

Water Treatment and Quality

Water Quality

As requested by CNA's SGT, infield measurements were made in order to determine the efficiency of the water evaporation control product known as *Water\$avr*. The infield testing campaign, which lasted one month, took place in the Las Escobas dam, in Tamaulipas, which has a reservoir spanning 4.4 ha. Evaporation measurements were made using two methods: direct measurement by turbulent correlation and the classical measurement in type "A" evaporimeter tanks. For the first method, tests were run without the product during the first two weeks. It was then applied at the dosage recommended by the manufacturer for the following fifteen days. As for the second method, two evaporimeter tanks were used: a control tank without the product and the other one with the *Water\$avr* product applied every other day according to the

manufacturer's specifications. The results obtained with the turbulent correlation method showed an evaporation reduction of 4.1%, which is not significant, since the manufacturer of the measuring equipment reports uncertainties of up to 10%. By applying the product in evaporimeters, the evaporation reduction efficiency averaged 9.4%. Water quality in the reservoir was not affected by adding the product, and toxicity tests applied to organisms such as *Selenastrum capricornutum*, *Vibrio fischeri*, and *Daphnia magna* were negative. In this case, the product failed to produce the 30% evaporation reduction claimed by the manufacturer.

IMTA offered consulting services to CNA's SGT on the adaptation and implementation of a quality system to comply with the standard NMX-EC-17025-IMNC-2000 *General Requirements for the Competence of Testing and Calibration Laboratories*, for four of its regional laboratories (Central Gulf, Northern Gulf, Northwest, and South Pacific). SGT's personnel was trained on the standard and on the analytical quality control applicable to the tests they perform. Once the quality system was implemented in the daily activities of the laboratories, their readiness to receive an evaluation visit from EMA—and eventually obtain the accreditation—was verified.



DEVICE FOR THE MEASUREMENT OF EVAPORATION THROUGH TURBULENT CORRELATION

Hydrobiology and Environmental Evaluation

Salvinia molesta is an exotic species recently introduced in Mexico by water coming from the Imperial Valley in California, which currently in-



SALVINA MOLESTA INFESTATION IN LAS ILUSIONES LAGOON



SAMPLING FOR WATER QUALITY TESTING USING BIOLOGICAL INDICATORS

vades Irrigation District 014, Río Colorado, B.C. Since its detection in 1999, its effective control and management has not been achieved. Likewise, another *Salvinia* species was detected in the Las Ilusiones Lagoon, in Tabasco. In order to deal with the problem generated by this aquatic weed, IMTA started a project for the determination of control agents. An insect specific to the weed was identified during the first stage of this project: *Cyrtobagous salviniae*, from the *Curculionidae* family. A colony of this coleopteran was donated to IMTA by the US Department of Agriculture and introduced in the country with the authorization of the Mexican Directorate General for Vegetal Health. Using inspection and quarantine tests and entomopathogen analysis, healthy colonies of *Cyrtobagous salviniae* were obtained, with the third generation currently being used for mass-breeding this insect. There are currently 546 healthy insects for the biological control of the weeds, as well as two species of phytopathogens: *Curvularia* and *Fusarium*, which are being laboratory tested to determine their specificity.

Upon request of CNA's SGT, the Institute transferred a method for assessing water quality using biological indicators. To this end, thirty specialists from laboratories of the 13 CNA regional offices were trained. The theoretical and practical training took place both at IMTA facilities and at five regional offices: Balsas, Northern Gulf, Yucatán Peninsula, Central Gulf, and Southern Border. The rivers selected to apply the methodology

were: Apatlaco, Morelos; Guayalejo, Tamaulipas; Candelaria, Campeche; Los Pescados, Veracruz; and Cuxtepeques, Chiapas. These methods can be used to assess water quality, and constitute a more economical and more simple contamination detection tool than conventional analyses. Using them together with the latter, they can provide comprehensive biological and physicochemical information of contamination problems affecting rivers. Also transferred to the five regional offices was the necessary equipment to perform the analysis in order to incorporate this methodology to the National Monitoring Network of the National Water Commission.

The contaminant dispersion of the submarine outfall of BASF Mexicana, S.A. de C.V., in the coastal zone of Tamaulipas, was evaluated. The evaluation was made by applying physicochemical, microbiological, heavy metal, organic compound (such as polycyclic aromatic hydrocarbons, organochlorinated pesticides, and volatile and semi-volatile organic chemicals), BTEX, and toxicity analyses. A total of 93 parameters were analyzed, and the results showed full compliance with the standard NOM-ECOL-001-1996. As for the Water Quality Ecological Criteria for seawater (CE-CCA-001/1989), only the ammoniacal nitrogen and nitrite values of the compound sample are beyond the maximum permissible limit of 0.01 and 0.002 mg/l, respectively. The toxicological evaluation showed that the discharge does not cause acute or chronic adverse effects on

tested species according to the standardized protocols applied. It was recommended that the outfall be continuously monitored to ensure its compliance with the corresponding standards.

PEMEX Refinación requested the characterization of sediments in the influence area of the discharge of its Salamanca, Guanajuato plant. Due to the fact that there are no reference values in Mexico, the results were compared with the *Canadian Sediment Guidelines*. Some organic compounds were detected to have higher values than the limits established in the guidelines. These compounds included phenanthrene, fluorene, naphthalene, and anthracene. The metals detected in high concentrations in the influence area were lead, vanadium, chromium, and cadmium. The impact of industrial wastewater discharges from Teckhem, PEMEX, CFE, and clandestine discharges, as well as those from Salamanca, Guanajuato, in the area evaluated, and that affect the quality of sediments, results in an anthropic enhancement of close to 64 times the antecedent value for cadmium, with a geoaccumulation index of 4. The area showed significant organic contaminants since before PEMEX's discharges, presumably from diffuse sources. Due to the characteristics of the study, the evaluation corresponds to contamination accumulated in the medium term, detecting organic and inorganic compounds that affect the quality of the sediment, and that, by a process of resuspension and mobilization of the contaminants adsorbed to the sediments, may become part of the water column.



SAMPLING FOR WATER QUALITY TESTING USING BIOLOGICAL INDICATORS

Water Treatment

As per request of CNA's SGC, the operation of the Clean Water Program was evaluated for the fiscal year 2002. The most striking result was a 14.7% reduction, with respect to 2001, of the nationwide morbidity rate due to gastrointestinal diseases, with 6,035 cases per 100,000 inhabitants. The aforesaid notwithstanding, the program faced, among others, the following problems: early in the year, the lack of funds did not allow for the supply of chlorine in 28 states, a situation not remedied until July, which caused the disinfection rate to drop from 75% in 2001 to 63% in 2002; there was not a continuous supply of chlorine, specially in those communities farthest from municipality head towns; residual chlorine is measured by visual comparison methods, which are quite inaccurate, so IMTA suggested substituting them by digital equipment; the states lack planning for including the different municipalities in the program, nor do they have mechanisms to follow up supports, and water offices are located in municipal head towns, leaving secluded communities with no access to information related to the program. Since the SSA, through the Opportunities Program of the Federal Government, gives monthly informative lectures on potable water, health, sanitation, and reproduction in all visited communities, it was recommended that the diffusion of the Clean Water Program become this ministry's responsibility.

By petition of the Potable Water and Sanitation Municipal Board of Mazatlán, Sinaloa, IMTA made the functional design for a water treatment plant to remove iron and manganese. To that end, treatability tests were developed, where iron and manganese removal efficiencies were 93% and 92.5%, respectively, with a filtration rate of 12 m³/m²h. In addition, the reference terms and the bidding bases were made for the development of the draft and executive projects, the construction, and the startup of the El Crestón wastewater treatment plant. Special considerations were included, such as odor control, the use of salinity- and corrosion-resistant equipment, special structures in case of earthquakes and



AIR CONTENT IN WELL WATER FROM THE PEÑÓN-TEXCOCO BRANCH IN THE STATE OF MEXICO

hurricanes, the maximum utilization of current installations, and the limitation of existing space for the horizontal growth of the plant.

By request of CNA's GRAVAMEX, IMTA evaluated the water treatment plant of the Peñón-Textcoco branch in the State of Mexico, which has some operation problems due to the presence of sand and gases in the filtration beds. It was found that both problems stem from the system's wells. The evaluation started by determining the gases in the wells, and it was found that in most of them there is dissolved CO₂, except in well No. 2, where there is dissolved air. The presence of dissolved air was controlled by putting well No. 2 out of operation, while in order to remove the CO₂ a multiple-tray pilot aerator was used. This made possible to obtain 89% removal efficiencies. The aeration system was designed based on the results. It is comprised of two desorption modules, each one comprised of five 23.4-m² square trays. The bottom of the trays will be a mesh with a 15-cm-thick bed of red volcanic rock. As for the removal of sand, two options were analyzed: the installation of hydrocyclones before the desorption units and a rectangular sand trap after them. In order for the plant to function efficiently while the final modifications were made, temporary measures were established.

As requested by Servicios Industriales Peñoles, IMTA carried out the first stage of a multiannual study on the disinfection of water for human use and consumption using three silver-based systems:

ionic silver, copper-silver ions, and hydrogen peroxide-silver ions. Different silver neutralization systems were tested in order to validate the method for reducing the effect of disinfectants during the time between the sampling and the bacteriological analysis. The controlled decay to pH and temperature curves showed that doses of 0.02 to 0.08 mg/l are sufficient to eliminate up to six logarithmic units of total heterotroph bacteria, total coliforms, and *Escherichia coli*. This allows to comply with national standards for bacteriological parameters and the maximum permissible limit for silver (0.1 mg/l) in packed or bulk water and ice for human use and consumption.

Wastewater Treatment

Petroquímica Pajaritos, S.A. de C.V. requested IMTA to characterize and quantify the flow of the discharges generated by each of the production processes, as well as all the discharges from oil, chemical, and storm drains, in order to determine their contamination degree and define the feasibility of their treatment, either jointly or individually, so as to comply with the standard. It was found that the discharges of used soda ash from the production of ethylene and that from the incinerator of the vinyl chloride production process, require an individual treatment prior to a general treatment. Thus, an acidification-desorption and chemical oxidation system was proposed for the first case, and neutralization and evaporation for the second one. For the final effluent, an aerobic biofiltration system is proposed. At the same time, it was determined that the general oil drain does not comply with the particular discharge conditions due to its high temperature and grease and oil concentration. In addition, the chemical drain does not comply either due to the presence of 1,2-dichloroethane and the high concentration of grease and oil, while the storm drain also fails to comply due to the presence of 1,2-dichloroethane.

The Ing. Héctor R. Lara Sosa refinery, located in Cadereyta, Nuevo Leon, processes two hundred thousand barrels of crude oil per day. Dur-



DISCHARGE FROM THE CHEMICAL DRAINAGE
IN PETROQUÍMICA PAJARITOS, S.A. DE C.V.

ing its refining process, it generates effluents with a high content of hydrocarbons, greases, and oils, which reach their treatment system. The initial phase of its pollutant load needs to be reduced to avoid contamination risks in the drains. Consequently, a CPI-type oil separator will be installed in order to optimize the hydrocarbon, grease, and oil recovery process. In order to produce an adequate design of the separator, it is

essential to have a correct characterization of the effluent to establish the design bases of the CPI. Thus, this project consisted in such characterization, and in the analysis of the results of the physicochemical tests carried out in plants one and two of the refinery. Four monitoring campaigns took place, where the measured flow ranged between 1.2 and 28.1 l/s. The results of natural flotation tests show that for concentrations as high as 1,500 mg/l of greases and oils there is a removal rate of up to 90%, with floating velocities of 2.3 m/h and a residence time of 60 minutes. If the concentration drops to values around 200 mg/l, grease and oil removal rates could also drop, reaching only 65 per cent.

The original proposal and the modifications suggested in the integrated sanitation plan of the Veracruz Bay was evaluated for the Metropolitan Water and Sanitation System of Veracruz-Bocadel Río-Medellín, Veracruz. Using the *CAPDET* computer program, which simulates the functioning of the treatment infrastructure, the investment, operation, and maintenance costs of the new plants, as well as the operation and

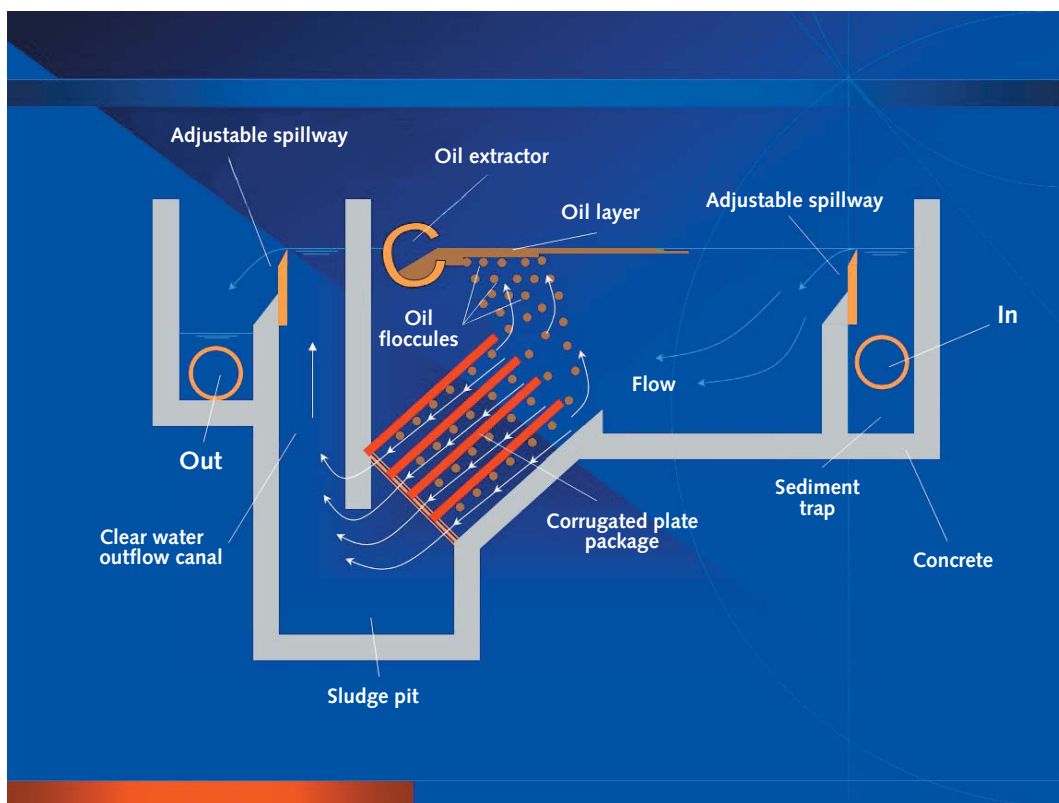


DIAGRAM OF A CPI-TYPE GREASE AND OIL SEPARATOR

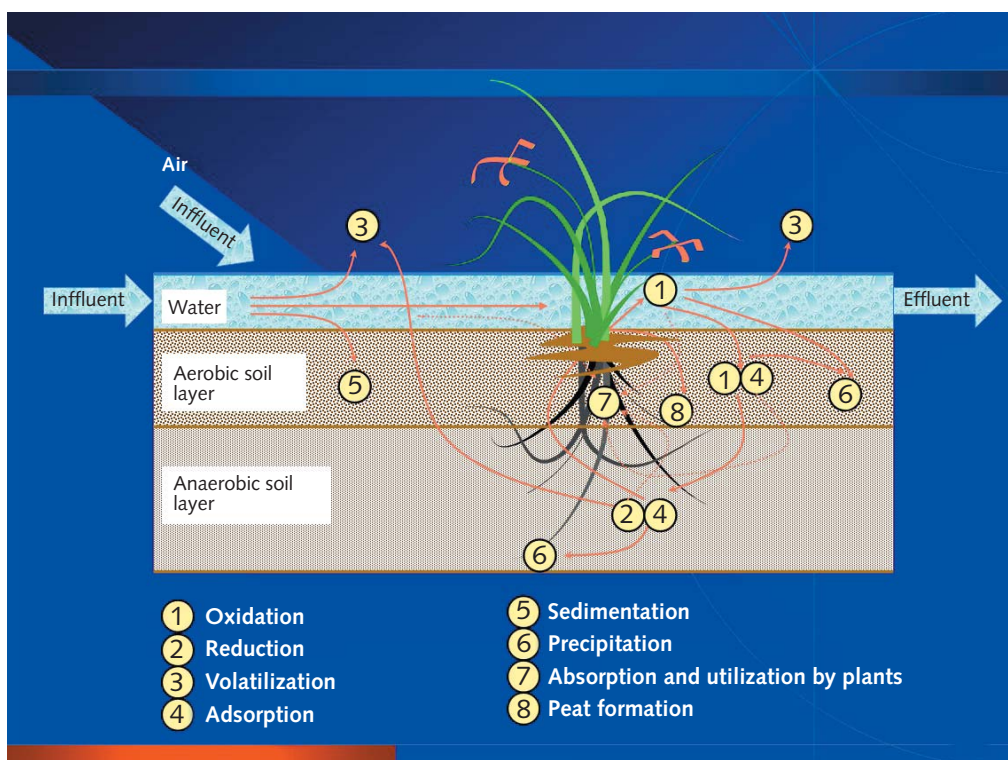


DIAGRAM OF REMOVAL MECHANISMS IN A WETLAND

maintenance costs of the existing plants were determined. Two alternatives were compared: the decentralized system, which consists of the use of the current treatment infrastructure plus the construction of additional small plants and the construction of a major work called *Planta Sur*. The area required for the construction of the *Planta Sur* varies from 6 ha, if a percolator filter is used, to 18 ha, if aerated lagoons are used. The surface required for the decentralized system varies from 3.88 to 6.72 ha. The cost of the cubic meter of treated water for *Planta Sur* varies from \$0.24 to \$0.77, depending on the biological process used. In contrast, the estimated cost of treated water in rehabilitated plants ranges from \$0.36/m³ for a 100-l/s plant to \$0.80/m³ for a 30-l/s flow, depending of the activated sludge process used. At present value, investment, operation, and maintenance costs of *Planta Sur* are lower than those of the decentralized system: \$0.219 per cubic meter.

Within the framework of the agreement entered into by IMTA and the Gonzalo Río Arronte Foundation for the environmental rehabilitation of the Lake Pátzcuaro watershed, sev-

eral activities are being carried out for the sanitation of the lake by using wetlands for wastewater treatment. In this regard, 18 wastewater discharges were located along the river bank and visited in field. In five of them, located in the municipalities of Erongarícuaro, Tzintzuntzan, Quiroga, and Pátzcuaro, Michoacán, the discharges were characterized and the functional design and executive project of the wetlands were developed. Furthermore, functional designs and executive projects were developed for model wetlands for single-family households and for one-hundred-, two-hundred-, five-hundred-, and one-thousand-strong localities, and an operation and maintenance guide identifying the localities where this design can be used was written.

In addition, the locality of Cucuchucho, Michoacán, was chosen for the installation of an experimental 0.5-l/s wetland. For this purpose, the discharge was characterized, the functional design and executive project were developed, and the operation and maintenance guide was written. The wetland is currently in the installation stage.