Control of Pollutants for the Oilseeds Industry

KENNETH W. BECKER, Blaw-Knox Chemical Plants, Inc.,
1 Oliver Plaza, Pittsburgh, Pennsylvania 15222

Abstract

To stay in business the oilseeds industry must comply with EPA and other regulations established by governing bodies. We must expect "ecology" to be the prime national concern for this decade. Hence ecological regulations will be sternly enforced. Causes of water and air pollution should be thoroughly investigated. The probable effects of uncontrolled pollution—severe penalties, product losses, hazards to community—are generally known. Fundamental commitments for pollution abatement must be made by governing bodies, operating company top managements, engineering firms and equipment manufacturers. Existing technology coupled with rigid engineering design will permit us to meet most of today's pollution abatement needs. However to meet tomorrow's ecological needs the oilseeds industry and engineering firms serving it must make technological breakthroughs and upgrade the quality of their engineering. Pollution remedies should be a major concern collectively by this technical society, operating companies and engineering firms.

By now all of us realize that pollution control affects our lives significantly. We read about it in the newspapers, and listen to newcasts and debates on TV about funding programs. "Ecology" has become a household word. The 1970 decade was ushered in by the President's signing of the National Environmental Policy Act. Few doubt that pollution control will affect the oilseeds industry, our community life, our government, and our whole existence on this planet.

As this decade continues additional pollution control legislation will be passed, and funds will be made available to carry out these programs. To stay in business our industry as well as others must comply with these regulations, and it will become increasingly difficult to obtain variances from governing bodies. However we need not give up in despair. We should recognize that pollution control is both a challenge and an opportunity. The challenge is to stay in business and make profits while solving the problems as our society demands. The opportunity is for some to become stronger by "survival of the fittest." How do we accomplish these objectives?

First we must understand the causes of the pollution problems before we can discuss potential remedies. To do this let's consider generally the type of plants used by this industry, products made, raw materials and chemicals utilized, and then discuss remedies for pollution. Many of the pollution problems of these plants, and incidentally those of other plants outside this industry, are closely related. Therefore only the basic plants and processes for this industry will be discussed at this time—solvent extraction, oil processing, protein isolates, fatty acids and fatty chemicals.

Solvent Extraction Plants

These plants generally produce a variety of meal products, crude vegetable oil, and sometimes degummed oil. In the U.S., the gums are frequently added back to the meal in the desolventizer. Hexane is normally used as the solvent for oilseeds. Water is collected from condensed steam and must be discharged safely to the sewer.

A typical soybean plant includes facilities for transportation, handling and storage of grain, offices and maintenance buildings, a steam boiler and a cooling tower, soybean flake preparation, solvent extraction, meal finishing and storage, and storage for the solvent and oil.

These plants should perform the following pollution control functions: (a) clean grain and dispose of foreign material; (b) collect dust from effluent air; (c) remove solvent from effluent air; (d) recover solvent and oil from water effluents.

Most of the facilities-cost for a complete soybean or oilseeds plant is in the unloading, storage and solids transport systems. For safety and pollution control it is essential that dust from each process system be collected and recovered. All of us are aware of the extreme hazards of dust explosions, and we have discussed the causes of these explosions on many occasions. Moreover very fine particles of grain dust may constitute air pollution in areas surrounding such plants. Frequently the coarser particles of dust settle within the plant or adjacent area and are then washed to the sewers by rain. Then a water pollution problem may occur—in some circumstances the BOD increase in water is phenomenal.

Spills of grain products and foreign material removed from grain should be disposed of promptly. Otherwise obnoxious odors may develop, rodents may thrive, and rain may wash these materials to the sewer and cause a water pollution problem.

Oil and solvent spills from tanks can be localized by diking the tanks. When oil or miscella spills occur in the extraction area, it is common practice to wash them to a sump decanter system. It is designed so that water underflows to the sewer, and the lighter weight oil and solvent stay in the compartments until they are pumped to reprocessing systems.

For the cottonseed industry special pollution problems exist—linters in the air and possibly aflatoxins and gossypol waste products (if removal of these components is required).

Oil Processing Plants

Crude vegetable oil is processed into a variety of products. Typical products include salad oils, hardened oils and margarines. Byproducts frequently include acidulated soapstocks, stearines from winterizing and deodorizer distillates. Sodium hydroxide, sulfuric acid, bleach clay and nickel catalyst are commonly employed in these plants. Water that is essentially free of chemicals must eventually be discharged to the sewer. Often a cooling tower is employed to re-use the water from the barometric condensers. Considerable care must be taken to avoid evolving obnoxious odors from this cooling tower, especially in summer.

A vegetable oil processing plant has facilities for storage of crude oil and products, an office and analytical laboratory, oil caustic refining and soapstock acidulation facilities, a bleaching system, a Dowtherm vaporizer, and deodorizer systems. Many plants also contain hydrogenation and packaging facilities. The deodorizer system and some storage tanks are usually located outside, but most of the other facilities are located within the building.

These plants should perform the following pollution control functions: (a) control pH and BOD in effluent water; (b) remove oil distillates from the barometric condenser water; (c) dispose of bleach clay and catalysts; (d) localize oil spills and recover the oil; (e) minimize obnoxious odors.

The distribution of facilities-cost for oil processing plants varies depending upon product and storage requirements, but pollution control systems are a major cost. Many plants employ scrubbing systems to remove oil distillates from barometric condenser water. Plant cleanliness (2) is essential and oil and product spills should be disposed of promptly. It is good practice to dike large outside storage tanks.

Protein Isolate Plants

There are a variety of protein isolates produced from defatted and desolventized soy flour. Protein isolate is the

fraction that is solubilized in alkaline solution, precipitated by adjusting pH and separated by centrifuges. The by-products are the insolubles and the whey. The recovered insolubles are sold as low protein meal. The whey, which contains albuminous proteins and other soluble materials, is concentrated before it is sold, or is added back to animal meal in desolventizer-toaster units. The addition of small quantities of whey to a sewer stream will cause a phenomenal increase in BOD—possibly the equivalent of a medium-sized city's sewers.

Protein isolates are prepared in suitable form to enhance the functional properties of bakery goods, meats and many other foods. The more sophisticated spun products are converted into various appetizing forms known as meat analogs. These protein processes are about ten times more efficient than a food animal in easing the world's "protein gap" (1).

A meat-analog plant includes facilities for transportation, handling and storage of raw materials and products, offices and maintenance, steam generation, extraction, precipitation, washing, drying, spinning and special analog preparation systems.

These plants should perform the following pollution control functions: (a) dispose of deteriorated material; (b) collect dust from effluent air; (c) control pH and BOD effluent water; (d) minimize obnoxious odors; (e) operate under dairy standards of sanitation.

Pollution control and maintenance of dairy standards account for a considerable portion of the facilities-cost of protein isolate plants. One of the major pollution control problems is disposal of the whey. A technological breakthrough is needed to make whey recovery systems more attractive economically. Reverse osmosis, a specialized technique for separating solubles from water, may eventually prove useful for this purpose. However further development is needed to make this recovery process economically attractive.

Fatty Acids and Fatty Chemicals

Common raw materials for fatty acids are coconut oil, tallow, soybean and cottonseed oil deodorizer distillates, vegetable oil foots, marine oils and tall oil. Water is used for hydrolysis of the fat to fatty acids and glycerine. Typical products from these plants are fatty acids (crude, distilled, saturated and unsaturated), glycerine (crude and purified), nitriles and other fatty nitrogen compounds, and soaps. Other materials such as hydrogen, ammonia and sodium hydroxide are employed in the various processing systems of these plants.

Fatty acid and fatty chemicals plants frequently include facilities for transportation, handling and storage of raw materials and products, offices and maintenance, steam generation, various fatty acid and fatty chemical processing units, and a diversified soap plant.

These plants should perform the following pollution control functions: (a) control pH and BOD in effluent water; (b) minimize obnoxious odors; (c) recover fats, slops, etc., from water; (d) dispose of trash and unusable materials.

Pollution control systems constitute a major cost for these plants. The fat-saturated water may be controlled by settling and by lime treatment. Fats, slops, etc., can sometimes be recovered, and under certain conditions can be incinerated by high temperature oxidation. The cooling tower and its blowdown in these plants are generally high in dissolved solids. Throughout these plants care must be taken to avoid obnoxious odors and sudden BOD increases in water.

Industry-Wide Pollution

Pollution problems for this whole industry are closely related. Note the similarities of typical causes of water and air pollution listed in Outlines I and II. Among the worst offenders are dust and solvent losses, accidents, contaminants in process water effluent, and obnoxious odors. We should especially concentrate our efforts on controlling these sources of pollution.

I. Typical Causes of Water Pollution

A. Rain water washing to sewers
   1. Spilled grains, oils, fatty acids
   2. Dust
   3. Accumulated refuse materials
   4. Results of accidents—fires, burst storage tanks, leaks
B. Process water containing
   1. Oil, fatty acids, soluble organics
   2. Solvents and chemicals
   3. Whey from protein plants
   4. Aflatoxins and gossypol
   5. Meal and grains

II. Typical Causes of Air Pollution

A. Process air effluents containing
   1. Dust
   2. Obnoxious odors
   3. Solvent
   4. Entrained chemicals
B. Natural air currents containing
   1. Dust
   2. Obnoxious odors
   3. Results of accidents—fires, burst storage tanks, leaks
C. Storage and product tank venting
D. Cooling towers
   1. Chemicals
   2. Oils
   3. Fatty acids

Outline III illustrates the probable effects and the dire consequences of uncontrolled pollution. No one doubts that these penalties will become more severe as society continues to demand upgrading our ecology. The penalties can include heavy fines, plant shutdown and even prison for certain offenders. This industry must make substantial progress toward solving these problems promptly. Only "the fittest" that solve pollution to the extent that society demands will remain in business.

III. Probable Effects of Pollution

A. Ecology downgraded, poor image for company
B. Violation of regulatory statutes
C. Severe penalties—fines, plant shutdowns, prison
D. Occasional large product losses
E. Hazardous solvent and dust losses
F. Constant small product losses
G. High water BOD
H. Obnoxious odors—air and water

Remedies for Pollution

All of us know that we are at the threshold of a long and arduous task. Pollution must be reduced so environmental quality can be improved. How do we approach this very complex problem?

As a nation we must fully and irrevocably commit ourselves to a task that technically and economically may surpass the A-bomb and space programs. Outline IV lists some of the fundamental commitments to be made for this industry by governing bodies, operating companies' top managements, and engineering firms and equipment manufacturers.

IV. Fundamental Commitments for Pollution Abatement

A. Governing bodies
   1. Understand problems
   2. Encourage educational programs
   3. Enforce laws
B. Operating company top management
   1. Cooperate with governing bodies
   2. Appoint pollution control manager
   3. Authorize technical programs

(Continued on page 44A)

• Control of Pollutants . . .

(Continued from page 42A)

4. Fund abatement projects
5. Cooperate with engineering firms and equipment manufacturers

C. Engineering firms and vendors
1. Cooperate with operating companies and governing bodies
2. Fully utilize expertise
3. Anticipate future problems
4. Develop new expertise

Governing bodies must understand the causes of the problems—social, technical and economic. They should not make decisions based upon emotions instigated by headline seekers. Under such circumstances it can become politically expedient to penalize some companies severely before the facts are known. To establish better understanding, governing bodies should encourage joint community-industry educational programs. Members from government, education, operating companies, engineering firms and equipment vendors should speak at these discussions. To be available to the general public, the discussion should be held in the evening. But when persistent and flagrant violations exist, it is our government's duty to enforce the laws and protect environmental quality for our society.

The top managements of operating companies should cooperate with government leaders, and help them formulate overall control programs. They should appoint a pollution control manager for each plant and give him authority to take necessary action. Prompt authorization should be given to research and engineering studies. Essential control projects should be funded and started without delay. They should also insist that their departments cooperate fully with qualified engineering firms and vendors in this field.

Engineering firms and equipment manufacturers likewise should cooperate with operating companies and governing bodies in pollution control. To be more effective they must be allowed to study pollution problems of operating companies well in advance of commitments for projects. Full utilization of the vast amount of expertise that these firms have accumulated in solving related problems can be had only when sufficient lead time and data are available to them. Under favorable circumstances it may be possible to anticipate future problems and develop new expertise, and thereby avoid difficult control problems. However the attitude and pressure for low price, regardless of quality, must be abandoned. Whether we like it or not, pollution control will increasingly be a major factor in profits. The owners of operating companies should realize that it is most important to obtain a plant which yields the greatest profit over the long run. This is the way to obtain the best plant for the least money.

As members of this society and our respective companies, what should we do to advance pollution control? Outline V lists briefly pollution control remedies. There is no easy and simple answer to this complex problem, but we must start the ball rolling.

V. Pollution Remedies

A. Technical society
1. Expedite exchange of ideas
2. Place major emphasis on pollution control

B. Operating companies
1. Obtain extensive data on every polluting source
2. Anticipate future problems
3. Keep abreast of new developments and laws
4. Inspect and maintain essential equipment promptly
5. Maintain clean plants

C. Engineering firms
1. Study the problems well in advance of deadline
2. Use the systems engineering approach

Our technical society should facilitate further exchange of ideas in this field. Major emphasis should be placed on pollution control. Perhaps a separate meeting devoted exclusively to pollution control should be held at the next short course session.

Operating companies should obtain extensive data on every polluting effluent and its source. Only with such data can effective corrections be made. Also they should help anticipate future pollution problems, and keep abreast of new developments and environmental legislation. The pollution control manager should insist on periodic inspections, and maintenance specifically directed toward pollution control. Naturally it is essential to maintain clean plants, and trash and refuse material should be removed promptly.

Engineering firms should study the problems of pollution control and recommend corrective measures well in advance of new projects. It is desirable for better communication to be established between operating companies and engineering firms, so that all expertise can be fully utilized. Most important, the systems engineering approach described by R.D. Good in his recent papers (3, 4) should be employed. For the benefit of those who have not heard or read these papers, systems engineering is defined as the cooperative application of all branches of engineering to all aspects of the whole problem. The objective is to obtain the most plant at the least investment, which has the lowest operating costs, consistent with making quality products within the constraints of governmental regulations and environmental legislation. In systems engineering all of the engineering specialties—process, mechanical, layout, ventilation, instrument, piping, electrical, structural—under the leadership of the project manager, cooperate as a group with the owner and the governing bodies to effect a maximum utilization of expertise. This will result in safer, cleaner, better, more profitable and less polluting plants.

REFERENCES

1. Odell, Arthur, D., Chem. Eng. News 00(12): 79 (1969).
2. Becker, Kenneth W., JAOCS 38: 30 (1961).
3. Good, Robert D., "Systems Engineering for Improved Oilseed Preparation," presented at AOCS-ISF World Congress, Chicago, September 1970.
4. Good, Robert D., "Solvent Extraction Preparation as Practiced Today," presented at Cooperative Oil Mill Superintendents Meeting, March 1971.

(Received May 7, 1971)

AOCS Member Gives Hilditch Memorial Lecture

In May 1970 the Society of Chemistry and Industry, the Royal Institute of Chemistry, and the Oil and Colour Chemists' Association invited AOCS Member Herbert J. Dutton to give the Third Hilditch Memorial Lecture in Liverpool, England, on November 4, 1971. This series, instituted in 1967, commemorates the pioneer work of Professor T.P. Hilditch who laid the foundation for modern fat chemistry in his 25 years at the University of Liverpool. Dutton's lecture on "Some New Approaches in Lipid Research" was combined with a 2 day symposium on recent advances in chemistry and technology of fats and oils. Before the symposium, in response to other invitations, Dutton addressed the Analytical Section of the Swedish Chemical Society in Stockholm, the 4th Catalyst Seminar at the University of Lund, and the staff of the Food Research Institute, Norwich.

Dutton heads Chemical and Physical Properties Investigations at the Oilseed Crops Laboratory, Northern Utilization and Development Division, Peoria, Illinois.