Environmental Science in the Salt Industry

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ABSTRACT

The current maze of complex societal problems has given rise to sober questioning of the contribution of science and technology to society. Reflecting this concern on a global scale, the nations of the world assembled in Stockholm last June to focus attention on the urgent necessity for man to find more intelligent ways to manage the world. Concerned public and private groups have succeeded in igniting debate on the "world problematique" in hopes of reversing current threats to life support systems of mother earth.

This paper deals with salt industry efforts to seek and apply interdisciplinary knowledge to problems which bear importantly on the societal science interface. The position is taken that technological advances do not move inexorably toward a doomsday world, but rather that science and technology is competent to deal with physical problems of the environment once man's value systems have determined which amenities of life should be preserved.

The position is also taken that the salt industry and its member companies are eager to maintain their vitality in ways that contribute positively to improving present methods of earth tending.

INTRODUCTION

Environmental science in the salt industry contains many of the elements found in professional ice hockey. Those of you familiar with this exciting and fascinating sport know the first rule of hockey is to keep your eye on the puck. Especially does this rule apply to goal tenders. Companies earning their living in the salt business are much like goalies in hockey. They find themselves playing the role of earth tenders in a fast moving game whose outcome is still in doubt. Concerned about the deteriorating quality of life encountered almost everywhere, yet unlike the goal tender in hockey, they find it difficult to keep their eye on a moving target. Environmental standards and the field of pollution abatement have been aptly described as a moving target. This is so because current standards are extensive, complex and still evolving.

The sense of urgency which came with recognition that a definite interplay of forces exists between man and the bio-community of which he is a part, has generated a new awareness and sensitivity that mother earth does indeed hold man accountable for behavior in the natural order. The economic impact of pollution abatement on the salt industry pales by comparison with problems in other fields, notably energy production, the manufacture of paper and chemicals, to name a few. One paper company reports allocating $55 million to abate air and water pollution at a single plant. Only two companies in the salt business have annual gross sales exceeding this figure. Nevertheless, the impact on salt has not been inconsequential. It has placed an added burden on an industry presently experiencing a serious cost/price squeeze. By and large, the industry has responded well to the challenge. In some instances the response has involved the imaginative adoption of new production processes hitherto unknown to the industry. Later in this paper examples will be cited.

ENERGY AND ENVIRONMENTAL ISSUES

The environmental conservation issue, without question, is one of the major issues facing the salt industry today. Its impact has already been felt on two fronts. On the one hand, production facilities must continue to apply expensive control technology to meet current and

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proposed regulatory standards. On the other hand, increased public concern regarding end uses of salt has slowed the amazing growth in dry salt markets which began in the late 1950s.

Because energy and environmental issues are closely interrelated, a change in one has immediate and significant repercussions in the other. Thus, any review of environmental matters must necessarily encompass the current national energy shortage. Every major energy source imposes some environmental penalty. Natural gas is the cleanest fuel available, but dwindling supplies, coupled with the high cost of gas supplements, inhibit the substitution of gas for other fuels. Both coal and oil present a major problem in sulfur dioxide control. It is possible to minimize the problem by burning low sulfur fuels. It is also possible to remove sulfur before and after burning. Whether the cleanup or low sulfur approach is taken, costs are substantially higher than for present fuels. The cleanup cost to remove particulates and sulfur has been estimated at 30¢/MM Btu for coal and 20¢/MM Btu for fuel oil. No estimates are available for removal of nitrogen oxides. They remain a major concern, but the best presently available technology is inadequate to remove NOx from stack gases. The Federal Power Commission has estimated that electric generating costs will increase about 40% through 1990 (in constant dollars). Crude imports from the Middle East have risen 40% since 1970 and provision is built into current agreements to escalate 10% per year until 1975, at which time current OPEC agreements expire.

What are the implications of the energy crisis for the salt industry? The price of all fuels is expected to rise substantially. Most severely affected will be fuel intensive methods of salt production, namely vacuum type evaporator operations. Least affected will be solar and rock mining facilities, and in the order given. Those evaporator plants sited close by major oil and gas supplies or a source of waste heat will, in the short term, at least, consider themselves fortunate. However, it is likely that emerging National Energy Policies, domestic and foreign, will, in future, discourage the use of natural gas for industrial fuel purposes in the interests of conservation. Hence, coal and oil, with their attendant cleanup costs, remain the primary fuels for salt production, solar energy excepted.

What does the future hold? The Federal Water Pollution Control Act passed by Congress in October, 1972, will materially affect the use of industrial salt. The Act requires that all industrial discharges into public waters must use the "best practicable" technology by July 1, 1977, and the "best available" technology by July, 1983. The goal for 1985 is zero discharge.

Conventional sewage treatment plants are not designed to remove chlorides. Therefore, continuing efforts are likely to be made to find substitutes for salt and more attention will be paid to recycling existing supplies.

Let us now examine what has been and is being done within the industry to contribute positively to present methods of earth tending.

THREE PRINCIPAL TYPES OF SALT

Three principal types of dry salt (sodium chloride) are produced in the world today. Classification is made according to the method adopted in recovery. In their order of world importance and ranked by output in tons, the recovery methods are:

1. Solar evaporation of brines.
2. Mining and quarrying of rock salt deposits.
3. Evaporation of brine in vessels.

For the purposes of this paper, each of the principal recovery methods is examined and an attempt is made to assess their impact on the ecosystems which support them and which they, in turn, serve. System inputs and outputs are identified and catalogued. In a typical salt plant, whether rock, evaporated, or solar, a flow of raw and processed materials is required to sustain the operation. Each of these components brings with it certain elements which must be controlled in order to meet cost and product quality standards. In the past decade, an important new element has surfaced to challenge, the old values and demand an increasing share of corporate attention. It is doubtful if one could find in the United States today an industrial enterprise which has not encountered the growth of public and private environmental concern. Thus, in addition to contending with cost and quality considerations, salt producers are keenly desirous to eliminate or minimize societal damage by adopting a more sophisticated approach to plant operations. Let us now look at the first of these primary methods of salt recovery.

SOLAR SALT ENVIRONMENTAL CONSIDERATIONS

To produce solar salt and successfully meet the needs of the marketplace in the '70s, certain physical elements are essential.

1. A supply of fresh, unpolluted sea water.
2. A favorable climate; hot, dry, windy weather.
3. Relatively inexpensive land; substantial acreage is needed.
4. Suitable topography: flat impervious land for salt ponds.

On the Island of Bonaire, each of these key factors was present and together they persuaded the management of International Salt Company to proceed with the construction of a solar salt plant. The agreement ratifying this decision was signed with the Netherlands Antillean Government in April, 1966.

In December, 1965, a monograph was published in

Holland by the distinguished Dutch biologist Jan Rooth on the habitat of the flamingos on Bonaire. In an introduction to Mr. Rooth's book, The Committee of the Foundation for Scientific Research in Surinam and the Netherlands Antilles expressed concern for the future of these colorful, stately creatures which have captured the imagination of bird lovers around the world. The committee stated, and I quote:

> "We hope that this book will contribute towards the protection of these birds . . . now that the flamingos are facing a real threat as a result of interest in the development of the salt industry in South Bonaire. The value which is attached to their preservation is evident inter alia from the fact that The World Wildlife Fund has included the protection of the biotope concerned as Full Project No. 102 (Flamingo National Park, South Bonaire, Netherlands Antilles) in its so-called 'Green Book,' an inventory of the world's threatened nature areas which are worthy of preservation."

To those unfamiliar with the geography of the area, Bonaire, along with Aruba and Curacao form the Leeward Islands group of the Netherlands Antilles. Figure 1 shows the Island of Bonaire in relation to the Leeward Islands group.

When International Salt Company decided early in 1966 to proceed with the construction of a solar salt facility on Bonaire, company officials determined to take all necessary measures to protect and preserve the flamingo colony. A number of meetings were held to decide on special means to protect the birds during construction and operation of the salt pans. Ornithologists, historians, biologists, engineers, government and company officials deliberated on how to best design and construct a modern salt plant without disturbing the natural habitat of this magnificent species. Experts now feel that the birds are adequately protected by the special measures undertaken by sensitive and enlightened planning of salt company management.

The location of the solar salt works and the flamingo sanctuaries at Goto Meer and Pekel Meer are shown in Figure 1. Notice the southern sanctuary is located within the concentrating ponds (Fig. 2). To encourage the birds to inhabit the salt ponds, the following measures were decided upon:

1. Nesting sites at the Pekel Meer were not disturbed. Construction machinery, vehicles and low flying aircraft are forbidden to disturb the Pekel Meer nesting sites.
2. An experienced brine biologist was retained to study plankton and bottom dwelling organisms, nutrient minerals and topography of the site.
3. Human disturbances to the birds were minimized by restricting entry to persons on company property.

An interesting consideration in these days of concerned environmentalists is the manner in which the flamingos themselves arranged to pay the costs of maintaining the sanctuary. The birds nest, feed, preen and reproduce in the concentrating ponds. Being natural advocates of the principal of recycling, the birds play an important role in supplying valuable amounts of nitrogen and phosphorus. These minerals stimulate the growth of algae which, in turn, provides a protective mat type seal preventing the concentrating brine from seeping through pond bottoms. Hence, the birds are encouraged to feed in the salt ponds because they do in fact contribute to the economy of operation.

Solar system inputs

1. Energy —Solar energy is the primary fuel.
   —Electric power, diesel fuel and gasoline are secondary sources.
2. Seawater—A supply of fresh, unpolluted ocean water.

Solar system outputs

1. Sodium Chloride—Solar Salt.
2. Bitterns—Concentrated brine containing impurities removed during the evaporation process.
3. Waste Heat—Engine exhaust from harvesters and loaders (minor).
4. Noise—Engines, stacking and loading belt conveyors (minor).
5. Air Pollutants—Engine combustion products (minor).

Rock salt environmental considerations

The second principal method of salt production is the mechanical mining of rock salt. Underground mining is the leading method of dry salt recovery employed in the United States and Canada. At ISCO's Retsof, New York mine, a number of environmental conservation measures have been adopted.

1. Outdoor stockpiles are covered.
2. Industrial type gas fired incinerator handles waste solids, i.e., paper, wood.
3. Dust collectors—Dry collectors are used to curb brine wastes.
4. Exhaust scrubbers—Oxy-Cat scrubbers are employed on all underground diesel equipment.
5. Air monitoring—Mine air is monitored daily for NOx. Air flow readings are taken quarterly to check adequacy of mine ventilation.
6. Fire protection—An automatic CO_2 system has been installed in approved oil storage areas. A sprinkler system protects the ammonium nitrate storage area.

Rock system inputs

1. Energy—Electric power, fossil fuels (fuel oil, diesel oil, gasoline, LPG).
2. Blasting agents—ANFO, dynamite.
3. Water—Process, potable.
4. Packaging materials—Multiwall paper and polyethylene bags, corrugated.

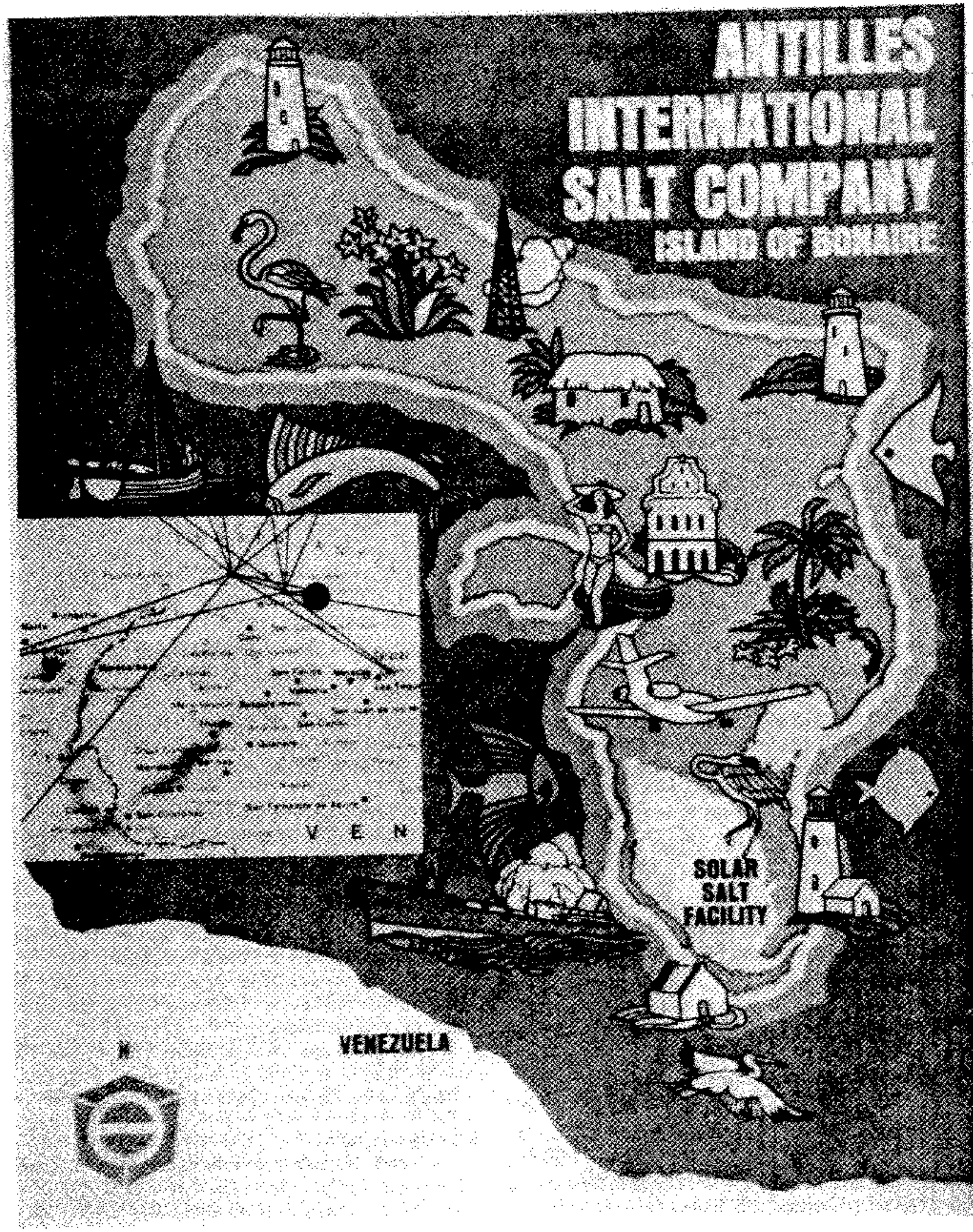

Figure 1. Location of Solar Salt Facility and Flamingo Sanctuaries, Island of Bonaire.

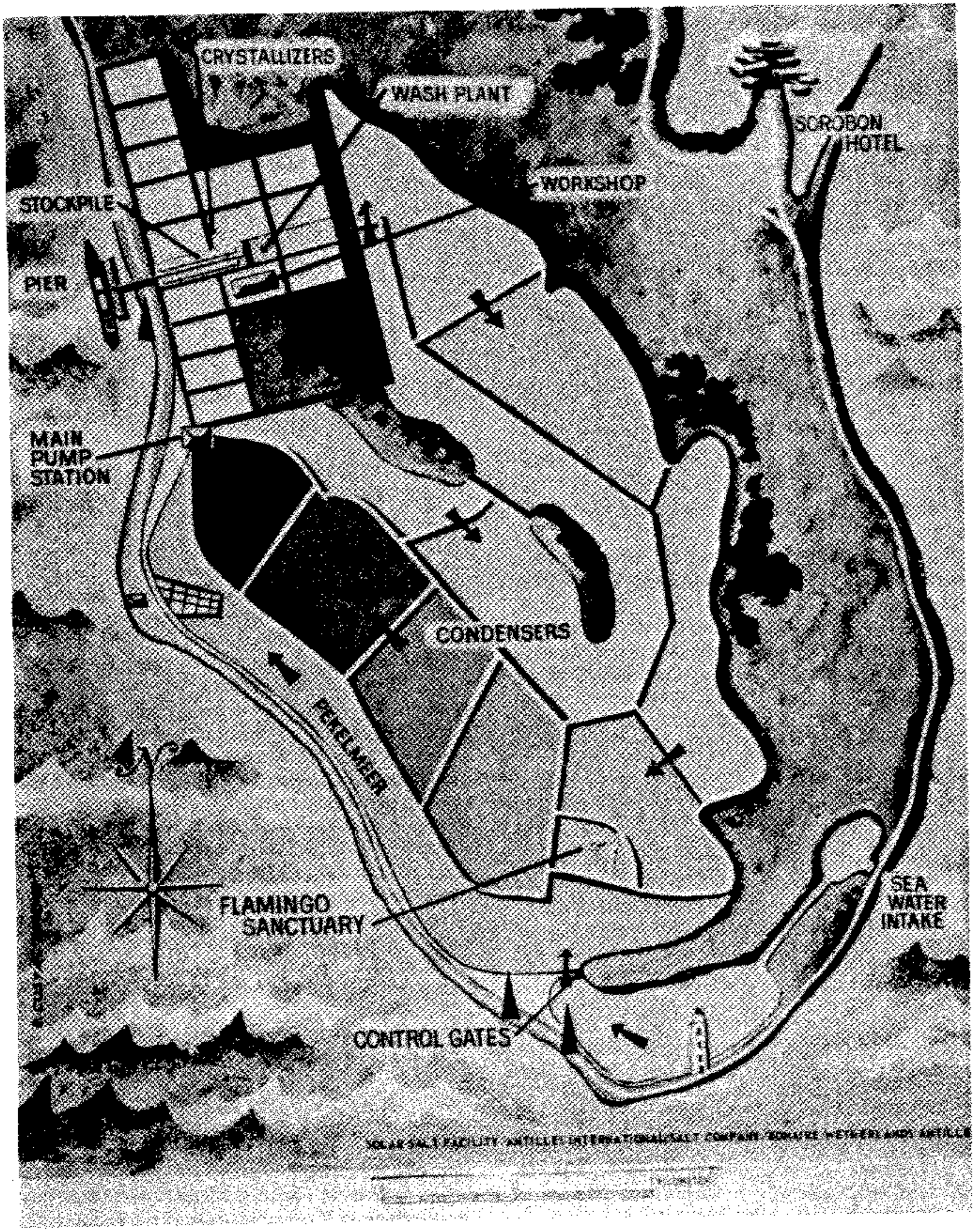

Figure 2. Details of the pond areas and Pekel Meer, South Bonaire.

5. Additives—Anticaking and drying agents.
6. Pallets.

Rock system outputs

1. Sodium chloride—rock salt.
2. Stack emissions—SO_2, NOx, CO_2, water vapor, hydrocarbons.
3. Waste heat—The ultimate polluter.
4. Noise—From screening, crushing, drilling, blasting and haulage operations.
5. Solid wastes—Salt dust, waste salt, cinders, fly ash.
6. Liquid wastes—Brine.

Evaporated salt environmental considerations

The third method of salt production involves the use of indirect heat to produce granulated salt by evaporating salt brine. Multiple effect vacuum pans are most commonly employed. At ISCO's evaporator plant at Watkins Glen, New York, the following environmental conservation measures have been adopted and are currently operational.

1. A waste disposal well handles process wastes consisting chiefly of waste salt, purge liquor.
2. An industrial type incinerator, the largest of its type and manufacture in New York State handles waste solids, primarily paper.
3. Tests conducted by the State Department of Environmental Conservation certified Glen as meeting particulate emission standards.
4. Sulfur levels of coal burned in the power plant meet current standards.
5. A secondary sewage treatment plant handles sanitary wastes.
6. A stack monitoring system continually records smoke density. Visible emissions to Ringlemann No. 1 are permitted.
7. Dust collectors are used extensively to remove salt dust from working areas. Several wet and dry collectors are employed including rotoclones, bag filters, and combinations of cyclone and bag filters.

Additional measures planned or under consideration include the installation of de-mister pads in the pan system and completion of additional waste disposal wells.

Evaporated salt system inputs

1. Energy—Fossil fuels, i.e., coal, natural gas, fuel oil, LPG.
2. Packaging materials—Multiwall paper and polyethylene bags, labels, cartons.
3. Additives—Anticaking and drying agents, TM premixes, coloring agents.
4. Water—Process and potable.
5. Salt—Saturated or nearly saturated brine.
6. Heavy metals—In fuel, raw materials.
7. Pallets.
8. Treatment chemicals—caustic soda, soda ash, boiler feedwater chemicals.

Evaporated salt system outputs

1. Sodium chloride—Refined evaporated salt.
2. Waste heat.
3. Liquid wastes—Purge liquor, condenser tail water, boiler blowdown.
4. Human wastes.
5. Stack emissions:
   a. Particulates—smokes, fly ash
   b. Sulfur dioxide
   c. Oxides of nitrogen, NOx
   d. CO, CO_2, water vapor
6. Solid wastes—cinders, fly ash.
7. Noise—OSHA.

MANAGEMENT'S ROLE IN ENVIRONMENTAL CONSERVATION

As management struggles to cope with wide-ranging problems of the environment and increasingly stringent regulations, recognition has followed that to stay healthy, perhaps even to survive, organizations structured to manage pollution control at the plant level no longer suffice. Formerly, the plant manager was the whole show in matters concerning pollution abatement. Today, an increasing number of line and staff people sustain the plant manager. Elements of corporate life organized to meet ecological problems range from specialists at plant and headquarters all the way up to and, in many cases, including the president. Although companies organize for pollution control to meet their specific needs, most wind up with structures that are similar. In an increasing number of companies, a new staff function has been created to coordinate pollution control efforts. Titles may vary, but the job is basically the same. The Director, Manager, or Coordinator heads a small staff, but he is anything but a one-man show. He is backed up by corporate legal, technical, engineering and public relations departments. The latter often have specialists assigned to handle environmental affairs.

Director's duties

As companies move to deal with a host of new problems which bear importantly on the quality of life, it has become apparent that employee health, on-the-job safety, land use and community considerations must be taken into account in planning environmental programs. It is very easy to fall into the "black box" trap. For example, before committing corporate funds to waste treatment, consideration is given to studying ways to reduce the waste load. This might involve the purchase of better quality raw materials, or the elimination of the process or the plant itself. The market prospects for plant or process offender ultimately determine the cost limits of the pollution control effort.

The director also works closely with specialists at the plant level and, most importantly, he provides a shoulder for plant managers to lean on when help is needed. However, he does not exercise line control over plant managers, because basic responsibility for pollution control still rests with the plant manager. At this point, plant managers may have the feeling they are being painted into the proverbial corner. Let me hasten to assure them they do not stand alone. Judgments have been rendered against senior executives and, undoubtedly, more will follow until the national cleanup effort produces results. Companies have different ideas on how the pollution control director reports to top management. At International Salt Company, environmental control fits into the management lineup as shown in Figure 3.

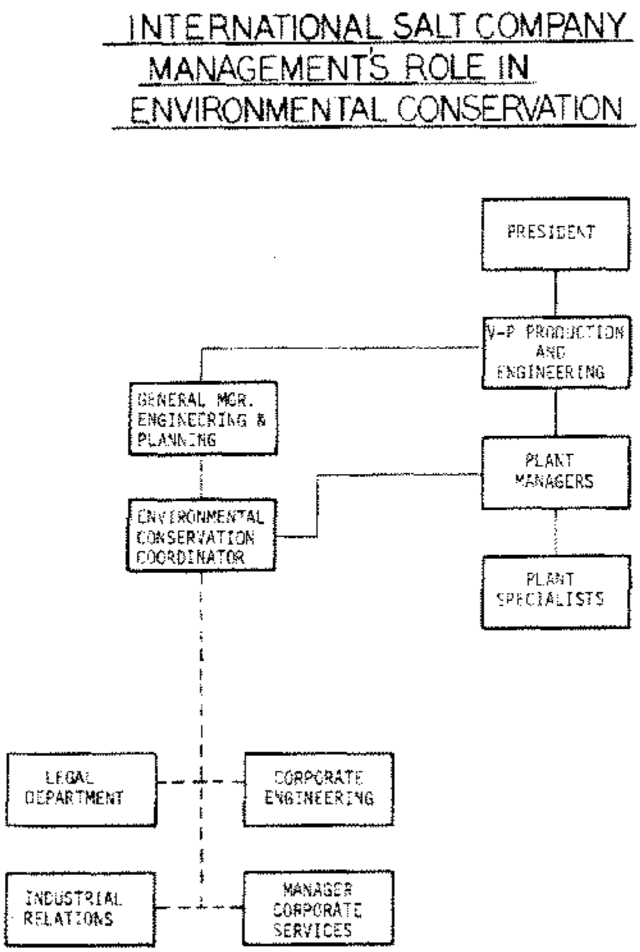

Figure 3. Management's Role in Environmental Conservation, International Salt Company.

ENVIRONMENTAL RESPONSES—OTHER PRODUCERS

Previously we have confined our review of what the salt industry is doing to meet environmental standards at three producing locations operated by International Salt Company. Other producers in the United States, Canada and abroad, have taken imaginative steps to contribute positively to improving industry methods of earth tending.

United States

1. The Diamond Crystal Salt Company in 1971 converted the St. Clair, Michigan plant from coal to clean burning butane. The switch to butane thus eliminates the problems of particulate matter, sulfur dioxide, coal dust and cinders.

2. In New Mexico, waste by-product potash salt is converted to salable product for farm feeding and highway de-icing purposes by an enterprising Texas producer.

3. In 1966, the American Salt Company constructed a processing and refining plant in Midland, Michigan to convert by-product industrial salt into a complete line of agricultural, industrial, chemical food processing and water softener salts.

Canada

1. The Canadian Salt Company Ltd., an affiliate of Morton-Norwich, constructed a plant at Belle Plaine, Saskatchewan in 1969 to utilize waste by-product potash salt. The salt, which previously went to waste on the Canadian prairie, is of excellent quality and is indicative of what can be done to implement the principal of re-cycling.

Europe

The Akzo salt evaporators in Holland, Germany and Denmark are good examples of modern, clean and efficient type operations, as anyone who has seen them will attest.

Two developments of interest to salt producers occurred in Europe recently:

1. The European Economic Community directed potash producers to reduce salt discharges to the Rhine by two-thirds. This was done to improve the quality of drinking water in the Dutch coastal cities where chloride levels last year reportedly exceeded 500 ppm.

2. The Organization for Economic Cooperation and Development recently obtained agreement from member countries to control the use of polychlorinated biphenyls because of environmental hazards associated with the use and disposal of PCB's.

SUMMARY

The economic impact of pollution abatement on the salt industry has not been inconsequential. It comes at a time when the industry is bearing the burden of a serious cost-price squeeze. By and large the industry has responded well to environmental challenges. The adoption of a Sensible Salting program aimed at carefully controlled applications of salt by skilled operators seeks to avoid economic waste and the environmental effects of indiscriminate spreading of de-icing salt. The imaginative conversion by some producers of previously wasted by-product salt to salable product is an example of the application on a large scale of the recycling principle.

The national energy shortage and environmental conservation issues are inexorably linked together. All options examined to date lead to increasing costs. The impact of the energy shortage is greatest in fuel intensive methods of salt recovery. Thus, evaporated salt is hardest hit by rapidly escalating fuel costs. It is therefore likely that utilization of waste heat from utilities or nearby petrochemical operations will be investigated as a means of lowering a substantial element of total process cost.

In the field of water pollution control, the goal of the Federal Water Pollution Control Act and amendments passed by Congress in October, 1972, is the total elimination of industrial wastes into public waters by 1985.

Solar salt operations possess two important advantages over vacuum pan and rock mining methods of recovery.

1. Solar salt is the least energy intensive of the three principal methods of recovery.
2. Pollution abatement costs are minimal.

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