or users, fail to recognize the values and assumptions on which a model is based or fail to take into account all the groups who would be affected by a model's results.

5.1. Waste water safety

Waste water from cities, industrial and the others manufactures are transported with various sewerage systems. Under infrastructured system understand process systems which using for recieving, collecting, evacuation and waste water treatment. Dependent of that how is collected and evacuation of waste water system can be general, separation and partical separated type.

At the general system all waste water is transported with one channel. The separation system are performed transport of all waste water from industry hausholders, and atmosphera separated channels. The partial separation systems mixing industrial water with hausholderswater or industrial and atmospheric water. Behinde these systems can made various combination in different parts of city. The waste water transport systems are consist from more connected elements. There are collectors, pipelines, valves, pumps which distributed in more streams as shown in Fig.7.

Maintenance waste water treatment and evacuation are very important. Safety of the waste water transport system is ecological significant. Because a diagnostic system for risk analysis and supervision of the waste water system is developed. In the safety analysis and operation the simulation getting started with data of the process components. For accident detection the derived model is forecasted the future behavior of the system and risk parameters are determined. The system is consisted of streams and process units data as well as the basic faults and symptoms.

This chapter illustrate the waste water transport safety protection system as shown in Fig. 8. In simulation, both qualitative and quantitative analysis are often applied together. Usually, qualitative decision efficiently made with symbolic and graphic information, and quantitative analysis is more conveniently performed by numerical information.

The diagnostic expert systems have important role how in risk analysis and accidents prevention of the production systems such as in transport systems (Fig.8). A diagnostic systems for supervision and maintaining process systems were developed [20]-[25].

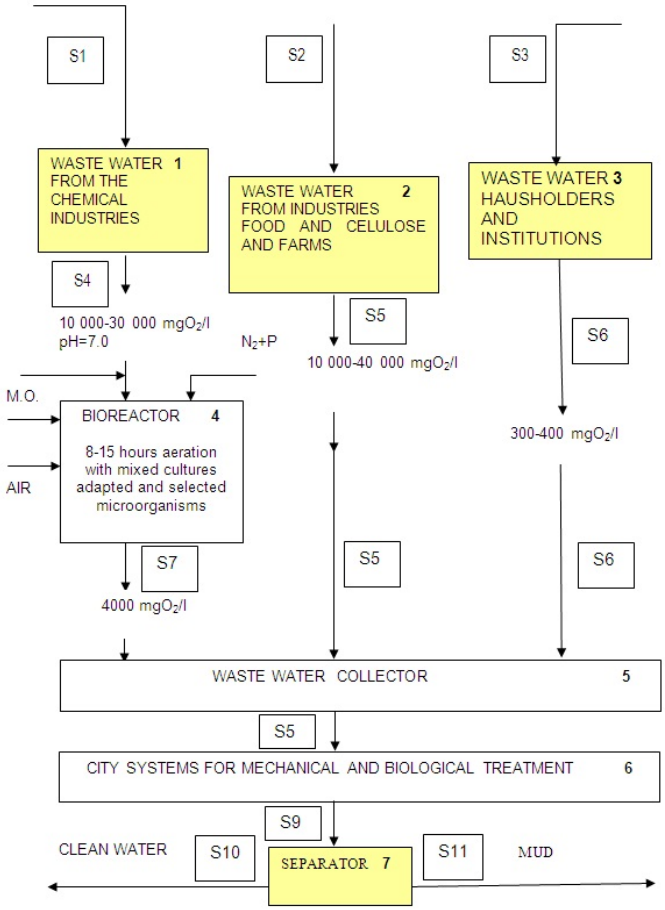

Figure 7. Waste water system evacuation.

Maintenance waste water treatment and evacuation are very important. Safety of the waste water transport system is ecological significant. Because a diagnostic system for risk analysis and supervision of the waste water system is developed. In the safety analysis and operation the simulation getting started with data of the process components. For accident detection the derived model is forecasted the future behavior of the system and risk parameters are determined.

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prevention of the production systems such as in transport systems. A diagnostic systems for supervision and maintaining waste water sewerage systems was developed in literature [1].

Operation makes history database of manipulates and object variables, symptoms and scenarios. Likely scenarios are typically generated by instantiating parameter values in a parametric model according to the given situation. Modelling of the risk parameters were involved uncertain processing.

The level of aggregation is defined by the modular component interconnections which define propagation paths of attributes within the system. Initial research starting by the phase of the development of a conceptual framework which will facilitate the modular specification of models, and second phase the development of a logic framework which will permit object using attributes and simulation techniques to be linked into executable models. The fault event of a system are in the first instance generally formulated in an IF-THEN form. This can be immediately reformulated using the operators AND, OR and NOT in Boolean form, if one can assume that the primary events have only two states existence and non-existence.

System identification involves identification of variables, element and equipment as well as material supplies. System variables are defined in three discret states low, medium and high. The equipment states are defined as blockage and leakage, system state as normal and does not work. Supply exists or not exists. As system variables consider pressure, flow and level.

The considered system consists of 11 waste water streams, four supply streams and 7 process units. A diagnostic system as a support decision system was built. The data base has involved data streams and process units data as well as the basic faults and symptoms which connecting by semantic network (Fig.8).

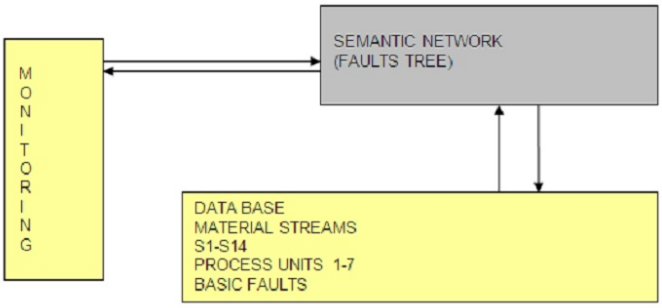

Figure 8. Sucture of the waste water diagnostic system.

The diagnostic system can assist to maintain waste water system safety transport. Waste water evacuation and treatment system safety is ecological very important problem. Fig.8 presents safety information support system, for waste water transport system diagnosis. The problem at hand is a problem of diagnosis, in which a major part of the solution consists of informing supervisor and action.

Such as systems can be used as a plant maintenance aids.

6. Proactive decision of the waste water management

A decision system on the process system which consists of operation and goal parameters was built. In the world mostly systems are used for solving structural problems, and they use retrospective view. These systems are used data from data base and directed to goal, but they have not view in front of and ability for unstructured problems solving. The process system for wastewater transport is unstructured. Goals and assumptions and decision support tools are examined such as events tree.

In recent years the study of systems management has successfully elucidated some basic techniques for generalizing concrete examples to more abstract descriptions [51]-[58]. These include heuristics for generalizing particular data types, candidate elimination algorithms, methods for generating decision trees and rule sets, back propagation of constraints through an explanation tree, function induction, and synthesis of procedures from execution traces [56],[57]. No coherent methodology has emerged for describing and categorizing management techniques to make them readily accessible to potential users. In fact there almost as many paradigms for management as there are systems and the variety of different, evocative, connotation laden words used to describe simple mechanism is one of the biggest problems in mastering the field. The apparent richness and variety of these approaches may give a misleading impression of a field teeming with fruitful techniques, with a selection of well defined methods for tacking and given problem [2]-[4].

From standpoint of knowledge engineering, concept management systems differ in their representation of concepts and examples, ways of biasing the search involved in determining a concept and model. This potential is rarely realized in practice because the field management is in turmoil and few useful general principles have been articulated. A model for decision making generates effective procedural, or rule based from a goal based architecture which further supports the development of secondary goals, as mental models.

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In this paper a model for decision making generates effective procedural, or rule based from a goal based architecture which further supports the development of secondary goals, as mental models.

The most important distinction in a knowledge acquisition framework is how systems represent what they manage. Knowledge representation has always been a central topic in process management [20],[21]. For both inductive and deductive concept the formalism above suggests representing concepts in an appropriately powerful form of logic (Fig 9). However, although formal logic provides a sufficient basis for deduction, as a foundation for induction it is at once too narrow and too powerful. On the other hand, logic is too powerful because the need to acquire knowledge automatically from environment and integrate it with what is already knows means that only the simplest representations are used by pro-

grams for system management. Any one representation will not encompass the broad application of concept management techniques, procedures or expressions composed of functions. These reflect fundamental formulations of computing that have been realized in logic, functional and imperative programming styles. Although equivalent in expressive power, the different representations are more or less appropriate for particular concept management problems, depending on the nature of the examples, background knowledge, the way the complexity of concepts are measured, and the style of interaction with the environment. For example, decision three are naturally represented as logic expressions, polynomials as functions and tasks as procedures. Functional representations incorporate the powerful mathematics available for numbers. Procedures embody the notions of sequencing, side effects and determinism normally required in sequential, real word tasks. There is an obvious overlap between logical and non-numerical function representations. For example, the concept of appending lists can equally well be written in logical and functional styles. The difference is that the logical form expression a pure relation without distinguishing input and output, while the functional representation acts on the input list to construct the output. Many management methods apply to examples that can be expressed as vectors of attributes in a form equivalent to propositional calculus. The values an attribute can assume may be nominal, linear, or tree structured. A nominal attribute is one whose values form a set with no further structure for examples the set of primary colors. A linear attribute is one whose values are totally ordered for example natural numbers. Ranges of values may be employed in descriptions. A tree structured attribute is one whose values are ordered hierarchically. Only values associated with leaf nodes are observable in actual examples: concept descriptions, however, can employ internal node names where necessary. Attribute vectors, propositional calculus are not powerful enough to describe situations where each example comprises a scene containing several objects.

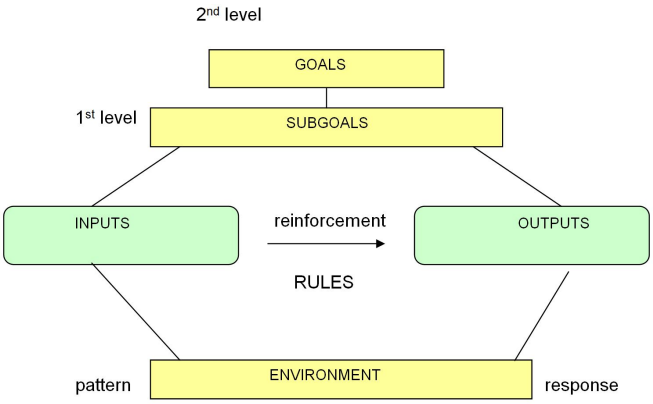

Figure 9. The goal based information system development.

Objects are characterized by their attributes. Moreover, pair wise relations may exist between them. This means that variables must be introduced to stand for objects in various relations.

Such relations can be described by predicates which, like attributes, may be normal linear or tree structured. Objects and concepts are characterized by combinations of predicates.

Functional expressions include many natural laws, as well as relationships between quantities and parameters. Functional representations are appropriate for nested and recursive numeric or non-numeric expressions. Any functional relationship f(x) can be represented in logic and this is no surprise since the two forms are expressively equivalent. But in a framework for induction, it is preferable to treat functional expressions separately and omit explicit quantifiers. An important difference is that functional representations of concepts must be single valued, while logical expressions do not need to be this greatly affects the search space involved.

A more suitable form of representation might be the functional calculus, or some incarnation of it in pure of it in functional programming languages. Work on programming language semantics, also partly based on functional calculus and often coupled with function programming languages may suggest appropriate forms of expressly prohibit aspects that distinguish functional from procedural representations in the framework, namely side effects and reliance in sequential execution. Work on programming language semantics, also partly based on functional calculus and often coupled with function programming languages may suggest appropriate forms of representation. Existing function induction systems are specially designed for particular domains with little attention to more general forms.

Typical concepts in procedures category include procedures for assembly welding, and standard office procedures. The procedural formalism suitable for representing sequential execution where side effects, such as variable assignment and real world outputs like movements, make it vital to execute the procedure in the correct order. To describe a procedural language formally, a binding environment model of execution is needed, instead of the simpler substitution model that suffices for pure functional representations must be deterministic to be useful procedural concepts.

Note the generalization of execution traces into a procedure is not reducible to an equivalent problem involving the generalization of non-sequential input/output pairs as such a reduction will lose information about sequential changes in state.

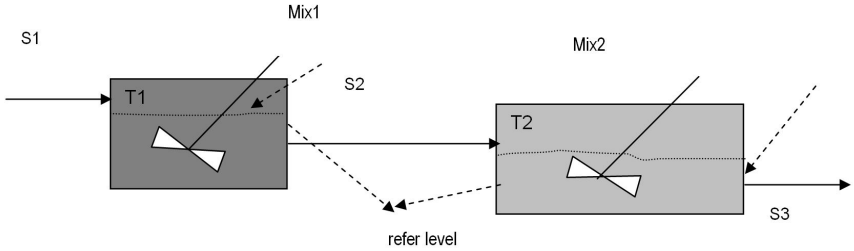

Figure 10. A simple wastewater flow system.

Let consider a simple process system wastewater transport as shown in Fig.10. The system consists of a two tanks, two mixers and pipes.

This system can be represented by qualitative events model expressed by logic algebra, M, B, and L are independent logic variables representing the basic events malfunction, blockage and leakage, respectively.

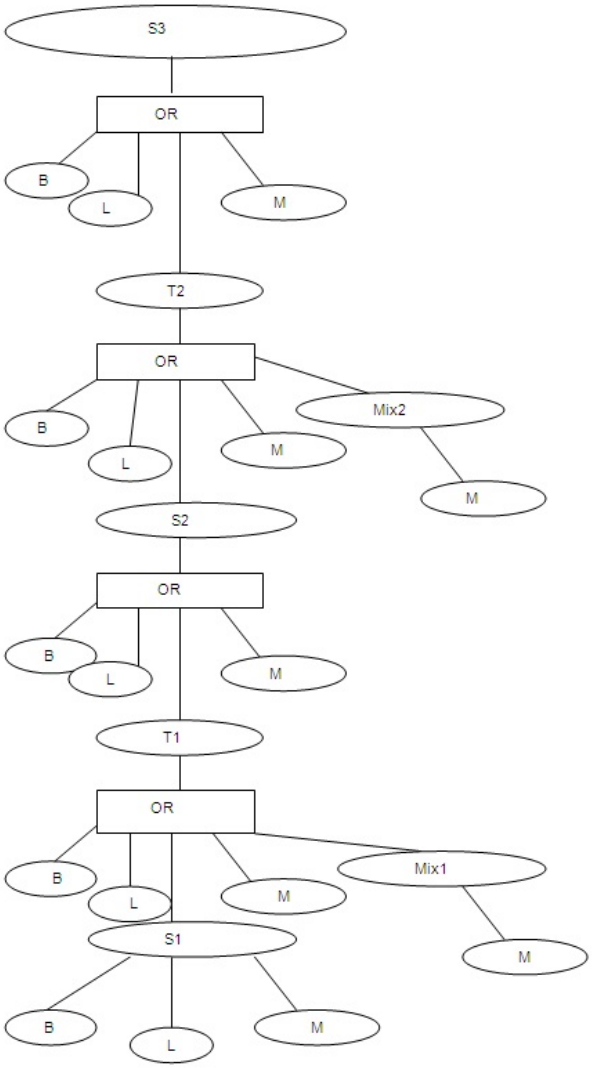

Figure 11. Fault tree diagnostic model.

The study of fault detection and supervision control of the flow system is concerned with designing a system that can assist a human operator in detecting and diagnosing faults as shown in Fig.11.

The two areas of model development and analysis are addressed through the discussion of generic simulation environment. The knowledge based simulation environment is an expression of some control law or cognitive theory. To the extent that the rule base is derived from set of assumptions about the environment and performance expectations, it is a belief system. However, in the existing form, the goals are not expressed and the underlying assumptions are not evident.

When expressed in hierarchical form the relationship that exist between goals and subgoals provide a basis for relating overall goal based system performance to specific assumptions about the variability and contribution of the supporting subgoals. In this form, the belief system is a full expression of some control theory in that the system's relationship with the environment, as expressed in a set of feasible state conditions, can be related either in overall system performance measures to be relationships and the subgoals that manage them.

Knowledge based system must represents information abstractly so that it can be stored and manipulated effectively, although experts have difficulty formulating their knowledge explicitly as rules and other abstractions. They find it easy to demonstrate their expertise in specific performance situations.

Concepts and examples are the output and input of the management acquisition system, what is manage and what is provided by a external agent. To be useful, a framework for representing concepts must provide knowledge engineers with methods for selecting appropriate representations for examples, concepts and background knowledge. Separate representations are required for examples and concepts.

Expert systems can be used to develop rules, based models and augment other types of models. Since can capture the experience, of experts, they can be used to forecast problems, advice, operators, validate data and ensure that the results from other are reasonable.

A functional approach to designing expert simulation systems was proposed many authors. They choose the differential games models is described using semantic networks. The model generation methodology is a blend of several problem solving paradigms, and the hierarchical dynamic goal system construction serve as the basis for model generation. Discrete event approach, based on the geometry of the games, can obtain the solution generally in much shorter time. Cooperation between systems is achieved through a goal hierarchy.

6.1. Decision support system

The distinction between deductive and inductive concept management can be viewed as a modern reincarnation of the long philosophical tradition of distinguishing necessary from contingent truths.

The best way to solve complicated problem by expert systems is to distribute knowledge and to separate domain expertise. In such case, several expert systems may be used togeth-

er. Each of them should be developed for solving a subdomain problem. Here, it is faced the problem of knowledge integration and data management (Fig.12).

Many expert systems can only be used alone for a particular purpose inflexibility. There are lack of coordination of symbolic reasoning and numeric computation, lack of integration of different expert system, lack of efficient management of intelligent systems and capability of dealing with conflict facts and events among the various tasks, being difficulty in modifying knowledge bases by end users other than the original developers.

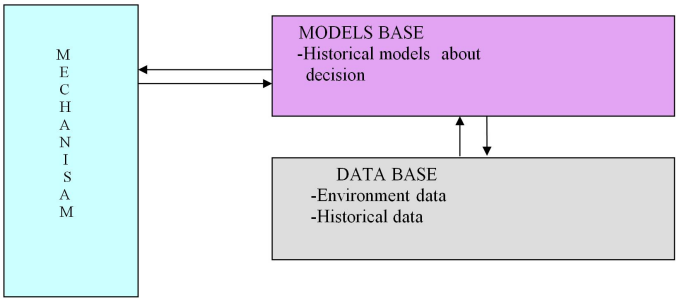

Figure 12. Decision support system building.

A knowledge based decision support system building is consisting from the following steps:

1. Wastewater system and treatment method identification
2. Goals and subgoals definition
3. Rules networking
4. Decision mechanism definition.
5. Monitoring system support

It can be indicated two possible approaches to complex contains modelling. The first, identified with structural knowledge, follows a deductive reasoning approach in which one tries to deduce from an existing theory model relationships for a given problem. The second, identified with a posterior empirical knowledge, follows an inductive approach in which one tries to develop a model from the sampled data. Ideally, these two approaches act as complementary stages of the modelling process.

One follows all six steps with model calibration and model validation serving as an empirical test bed for a prior model as a learning tool. Yet, in some situations characterized by difficulties in obtaining empirical data due to a budget and time constraints or peliminary scope of the analysis, the model specification may be reduced to the a priori stage.

In the traditional view of modelling the behavior of natural system these six steps, although logically connected, comprise separate tasks. Therefore, the development of an operational structure model is a rather lenghty and expensive undertaking. There is a strong need for a

more integrated framework for modelling of system in general that would better link the steps leading to model development and implementation.

The best way to solve complicated problem by management systems is to distribute knowledge and to separate domain expertise. At this, several expert systems may be used together. Each expert system should be developed for solving a subdomain problem and it is faced the problem of knowledge integration and management.

The coordination of symbolic reasoning and numerical computation is required heavily for simulation with expert systems. A few developers tried to develop expert systems with conventional languages. Other suggested to field expert systems in conventional languages, in order to achieve integration. Another disadvantages is that the procedural language environment cannot provide many good features that the symbolic language provides, such as easy debugging allowance for interruption by human experts.

Many integrated intelligent systems are a large knowledge environment, which consists of several symbolic reasoning systems and numerical computation packages. They are under the control of a supervising intelligent system, namely, meta-system. The meta system manages the selection, operation and communication of these programs.

For example, decision support building for wastewater treatment management can outlines in four stages:

1. The physical control of information by computer, which became more complex as the volume of information increased, due to system growth, diversification and government regulation.

2. The management of automated technologies, where the introduction of data processing etc., led to fragmentation and uncoordinated activities.

3. Process system resources management, where data processing, office automation etc., converged along with central and personal computing resources.

4. Technology management, where the physical and technical management of information is integrated with decision making, planning and operations.

Waste water plant operation management support system aimed at helping engineers and managers optimize all phases of process plant design, operations, optimization and process safety. Decision support system is useful for supervision of process plant operations, real - time optimization, advanced interactive control and process hazard analysis. Some techniques are very important for implementing and evaluating decision support systems which expand such diverse areas as computer supported cooperative work, data base management, decision theory, economics, mathematical modeling, artificial intelligence, user interface management system and others [25].

Decision support system principles, concepts, theories and frameworks develops methods, tools, and techniques for developing the underlying functional aspects of a process plant management support systems, solver/model management in plant operation support sys-

tems, rule management and artificial intelligence in process plant system coordinating a plant management systems functionality within its user interface.

Decision of wastewater treatment process design and operation support system interfaces develops methods, tools, and techniques for developing the overt user interface, user knowledge, help of a facilities, coordinating interface event, with its functionality events.

Wastewater plant operation decision support system impacts shows economics, system measurements, decision support system impacts on individual users, multi participants users, evaluating and justifying.

A process plant management system was considered in papers [47]-[57]. Plant management decision support systems was studied in the paper [58]. Process plant information system and process safety management support system were investigated in the paper [5], [4],[17],[18].

The computer supported cooperative work with data base management and mathematical modeling and simulation of process plant provide intelligent plant management support. The model plant operation manager workflow is shown in Fig. 12. The plant manager workflow can be used for the new product quality improvement, the model operation network optimization and generating new data and specified tools. Real-time software need to build intelligent process management applications.

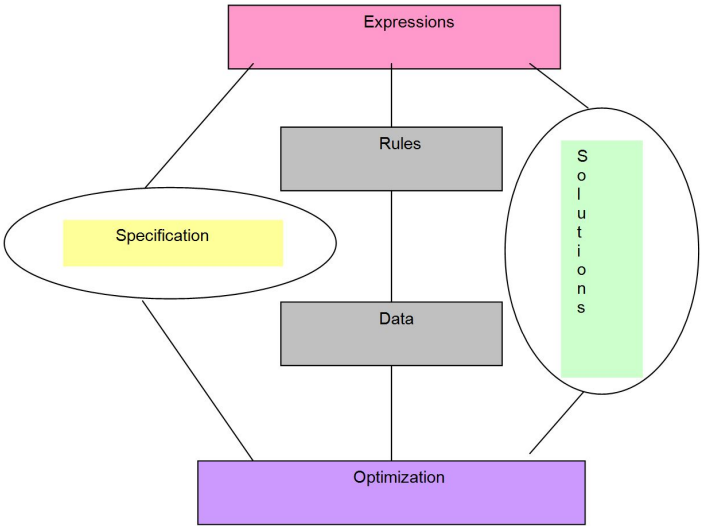

Figure 13. Management activities optimization.

Automatically create process operation models requires a windows based software tool for system identification which claimed to enable users to automatically create high fidelity models of physical systems, processes and plant.

System identification is technique that creates model of a plant operation process from input and output data, eliminating the need for detailed knowledge of the system physics. The new software automated the process, enabling engineers to perform modelling and simulation studies without having to create the underlying mathematical models from first principles.

Advanced commercial simulation systems also come, with in intelligent graphical user interfaces, which speed the development of error-free simulation problems and provide some help with thermodynamics and modelling.

Model operation manager shows how do you seek out a new way to create process operation, how do you model the plant life cycle and how do you make plant operation history in the process waste water treatment. A model plant manager is given by eq.(12).

$$MM = \sum_{i}^{n} M_i < T, P, A, F, E, Q(T), Q(P), Q(A) Q(F), Q(E) > \tag{12}$$

where T – set of elements, P-set of syntax rules, A –set of expression, F- set of

semantic rules, E - set stochastic events, $Q(J), J=T,P,A,B,E$ changeable functionality, M_i- operation model and MM-management model.

In the process operation and control safety models "What if " help to build intelligent process management applications. They shoot stochastic events a day to day. It is improves plant operation reliability.

Process waste water operation involves sensitivity analysis of manipulate and object variables, parameters estimation, noises identification, dynamic simulation, detect process disturbance before they cause significant disruption (Fig.14).

Waste water treatment optimization provides optimal process condition, equipment services life, troubleshooting, advanced process control and minimization.

Superior customer support requests model evaluation. This future model is called "asses and control" as shown in Fig. 15. Where asses means:

- uncertainties not currently amenable to mathematical solution,
- people involvement, and
- advanced technologies support people

and control means:

- must work automatically,
- uncertainties can be handled rigorously,
- people eliminating, and advanced technologies support automatic operation.

Inherent softness exists in product pieces and forecast demands. In this frame it will throw lots of technology at these uncertainties or soft areas expert systems, neural networks, data reconciliation etc.. However, these will support people decision to prevent abnormal situation management, not replace the people.

Also, user can make a new overview this spreadsheet and printout. User can make input data tables, tables of consumption's and tables of flow rates.

6.2. Database management

User can make different waste water plant database models. From the result summary user can extract and flow rates, conditions and consumption. If user whishes to see input and output streams results between stages should to mark on the appropriate block. When block menu appeared, select stream results for retrieval material and energy balances.

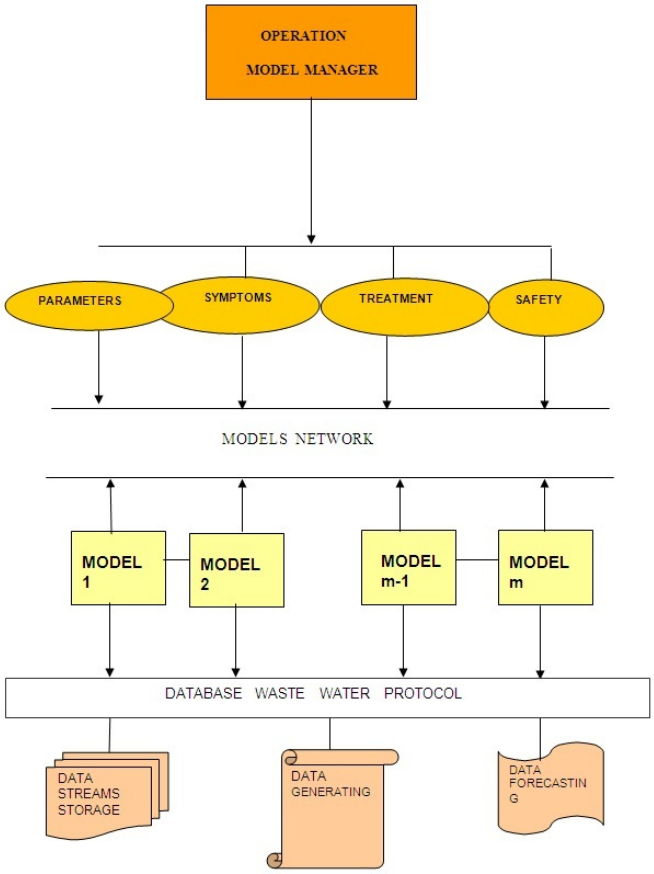

Figure 14. The wastewater operation model manager.

Databases protocol manages all databases, reports and tables. These tables could be distributed and extracted by multimedia databases. User can build hierarchical and relational process plant data bases for the plant management in concurrent operations (Fig.14).

The networks optimization requests maximum product capacity, minimum costs, concern the assignment problem, the matching and the minimum spanning trees, computer implementations and heuristics.

Process hazard analysis creates a resource allocation model by linking risk with cost and database of the values of basic events. In order to predict complete life cycle of the plant the plant life cycle reliability and the life cycle of the cost should be included.

Policy modeling emphasizes formal modeling techniques serving the purposes of decision making. These systems Computer aided process engineering-CAPE, Computer aided control-CAC, Computer integrated manufacturing-CIM, Computer aided safety-CAS make distributed computing.

The use of mathematical models to support decision making is proliferating in both the public and private sectors. Advances in computer technology and greater opportunities to learn the appropriate techniques are extending modeling capabilities to more and more people.

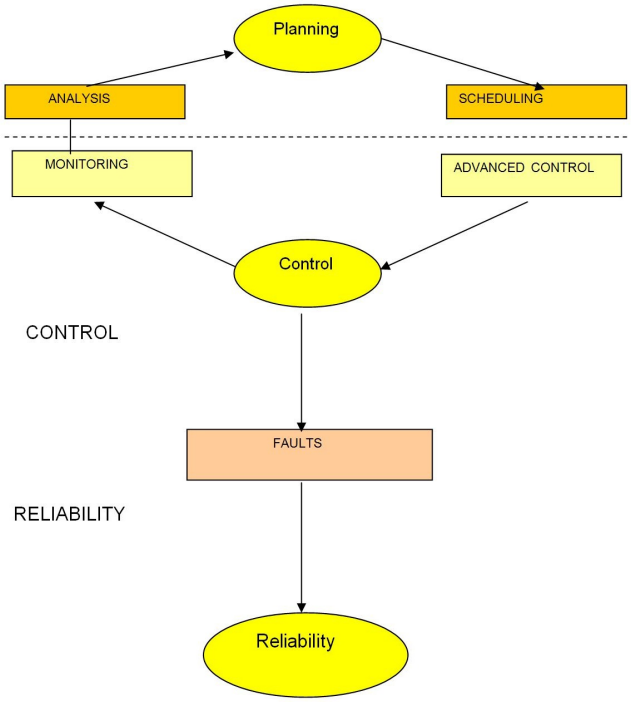

Figure 15. Asses, control and reliability.

As powerful decision aids process operation models can be both beneficial and harmful. At present, few safeguards exist to prevent model builders or users from deliberately carelessly, or recklessly manipulating data to further their own ends. Perhaps more importantly few people understand or appreciate, the harm can be caused when builders or users, fail to recognize the values and assumptions on which a model is based or fail to take into account all the groups who would be affected by a model's results.

Simulation manager models provide a setting for dialog and show the need to continue and define a vocabulary for exploring process operation. It will become increasingly important for model builders and users to have a clear and strong code to guide process plant operation.

The computer supported cooperative work provides explanation based process learning systems. As a cooperate function training is a subsystem within the plant's large organizational system. When training strategies ensure acquisition of knowledge, skills and attitudes which results in improved performance or safety on the plant operation, the training subsystem makes a positive contribution to organizational goal and effectiveness. Process performance, then, is the criterion of success in training.

7. Notation

A-set of expression

c-concentration, mg/L

F- set of semantic rules

k-specific constant

M-model

MM-model manager

P- set of syntax rules

Q- function

T- set of elements

X-equilibrium amount loading

8. Index

i - component

9. Abbervation

COD-contaminants oxidative degradation

AOX- adsorabable organic halide

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