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# SUPPLEMENT TO DEVELOPMENT DOCUMENT FOR EFFLUENT LIMITATIONS GUIDELINES EXISTING SOURCES

FOR THE

# CORN WET MILLING SUBCATEGORY to the GRAIN PROCESSING SEGMENT OF THE GRAIN MILLS POINT SOURCE CATEGORY

Douglas M. Costle
Administrator

Thomas C. Jorling
Assistant Administrator
for Water and Hazardous Materials

Robert B. Schaffer
Director, Effluent Guidelines Division

William Sonnett
Project Officer

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Effluent Guidelines Division
Office of Water and Hazardous Materials
U.S. Environmental Protection Agency
Washington, D.C. 20460

## ABSTRACT

This document presents the findings of an extensive study of the corn wet milling segment of the grain milling industry for the purpose of developing revised effluent limitations guidelines for the industry, to implement Sections 301 and 304 of the Federal Water Pollution Control Act Amendments of 1972 (the "Act"). This study is submitted in response to an order issued by the United States Court of Appeals for the Eighth Circuit on December 3, 1976.

Effluent limitations guidelines contained in this document set forth the degree of effluent reduction attainable through the application of the best practicable control technology currently available and the degree of effluent reduction attainable through the application of the best available technology economically achievable, which must be achieved by existing point sources by July 1, 1977 and July 1, 1983, respectively.

Treatment technology is recommended to achieve the 1977 limitations. This technology includes equalization and biological treatment followed by secondary clarification. In order to attain the 1983 limitations, additional solids removal techniques will be required.

Updated costs of achieving the limitations are described in this report. Supportive data and rationale for development of the proposed effluent limitations guidelines are also presented.

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# SECTION I

## CONCLUSIONS

An extensive review of available data on raw waste loads and waste treatment within the corn wet milling industry was conducted. It was concluded that the technologies originally recommended for the industry are still appropriate. For 1977, these technologies include certain in-plant controls, such as elimination of once-through cooling water, and end-of-pipe biological treatment. The recommended 1983 technology includes more stringent in-plant control and deep bed filtration following biological treatment.

The data reviewed indicate that the original 1977 and 1983 BOD limitations are still valid. It was determined that increasing the suspended solids limitations would better reflect the situation at existing corn wet milling treatment facilities. The suspended solids levels in effluents from these facilities are generally somewhat higher than the BOD levels.

Recent information submitted by the industry shows that increased raw waste loads may result from production of modified starches. Significant production of modified starches may affect waste treatment plant performance and cause increased BOD and suspended solids effluent levels. For these reasons, it was concluded that an allowance in the corn wet milling effluent limitations for modified starch production is warranted.

Variability factors for the effluent limitations were reviewed. It was concluded that a single-day BOD limit three times the maximum 30-day limit is appropriate for 1977 and 1983. A single-day suspended solids limit four times the 30-day limit was determined appropriate for the 1977 limitations. A factor of three is recommended for the 1983 TSS limitation, however, reflecting improved solids control through deep bed filtration and in-plant measures. It was also concluded that provisions for excursions beyond the 30-day and single-day limits are not necessary.

The costs required to meet the recommended effluent limitations were reviewed and updated to January, 1977 dollar values. Costs for treatment technologies, replacement of barometric condensers with surface condensers, and recirculation of barometric cooling water with cooling towers are summarized in this report.

## SECTION II

## REVISED LIMITATIONS

The effluent limitations for the corn wet milling industry are summarized below. The limitations for 1977 and 1983 include basic limits for standard product plants, plus allowances for plants producing modified starches.

The effluent limitations to be achieved with the best practicable control technology currently available are as follows. The basic limitations are:

Effluent Limitations

| Effluent Characteristic | Maximum for Any One Day | Average of Daily Values for 30 Consecutive Days Shall Not Exceed |
|---|---|---|
| | Metric Units (kilograms per 1,000 kg of corn) | |
| $BOD_5$ | 2.67 | 0.89 |
| TSS | 4.32 | 1.08 |
| pH | within the range | 6.0 to 9.0 |
| | English Units (pounds per 1,000 std bushels of corn) | |
| $BOD_5$ | 150 | 50 |
| TSS | 240 | 60 |
| pH | within the range | 6.0 to 9.0 |

For those plants producing modified starches at a rate of at least 15 percent by dry-basis weight of total sweetener and starch products per month for 12 consecutive months, the following limitations should be used to derive an additive adjustment to the above basic limitations:

Effluent Limitations

| Effluent Characteristic | Maximum for Any One Day | Average of Daily Values for 30 Consecutive Days Shall Not Exceed |
|---|---|---|
| | Metric Units (kilograms per 1,000 kg of corn) | |
| $BOD_5$ | 0.81 | 0.27 |

| | | |
|---|---|---|
| TSS | 2.16 | 0.54 |

English Units (pounds per 1,000 std bushels of corn)

| | | |
|---|---|---|
| BOD5 | 45 | 15 |
| TSS | 120 | 30 |

The effluent limitations to be achieved with the best available control technology economically achievable are as follows. The basic limitations are:

Effluent Limitations

| Effluent Characteristic | Maximum for Any One Day | Average of Daily Values for 30 Consecutive Days Shall Not Exceed |
|---|---|---|
| | Metric Units (kilograms per 1,000 kg of corn) | |
| BOD5 | 1.08 | 0.36 |
| TSS | 1.62 | 0.54 |
| | within the range | 6.0 to 9.0 |
| | English Units (pounds per 1,000 std bushels of corn) | |
| BOD5 | 60 | 20 |
| TSS | 90 | 30 |
| pH | within the range | 6.0 to 9.0 |

For plants producing modified starches at a rate of at least 15 percent by dry-basis weight of total sweetener and starch products per month for 12 consecutive months, the following limitations should be used to derive an additive adjustment to the above basic 1983 limitations:

Effluent Limitations

| Effluent Characteristic | Maximum for Any One Day | Average of Daily Values for 30 Consecutive Days Shall Not Exceed |
|---|---|---|
| | Metric Units (kilograms per 1,000 kg of corn) | |
| BOD5 | 0.43 | 0.14 |
| TSS | 0.66 | 0.22 |

| | English Units (pounds per 1,000 std bushels of corn) | |
|---|---|---|
| $BOD_5$ | 24 | 8 |
| TSS | 36 | 12 |

# SECTION III

# INTRODUCTION

## BACKGROUND

EPA's original effluent guidelines study of the corn wet milling industry was conducted from December, 1972 to June, 1973. A contractor-prepared Draft Development Document was completed and distributed at that time. After receiving and reviewing comments from the industry and other interested parties, EPA published a notice of proposed rulemaking for the industry in December, 1973. A revised Draft Development Document and a Draft Economic Report were also issued. Final effluent limitations and new source standards were promulgated on March 20, 1974.

In December, 1974, certain members of the corn wet milling industry filed petitions for review in the U.S. Court of Appeals for the Eighth Circuit, contesting the final regulations. In a decision rendered in May, 1975, the Court remanded the new source standards and claimed no jurisdiction over existing source (1977 and 1983) regulations, CPC International, Inc. v. Train, 515 F 2d 1032 (May 5, 1975) (CPCI).

During the period May to July, 1975, EPA conducted a remand study to reassess the new source performance standards for the industry. Of particular concern was the technology of deep bed filtration as applied to the effluent from corn wet milling waste treatment facilities. EPA published a Supplement to the Development Document in August, 1975, and, after receiving and evaluating comments, issued a notice of its decision not to revise the new source performance standards. This notice was published in November, 1975, and was based on EPA's finding that filtration could be successfully applied in corn wet milling waste treatment.

At the same time, certain members of the corn wet milling industry filed suit in the U.S. District Court for the Southern District of Iowa to contest the 1977 and 1983 regulations for existing plants. The suit was filed in June, 1975; arguments were heard in September; and a decision was issued by the Court in January, 1976. This decision remanded the existing source regulations back to EPA, primarily because ranges and factors were not identified.

The industry was also not satisfied with EPA's expanded new source record and its decision not to change the new source standards. Therefore, in December, 1975, industry members challenged the decision by EPA's Administrator in the Eighth Circuit. Arguments were heard in March, 1976, and a decision was reached in August, 1976. CPC International, Inc. v. Train, 540 F 2d 1329 (August 18, 1976) (CPCII). The Court upheld EPA's BOD limit for new sources (0.357 kg/kkg or 20 lb/MSBu* for a maximum 30-day average) but suggested that the suspended solids limit of 0.179 kg/kkg (10 lb/MSBu) be increased to 0.447 kg/kkg (25 lb/MSBu). EPA accepted the Court's findings and issued revised new source standards in November, 1976.

In July, 1976, EPA appealed the District Court decision on existing source standards to the Eighth Circuit Court of Appeals. Arguments were heard in October, and an order was issued from the Court in December, 1976. The Court agreed to postpone a decision until after the Supreme Court's ruling in the duPont case.** In the interim, however, the Court instructed the EPA to gather new and updated data relating to the 1977 and 1983 effluent limitations.

The Supreme Court issued a decision in the duPont case on February 23, 1977. The court concluded that EPA has authority under Sections 301 and 304 of the Federal Water Pollution Control Act Amendments of 1972 (the "Act") to limit discharges through industry-wide regulations establishing uniform effluent limitations for 1977 and 1983. The court also determined that review of both existing plant and new source effluent regulations should be held exclusively in the United States Courts of Appeal.

*The effluent limitations are expressed in terms of quantity of pollutant per unit of raw material processed. The units are kilograms (kg) of pollutant per thousand kilograms (kkg) of corn processed and pounds (lb) of pollutant per thousand standard bushels (MSBu) of corn processed. One standard bushel equals 56 lb or 25.4 kg. To convert lb/MSBu to kg/kkg, a factor of 0.01787 (0.454 kg/lb ÷ 25.4 kg/SBu) is used.

**E.I. duPont de Nemours & Co. v. Train, S. Ct. Nos. 75-978 and 75-1473, and Train V. E.I. duPont de Nemours & Co., S. Ct. No. 75-1075. This case was an appeal of a Fourth Circuit Court of Appeals decision regarding effluent regulations for the inorganic chemicals industry.

## CURRENT STUDY

In response to the Eighth Circuit's order of December, 1976, EPA made a request for new data to the industry on January 26, 1977. The industry submitted information on February 28 that included proposals for revised effluent limitations specifying ranges of numbers and allowances for factors such as barometric condensers, wet scrubbers, and old plants. Also included in the submittal were testimonies from the CPC International - Corpus Christi NPDES adjudicatory hearings, data on wet scrubber waste loads, and data on product mix and raw waste loads at CPC's Pekin and Corpus Christi plants.

Cost information was submitted by the industry on March 22, 1977. Included were data on industry revenues (prices of various products) and costs of waste treatment at Hubinger's Keokuk plant and CPC's Corpus Christi and Pekin plants. Also included were two additional testimonies from the NPDES permit proceedings for CPC - Corpus Christi.

Information was submitted by the industry on May 2 regarding the following: waste treatment performance data for CPC's Corpus Christi and Pekin plants, a summary of effluent results and variability at CPC - Corpus Christi, and raw waste load data for Hubinger. In addition, data on raw waste loads from modified starch production were submitted on June 3, 1977.

EPA and its contractor visited the American Maize corn wet mill at Hammond, Indiana, and the CPC corn wet mill at Pekin, Illinois. The visits were made in May, 1977. Both of these mills have waste water treatment facilities and direct discharges to navigable waterways.

Current waste load data were received for several mills, including American Maize, Clinton Corn, CPC - Corpus Christi, and CPC - Pekin. These data were computerized and evaluated in terms of pollutant discharge (BOD and TSS) per unit of raw material processed.

# SECTION IV

# WASTE TREATMENT RESULTS

## INTRODUCTION

At the time of the original effluent guidelines study for the corn wet milling industry in 1973, there were 12 companies operating 17 mills in this country. Only four of these mills have direct discharges of concentrated process waste waters following on-site treatment. These four mills are American Maize at Hammond, Indiana; Clinton Corn at Clinton, Iowa; CPC at Corpus Christi, Texas; and CPC at Pekin, Illinois. The current situation at each of these four plants is described in detail below.

Of the other 13 mills operating in 1973, six plants pretreat their wastes before discharge to municipal treatment systems, six mills discharge untreated wastes to municipal systems, and one mill uses land treatment to dispose of its wastes. Several mills have direct discharges of untreated, contaminated cooling water to surface waters.

Five mills have been constructed or are under construction since 1973. One new mill has complete waste treatment facilities and direct discharge of the treated effluent. The other four mills will pretreat their wastes before discharge to municipal systems. Figure 1 shows the locations of corn wet milling plants in the United States.

The effluent data reviewed generally reflect long-term performance of treatment plants within the industry. In most cases, all of the available data were analyzed. Only in cases where extreme values or anomalies were noted were data points excluded. For example, treated effluent levels at one plant were extremely higher than normal during a labor strike, and these data were omitted. In another case, a huge spill of corn syrup to a mill's waste treatment plant occurred, causing an upset that lasted several weeks. Because this occurrence was deemed preventable, the treatment data for that period were not included in the analysis.

A note should be made concerning use of once-through barometric condensers for cooling. Several mills use such systems for cooling in steepwater and syrup evaporation processes. These systems result in the discharge of large quantities of mildly contaminated cooling water. Use of surface condensers rather than barometric condensers, or

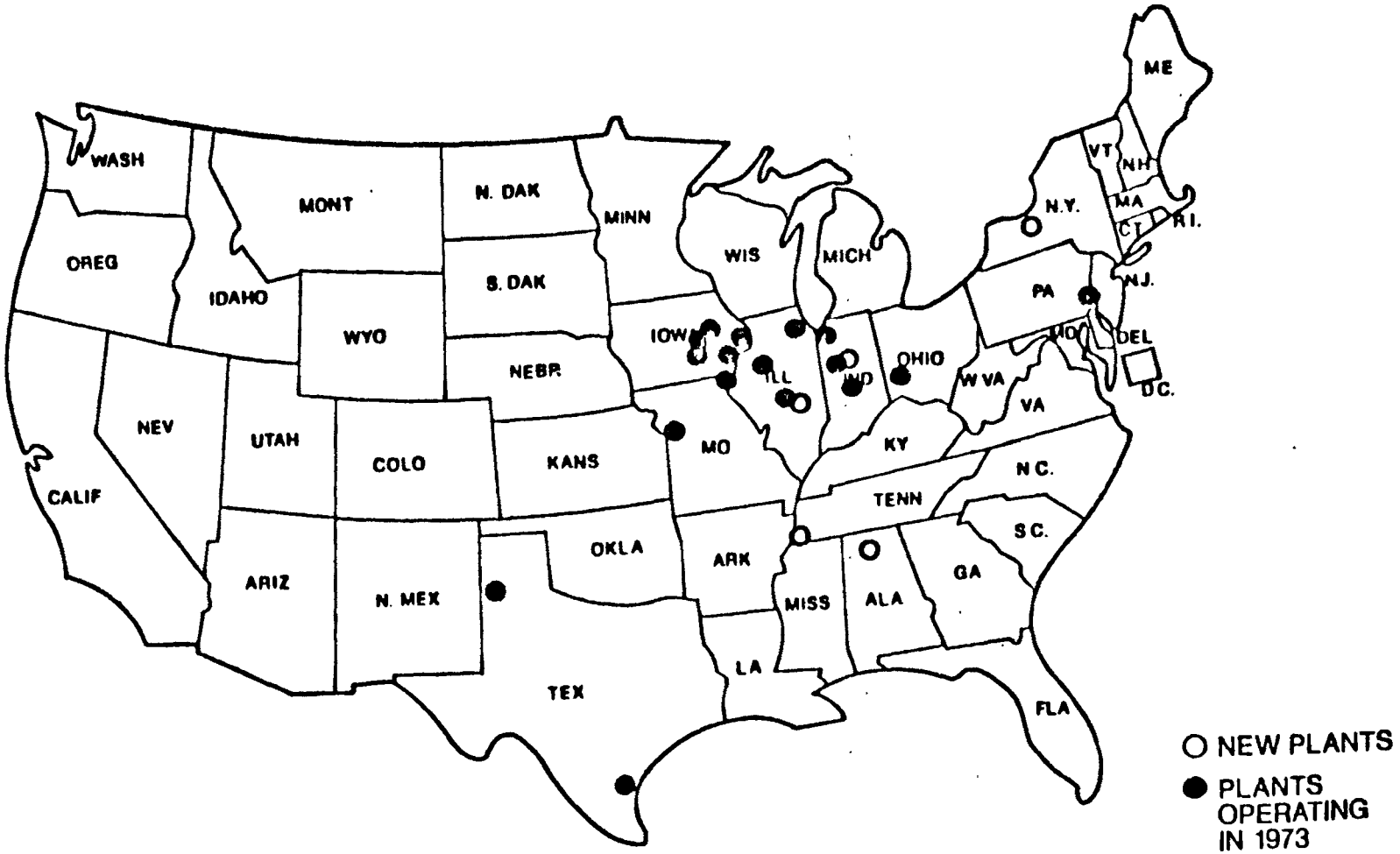


**FIGURE 1**
**LOCATION OF CORN WET MILLING PLANTS**

cooling towers to recirculate the cooling water, results in a concentrated waste stream that can be sent to a mill's waste treatment system. This waste stream, although concentrated, is readily treatable in a biological system. Conversion to surface condensers or cooling towers would increase the waste load to be treated at a mill and would necessitate increased treatment plant capacity, but would not create treatment problems or increased effluent concentrations.

AMERICAN MAIZE

The American Maize corn wet mill at Hammond, Indiana, has on-site facilities for treatment and discharge of process wastes. Production at the mill has increased by about 50 percent since 1973, and all of this increase has been in the manufacture of modified starches. Three main waste streams are sent to the mill's treatment facility: (a) steepwater condensates, (b) starch filtrates, and (c) carbon filter sluice water. Treatment consists of activated sludge (aeration and clarification) followed by three polishing lagoons. The lagoon effluent is combined with spent cooling water from the mill and discharged to Lake Michigan.

American Maize has recently added a chemical coagulation treatment step for polishing the lagoon effluent. Alum and polymer are added, followed by settling in a clarifier. Laboratory tests have indicated that BOD and TSS levels of 20 mg/l can be expected after chemical treatment.(1)

Since 1973, American Maize has eliminated use of its sludge lagoon, enlarged its aeration basin, and constructed a larger secondary clarifier. Waste treatment BOD and TSS effluent levels are summarized below in terms of kg/kkg and lb/MSBu. Current treated effluent flow is now about 2,650 cu m/day (0.7 mgd).

AMERICAN MAIZE TREATMENT PLANT

| | | BOD kg/kkg | BOD lb/MSBu | TSS kg/kkg | TSS lb/MSBu |
|---|---|---|---|---|---|
| 1972: | average | 0.04 | 2.1 | 0.19 | 10.5 |
| | maximum month | 0.06 | 3.3 | 0.37 | 20.8 |
| | maximum day | 0.11 | 6.0 | 1.23 | 69.0 |
| 1975-77: | average | - | - | 0.12 | 6.6 |
| | maximum month | - | - | 0.36 | 20.4 |
| | maximum day | - | - | 0.96 | 54.0 |

Total discharge from the American Maize corn wet mill includes spent cooling water. This water is primarily from surface condensers, although the plant still has three barometric condensers in the syrup refinery. Replacement of these units is planned before 1982. The cooling water flow of about 41,635 cu m/day (11 mgd) is combined with treated process waste water before discharge. BOD and TSS levels in the mill's total discharge are summarized below:

AMERICAN MAIZE TOTAL PLANT*

| | | BOD | | TSS | |
|---|---|---|---|---|---|
| | | kg/kkg | lb/MSBu | kg/kkg | lb/MSBu |
| 1972: | average | 0.25 | 14.1 | 0.19 | 10.8 |
| | maximum month | 0.41 | 22.8 | 0.39 | 21.8 |
| | maximum day | 3.40 | 190.0 | 1.17 | 65.4 |
| 1975-77: | average | 0.31 | 17.5 | 0.51 | 28.7 |
| | maximum month | 0.64 | 35.6 | 0.83 | 46.5 |
| | maximum day | 3.66 | 204.7 | 3.18 | 178.0 |

The American Maize NPDES permit sets limits on BOD and TSS discharges in terms of lb/day. Using current estimated production figures for the mill, the NPDES permit levels convert to the following kg/kkg and lb/MSBu figures:

AMERICAN MAIZE NPDES LIMITS

| | Maximum 30-Day | | Maximum Day | |
|---|---|---|---|---|
| | kg/kkg | lb/MSBu | kg/kkg | lb/MSBu |
| BOD | 0.40 | 22.2 | 1.19 | 66.7 |
| TSS | 0.37 | 20.7 | 1.11 | 62.0 |

CLINTON CORN

The Clinton Corn Processing Company corn wet mill has on-site biological treatment facilities for process waste waters. Treatment includes limited equalization, trickling filtration, aeration, secondary clarification, and deep bed filtration. Treated effluent is recycled back to the mill's raw water supply. The treatment plant began operating in November, 1974, and operations continued until December, *TSS values for 1975-1977 are gross values; figures for 1972 are net values. The plant's NPDES permit levels are based on net discharge. Maximum day BOD and TSS values reflect apparent upsets; normal daily maximums are 1.39 kg/kkg (78 lb/MSBu) BOD and 1.79 kg/kkg (100 lb/MSBu)

1975, when an explosion in the mill destroyed the plant's waste water collection and equalization basin. Treatment operations resumed in late 1976. Treatment results for the two periods of operation, in terms of kg/kkg and lb/MSBu BOD and TSS, are summarized below. Average effluent flow is 9,084 cu m/day (2.4 mgd).

CLINTON CORN TREATMENT PLANT

| | | BOD | | TSS | |
|---|---|---|---|---|---|
| | | kg/kkg | lb/MSBu | kg/kkg | lb/MSBu |
| 1975: | average | 0.11 | 6.0 | 0.30 | 17.0 |
| | maximum month | 0.19 | 10.8 | 0.55 | 30.5 |
| | maximum day | 1.19 | 66.7 | 3.12 | 174.5 |
| 1976-77: | average | 0.26 | 14.8 | 0.34 | 19.3 |
| | maximum month | 0.62 | 34.5 | 0.77 | 43.1 |
| | maximum day | 3.23 | 180.5 | 3.46 | 193.5 |

Clinton Corn discharges spent cooling water and certain other waste waters to the Mississippi River. Surface condensers have replaced barometric condensers for steepwater evaporation, but barometric condensers are still used in other areas of the mill. Limited data are available on total discharges from the mill and are summarized below in terms of kg/kkg and lb/MSBu BOD and TSS:

CLINTON CORN TOTAL PLANT

| | | BOD | | TSS | |
|---|---|---|---|---|---|
| | | kg/kkg | lb/MSBu | kg/kkg | lb/MSBu |
| Oct.-Dec., 1975: | average | 0.81 | 45.4 | 0.36 | 20.4 |
| | maximum month | 1.20 | 64.4 | 0.43 | 23.9 |
| Nov., 1976-Apr., 1977: | average | 2.12 | 118.7 | 0.76 | 42.8 |
| | maximum month | 3.63 | 202.9 | 1.26 | 70.7 |

Clinton Corn's NPDES permit limits are based on EPA's original effluent limitations promulgated in 1974 (0.89 kg/kkg or 50 lb/MSBu maximum 30day values for BOD and TSS, with maximum daily values of 2.68 kg/kkg or 150 lb/MSBu).

CPC - CORPUS CHRISTI

CPC's Corpus Christi corn wet mill treats its process waste waters prior to discharge into the Corpus Christi Ship Channel. Treatment includes tilted plate separation of starch wastes, cooling and equalization of all wastes, aeration, and secondary clarification. A polishing lagoon and final clarifier have recently been added after the secondary clarifier. The waste treatment plant has rarely operated satisfactorily for any length of time and is subject to frequent upsets. During the period 1975 to 1976, for example, average effluent BOD was 141 mg/l and average effluent TSS was 498 mg/l. Average effluent flow from the waste treatment plant was 1,136 cu m/day (0.3 mgd). Treatment plant results for the period in terms of kg/kkg and lb/MSBu are summarized below: (2)

CPC- CORPUS CHRISTI TREATMENT PLANT

| | | BOD | | TSS | |
|---|---|---|---|---|---|
| | | kg/kkg | lb/MSBu | kg/kkg | lb/MSBu |
| 1975 - 1976: | average | 0.36 | 20.1 | 1.27 | 70.9 |
| | maximum month | 2.13 | 119.2 | 3.49 | 195.1 |
| | maximum day | 5.21 | 291.4 | 16.29 | 911.5 |

The above results do not reflect the polishing lagoon and clarifier that were recently added.

The Corpus Christi mill also has a separate discharge that includes spent cooling water, boiler blowdown, cooling tower blowdown, and storm runoff. Surface condensers are primarily used in the plant, but there are two barometric condensers in the syrup refinery. Net BOD discharge in the cooling water stream averaged 7 mg/l or 84 kg/day (186 lb/day) in 1975. The maximum monthly value was 17 mg/l (264 kg/day or 582 lb/day), and the maximum daily value was 52 mg/l (887 kg/day or 1,909 lb/day). These discharges convert to the following kg/kkg and lb/MSBu figures: (3)

CPC - CORPUS CHRISTI COOLING WATER DISCHARGE

| | | BOD | |
|---|---|---|---|
| | | kg/kkg | lb/MSBu |
| 1975: | average | 0.20 | 11.3 |
| | maximum month | 0.63 | 35.3 |
| | maximum day | 2.07 | 115.7 |

CPC - PEKIN

CPC's Pekin, Illinois, corn wet mill has operated waste treatment facilities for concentrated process wastes since 1970. The present treatment scheme includes equalization, cooling, activated sludge (aeration and clarification), chemical settling after alum addition, and dissolved air flotation. Treated effluent is combined with spent cooling water and discharged to the Illinois River. The present volume of concentrated waste water treated is about 2,270 cu m/day (0.6 mgd). This volume is considerably less than the flow of 3,030 cu m/day (0.8 mgd) being treated in 1972, and reflects significant waste reduction through recent in-plant controls.(4,5) Current treatment plant data, reflecting biological treatment followed by chemical clarification and dissolved air flotation, show an average effluent BOD of 6 mg/l and an average TSS level of 35 mg/l. Treatment plant effluent data, in kg/kkg and lb/MSBu, are summarized below for several periods of operation:(2)

CPC - PEKIN TREATMENT PLANT

| | | BOD | | TSS | |
|---|---|---|---|---|---|
| | | kg/kkg | lb/MSBu | kg/kkg | lb/MSBu |
| Jan.-June, 1972: | average | 0.48 | 27.0 | 0.62 | 34.7 |
| | maximum month | 0.73 | 41.1 | 1.15 | 64.2 |
| | maximum day | 3.16 | 176.7 | 3.51 | 196.2 |
| Jul.1972-Jan.1973: | average | 0.14 | 7.6 | 0.24 | 13.7 |
| | maximum month | 0.28 | 15.9 | 0.78 | 43.6 |
| | maximum day | 1.85 | 103.4 | 2.31 | 129.1 |
| Jun.1973-Jun.1974: | average | 0.15 | 8.5 | 0.29 | 16.1 |
| | maximum month | 0.34 | 19.3 | 0.61 | 34.0 |
| | maximum day | 1.58 | 88.3 | 3.88 | 217.2 |
| Sep.1976-Mar.1977: | average | 0.007 | 0.4 | 0.04 | 2.4 |
| | maximum month | 0.01 | 0.6 | 0.09 | 5.0 |
| | maximum day | 0.10 | 5.4 | 0.85 | 47.8 |

The Pekin mill makes extensive use of barometric condensers in the steepwater evaporation and syrup refining operations. About 87,000 cu m/day (23 mgd) of spent, contaminated cooling water are discharged. Recent data indicate an average BOD concentration of 34 mg/l in the cooling water, with a maximum monthly value of 62 mg/l and maximum daily value of 231 mg/l. Discharge quantities of BOD in kg/kkg and lb/MSBu are summarized below for the Pekin mill's cooling water discharge:

CPC - PEKIN COOLING WATER

| | BOD | |
|---|---|---|
| | kg/kkg | lb/MSBu |
| Sept., 1976 - Mar., 1977: | | |
| average | 1.70 | 95.2 |
| maximum month | 2.82 | 157.6 |
| maximum day | 11.85 | 663 |

The NPDES permit for CPC-Pekin sets BOD and TSS concentration limits for treatment plant effluent and cooling water discharge. The BOD limits for both streams are 20 mg/l daily average (30-day average) and 50 mg/l daily maximum. The TSS limits for the treatment plant effluent are 25 mg/l daily average and 62.5 mg/l daily maximum. An average net TSS increase of 5 mg/l over intake water levels is allowed in the cooling water discharge.

SUMMARY

Tables 1 and 2 summarize present effluent discharge levels at the four corn wet mills discussed above. The data in Table 1 are presented in kg/kkg; lb/MSBu figures are used in Table 2.

TABLE 1

SUMMARY OF CURRENT CORN WET MILLING DISCHARGES
IN KG/KKG

| | BOD | | TSS | |
|---|---|---|---|---|
| | Max 30-day Value | Max Day | Max 30-day Value | Max Day |
| **nerican Maize** | | | | |
| WTP (Waste Treatment Plant) | 0.05-0.07 | 0.11 | 0.38 | 0.96 |
| Total Plant | 0.41-0.64 | 1.43 | 0.39-0.82* | 1.79* |
| NPDES Allowance | 0.40 | 1.19 | 0.37 | 1.11 |
| **linton Corn** | | | | |
| WTP | 0.20 | 1.20 (0.61)** | 0.55 | 3.13 (1.79) |
| Total Plant | 1.20-3.63 | - | 0.43-1.27 | - |
| NPDES Allowance | 0.89 | 2.68 | 0.89 | 2.68 |
| **PC-Corpus Christi** | | | | |
| WTP | 2.13 (0.82) | 5.21 (2.81) | 3.49 (2.32) | 16.29 (5.52) |
| Cooling Water | 0.63 | 2.07 | Negligible | |
| Total Plant | 2.76 (1.45) | 7.27 (4.88) | 3.49 (2.32) | 16.29 (5.52) |
| **PC-Pekin** | | | | |
| WTP (1976-77) | 0.01 | 0.10 | 0.09 | 0.86 |
| WTP (1973-74) | 0.34 | 1.57-1.79 | 0.61 | 2.32-3.57 |
| Cooling Water (1976-77) | 2.82 | 11.85 | 5 mg/l increase over raw water*** | |
| Total Plant | 2.82 | 11.94 | | |

* Gross discharge; permit limits are based on net TSS discharged.
** Numbers in parentheses are adjusted values; adjustment made by eliminating values during preventable upsets or anomalies.
*** A 5 mg/l TSS increase at CPC - Pekin represents about 0.21 kg/kkg.

TABLE 2

SUMMARY OF CURRENT CORN WET MILLING DISCHARGES
IN LB/MSBU

| | BOD | | TSS | |
|---|---|---|---|---|
| | Max 30-day Value | Max Day | Max 30-day Value | Max Day |
| nerican Maize | | | | |
| WTP | 3-4 | 6 | 21 | 54 |
| Total Plant | 23-36 | 80 | 22-46* | 100* |
| NPDES Allowance | 22.2 | 66.7 | 20.7 | 62 |
| linton Corn | | | | |
| WTP | 11 | 67 (34)** | 31 | 175 (100) |
| Total Plant | 67-203 | - | 24-71 | - |
| NPDES Allowance | 50 | 150 | 50 | 150 |
| PC-Corpus Christi | | | | |
| WTP | 119.2 (46) | 291.4 (157) | 195.1 (130) | 911.5 (309) |
| Cooling Water | 35.3 | 115.7 | Negligible | |
| Total Plant | 154.5 (81.3) | 407 (273) | 195.1 (130) | 911.5 (309) |
| PC-Pekin | | | | |
| WTP (1976-77) | 0.6 | 5.4 | 5.0 | 48 |
| WTP (1973-74) | 19 | 88-100 | 34 | 130-200 |
| Cooling Water (1976-77) | 157.6 | 663 | 5 mg/l increase over raw water*** | |
| Total Plant | 158 | 668 | | |

* Gross discharge; permit limits are based on net TSS discharged.
** Numbers in parentheses are adjusted values; adjustment made by eliminating values during preventable upsets or anomalies.
*** A 5 mg/l TSS increase at CPC - Pekin represents about 12 lb/MSBu.

## SECTION V

## BASIS FOR 1977 LIMITATIONS

### BACKGROUND

The original effluent guidelines study for the corn wet milling industry defined the best practicable control technology currently available (BPT). This technology, which is the basis for the recommended 1977 effluent limitations, includes the following (as discussed in the Development Document, pages 108-109):(6)

1. Isolating and collecting the major waste streams for treatment.

2. Eliminating once-through barometric cooling waters, especially from the steepwater and syrup evaporators. This change can be accomplished by recirculating these cooling waters over cooling towers or replacing the barometric condensers with surface condensers.

3. Isolating once-through noncontact (uncontaminated) cooling waters for discharge directly to the receiving waters or provision of recirculating cooling tower systems with the blowdown directed to the treatment plant.

4. Diking of all process areas subject to frequent spills in order to retain lost product for possible reuse or by-product recovery.

5. Installing and maintaining modern entrainment separators in steepwater and syrup evaporators.

6. Monitoring the major waste streams to identify and control sources of heavy product losses.

7. For the resulting process waste waters, providing extensive waste treatment consisting of: flow and quality equalization, neutralization, biological treatment, and solids separation. The biological treatment methods available include activated sludge, pure oxygen activated sludge, bio-discs, and possible combinations of other biological systems.

The original 1977 effluent limitations for the corn wet milling subcategory were as follows:

| Effluent Characteristic | Maximum for Any One Day | | Average of Daily Values for 30 Consecutive Days Shall Not Exceed | |
|---|---|---|---|---|
| | kg/kkg | lb/MSBu | kg/kkg | lb/MSBu |
| BOD5 | 2.68 | 150 | 0.89 | 50 |
| TSS | 2.68 | 150 | 0.89 | 50 |
| pH | within the range 6.0 to 9.0 | | | |

The current study of the industry has shown that the technology forming the basis for the original 1977 effluent limitations is still valid. The revised limitations discussed below are based on the technology outlined above.

REVISED LIMITATIONS

The revised 1977 effluent limitations for corn wet mills are as follows:

| Effluent Characteristic | Maximum for Any One Day | | Average of Daily Values for 30 Consecutive Days Shall Not Exceed | |
|---|---|---|---|---|
| | kg/kkg | lb/MSBu | kg/kkg | lb/MSBu |
| BOD5 | 2.67 | 150 | 0.89 | 50 |
| TSS | 4.32 | 240 | 1.08 | 60 |
| pH | within the range 6.0 to 9.0 | | | |

The BOD limits are the same as the limits originally promulgated in 1974. The 30-day TSS limit has been increased somewhat to reflect data from existing treatment plants indicating normal TSS:BOD ratios greater than 1.0. The factor used to establish the single-day TSS limit has been increased to four, reflecting the fact that effluent TSS levels may vary more than BOD levels.

The limits are supported by data from existing corn wet milling treatment plants, as discussed in Section IV. Maximum monthly effluent values for three mills are summarized below:

| Plant | BOD | | TSS | |
|---|---|---|---|---|
| | kg/kkg | lb/MSBu | kg/kkg | lb/MSBu |
| American Maize (total discharge) | 0.64 | 35.6 | 0.83 | 46.5 |
| Clinton Corn (waste treatment plant) | 0.62 | 34.5 | 0.77 | 43.1 |
| CPC - Pekin (waste treatment plant) | 0.28-0.34 | 15.9-19.3 | 0.61-0.78 | 34-43.6 |

The American Maize data are for the year 1972 and reflect activated sludge and lagoon treatment. The total discharge includes some once- through barometric condenser water. The Clinton Corn figures are from 1975 and show effluent levels

after biological treatment and filtration. Equalization of the raw wastes was limited, however, and the filters were bypassed on occasion. Effluent levels for CPC - Pekin reflect treatment plant operation during the period 1972 to 1974, when treatment included activated sludge and dissolved air flotation. American Maize and Clinton are presently meeting NPDES requirements that are more stringent than the recommended effluent limitations. It should be noted that none of the above three mills employs all of the recommended 1977 technology. All three mills discharge contaminated cooling water from barometric condensers without treatment. In fact, all of the evaporators at CPC's Pekin plant use once-through barometric condensers. American Maize and Clinton Corn have made significant replacements of barometric condensers with surface condensers.

The 0.89 kg/kkg (50 lb/MSBu) BOD limit is supported by data from three existing corn wet mills. Support for the limit was also given by the Eighth Circuit Court of Appeals in its decisions in CPC I and CPC II. In CPC I the Court determined that the 1977 technology, if installed in a new plant, would enable the facility to meet the 1977 effluent limitations.(7) In CPC II the Court reaffirmed its position, and also supported a new source BOD standard of 0.36 kg/kkg (20 lb/MSBu), based on 1983 technology.(8) The 1983 technology basically consists of deep bed filtration following biological treatment.

The 1977 TSS limit is to be increased because the evidence shows that effluent TSS levels are usually somewhat higher than BOD levels. A TSS:BOD ratio of 1.2 is approximated in the effluent data for American Maize and Clinton Corn. For example, TSS levels in the Clinton Corn treatment effluent are generally about 0.09 kg/kkg (5 lb/MSBu) higher than the BOD levels. A similar situation exists at American Maize, although the polishing lagoons tend to generate additional suspended solids because of algae growth. Lagoons are not part of EPA's recommended 1977 technology.

To set single-day effluent limits, factors of three for BOD and four for TSS were applied to the 30-day values. The TSS factor was increased to accomodate the higher variation in effluent TSS values experienced at several corn wet mills. These factors find extensive support in data from existing treatment plants:

| Plant | Ratio of Single-day Value to 30-day Value | |
|---|---|---|
| | BOD | TSS |
| American Maize | 1.8 | 2.6-3.3 |
| Clinton Corn | 3.1 | 3.3 |
| CPC - Corpus Christi | 2.4 | 4.7 |
| CPC - Pekin (treatment plant) | 4.6 | 3.0-6.4 |
| CPC - Pekin (total plant) | 2.6-3.1 | 2.5-3.6 |

The above factors are ratios of single-day maximum values to 30-day maximum values. The factors are based on the effluent data presented in Section IV. It should be noted that not all of the above treatment operations represent stable operation and maximum efficiency. A discussion of the shortcomings of the various treatment plants in the industry can be found in the 1975 Supplement to the Development Document. (9)

## SECTION VI

## BASIS FOR 1983 LIMITATIONS

### BACKGROUND

For corn wet milling plants, the best available technology economically achievable (BAT) was defined during the original effluent guidelines study. The main element of this technology is improved solids separation following biological treatment. Improved solids separation is best represented by deep bed filtration, although other means are available and are in use for solids removal after biological treatment. Other components of BAT for corn wet mills include: (6)

1. Isolation and treatment of all process waste waters. No process wastes should be discharged without treatment.

2. Institution of maximum water reuse at all plants over and above the current levels of practice.

3. Provisions for improved solids recovery at individual waste sources.

The original 1983 effluent limitations for the corn wet milling subcategory were as follows:

| Effluent Characteristic | Maximum for Any One Day | | Average of Daily Values for 30 Consecutive Days Shall Not Exceed | |
|---|---|---|---|---|
| | kg/kkg | lb/MSBu | kg/kkg | lb/MSBu |
| $BOD_5$ | 1.07 | 60 | 0.36 | 20 |
| TSS | 0.54 | 30 | 0.18 | 10 |
| pH | within the range 6.0 to 9.0 | | | |

The current study of the industry has shown that the technology forming the basis for the original 1983 effluent limitations is still valid. The revised limitations discussed below are based on the technology outlined above.

### REVISED LIMITATIONS

The revised 1983 effluent limitations are as follows:

| Effluent Characteristic | Maximum for Any One Day | Average of Daily Values for 30 Consecutive Days Shall Not Exceed |
|---|---|---|

| | kg/kkg | lb/MSBu | kg/kkg | lb/MSBu |
|---|---|---|---|---|
| BOD5 | 1.08 | 60 | 0.36 | 20 |
| TSS | 1.62 | 90 | 0.54 | 30 |
| pH | | within the range 6.0 to 9.0 | | |

The BOD limit for 1983 is identical to the original limitation promulgated in 1974. The TSS limit has been increased from 0.18 kg/kkg (10 lb/MSBu) to 0.54 kg/kkg (30 lb/MSBu) to reflect recent data on waste treatment performance within the industry. These data have shown that effluent TSS levels are generally somewhat higher than BOD levels.

Deep bed filtration, the recommended 1983 technology, is currently in use at one corn wet milling plant, Clinton Corn in Clinton, Iowa. (Clinton has also installed filters as part of the waste treatment facilities at its new plant in Montezuma, New York.) The applicability of deep bed filtration to corn wet milling waste waters was at issue in CPC II. EPA made an extensive analysis of filtration as part of the new source remand study conducted in 1975.(9) It was concluded that filtration was applicable to the industry. In its decision in CPC II, the Eighth Circuit upheld the applicability of deep bed filtration, although it recommended that the new source TSS standard be increased from 0.18 kg/kkg (10 lb/MSBu) to 0.45 kg/kkg (25 lb/MSBu). The Court based its recommendation on treatment results from Clinton Corn.(8)

Although filtration is the recommended step to be added to biological treatment, there are other available and demonstrated technologies that can be used to improve effluents from corn wet milling treatment plants. Chemical coagulation with alum and polymers has been successfully demonstrated at CPC's Pekin plant. The chemical coagulation step follows a conventional activated sludge treatment system. Chemical coagulation has also been successfully tested at the American Maize plant in Hammond, Indiana. A full-scale system has recently been installed to polish the effluent from American Maize's activated sludge and lagoon system. Pilot tests demonstrated that BOD and TSS levels of 20 mg/l can be achieved with chemical coagulation. Dissolved air flotation is also an available effluent polishing technology that is in use at CPC's Pekin plant following the chemical coagulation step. The present treatment system at CPC - Pekin is producing an effluent with BOD levels less than 10 mg/l and TSS levels generally less than 40 mg/l. A third available technology is effluent polishing with lagoons. Lagoons have been successfully used at the American Maize plant for several years following

activated sludge treatment, and CPC's Corpus Christi plant has recently installed a secondary lagoon and clarifier following its biological treatment plant.

The 1983 BOD limit of 0.36 kg/kkg (20 lb/MSBu) is supported by data from several corn wet milling plants. The American Maize treatment system (activated sludge and lagoons) achieved a maximum 30-day BOD level of 0.06 kg/kkg (3.3 lb/MSBu). Tests with chemical coagulation indicate that BOD values will be even lower after treatment with alum and polymer. The Clinton Corn treatment facility (activated sludge and filtration) produced an effluent with an average BOD load of 0.11 kg/kkg (6 lb/MSBu) and maximum monthly value of 0.19 kg/kkg (10.8 lb/MSBu). Recent data from CPC's Pekin plant indicate a 30-day BOD level of 0.01 kg/kkg (0.6 lb/MSBu) after biological treatment, chemical coagulation, and dissolved air flotation. Even CPC's Corpus Christi plant, with a poorly operating activated sludge system and no effluent polishing, achieved an average effluent BOD level of 0.36 kg/kkg (20.1 lb/MSBu). This value will improve when the polishing lagoon and clarifier are in operation. It should be noted that none of the above plants has installed all of the recommended 1983 technology. Specifically, the plants rely to varying degrees on once-through barometric condensers for cooling.

A BOD limit of 0.36 kg/kkg (20 lb/MSBu) for new plants was also upheld by the Eighth Circuit in CPC II. (8)

The revised 1983 TSS limit of 0.54 kg/kkg (30 lb/MSBu) is also amply supported. For example, current maximum 30-day TSS values at American Maize are less than 0.38 kg/kkg (21 lb/MSBu), and effluent TSS levels will decrease when chemical coagulation is added. The current maximum 30-day TSS level at CPC Pekin plant is 0.09 kg/kkg (5.0 lb/MSBu) following activated sludge, chemical coagulation, and dissolved air flotation. The maximum 30-day TSS value at Clinton Corn's treatment plant in 1975 was 0.55 (30.5 lb/MSBu). These last two figures reflect only treatment plant discharges.

To determine single-day limits for 1983, a factor of three was applied to the 30-day limits. The rationale for the factors used in the 1977 limits is discussed in Section V. The factor of three used for the 1983 TSS limit reflects improved effluent control through a polishing step (such as filtration) and more stringent in-plant control.

## SECTION VII

## MODIFIED STARCH STUDY

### BACKGROUND

The original Development Document noted that waste waters from modified starch production represent the largest single source of organic load from corn wet mills. These waste waters were described as high strength and highly variable in terms of composition, flow, and biodegradability. It was also noted that production of modified starches varies not only from plant to plant, but also from day to day and week to week at a given plant. Also, the organic strength of the waste waters depends on the degree of starch modification.

Although EPA was aware that higher raw waste loads could result from modified starch production, no correlation could be established between the types and amounts of starches being produced and the resulting waste loads. EPA had requested data on product mix and raw waste loads so that such a correlation could be attempted. The variability of the raw waste load could not be quantitatively defined in terms of product mix. Furthermore, there was no evidence indicating that waste waters from any specific process (such as modified starch production) so affected the total plant waste stream as to reduce the ability of a mill to implement the best practicable control technology currently available. For this reason, no additional allowances for modified starch production were included in the promulgated effluent regulations. (6)

### RECENT DATA

During the new source standards remand study conducted in 1975, EPA solicited additional information from the corn wet milling industry regarding effects of modified starch production. On June 25, 1975, CPC submitted data on raw waste loads and treatability for modified starch wastes. During the design phase of the waste treatment facility at CPC's Pekin plant, batch treatability tests were run on various components of the mill's raw waste load. The tests were run in 1969, using a biomass that had been developed on mixed waste. The COD removal rates for modified starch filtrate were considerably lower than the rates for other waste components such as ethyl alcohol, dextrose, and steepwater. The results would indicate that modified starch wastes have a lower treatability (or reaction rate in the aeration basin) than other components of a mill's waste load. At the Pekin plant during the period June, 1973 to

June, 1974, a particular modified starch was produced on about 40 different occasions. On about half of these occasions, there was a significant increase in the suspended solids level of the waste treatment plant effluent, despite the fact that there was no significant increase in the organic loading (measured as COD) to the aeration basins in the treatment system. There were about 20 other occasions when production of modified starch did not affect performance of the waste treatment plant.

CPC's data submittal also included information on modified starch raw waste loads at its Argo, Illinois, plant. Data were presented for long- term average waste loads at the 50 percent probability level. Data were gathered during production of regular starch, a starch ether, and a cationic starch ether. The data are summarized below, and are expressed per 100 lb of starch produced:

| | Background Plus Unmodified Starch | Background Plus Starch Ether | Background Plus Cationic Starch Ether |
|---|---|---|---|
| Flow, gal/100 lb | 470 | 760 | 740 |
| BOD, lb/100 lb | 1.8 | 18 | 5.0 |
| TSS, lb/100 lb | 1.2 | 3.2 | 2.0 |

The information was gathered from an isolated waste stream, and appears to indicate significant increases in raw waste flow, BOD, and suspended solids.

At CPC's Corpus Christi plant, production of a particular starch ether on two occasions caused a large increase in the waste treatment plant effluent suspended solids. The solids became extremely difficult to settle. On one occasion, effluent TSS increased from 300 mg/l to over 4,000 mg/l; at the other time the starch ether was produced, effluent TSS increased from 90 mg/l to over 1,500 mg/l. CPC also submitted data on laboratory-scale biodegradability studies of seven simulated wastes. The studies were done as part of the development work for the Corpus Christi waste treatment plant. The following wastes were studied: (a) unmodified starch filtrate, (b) hydrolyzed starch filtrate, (c) starch ether filtrate, (d) starch ester filtrate, (e) cationic starch ether filtrate, (f) wet starch and refinery waste mixture. Although CPC admits that the experiments were done on only one or two samples of waste and are probably not truly representative, the tests do indicate differences in observed treatability, even with acclimated sludge.(10)

More recently, the corn wet milling industry has submitted additional information on modified starch raw waste loads. In their February 28, 1977, submittal, the industry estimated that the total raw waste load for a mill would increase as the percentage of modified starch production increased. The estimates were as follows:

| Plant | Percentage of Modified Starch | Total Plant Raw Waste BOD | |
|---|---|---|---|
| | | kg/kkg | lb/MSBu |
| Basic | 0 | 4.20 - 6.70 | 235 - 375 |
| Standard | Less than 25 | 6.25 - 8.94 | 350 - 500 |
| Complex | 25 - 40 | 7.77 -10.28 | 435 - 575 |

These estimates were based on revisions to Table 8 in the original Development Document. A figure of 10.72 kg/kkg (600 lb/MSBu) BOD was used for the raw waste load attributable to modified starch production, although the industry stated that the amount could be as high as 41.1 kg/kkg (2300 lb/MSBu).

In their testimony during the Corpus Christi NPDES permit hearings, CPC indicated that filtrates from production of acid modified and derivatized starches contain up to 5 lb per hundredweight of soluble and insoluble starches. Filtrates from modified starch production were claimed to contain up to ten times the amount of waste (per unit of production) produced by regular starch production. CPC developed a product mix analysis and presented the following waste load factors for different modified starches:

| Product | Waste Load (lb BOD per hundredweight of product) |
|---|---|
| Acid Modified | 3.27 |
| Cross Bonded | 3.08 |
| Double Derivatized | 7.10 |

The above data were based on actual operating experience and actual product loss measurements. The BOD load from acid modified and cross bonded products results from soluble and insoluble starch losses because of the chemical modifications. The major part of the double derivatized waste load also results from such losses, but there is an additional load from the treating chemical used. Using Corpus Christi production data and the above factors, CPC calculated that modified starches (specials) accounted for less than 10 percent of the grind by weight, yet contributed about 23 percent of the total equalized waste load BOD.

Additional information on modified starch waste loads was submitted by Hubinger and CPC. As part of an industry data submittal on May 2, Hubinger provided the following data on waste loads that would not be generated if only regular starch were produced (Hubinger's actual submittal was dated April 29, 1977):

| | Flow | | BOD | | TSS | |
|---|---|---|---|---|---|---|
| | cu m/kkg | gal/SBu | kg/kkg | lb/MSBu | kg/kkg | lb/MSBu |
| Before stripping centrifuge | 3.23 | 21.7 | 44.68 | 2,500 | 11.92 | 667 |
| After stripping centrifuge | 3.17 | 21.3 | 24.57 | 1,375 | 2.54 | 142 |

The above figures are based on the amount of grind converted to modified starch. Hubinger also provided raw waste loads for the total 80,000 bu/day mill. Waste loads for starch modifying were: 0.25 cu m/kkg (1.7 gal/SBu), 3.43 kg/kkg (192 lb/MSBu) BOD, 0.93 kg/kkg (52 lb/MSBu) TSS. (12)

In a data submittal dated June 3, 1977, CPC provided the following raw waste loads for production of various modified starches:

| Type of Starch | BOD kg/kkg | BOD lb/MSBu |
|---|---|---|
| Mill starch (unmodified) | 3.04 | 170 |
| Hydrolyzed starch | 12.15- 27.34 | 680-1,530 |
| Starch ether | 20.73-101.5 | 1,160-5,680 |
| Starch ester | 6.08- 46.82 | 340-2,620 |
| Oxidized | 3.04- 16.08 | 170- 900 |

CPC indicated that production of more highly modified starches will result in even higher raw waste loads. (13)

EFFLUENT ALLOWANCE

On the basis of the recently supplied industry data, it was determined that an effluent allowance for modified starch production might be required for certain plants. An allowance is to be allowed for plants producing modified starches at a rate of at least 15 percent by dry-basis weight of total sweetener and starch products. This figure of 15 percent was based on industry comments and on waste treatment experience at CPC's Corpus Christi corn wet mill. Production of modified starches at Corpus Christi have apparently had adverse effects on treatment plant performance on certain occasions. In the past the mill has

operated below a 15 percent modified starch production level, and CPC projects production greater than 15 percent by 1983. A plant such as CPC-Pekin would not be eligible for a modified starch allowance at current production levels. This determination of a modified starch allowance for existing plants does not affect EPA's previous determination that such an allowance is not required for new plants. This determination for new plants is discussed in the 1975 Supplement to the Development Document.

The modified starch allowances for 1977 and 1983 are as follows:

| | | Maximum for Any One Day | | Average of Daily Values for 30 Consecutive Days Shall Not Exceed | |
|---|---|---|---|---|---|
| | | kg/kkg | lb/MSBu | kg/kkg | lb/MSBu |
| 1977: | BOD | 0.27 | 15 | 0.81 | 45 |
| | TSS | 0.54 | 30 | 2.16 | 120 |
| 1983: | BOD | 0.14 | 8 | 0.43 | 24 |
| | TSS | 0.22 | 12 | 0.66 | 36 |

To arrive at the allowances, an additional raw waste BOD figure of 14.3 kg/kkg (800 lb/MSBu) for modified starch production was used. This was based on an average of the data submitted by industry. Assuming a plant produced 15 percent modified starch, the additional raw waste load (above production of sweeteners and regular starch) would be 14.3 kg/kkg x 0.15 = 2.15 kg/kkg (800 x 0.15 = 120 lb/MSBu). The recommended 1977 30-day BOD effluent limitation for plants producing less than 15 percent modified starch is 0.89 kg/kkg (50 lb/MSBu), which requires a reduction of 88 percent from the standard raw waste load of 7.15 kg/kkg (400 lb/MSBu) BOD. If the same reduction is applied to the modified starch waste load, the necessary allowance would be 2.15 x 0.12 = 0.26 kg/kkg (120 x 0.12 = 14.4 lb/MSBu). The allowance recommended is 0.27 kg/kkg (15 lb/MSBu).

The allowance for suspended solids is higher than the BOD figure, since the data indicate that modified starch wastes cause more problems with effluent TSS than BOD. The recommended 1977 TSS allowance is twice the BOD allowance, reflecting TSS:BOD ratios in effluents from existing corn wet milling waste treatment plants.

To determine the modified starch allowance for the 1983 effluent limitations, a BOD reduction factor of 95 percent was used, based on the reduction required by the basic 1983

BOD limitation. A TSS:BOD ratio of 1.5 was used to establish the TSS allowance, reflecting better solids control through use of deep bed filtration, part of the recommended 1983 control technology.

The factors used to convert 30-day limits to single-day maximums are identical to the factors used for the basic 1977 and 1983 limitations. For 1977, the single-day BOD allowance is three times the 30-day value. A factor of four was used for the TSS limits. For both the 1983 BOD and TSS single-day limits, a factor of three was used. The basis for these factors is explained in Sections V and VI.

## SECTION VIII

## VARIABILITY AND EXCURSIONS

### VARIABILITY

The factors used to convert 30-day limitations to single-day limitations were 4.0 for the 1977 TSS limit and 3.0 for the 1977 BOD limit and the 1983 BOD and TSS limits. Support for these factors can be found in existing waste treatment data, and a discussion of the rationale is included in Sections V and VI. Variability factors at existing treatment plants are summarized below:

| | BOD | | TSS | |
|---|---|---|---|---|
| | Max. Month Average | Max. Day Max. Month | Max. Month Average | Max. Day Max. Month |
| American Maize | 1.6 | 1.8 | 2.0 | 3.3 |
| Clinton Corn | 1.8 | 3.1 | 1.8 | 3.3 |
| CPC-Corpus Christi | 5.9 | 2.4 | 2.8 | 4.7 |
| CPC-Pekin (1972-74) | 2.1-2.3 | 4.6-6.5 | 2.1-3.2 | 3.0-6.4 |
| (1975-76) | 1.5 | 9.5* | 2.1 | 9.5* |

*These values occurred during a period when the maximum 30-day value was well below that required by the revised effluent limitations.

The above factors were calculated from the data presented and discussed in Sections IV, V, and VI. It should be noted that these figures do not represent a strict statistical analysis that led to determination of appropriate effluent limitations. The figures are presented merely to show that the variability factors in the effluent limitations are reasonable and supported by existing data.

EPA's new source standards remand study, completed in 1975, indicated that the data base from existing corn wet milling treatment plants was deficient and was not suitable for strict statistical variability calculations. It was pointed out that suitable data should reflect good, stable operation of a plant that has implemented all of the recommended technology, including end-of-pipe treatment and in-plant controls. This was and still is not the case at any mill within the industry, and the 1975 Supplement to the Development Document (pp. 19-23, 43-45) makes this clear in its evaluation of present treatment systems.(9)

The Eighth Circuit upheld EPA's approach to variability in its decisions in CPC I and again in CPC II. In CPC I, the Court stated that "there are an infinite number of ways in which the Administrator may approach the related questions of basic standards, variability, and excursions". The Court felt that the critical issue was whether the recommended technology would enable a plant to meet the required effluent limitations.(7) The Court in CPC II agreed with EPA that "strict statistical computation of the variability factor for new plants based upon existing plant results creates an artificially high number".(8) Although the Court was considering new plants, the same reasoning applies to use of data to determine limitations for existing plants. It is inappropriate to use a data base from plants that have not incorporated the recommended technology. The Court also upheld EPA's use of a single-day limit three times the 30-day limit.

EXCURSIONS

The corn wet milling industry has continually asserted that provisions for excursions should be included in the effluent limitations. They argue, for example, that if variability factors based on 99 percent probability are used to determine effluent limitations, then an additional allowance should be made to take care of excursions occurring the remaining one percent of the time.

The industry has asserted that even if the effluent limitations accurately reflect daily and 30-day fluctuations in effluent quality from a well- run treatment facility, there will be times when the limitations are exceeded. They claim that even the best-operated facility will occasionally be subject to excessive discharges because of factors such as (a) influent quality changes, (b) plant start-up or shut-down conditions, (c) equipment malfunction, (d) catastrophic conditions, or (e) other circumstances.

Factors beyond the control of a plant that may cause upsets or excursions, such as mechanical failure, accidental spills, or catastrophic conditions, can be handled informally by the permit-issuer. EPA's "Guidelines for Water Pollution Enforcement", 8 (July 23, 1974), provide direction. Such uncontrollable events can be handled either through a force majeure clause in a permit or by enforcement discretion.

Industry claims that certain other factors causing excursions are unique to corn wet milling plants and exist

in the course of normal operations. The following were cited as examples of such factors:

1. Influent quality changes reflecting intermittent production of specialty products and changes in raw materials used.

2. Extraordinary additions to the raw waste load.

3. Exceptional production of finished products at plants where finishing capacity exceeds normal grind capacity.

4. Difficulty at older plants of continuously monitoring and controlling raw waste flows.

Industry proposes that permit-issuers be given the authority to include an "excursion provision" in a permit for a corn wet milling plant. Such a provision would be based on the plant's demonstrating that one or more factors such as those listed above do indeed cause upsets or excursions beyond the uniform effluent limitations.

EPA has determined that such an "excursion provision" is not a necessary component of a corn wet milling discharge permit. Regarding events that may occur in the course of normal operations in the industry, EPA is bound by the rationale of the Decision of the General Counsel on Matters of Law Pursuant to 40 C.F.R. sec. 125.36(m), No. 57 (March 16, 1977). That decision essentially states that a permit-issuer may consider including an excursion or upset provision in a permit only if the particular events giving rise to the upset condition have not been taken into account in establishing the effluent limitations guidelines. After reexamining all available information, EPA has determined that the kind of events that the industry proposes should be accorded exceptional consideration by the permit-issuer (for example, influent quality changes reflecting intermittent production of certain special corn products and changes in raw materials used) have already been incorporated into the data base from which the guidelines were derived. Since these types of factors were considered a part of the normal operation of corn wet milling plants and were incorporated into the data base and reflected in the guidelines, EPA cannot authorize permit-issuers to reconsider these same factors in the context of special excursion or upset provisions.

The only factors used to exclude certain data points from the effluent guidelines data base were occurrences such as

labor strikes and preventable spills. Such factors can be adequately handled either through a force majeure clause or by enforcement discretion, as discussed above. EPA has determined that most excursions or upsets occurring at corn wet milling treatment plants are caused by controllable factors or deficiencies in the treatment system. These factors and deficiencies can be corrected through diligent use of in-plant controls and improved design and operation of treatment facilities.

Provision for variability of treatment plant performance can also be found in EPA's recommended effluent limitations and modified starch allowance. The 30-day and daily TSS limits for both 1977 and 1983 have been increased to more accurately reflect data from existing treatment plants. In addition, the modified starch allowance provides additional effluent discharge for plants with significant production of specialty modified starches.

In CPC II, the Eighth Circuit agreed with EPA's position on excursion. The Court agreed that excursions within this industry could be controlled. The Court also pointed to the conclusions of Dr. Raymond C. Loehr, who stated that industry could decrease variability by at least one percent and more likely by five percent, through use of better treatment technology, attention to treatment system operation and maintenance, and improved in-plant control.(8)

It should also be noted that, if a plant is found to be affected by factors "fundamentally different" from those considered in establishing the guidelines, the current regulations allow for a "variance provision" relative to the limitations based on application of the "best practicable control technology currently available", 40 C.F.R. sec. 406.12 (a). Similarly, according to Section 301(c) of the Act, the Administrator is authorized to modify the requirements pertaining to the "best available technology economically achievable" for an individual point source upon a sufficient showing by the point source operator, under the conditions specifically set forth in 301(c).

# SECTION IX

# COSTS

## BACKGROUND

In the original Development Document (March, 1974), costs to meet EPA's effluent limitations were developed for a hypothetical corn wet mill. The hypothetical plant was a medium-sized mill with a daily grind of 1,524 kkg (60,000 SBu) and was assumed to practice good in-plant control and to use recirculated cooling water. The waste water characteristics for this hypothetical mill were as follows:

| | |
|---|---|
| Flow | 11,355 cu m/day (3 mgd) |
| BOD5 | 7.14 kg/kkg (400 lb/MSBu) |
| TSS | 3.57 kg/kkg (200 lb/MSBu) |

The costs developed for waste treatment at the hypothetical mill were based on August, 1971 dollar values. Capital costs for 1977 and 1983 treatment levels were as follows:

| Treatment Levels | Capital Costs |
|---|---|
| BPT (1977) | $2,544,000 |
| BAT (1983) | $ 288,000 |

The cost for BPT included equalization and activated sludge. The BAT cost included the addition of deep bed filtration. In addition, a cost of $288,000 was estimated for a recirculating cooling tower system for a plant utilizing once-through barometric condensers.

As part of the new source standards remand study conducted in 1975, EPA prepared new cost estimates for three different sized hypothetical corn wet mills. The costs were reported in terms of January, 1975 dollars. These updated costs are summarized below (all costs are in $1,000):

| | 30,000 bu/day | 60,000 bu/day | 90,000 bu/day |
|---|---|---|---|
| Capital Costs | | | |
| Waste Treatment (1977) | 3,017 | 4,768 | 6,407 |
| Filters (1983) | 160 | 240 | 320 |
| Recirculating Barometric Cooling | 215 | 335 | 430 |
| Operation and Maintenance | | | |

| | | | |
|---|---|---|---|
| Waste Treatment | 260 | 378 | 483 |

The waste treatment facilities costed in the above figures include 24- hour equalization, raw waste cooling, nutrient addition, activated sludge treatment, and chlorination. Deep bed filters are costed separately.

In 1975, the industry provided data and estimates on the costs of surface condensers versus barometric condensers. Grain Processing Corporation provided the following data on costs of replacing barometric condensers with surface condensers: (14)

| Date | Equipment Cost | Installed Cost |
|---|---|---|
| July, 1974 | $49,354 | $ 89,626 |
| Nov, 1974 | $62,800 | $215,093 |
| May, 1975 | $29,684 | $ 68,000 |

CPC provided estimates for costs of barometric condensers versus surface condensers in new plants. Estimates were included for three different new plant sizes: (10)

| Condensers | 30,000 bu/day | 60,000 bu/day | 90,000 bu/day |
|---|---|---|---|
| Barometric | $ 660,000 | $1,000,000 | $1,300,000 |
| Surface | 1,600,000 | 2,300,000 | 3,000,000 |

CURRENT COSTS

In the current study, the technologies comprising BPT and BAT have not changed from those discussed in the original 1974 Development Document. These technologies are summarized in Sections V and VI of this report. To develop up-to-date costs for BPT and BAT, the figures presented in the original 1974 Development Document and in the 1975 Supplement to the Development Document were reviewed and updated to 1977 dollar values. The EPA-STP cost index was used for updating. The following index values were used: August, 1971 - 162.5; January, 1975 - 225.7; January, 1977 - 270.9.

The updated costs for 1977 and 1983 are presented in Table 3. It should be noted that these figures represent costs for a plant that has not yet installed any waste treatment facilities and that relies on once-through barometric condensers for cooling. This is not the case for any plant now discharging directly to a waterway. The treatment facilities now in place for the four direct dischargers in

the industry approach BAT technology. Of the four plants, one was designed with primarily surface condensers, and two others have made significant replacements of barometric condensers with surface condensers.

TABLE 3

COSTS TO MEET 1977 AND 1983
EFFLUENT LIMITATIONS

| | Capital Costs ($1,000) | | |
|---|---|---|---|
| | 30,000 bu/day | 60,000 bu/day | 90,000 bu/day |
| 1977 (Equalization and Activated Sludge) | 3,620 | 5,722 | 7,688 |
| Cooling Tower (Recirculating Barometric Condenser Water) | 305 | 481 | 646 |
| Surface Condensers | 2,820 | 3,900 | 5,100 |
| 1983 (Filters) | 305 | 481 | 646 |

| | Annual Costs (O&M) ($1,000) | | |
|---|---|---|---|
| | 30,000 bu/day | 60,000 bu/day | 90,000 bu/day |
| 1977 (Equalization and Activated Sludge) | 312 | 454 | 580 |
| Cooling Tower | 19.1 | 27.7 | 34.6 |
| Surface Condensers | 48 | 72 | 108 |
| 1983 (Filters) | 46 | 73 | 98 |

## SECTION X

## REFERENCES


1. Memorandum - Job 4857E, Subject: Visit to American Maize Corn Wet Milling Plant, June 6, 1977.

2. Cleary, Gottlieb Data Submittal to EPA, May 2, 1977.

3. "Wastewater Sampling Program for Outfall 001", CPC International Inc., Corpus Christi, Texas, Prepared for the Texas Water Quality Board, March 16, 1976.

4. Memorandum - Job 4857E, Subject: Visit to CPC - Pekin Corn Wet Milling Plant, August 30, 1976.

5. Memorandum - Job 4857E, Subject: Visit to CPC - Pekin, June 7, 1977.

6. U. S. Environmental Protection Agency, "Development Document for the Grain Processing Segment of the Grain Mills Point Source Category", EPA-440/1-74-028-a, March, 1974.

7. CPC International Inc. v. Train, 515 F.2d 1032 (May 5, 1975) (CPC I).

8. CPC International Inc. v. Train, 540 F.2d 1329 (August 18, 1976) (CPC II)

9. U. S. Environmental Protection Agency, "Supplement to Development Document for the Corn Wet Milling Subcategory, Grain Processing Segment of the Grain Mills Point Source Category", EPA-440/1-74-028-b, August, 1975.

10. CPC Data Submittal to S&P, June 25, 1975.

11. Cleary, Gottlieb Data Submittal to EPA, February 28, 1977.

12. Cleary, Gottlieb Data Submittal to EPA, May 2, 1977.

13. Cleary, Gottlieb Data Submittal to EPA, June 3, 1977.

14. Grain Processing Corporation Data Submittal to S&P, June 3, 1975.

TABLE 4

METRIC TABLE

CONVERSION TABLE

| MULTIPLY (ENGLISH UNITS) | | by | TO OBTAIN (METRIC UNITS) | |
|---|---|---|---|---|
| ENGLISH UNIT | ABBREVIATION | CONVERSION | ABBREVIATION | METRIC UNIT |
| cre | ac | 0.405 | ha | hectares |
| acre - feet | ac ft | 1233.5 | cu m | cubic meters |
| British Thermal Unit | BTU | 0.252 | kg cal | kilogram - calories |
| British Thermal Unit/pound | BTU/lb | 0.555 | kg cal/kg | kilogram calories/kilogram |
| cubic feet/minute | cfm | 0.028 | cu m/min | cubic meters/minute |
| cubic feet/second | cfs | 1.7 | cu m/min | cubic meters/minute |
| cubic feet | cu ft | 0.028 | cu m | cubic meters |
| cubic feet | cu ft | 28.32 | l | liters |
| cubic inches | cu in | 16.39 | cu cm | cubic centimeters |
| degree Fahrenheit | °F | 0.555(°F-32)* | °C | degree Centigrade |
| feet | ft | 0.3048 | m | meters |
| gallon | gal | 3.785 | l | liters |
| gallon/minute | gpm | 0.0631 | l/sec | liters/second |
| horsepower | hp | 0.7457 | kw | killowatts |
| inches | in | 2.54 | cm | centimeters |
| inches of mercury | in Hg | 0.03342 | atm | atmospheres |
| pounds | lb | 0.454 | kg | kilograms |
| million gallons/day | mgd | 3,785 | cu m/day | cubic meters/day |
| mile | mi | 1.609 | km | kilometer |
| pound/square inch (gauge) | psig | (0.06805 psig +1)* | atm | atmospheres (absolute) |
| square feet | sq ft | 0.0929 | sq m | square meters |
| square inches | sq in | 6.452 | sq cm | square centimeters |
| ton (short) | ton | 0.907 | kkg | metric ton (1000 kilograms) |
| yard | yd | 0.9144 | m | meter |

* Actual conversion, not a multiplier