DEPARTMENT OF CIVIL ENGINEERING
BRIGHAM YOUNG UNIVERSITY

UTAH INDUSTRIAL WASTE TREATMENT
COMPARED WITH NATIONAL PRACTICE

by
Bhagu M. Patel

A PROJECT SUBMITTED IN PARTIAL
FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE
MASTER OF CIVIL ENGINEERING
UTAH INDUSTRIAL WASTE TREATMENT
COMPAUED WITH NATIONAL PRACTICE

A Project
Presented to the
Department of Civil Engineering Science
Brigham Young University

In Partial Fulfillment
of the Requirements for the Degree
Master of Civil Engineering

By
Bhagu M. Patel
December 1972
This project, by Bhagw M. Patel, is accepted in its present form by the Department of Civil Engineering Science of Brigham Young University as satisfying in part the requirements for the degree of Master of Civil Engineering.

Chairman, Advisory Committee

Member, Advisory Committee

Dec. 22, 1972

DATE

Chairman, Major Department
DEDICATION

Respectfully to my elder brother

Mr. S. M. Patel

for his contribution

in my academic career
ACKNOWLEDGMENTS

The author expresses his sincere appreciation to Professor Clifford N. Stutz of the Civil Engineering Department for his personal guidance throughout this entire project. Also thanks for his valuable suggestions to guide the author toward the selection of this particular topic of the project.

Other members of the Brigham Young University faculty are also deserving of recognition with respect to this project, Dr. LaVere B. Merritt and Dr. Cliff S. Barton for review of this project and comments made and help rendered.

A special thanks is extended to Mr. Cliff Crane of the Bureau of Environmental, State Health Department, Salt Lake City, Utah; for letting me look into their files and drawings of the Utah Industrial Waste Treatments. Without his help, the scope of this work would have been, of necessity, much more limited than it is.

Many thanks are expressed to the author's friend, Harsad J. Shah, for his help and encouragement.

The author is especially indebted to his parents and his wife for their expressions of confidence and inspiration.
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CHAPTER I

INTRODUCTION

The effluents from the industrial waste treatment plants are important sources of water pollution of rivers, lakes and impoundments. In Utah, the effluents from industrial waste streams are analyzed by the State Health Department, Salt Lake City; before the waste is discharged into the receiving water bodies. Partial treatments and inadequate treatments for industrial wastes are today recognized as one of the main causes of water pollution.

The main purpose of this project is to compare the industrial waste treatment methods of Utah state, with the national practice.

However, its scope is limited because at the time of surveying, the availability of the design data for the Utah Industrial waste treatment methods from the State Health Department, Salt Lake City; was limited. This situation restricted the author to compare only the B.O.D. removal efficiency of each treatment plant; with the national practice. Also the comparative data available from profiles on national basis, published by the F.W.P.C.A. are not found often enough to take into account all of the industries of Utah. In this situation, under the guidance of Professor C. N. Stutz, the survey was restricted to collect the operating data and design data of five major industries in Utah, namely; steel industries, meat packing plants, oil refineries, dairies and canneries. The
selective industries are those which are not discharging their effluents directly into the municipal sewer or into underground aquifers.

This project attempts to collate the available information on Utah industrial waste treatment methods and effluents compared to the national practice. The study is based on present treatment methods.

It essentially consists of the following works:

(1) The review of the waste treatment details which includes waste discharge flows, present treatment, proposed treatment and effluent discharge characteristics.

(2) Line diagrams of the plants for present and additional proposed treatments are made.

(3) Curves are plotted showing the relationships of time period versus B.O.D. and temperature, of time period versus MPN coliforms and temperature and also of time period versus pH and total suspended solids for the data available from 1968 to 1972.

(4) The quality of various effluents are tabulated to show maximum, minimum and average values for major pollutants and are discussed in brief with respect to the code of waste disposal.

(5) A graphical comparison is made, by calculating B.O.D. removal efficiency and is discussed for each industry. Many of the industries in Utah have had their present treatments since 1968-69 and the effluent analyses is available since 1967.
6. According to the A.P.I, Manuals, the minimum required dimensions of A.P.I. separator for all of the oil refineries are designed; considering the industrial waste water flow only.

The Code of Waste Disposal Regulations for quality standards of "C" and "D" class waters of the state and a typical design of A.P.I. separator is also given in the Appendix.

Also suitable detention period with respect to temperature is discussed in the Conclusions.
CHAPTER II

STEEL INDUSTRIES

GENEVA WORKS U.S.S. CORPORATION

1. Treatment Details:

(a) Waste discharge flow:
Average discharge flow = 20 million gal/day

(b) Present treatments:
The following water pollution control facilities are provided for the industrial waste treatments.
1950 - Two settling ponds, oil skimmers and oil basins - waste water system
1958 - Two clarifiers, including oil skimmers
1962 - Experimental retention pond
   - Two clarifiers (gas cleaning)
   - Sinter plant gas cleaning clarifier
1964 - Small retention pond (nitrogen plant waste)
1968 - Oil reclaiming facilities
   - Final retention pond

(c) Proposed Treatments
N/A

(d) Effluent discharge:
The effluent is finally discharged into Utah Lake after the treatments.
2. Line Diagram For Waste Treatments

1. Sampling point #1
2. Final effluent sampling point #2
3. (a) TIME PERIOD V/S BOD AND TEMPERATURE
3 (c) TIME PERIOD V/S TOTAL S.S., NITROGEN (NH₃), pH AND CYANIDE

GENEVA STEEL
(waste to final lagoon)
Effluent Analyses

Suspended Solids (10² mg/l)
Cyanide
Nitrogen (NH₃)
4. The Quality of Final Effluent

(a) The effluent analyses at sampling point #1, before the final lagoon is tabulated for maximum, minimum and average value of the main pollutants:

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.O.D.</td>
<td>22.5 mg/l</td>
<td>4.2 mg/l</td>
<td>13.4 mg/l</td>
</tr>
<tr>
<td>Total coliforms</td>
<td>93000/100 ml</td>
<td>930/100 ml</td>
<td>46965 mg/l</td>
</tr>
<tr>
<td>Total S.S.</td>
<td>360 mg/l</td>
<td>25 mg/l</td>
<td>192.5 mg/l</td>
</tr>
<tr>
<td>pH</td>
<td>9.65</td>
<td>6.75</td>
<td>8.3</td>
</tr>
<tr>
<td>Temperature</td>
<td>91°F</td>
<td>63°F</td>
<td>77°F</td>
</tr>
<tr>
<td>N-Ammonia(NH₃)</td>
<td>38 mg/l</td>
<td>1.4 mg/l</td>
<td>19.7 mg/l</td>
</tr>
<tr>
<td>Cyanide</td>
<td>0.43 mg/l</td>
<td>0.00</td>
<td>0.22 mg/l</td>
</tr>
</tbody>
</table>

(b) The analyses of the pollutants at sampling point #2 after the final lagoon is tabulated for maximum, minimum, and mean values.

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.O.D.</td>
<td>6.5 mg/l</td>
<td>2.0 mg/l</td>
<td>4.93 mg/l</td>
</tr>
<tr>
<td>Total coliforms</td>
<td>2300/100 ml</td>
<td>230/100 ml</td>
<td>958/100 ml</td>
</tr>
<tr>
<td>Fecal coliforms</td>
<td>2300/100 ml</td>
<td>43/100 ml</td>
<td>577/100 ml</td>
</tr>
<tr>
<td>pH</td>
<td>8.35</td>
<td>7.70</td>
<td>7.96</td>
</tr>
<tr>
<td>Temperature</td>
<td>78°F</td>
<td>54°F</td>
<td>65°F</td>
</tr>
<tr>
<td>Ammonia</td>
<td>6.2 mg/l</td>
<td>2.0 mg/l</td>
<td>4.54 mg/l</td>
</tr>
<tr>
<td>Nitrite</td>
<td>1.2 mg/l</td>
<td>1.2 mg/l</td>
<td>1.2 mg/l</td>
</tr>
<tr>
<td>Nitrate</td>
<td>2.18 mg/l</td>
<td>13.2 mg/l</td>
<td>17.5 mg/l</td>
</tr>
<tr>
<td>Cyanide</td>
<td>0.05 mg/l</td>
<td>0.00 mg/l</td>
<td>0.0175 mg/l</td>
</tr>
<tr>
<td>Chloride</td>
<td>54 mg/l</td>
<td>46 mg/l</td>
<td>50 mg/l</td>
</tr>
<tr>
<td>Total Hardness</td>
<td>3.42 mg/l</td>
<td>314 mg/l</td>
<td>328 mg/l</td>
</tr>
</tbody>
</table>
The quality of the final effluent is very good and it satisfied all the requirements of the water quality standard "C", which is classified for the receiving water of Utah Lake.

5. Removal Efficiency of the Final Lagoon

Detention period of the final lagoon = \( \frac{\text{Volume}}{\text{Flow}} \)

\[
= \frac{80 \times 10^6 \text{ gal}}{20 \times 10^6 \text{ gal/day}}
= 4 \text{ days}
\]

B.O.D. removals -

av. B.O.D. in influent of the lagoon = 13.4 mg/l
av. B.O.D. in effluent of the lagoon = 4.93 mg/l

removal efficiency = \( \frac{13.4 - 4.93}{13.4} \times 100 \)

\[
= \frac{8.47}{13.4} \times 100
= 63\%
\]

Coliform removals

av. total coliforms in influent of the lagoon = 46,965/100 ml
av. total coliforms in effluent of the lagoon = 958/100 ml

removal efficiency = \( \frac{46965 - 958}{46965} \times 100 \)

\[
= \frac{46007}{46965} \times 100
= 98\%
\]
Cyanide removals

av. cyanide in influent of the lagoon = 0.22 mg/l
av. cyanide in effluent of the lagoon = 0.0175 mg/l

\[
\text{removal efficiency} = \frac{0.22 - 0.0175}{0.22} \times 100
\]

\[
= \frac{0.2025}{0.22} \times 100
\]

= 92%

Nitrogen - Ammonia (NH₃) removals -

av. ammonia in influent of the lagoon = 19.7 mg/l
av. ammonia in effluent of the lagoon = 4.54 mg/l

\[
\text{removal efficiency} = \frac{19.7 - 4.54}{19.7} \times 100
\]

\[
= \frac{15.16}{19.70} \times 100
\]

= 79%

6. Comparison of Removal Efficiency with National Practice

The comparative data on national bases was not available.
CHAPTER III

MEAT PACKING PLANTS

E. A. MILLER & SONS MEAT PACKING CO.

1. Treatment Details

(a) Waste discharge flow:
   Average discharge flow = 122,400 gal/day

(b) Present treatments
   Four cell lagoon system is provided
   An anaerobic cell #1 of 28,710 sq. ft. x 12' deep
   Aerobic cell #2 of 113,100 sq. ft. x 6' deep
   Aerobic cell #3 of 191,350 sq. ft. x 6' deep
   Aerobic cell #4 of 390,500 sq. ft. x 6' deep

(c) Proposed treatments
   An additional cell #5 of 8 acres water surface and 6'
   deep is proposed to operate in 1973, to provide total
   containment and total detention period of one year.

(d) Effluent discharge
   The lagoon effluent is utilized to sprinkle irrigation
   system. The small dikes around the low level boundary,
   have been constructed to prevent any surface run-off
   that may occur.
2. Line Diagram for Waste Treatments

Note: Dotted Lines indicate proposed treatment
E. A. MILLER PACKING COMPANY
MEAT PLANT
Effluent Analysis

B.O.D.

Temperature

Class "D" Std B.O.D.

Class "C" Std. B.O.D.

68 | 69 | 70 | 71 | 72

3 (a) TIME PERIOD V/S B.O.D. AND TEMPERATURE
E. A. MILLER MEAT PACKING COMPANY
Effluent Analyses

MPN Coliforms

Temperature

Class "C" & "D" Std. (MPN Coliforms)


3 (b) TIME PERIOD V/S MPN COLIFORMS AND TEMPERATURE
E. A. MILLER MEAT PACKING COMPANY
Effluent Analyses

3 (c) TIME PERIOD V/S TOTAL SUSPENDED SOLIDS AND pH
4. The Quality of Final Effluent

The present treatment units are operated since 1969. The table shows maximum, minimum and average values of effluent analyses after treatment is provided.

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.O.D.</td>
<td>110 mg/l</td>
<td>5.1 mg/l</td>
<td>50 mg/l</td>
</tr>
<tr>
<td>MPN Coliforms</td>
<td>430,000/100 ml</td>
<td>230/100 ml</td>
<td>7500/100 ml</td>
</tr>
<tr>
<td>Total S.S.</td>
<td>210 mg/l</td>
<td>5 mg/l</td>
<td>90 mg/l</td>
</tr>
<tr>
<td>pH</td>
<td>9.05</td>
<td>7.25</td>
<td>8.0</td>
</tr>
<tr>
<td>Temperature</td>
<td>76°F</td>
<td>31°F</td>
<td>53°F</td>
</tr>
</tbody>
</table>

The average amount of B.O.D. and the MPN coliforms are high in the final effluent and can be classified in the category of water quality standard "D" or below. The amount depends upon the variation of the temperature. During low temperature periods organic degradation is decreased.

5. Efficiency & Detention Period

(a) B.O.D. removals -

av. B.O.D. before the treatments = \( \frac{335 + 20}{2} \) = 177.5 mg/l

av. B.O.D. after the treatments = 50 mg/l from the graph

removal efficiency = \( \frac{177.5 - 50}{177.5} \)

= \( \frac{127.5}{177.5} \) = 72%

Say 70 to 75%
(b) Detention period

Total volume of the waste water in lagoons = 28710 x 12
+ (113,100 + 191,350 + 390,500) x 6 = 343,200
+ 694,950 x 6 = 343,200
+ 4160,000 = 4,503,200
= 33,720,000 gal.

Detention Period = \frac{\text{Volume}}{\text{Flow}} \text{ days}

= \frac{33,720,000 \text{ gal}}{122,400 \text{ gal/day}}

= 27.5 days

Say 28 days

6. Comparison of B.O.D. Removal Efficiency With National Practice


The B.O.D. removal efficiency for lagoons, where anaerobic and aerobic pond system is applied = 94% so, the efficiency of waste removal in E. A. Miller & Sons Meat Packing Company is 70 to 75. That is low compared to the national practice. The reason may be because of the low detention period and the vast variation of temperature in Utah.
TRI-MILLER MEAT PACKING CO.  
(at Hyrum, Utah)

I. Treatment Details

(a) Waste discharge flow:
    Average discharge flow = 11,300 gal/day

(b) Present treatments
    Two cell lagoon system with 3 grease traps are provided
    (i) Anaerobic cell of 24,768 sq. ft. - 
    (ii) Aerobic cell of 30,096 sq. ft. - 

(c) Proposed treatments
    An additional lagooning system is proposed to build a cell
    of 1.3 acres to provide total containment.

(d) Effluent discharge
    The final effluent is discharged to private holding pond.

2. Line Diagram For Waste Treatments:

```
  waste stream → 3 grease traps → Anaerobic Cell #1 → Aerobic Cell #2 → To holding pond
```
TRI-MILLER MEAT PACKING CO.
Effluent Analyses

3 (a) TIME PERIOD V/S B.O.D. AND TEMPERATURE
3 (b) TIME PERIOD V/S MPN COLIFORMS AND TEMPERATURE
3 (c) TIME PERIOD V/S TOTAL SUSPENDED SOLIDS AND pH
4. Effluent Quality
   a. MPN coliforms are high in the effluent.
   b. pH ranges from 7.1 to 9.0 which can be categorized in the "D" water quality standard.
   c. Total suspended solids are within 250 mg/l, except some peak points of 450 mg/l.
   d. Temperature of the effluent can be classified in "CW" standard.
   e. B.O.D. are within 5 mg/l, except low temperature period. During cold weather periods, B.O.D. are high because degradation of organic matter depends on temperature. Average value of B.O.D. in the final effluent is 10 mg/l.

5. B.O.D. Removal Efficiency of the Treatment Plant

B.O.D. removal efficiency:

\[
\text{av. B.O.D. in influent} = \frac{30 + 20}{2} = 50 \text{ mg/l}
\]

\[
\text{av. B.O.D. in effluent} = 10 \text{ mg/l}
\]

\[
\text{B.O.D. removal efficiency} = \frac{50 - 10}{50} \times 100
\]

\[
= \frac{40}{50} \times 100
\]

\[
= 80\%
\]

6. Comparision of B.O.D. Removal Efficiency With National Practice

The B.O.D. removal efficiency of the plant = 85 to 90% and according to FWPCA Publication No. I.W.P.-8.56, Meat Products, the B.O.D. removal efficiency for the same kind of treatments
94% on the national basis.

The efficiency of the industrial waste treatment plant of the Tri-Miller Meat Packing Company is lower than the national practice; because of the wide variation in the temperature of the state.
CHAPTER IV

OIL REFINING INDUSTRIES

CARIBOU-FOUR-CORNERS OIL COMPANY

1. Treatment Details:

   (a) Waste discharge flow
       Average discharge flow = 30,000 gal/day
   (b) Present treatments:
       The following treatments are provided at present:
       1. A collection sewer on the low side of the plant to
          catch any surface runoff.
       2. Oil separator
       3. Bypass to the pump station
       4. Pump station wet well
       5. Lagoon system
       Three aerobic lagoons are provided. Total capacity is
       1.90 million gallons.
   (c) Proposed treatments:
       N/A
   (d) Effluent discharge:
       The final effluent is discharged into the drain ditches
       leading to Farmington Bay and the Great Salt Lake.
2. Line Diagram for Waste Treatments Plant:

waste stream from the plant

API Separator

Pump wet well

Aerated Cell #1
Aerated Cell #2
Aerated Cell #3

collection sewer for surface water runoff

To Great Salt Lake
CARIBOU FOUR CORNERS CO.
Effluent Analysis

3 (b) TIME PERIOD V/S MPN COLIFORMS AND TEMPERATURE
4. The Quality of Final Effluent

The quality of the final effluent was improved after the new oil separator was employed. Oil and grease are reduced considerably by the new oil separator and B.O.D. was reduced after lagoon treatment to permissive limits except during low temperature periods.

The main pollutants are tabulated for their maximum, minimum and average value after lagooning.

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.O.D</td>
<td>82 mg/l</td>
<td>3.2 mg/l</td>
<td>20 mg/l</td>
</tr>
<tr>
<td>MPN coliforms</td>
<td>$1.5 \times 10^6/100$ ml</td>
<td>$23/100$ ml</td>
<td>$30,000/100$ ml</td>
</tr>
<tr>
<td>Total S.S.</td>
<td>110 mg/l</td>
<td>5 mg/l</td>
<td>30 mg/l</td>
</tr>
<tr>
<td>pH</td>
<td>9.9</td>
<td>7.40</td>
<td>8.3</td>
</tr>
<tr>
<td>Temperature</td>
<td>80°F</td>
<td>35°F</td>
<td>60°F</td>
</tr>
<tr>
<td>Oil &amp; grease</td>
<td>7.5 mg/l</td>
<td>2.0 mg/l</td>
<td>5 mg/l</td>
</tr>
</tbody>
</table>

The B.O.D. and coliforms are still variable and high in magnitude depending upon the temperature conditions.

The Tertiary treatments may be provided to solve the problem.

5. Efficiency of the Treatment Plant

B.O.D. Removals:

av. B.O.D. before the treatments = 200 mg/l

av. B.O.D. after the treatments = 20 mg/l

\[
\text{B.O.D. Removal} = \frac{200 - 20}{200} = \frac{180}{200} = 90\%
\]
Detention period of the lagooning system = \frac{\text{total capacity of lagoons}}{\text{av. flow}}

= \frac{1.9}{3 \times 10^{-2}}

= \frac{190}{3}

= 63.3 \text{ days}

6. Comparision of B.O.D. Removal Efficiency with National Practice

The B.O.D. removal efficiency of the plant = 90\% and according to F.W.P.C.A.; No. I.W.P.--5, Table 10, the B.O.D. removal efficiency = 50 to 90\%.

This shows that the B.O.D. removal efficiency of the treatment plant is good enough but the biodegradation during Winter is not satisfactory.

7. Design of A.P.I. Separator

According to the A.P.I. Manuals, the minimum required dimensions of the A.P.I. Separator should be 40 \times 5 \times 4.5 \text{ ft.}, to treat industrial waste flow only.

The design of A.P.I. separator, which is operated at present, is designed on the basis of the waste water plus storm water. The dimensions of the present A.P.I. separator is 63.5 \times 8.0 \times 8.0 \text{ ft.}
AMERICAN OIL COMPANY

I. Treatment Details:

(a) Waste discharge flow:
Average discharge flow = 1.5 mgd

(b) Present treatments
Following treatment units are provided for the industrial waste treatments.
1. A.P.I. Oil Separator
2. Air Flotation Basin
3. Solid Media Filter

Also the following units are in operation since 1972.
1. Three units of filter basins
2. Two units of settling basins to treat waste water from back wash.

(c) Proposed treatments
N/A

(d) Effluent discharge
The final effluent is discharged into a waste ditch flowing to the Great Salt Lake
2. Line Diagram For Waste Treatments Plant

To waste ditch following to Great Salt Lake
AMERICAN OIL COMPANY
Effluent Analyses

B.O.D.

Temperature

Class "D" Std (B.O.D.)

Class "C" Std (B.O.D.)

3 (a) TIME PERIOD V/S B.O.D. AND TEMPERATURE
AMERICAN OIL COMPANY

Effluent Analyses

Temperature

MPN Coliforms

Class "C" and "D" Std (MPN Coliforms)

3 (b) TIME PERIOD V/S MPN COLIFORMS AND TEMPERATURE
4. The Quality of Final Effluent

The analyses of the effluent, after the filter basins were employed; is tabulated for maximum, minimum and average value of main pollutants.

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.O.D.</td>
<td>22 mg/l</td>
<td>16.5 mg/l</td>
<td>19.25 mg/l</td>
</tr>
<tr>
<td>MPN Coliforms</td>
<td>4300/100 ml</td>
<td>230/100 ml</td>
<td>2265/100 ml</td>
</tr>
<tr>
<td>Total S.S.</td>
<td>15 mg/l</td>
<td>10 mg/l</td>
<td>12.5 mg/l</td>
</tr>
<tr>
<td>pH</td>
<td>7.45</td>
<td>7.15</td>
<td>7.30</td>
</tr>
<tr>
<td>Temperature</td>
<td>104°F</td>
<td>96°F</td>
<td>100°F</td>
</tr>
<tr>
<td>Oil</td>
<td>10.4 mg/l</td>
<td>1.7 mg/l</td>
<td>6 mg/l</td>
</tr>
</tbody>
</table>

The final effluent has high B.O.D. The MPN coliforms are within permissible value. The effluent is finally discharged into the class "CC" water of the Great Salt Lake; but the effluent does not meet the quality requirements of class "CC" water.

5. Efficiency of the Treatment Plant

B.O.D. removal efficiency

\[
\text{av. influent B.O.D.} = 200 \text{ mg/l} \\
\text{av. effluent B.O.D.} = 19.25 \text{ mg/l} \\
\text{B.O.D. removal efficiency} = \frac{200 - 19.25}{200} = \frac{180.75}{200} = 90.4\% \\
\text{Say 89 to 91%}
\]

6. Comparison of B.O.D. Removal Efficiency with National Practice

The B.O.D. removal efficiency of the plant = 89 to 91%. The
comparative data on national basis are not available for the same kind of treatments.

The biological waste removals are still not satisfactory.

7. Design of A.P.I. Separator

According to the A.P.I. Manuals, the minimum required dimensions of the A.P.I. Separator should be 75 x 10.5 x 7 ft; for the treatment of industrial waste flow only.

The design of filter basins should be on the basis of 2 gal/sq. ft./min. mixed media bed.
CHEVRON PETROLEUM REFINERY

1. Treatment Details

(a) Waste discharge flow
Average discharge flow = 1.47 million gallon/day

(b) Present treatments
Refinery effluent waste streams are collected from each area of the plant. The bulk of the industrial waste water, contaminated with oil is sent to the following treatment units:
1. A.P.I. Separator
2. Baffle Board Separator (Pond)
3. Aeration Lagoon System
   (i) Cell # 1 of 13.4 million gal. capacity
   (ii) Cell # 2 of 13.0 million gal. capacity
   (iii) Cell # 3 of 8.4 million gal. capacity
   (iv) A small circulation pond of approximately 2 million gal. capacity

(c) Proposed Treatments:
N/A

(d) Effluent discharge:
The final effluent is discharged into the Salt Lake sewage canal which flows to the Great Salt Lake.
Notes: 1. Refinery sanitary sewage is piped to Davis County sewage plant, does not enter Refinery Waste Water System.
   2. Spent caustics are tanked and sold to Los Angeles processor. They do not enter the Waste Water System.
3 (a) TIME PERIOD V/S B.O.D., OIL AND GREASE AND TEMPERATURE
3 (c) TIME PERIOD V/S TOTAL SUSPENDED SOLIDS AND pH
4. The Quality of Final Effluent

The analyses of the effluent, from the present treatments is tabulated for maximum, minimum and average value of the main pollutants.

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.O.D.</td>
<td>160 mg/l</td>
<td>18.7 mg/l</td>
<td>78 mg/l</td>
</tr>
<tr>
<td>MPN coliforms</td>
<td>0.43 x 10^6 / 100 ml</td>
<td>23 / 100 ml</td>
<td>6000 / ml</td>
</tr>
<tr>
<td>Total S.S.</td>
<td>75 mg/l</td>
<td>5 mg/l</td>
<td>22 mg/l</td>
</tr>
<tr>
<td>pH</td>
<td>8.85</td>
<td>6.9</td>
<td>8.0</td>
</tr>
<tr>
<td>Temperature</td>
<td>79°F</td>
<td>34°F</td>
<td>55°F</td>
</tr>
<tr>
<td>Oil</td>
<td>60 mg/l</td>
<td>2.2 mg/l</td>
<td>25 mg/l</td>
</tr>
</tbody>
</table>

The present treatments are not efficient to reduce organic waste to the limiting value of B.O.D. and coliforms for class "CC" water of the receiving water body.

5. Efficiency of the Treatment Plant

B.O.D. Removal efficiency

Assume that the difference between the peak B.O.D. values of maximum and minimum be the B.O.D. removals by the treatment plant.

Maximum B.O.D. = 160 mg/l
Minimum B.O.D. = 18.3 mg/l

\[
\text{B.O.D. removal efficiency} = \frac{160 - 18.3}{160} \times 100
\]

\[
= \frac{141.7}{160} \times 100
\]

= 88.6%

Say 85% to 90%
This efficiency is most applicable during summer.

\[ \text{Detention period of lagooning system} = \frac{\text{total capacity of lagoons}}{\text{av. flow}} \]
\[ = \frac{13.4 + 13 + 8.4 + 2}{1.47} \]
\[ = 25 \text{ days} \]

6. Comparision of B.O.D. Removal Efficiency With National Practice

The B.O.D. removal efficiency of the plant = 85 to 87% and according to F.W.P.C.A. Publication No. I.W.P. - 5, Table 10, Petroleum Refining, the B.O.D. removal efficiency for the same kind of treatment is 50 to 90% on the national basis. This shows the efficiency of the industrial waste treatment system of Chevron Petroleum Refinery is not bad, compared to national practice. The detention period of the lagooning system is not enough to reduce B.O.D. to meet the requirements of class "CC" water of the receiving water quality. The capacity of the lagooning system may be increased to solve the problem.

7. Design of A.P.I. Separator

According to the A.P.I. Manuals, the minimum required dimensions of the A.P.I. Separator should be 135 x 10.5 x 7.5 ft.

Suitable detention period with respect to temperature is discussed in Chapter VII.
HUSKY PETROLEUM

1. Treatment Details
   (a) Waste discharge flow:
       Average discharge flow = 29,000 gal/day
   (b) Present treatments:
       The waste from the refinery is treated in A.P.I. separators.
       The effluent from the separator goes to a small drainage
ditch following to the Great Salt Lake.
   (c) Proposed treatments
       N/A
   (d) Effluent discharge
       The final effluent is discharged into the sewage canal
       flowing to the Great Salt Lake.

2. Line Diagram for Waste Treatments
HUSKY OIL COMPANY
Effluent Analyses

3 (b) TIME PERIOD V/S MPN COLIFORMS AND TEMPERATURE
HUSKY OIL COMPANY
Effluent Analyses

3 (c) TIME PERIOD V/S TOTAL SUSPENDED SOLIDS AND pH
4. The Quality of Final Effluent

The analyses of the effluent from the present treatments is tabulated for maximum, minimum and average value of the main pollutants.

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.O.D.</td>
<td>730 mg/l</td>
<td>23 mg/l</td>
<td>265 mg/l</td>
</tr>
<tr>
<td>MPN coliforms</td>
<td>43000/100 ml</td>
<td>23/100 ml</td>
<td>4000/100 ml</td>
</tr>
<tr>
<td>Total S.S.</td>
<td>110 mg/l</td>
<td>5 mg/l</td>
<td>62 mg/l</td>
</tr>
<tr>
<td>pH</td>
<td>9.9</td>
<td>7.6</td>
<td>9.2</td>
</tr>
<tr>
<td>Temperature</td>
<td>80°F</td>
<td>36°F</td>
<td>62°F</td>
</tr>
<tr>
<td>Oil</td>
<td>54 mg/l</td>
<td>2.5 mg/l</td>
<td>33 mg/l</td>
</tr>
</tbody>
</table>

The presently treated effluent has high B.O.D. It contains high oil and grease also. The effluent should be treated further to reduce B.O.D. in the effluent and pH should be lowered to the range of 6.5 to 8.5 to meet the class "CC" water standard of the receiving water body.

5. Efficiency of the Treatment Plant

Assume that the difference between the peak B.O.D. values of maximum and minimum be the B.O.D. removals by the treatment plant.

\[
\text{B.O.D. in influent} = \text{maximum B.O.D.} = 730 \text{ mg/l}
\]

\[
\text{B.O.D. in effluent} = \text{minimum B.O.D.} = 23 \text{ mg/l}
\]

\[
\text{B.O.D. removal efficiency} = \frac{730 - 23}{730} \times 100
\]

\[
= \frac{70700}{730} = 97\%
\]

This efficiency is based on the assumptions and is most
applicable during the summer.

6. Comparison of B.O.D. Removal Efficiency With National Practice

The B.O.D. removal efficiency of the plant = 97% and according to F.W.P.C.A. Publication No. I.W.P. - 5 Table 10, Petroleum Refining, the B.O.D. removal efficiency for the same kind of treatments is 50 to 90%. This shows that the industrial waste treatment system of Husky Petroleum Company works better compared to national practice. However the final effluent quality does not satisfy the requirements of class "CC" of the receiving water quality. Tertiary treatments may be provided to improve secondary treatments.

7. Design of A.P.I. Separator

According to the A.P.I. Manuals, the required dimensions of the A.P.I. separator should be 74 x 5 x 4.5 ft.
PHILLIPS PETROLEUM COMPANY

1. Treatment Details
   (a) Waste discharge flow
       Average discharge flow = 0.87 mgd
   (b) Present treatments
       At present, the industrial waste treatment facilities include the following units.
       (i) A.P.I. separator
       (ii) Skimming Pond
       (iii) Three cell lagoon system
   (c) Proposed treatments
       At present, the Phillips Petroleum Company has submitted plans to the State Health Department to build an additional 3 cells into the lagoon system which will increase the detention time.
   (d) Effluent discharge
       The final effluent is discharged into state sewage canals.

2. Line Diagram for Waste Treatments

   ![Diagram](image)

   A.P.I. Separator → Skimming Pond → Cell #1, Cell #2, Cell #3 to the State Sewage Canal

   Total area of lagoon = 21.5 acres
   Total detention period = 21 days

   Note: Dotted lines indicate proposed treatment
PHILLIPS PETROLEUM COMPANY
Effluent Analyses

Temperature

B.O.D.

Oil & Grease

Class "D" Std.
B.O.D.

Class "C" Std.
B.O.D.

B.O.D., mg/l, Oil mg/l, Temperature °F


3 (a) TIME PERIOD V/S B.O.D. AND TEMPERATURE
4. The Quality of Final Effluent

The analyses of the effluent from the present treatments is tabulated for maximum, minimum, and average value of the main pollutants.

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.O.D.</td>
<td>115 mg/l</td>
<td>3.7 mg/l</td>
<td>25 mg/l</td>
</tr>
<tr>
<td>MPN coliforms</td>
<td>$23 \times 10^5/100$ ml</td>
<td>93/100 ml</td>
<td>5000/100 ml</td>
</tr>
<tr>
<td>Total S.S.</td>
<td>43.5 mg/l</td>
<td>0</td>
<td>20 mg/l</td>
</tr>
<tr>
<td>pH</td>
<td>9.2</td>
<td>6.7</td>
<td>8.0</td>
</tr>
<tr>
<td>Temperature</td>
<td>72°F</td>
<td>37°F</td>
<td>54°F</td>
</tr>
<tr>
<td>Oil</td>
<td>40 mg/l</td>
<td>2 mg/l</td>
<td>16 mg/l</td>
</tr>
</tbody>
</table>

Presently treated effluent has good quality, except high B.O.D. during low temperature periods.

5. Efficiency of the Treatment Plant

Assume that the difference between the peak B.O.D. values of maximum and minimum be the B.O.D. removals by the treatment plants.

\[
\text{B.O.D. in influent} = \text{maximum B.O.D.} = 115 \text{ mg/l} \\
\text{B.O.D. in effluent} = \text{minimum B.O.D.} = 3.7 \text{ mg/l} \\
\text{B.O.D. removal efficiency} = \frac{115 - 3.7}{115} \times 100 \\
= \frac{111.3}{115} \times 100 \\
= 98.3\% \\
\text{Say 98%}
\]

This efficiency is most applicable during the summer.
CHAPTER V
DAIRIES

CACHE VALLEY DAIRY

1. Treatment Details

(a) Waste discharge flow

Average discharge flow = 720,000 gal.

(b) Present treatments

A lagoon system, with aeration and chlorination is employed at present for the waste treatment.

(c) Proposed treatments

It is proposed to increase the capacity of lagooning system by providing additional lagoons for total containment of effluent. About 40 acres of the lagooning surface area will be needed for adequate treatments.

(d) Effluent discharge

The effluent is finally discharged into the Bear River.

2. Line Diagram for Waste Treatments

![Diagram of waste treatment process]

waste stream → Aeration Lagooning System → Chlorination Lagoon → Bear River
CACHE VALLEY DAIRY ASSOCIATION
Effluent Analysis

B.O.D. mg/l and Temperature °F

Class "D" Std (B.O.D.)
Class "C" Std (BOD)

3 (a) TIME PERIOD V/S B.O.D. AND TEMPERATURE
3 (b) TIME PERIOD V/S MPN COLIFORMS AND TEMPERATURE

- MPN Coliforms
- Temperature
- Class "C" & "D" (MPN Coliforms)
- Effluent Analysis
- Cache Valley Dairy Assn.
4. The Quality Of Final Effluent

The effluent analyses is tabulated for maximum, minimum and average value of the different pollutants. The effluent is analyzed after the treatments.

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Average (from graph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.O.D.</td>
<td>24.1 mg/l</td>
<td>4.6 mg/l</td>
<td>10 mg/l</td>
</tr>
<tr>
<td>MPN coliforms</td>
<td>430,000/100 ml</td>
<td>43/100 ml</td>
<td>160,000/100 ml</td>
</tr>
<tr>
<td>Total S.S.</td>
<td>260 mg/l</td>
<td>20 mg/l</td>
<td>95 mg/l</td>
</tr>
<tr>
<td>pH</td>
<td>8.75</td>
<td>6.65</td>
<td>7.8</td>
</tr>
<tr>
<td>Temperature</td>
<td>72°F</td>
<td>37°F</td>
<td>50°F</td>
</tr>
</tbody>
</table>

The above table is based on the effluent analyses made after the treatments are employed. The effluent has high MPN coliforms and also the B.O.D. are not within the permissible value to meet the same water quality standards of the receiving water body. The effluent is discharged into the Bear River which is classified in "CC" standards. The detention period of the lagooning system may be raised by providing additional lagoons to satisfy the effluent quality requirements.

5. Removal Efficiency of the Treatment Plant

B.O.D. removals (from graph)

av. B.O.D. before treatments = 235 mg/l
av. B.O.D. after treatments = 10 mg/l

removal efficiency = \( \frac{235 - 10}{235} = \frac{225}{235} \)
GOSSNERS CHEESE FACTORY

1. Treatment Details
   (a) Waste discharge flow
       Average discharge flow = 36,000 gal/day
   (b) Present treatments
       The waste stream from the cheese factory is treated in
       three anaerobic lagoons, arranged in a series after
       which it flows through a pressure sprinkling irrigation
       system and is evenly dispersed upon the land of about
       10 acres.
   (c) Proposed treatments
       The enlargement of the sprinkling irrigation is proposed.
   (d) Effluent Discharge
       The final effluent is totally utilized for sprinkling
       irrigation.

2. Layout Plan for Waste Treatments
GOSSNERS CHEESE FACTORY
Effluent Analysis

3 (a) TIME PERIOD V/S B.O.D. AND TEMPERATURE

Class "C" Std
B.O.D. = 5 mg/l

Class "D" Std
B.O.D. = 25 mg/l
3 (b) TIME PERIOD V/S MPN COLIFORMS AND TEMPERATURE
4. The Quality of Final Effluent

The sampling point for the effluent analyses is located at the influent of spray irrigation. The pollutants have high values after lagooning system and are tabulated for their maximum, minimum and average values.

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.O.D.</td>
<td>2,000 mg/l</td>
<td>265 mg/l</td>
<td>125 mg/l</td>
</tr>
<tr>
<td>MPN coliforms</td>
<td>930,000/100 ml</td>
<td>430/100 ml</td>
<td>450,000/100 ml</td>
</tr>
<tr>
<td>Total S.S.</td>
<td>940 mg/l</td>
<td>115 mg/l</td>
<td>450 mg/l</td>
</tr>
<tr>
<td>pH</td>
<td>7.35</td>
<td>3.9</td>
<td>5.6</td>
</tr>
<tr>
<td>Temperature</td>
<td>82°F</td>
<td>32°F</td>
<td>54°F</td>
</tr>
</tbody>
</table>

The above table is basically for the following period, where the treatments were employed. The high amount of the organic pollutants are entering into sprinkling irrigation systems. So the enlargement of the sprinkling system is proposed by the State Health Department.

5. Removal Efficiency of the Treatment Plant

(1) B.O.D. removals in lagoons only

av. B.O.D. before treatments = 3,900 mg/l

av. B.O.D. after treatments = 125 mg/l

removal efficiency = \( \frac{3900 - 125}{3900} \times 100 \)

\[ = \frac{3725}{3900} \times 100 \]

\[ = 95\% \text{ of the lagooning system only} \]

Note: Comparative data on the national basis are not available
for the same kind of the treatments.

(2) Rate of spray irrigation

\[
\text{av. flow} = 36,000 \text{ gal/day}
\]

\[
= \frac{36,000}{7.48} \text{ cu. ft/day}
\]

\[
= 4,820 \text{ cu. ft/day}
\]

Total area of land for spray irrigation = 10 acres. Assume that spray irrigation is done 10 hour/day

\[
\text{rate of sprinkling} = \frac{4820}{10} \times \frac{12}{43560} \times \frac{24}{10} \text{ inch/acre}
\]

\[
= 0.318 \text{ inch/acre}
\]

B.O.D. loading rate in spray irrigation:

Average B.O.D. = 125 mg/l

\[
= 125 \times 36,000 \times 10^{-6} \times 8.33 \text{ lb/day}
\]

\[
= 37.5 \text{ lb/day}
\]

B.O.D. loading rate = \[
\frac{37.5}{10}
\]

\[
= 3.75 \text{ lb/acre/day}
\]
HI-LAND DAIRY
(at Richmond, Utah)

1. Treatment Details:
   (a) Waste discharge flow:
       Average discharge flow = 500,000 gal/day
   (b) Present treatments
       A small unit of activated sludge is the only present
       treatment of the effluent.
   (c) Proposed treatments
       Four lagoons in series are proposed to operate by
       December 31, 1972. A chlorination unit is also proposed
       1. Aerated lagoon - 195' x 270' x 5' = 263,000 cu. ft.
       2. Aerated lagoon - 258' x 285' x 5' = 368,000 cu. ft.
       3. Settling lagoon - 215' x 95' x 5' = 102,000 cu. ft.
       4. Chlorinator
       5. Storage Pond - 254' x 305' x 5' = 404,500 cu. ft.
       The proposed lagooning system is designed to bypass the
       waste stream directly into the aerated lagoon #1.
   (d) Effluent discharge
       During summer, the effluent is utilized for sprinkler
       irrigation and it is discharged into the Cub River during
       winter.
2. Line Diagram For Waste Treatments

Waste Stream → By pass → Activated Sludge → Aerated Lagoon #1 → Aerated Lagoon #2 → Settling Lagoon #3 → Chlorinator → Storage Pond #4

Note: Dotted lines indicate proposed treatments

To Cub River or Sprinkling Irrigation
HI-LAND DAIRY
Effluent Analyses

Temperature

B.O.D.

Class "C" Std. (B.O.D.) = 5 mg/l

Class "D" Std. B.O.D.

3 (a) TIME PERIOD V/S B.O.D. AND TEMPERATURE
3 (c) SUSPENDED SOLIDS AND pH
4. The Quality of Final Effluent

The analyses of the untreated present effluent is tabulated for the main pollutants. The Table indicates the maximum, minimum and mean value of the pollutants in the final effluent discharged to the receiving water body.

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Average (from graph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.O.D.</td>
<td>710</td>
<td>30</td>
<td>300 mg/l</td>
</tr>
<tr>
<td>MPN coliforms</td>
<td>$9.3 \times 10^6$/100 ml</td>
<td>$2300/100$ ml</td>
<td>$1.9 \times 10^6$/100 ml</td>
</tr>
<tr>
<td>Total S.S.</td>
<td>5870 mg/l</td>
<td>40 mg/l</td>
<td>200 mg/l</td>
</tr>
<tr>
<td>pH</td>
<td>7.8</td>
<td>4.0</td>
<td>6.8 mg/l</td>
</tr>
<tr>
<td>Temperature</td>
<td>105°F</td>
<td>58°F</td>
<td>87°F</td>
</tr>
</tbody>
</table>

The average B.O.D. and coliforms are high in the final discharging effluent; that can be classified in class "D" water or below, according to the requirements of the Utah Code of waste disposal regulations. The treatment plant has not been in operation since 1967. In order to improve the effluent quality, the proposed treatment system should be applied as early as possible.

5. Removal Efficiency of the Treatment Plant

The Dairy does not have any waste treatment at present. The activated sludge process has not been in operation since 1967.
Detention period of proposed lagoons = \( \frac{\text{total capacity of lagoons}}{\text{av. flow}} \)

\[\frac{(263 + 368 + 102 + 404.5) \times 10^3 \times 7.48}{500,000} \]

\[\frac{1137.5 \times 7.48}{500} \]

= 17 days

According to F.W.P.C.A. Publication No. I.W.P. - 9-146, Dairies, the normal removal efficiency of the total wasteload removal for the same kind of treatments is 90 to 95%.
CHAPTER VI

CANNERIES

CALIFORNIA PACKING CORP.
(Dei Monte Corp. at Smithfield, Utah)

1. Treatment Details
   (a) Waste discharge flow
       Average flow during operating season = 5 to 14 million gal/month.
       Operating season = 1st August to the 10th of October.
   (b) Present treatments
       The effluent is screened and dumped directly into the irrigation ditch. The waste water is utilized in field irrigation from the ditch.
   (c) Proposed treatments
       The following treatments are proposed to operate during the season of 1973.
       (i) Screening - 20 mesh
       (ii) Sprinkle irrigation in 30 acres and flood irrigation in 19 acres are proposed at a rate of one inch/acre to prevent runoff or seepage into the ground water.
   (d) Effluent
       The final effluent is discharged into the irrigation ditch.
2. Line Diagram for Waste Treatments

Waste stream → Screen → Irrigation Ditch → Sprinkle Irrigation 30 acres

↓
To Irrigation System

↓
Flood Irrigation 19 acres

Note: Dotted lines indicate proposed treatments
<table>
<thead>
<tr>
<th>Date</th>
<th>B.O.D. mg/l</th>
<th>MPN coliforms per 100 ml</th>
<th>Total Suspended Solids, mg/l</th>
<th>pH</th>
<th>Temperature °F</th>
<th>MPN Fecal coliforms</th>
</tr>
</thead>
<tbody>
<tr>
<td>9-6-67</td>
<td>640</td>
<td>23,000,000</td>
<td>466.0</td>
<td>7.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-31-68</td>
<td>531</td>
<td>23,000,000</td>
<td>20.5</td>
<td>7.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9-11-68</td>
<td>688</td>
<td>930,000</td>
<td>495.0</td>
<td>7.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-23-68</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No sample, campaign completed</td>
<td></td>
</tr>
<tr>
<td>4-9-69</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No discharge</td>
<td></td>
</tr>
<tr>
<td>7-2-69</td>
<td>28.3</td>
<td>2,300</td>
<td>15.0</td>
<td>7.80</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>8-13-69</td>
<td>7670</td>
<td>4,300,000</td>
<td>690.0</td>
<td>7.00</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>9-24-69</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No sample, plant not operating</td>
<td></td>
</tr>
<tr>
<td>11-13-69</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No sample, plant not operating</td>
<td></td>
</tr>
<tr>
<td>7-15-70</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No sample, plant not operating</td>
<td></td>
</tr>
<tr>
<td>8-26-70</td>
<td>2000</td>
<td>4,300,000</td>
<td>720.0</td>
<td>7.35</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>11-23-70</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No sample, no discharge</td>
<td></td>
</tr>
<tr>
<td>8-10-71</td>
<td>4050</td>
<td>23,000,000</td>
<td>2200</td>
<td>4.50</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>9-14-71</td>
<td>2480</td>
<td>23,000,000</td>
<td>2120</td>
<td>7.25</td>
<td>74</td>
<td>23,000</td>
</tr>
<tr>
<td>10-26-71</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No sample, campaign ended</td>
<td></td>
</tr>
<tr>
<td>7-5-72</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No sample, plant shut down</td>
<td></td>
</tr>
</tbody>
</table>

3. Water and Wastewater Analyses of California Packing Corp.
4. The Quality of Final Effluent

There is no waste treatment provision at present in the California Packing Corp. The effluent has high B.O.D. and coliform bacteria and it is utilized for field irrigation. The sprinkling irrigation and flood irrigation are proposed by the State Division of Health.

Recommendations:

(1) The rate of the (proposed) spray irrigation

\[
\text{av. waste flow} = 5 \text{ to } 14 \text{ million gal/month}
\]

Design the rate for 14 million gal/month

\[
= \frac{14 \times 10^6}{30} \times \frac{1}{7.48} \text{ cu. ft./day}
\]

= 62,500 cu. ft.

Assume the rate of flow in spray irrigation and in flood irrigation be the same.

The flow in spray irrigation = \(\frac{30}{49} \times 62500\)

= 38,200 cu. ft/day/30 acres

The rate of sprinkling = \(\frac{38200}{30 \times 43560}\) x 12 inch/acre/day

= 0.35 inch/acre/day

Assume that the sprinkling is done for 10/hour/day

The rate of sprinkling = \(\frac{24}{10}\) x 0.35 inch/acre

= 0.845 inch/acre

Provide one inch/acre
(2) B.O.D. loading rate in spray irrigation

Average B.O.D. in the waste water = 2,000 mg/l

\[ = 2000 \times \frac{14}{30} \times \frac{30}{49} \times 8.33 \text{ lb/day} \]

\[ = 4760 \text{ lb/day} \]

B.O.D. loading rate = \( \frac{4760}{30} \) lb/acre

\[ = 158.7 \]

Say 160 lb/acre/day

According to F.W.P.C.A. Publication No. I.W.P. - 6, page 42, Fruits and Vegetables, the normal removal efficiency of the B.O.D. to surface water by spray irrigation is 100%. 
CHAPTER VII

CONCLUSIONS AND DISCUSSIONS

The following general conclusions can be drawn from this study:

1. Many of the Utah Industrial Waste Treatment Plants discharge effluents, which are inferior to the quality of the receiving water. The present treatment provided at most of the Utah Industries is not sufficient to satisfy the effluent quality requirements of the Utah State Division of Health. There are two main reasons for this:

(a) Temperature:

Between November and April, the average lagoon temperature is between 20°F and 50°F. At this temperature the theoretical 5 day 20°C B.O.D. reduction rate is 25.1 percent less than the B.O.D. reduction rate during May to October, when the temperature is between 50°F to 80°F (Temperature chart of Salt Lake City, Utah and the sample calculations for the B.O.D. reduction rate are shown in the Appendix).

(b) Detention Period:

Between November and April, the average lagoon detention period required, if adequate oxygen is available to satisfy the oxygen uptake rate is over 20 days. (See the chart given in the Appendix).
2. The exposed surface for oxygen uptake purposes is often frozen over during the winter thus reducing the amount of oxygen available to satisfy the oxygen uptake rate.

3. With high B.O.D. loadings, it is necessary to provide at least one acre of exposed surface for each 50 pounds of oxygen demand per day. Data was not available for making determinations as to the adequacy of the present lagoon areas for the loads applied to the lagoons. This should be the basis for another study.

4. The State Division of Health has proposed additional treatments individually to many of the State Industries, which may improve the quality of the present effluents after additional treatment is placed into operation.

5. The growth of industries in the future will increase the number of effluents into the receiving water quality. In the future the newly establishing industries should provide adequate waste treatment to avoid further water pollution problems.
LIST OF REFERENCES

1. Utah State Division of Health, "Industrial Wastewater Facilities in Utah", 1965 and Inventory revised 1968.


5. American Petroleum Institute, "A.P.I. Manuals".


15. Utah Water Pollution Committee and the Utah State Board of Health, "Classifications of all Surface Waters in the State of Utah", (June 23, 1972).
APPENDIX

I. A Code of Water Quality for Class "C" and Class "D" Waters

The surface waters, receiving the effluents from the selected industries of this project are classified into class "C" waters.

The standards of quality for class "C" and class "D" waters of Utah are mainly applicable in this project. The following standards have been taken from the Code of Waste Disposal Regulations, Part II, "Standards of Quality for Waters of the State", published by the Utah State Division of Health.

Class "C" Waters shall be so protected against controllable pollution, including heat, as to be suitable at all times for domestic water supplies which are treated before use by coagulation, sedimentation, filtration, and disinfection. Class "C" waters shall be suitable without treatment for aesthetics, irrigation, stock watering, propagation and perpetuation of fish, other aquatic life, and wildlife, recreation (except swimming) /1/, as a source for industrial supplies, and for other uses as may be determined by the Committee and Board.

It shall be unlawful to discharge or place any wastes or other substances in such a way as to result in:

---

/1/ In bodies of water where natural purification action can be shown to result in water quality consistent with the "CR" quality standard presented in Section II-11, swimming may be permitted subject to specific approval by the State Board of Health, notwithstanding any different initial classification.
(a) Materials that will settle to form objectionable deposits;
(b) Floating debris, oil, scum and other matters;
(c) Substances producing objectionable color, odor, taste or turbidity;
(d) Materials, including radionuclides, in concentrations or combinations which are toxic or which produce undesirable physiological responses in humans, fish and other animal life and plants;
(e) Substances and conditions or combinations thereof which produce undesirable aquatic life; or
(f) Other constituents which will interfere with the stated Class "C" water uses; or
(g) The following specific standards being violated in any Class "C" waters:

1. Chemical and radiological standards shall be as prescribed for drinking water by "Public Health Service Drinking Water Standards, 1962".

2. Radioactive substances shall not exceed 1/30th of the $\text{MPC}_W$ values given for continuous occupational exposure in National Bureau of Standards Handbook 69 or result in accumulations of radioactivity in edible plants and animals that present a hazard to consumers.

3. Hydrogen-ion concentration shall not exceed the range described by a pH of 6.5 to 8.5, nor shall it change more than 0.5 pH unit, from other than natural causes.
4. Monthly arithmetical mean coliform density shall not exceed 5000 per 100 milliliters, as determined by standard multiple-tube fermentation or membrane filter techniques; except that 20% of all samples collected in any month may exceed this standard if no more than 5% of all samples collected in the same month exceed a coliform density of 20,000 per 100 milliliters; AND, monthly arithmetical mean fecal coliform density shall not exceed 2000 per 100 milliliters.

5. Monthly arithmetical mean biochemical oxygen demand (BOD) shall not exceed 5 milligrams per liter; except that 20% of all samples collected in any month may exceed this value if no more than 5% of all samples collected in the same month exceed a BOD of 10 milligrams per liter.

6. Dissolved oxygen shall be not less than 5.5 milligrams per liter.

Class "CC" Waters shall be protected as Class "C" waters, and also against any wastes or activities which alone or in combination will cause an incremental increase in temperature of said waters of more than 20°F., or an elevation in such temperature above 68°F., or will cause the dissolved oxygen level of such waters to fall below 6.0 milligrams per liter.

Class "CW" Waters shall be protected as Class "C" waters, and also against any wastes or activities which alone or in combination will
cause an incremental increase in temperature of said waters of more
than 4°F., or an elevation in such temperature above 80°F.
Class "CR" Waters shall be suitable for swimming as well as for
other uses specified and shall be protected as Class "C" waters except
for specific standard No. 4 which is modified as follows for applica-
tion to Class "CR" waters:

Monthly arithmetical mean coliform density shall not exceed 1,000
per 100 milliliters, as determined by standard multiple-tube
fermentation or membrane filter techniques; no more than 20% of
all samples collected in any month may exceed a coliform density
of 1000 per 100 milliliters and no more than 5% of all samples
collected in the same month may exceed a coliform density of
4000 per 100 milliliters; AND, monthly arithmetical mean fecal
coliform density shall not exceed 200 per 100 milliters,
provided that no more than 10% of all samples collected in any
month shall exceed a fecal coliform density of 400 per 100
milliliters.

Class "CCR" Waters shall be protected as Class "CC" and Class "CR"
waters.

Class "CWR" Waters shall be protected as Class "CW" and Class "CR"
waters.

Class "D" Waters shall be so protected against controllable pollu-
tion, including heat, as to be suitable at all times for limited
irrigation, not including irrigation of lawns, recreational areas,
pastures used for dairy cattle, root crops, or any low growing crops
produced for human consumption. Class "D" waters shall be suitable as a source for industrial supplies and for other uses as may be determined by the Committee and Board.

It shall be unlawful to discharge or place any wastes or other substances in such a way as to result in slicks, floating solids, suspended solids, toxic materials, or other constituents which interfere with the stated Class "D" water uses or to cause the following specific standards to be violated in any Class "D" waters.

1. Chemical and radiological standards shall be as prescribed for drinking water by "Public Health Service Drinking Water Standards, 1962".

2. Radioactive substances shall not exceed \( \frac{1}{30} \)th of the \( \text{MPC}_W \) values given for continuous occupational exposure in National Bureau of Standards Handbook 69 or result in accumulations of radioactivity in edible plants and animals that present a hazard to consumers.

3. Hydrogen-ion concentration shall not exceed the range described by a \( \text{pH} \) of 6.5 to 9.0.

4. Monthly arithmetical mean coliform density shall not exceed 5000 per 100 milliliters, as determined by standard multiple-tube fermentation or membrane filter techniques; except that 20% of all samples collected in any month may exceed this standard if no more than 5% of all samples collected in the same month exceed a coliform density of 20,000 per 100 milliliters.
5. Monthly arithmetical mean biochemical oxygen demand (BOD) shall not exceed 25 milligrams per liter; except that 20% of all samples collected in any month may exceed this value if no more than 5% of all samples collected in the same month exceed a BOD of 50 milligrams per liter.

2. A Typical Design of A.P.I. Separator for Phillips Petroleum Company

I. Conditions of Waste Water and Oil

a. Waste water and oil

\[ Q_{av.} = 0.87 \text{ mgd} \]

\[ = 0.87 \times 10^{-6} \text{ gal/day} \]

Assume \( Q_{max} \) is 10 percent more than \( Q_{av.} \).

\[ Q_{max.} = \frac{0.87 \times 10^6 \times 1.1}{24 \times 60 \times 7.48} \text{ cfm} \]

\[ = 88.7 \text{ cfm} \]

Minimum temperature of the waste flow = 37°F

Sp. gravity of water = \( S_w = 0.99 \)

Sp. gravity of oil = \( S_o = 0.94 \) at 50°F or less

Absolute viscosity = \( \mu = 0.0065 \) poise

Maximum allowable mean horizontal velocity

\( V_H = 15 \text{ Ft. not to exceed 3 fpm} \)

b. Rate of rise in waste water

Rate of rise = \( V_t = 0.0241 \left( \frac{S_w - S_o}{\mu} \right) \)

\[ = 0.0241 \times \frac{0.99 - 0.94}{0.0065} \]
\[ = 0.1855 \text{ fpm} \]

Maximum allowable mean horizontal velocity

\[ VH = 15 \times 0.1855 = 2.78 \text{ fpm} \]

This is less than maximum allowable velocity 3 fpm

therefore, use \( VH = 2.78 \text{ fpm} \)

II. Design Factors

a. For turbulence with:

\[
\frac{VH}{Vt} = \frac{2.78}{0.1855} = 14.95
\]

\( Ft = 1.37 \) (interpolated from Table 5-1 of A.P.I. Manuals)

b. For short circuiting

\( Fs = 1.2 \)

c. Total design factor \( F = Ft \times Fs = 1.37 \times 1.2 = 1.64 \)

III. Minimum Areas and Dimensions

a. Minimum Cross-sectional area

\[
Ac = \frac{Qm}{VH}
\]

\[ = \frac{88.7}{2.78} = 31.9 \text{ sq. ft.} \]

b. Number of channels

The largest practicable channels is one 20 ft. wide and 8 ft. deep, having cross sectional area of 160 sq. ft.

Provide one channel

c. Dimensions of acceptable separator channel
Assume \( d/B = 0.5 \) \( \Rightarrow d = 0.5B \)

\( Ac = d \times B = 0.5B^2 = 31.9 \) sq. ft.

\( B^2 = 63.8 \)

\( B = 7.98, \) Say 8 ft.

Provide \( B = 8 \) ft.

and \( d = 4 \) ft. + 1.5 ft. free board = 5.5 ft.

Length of the separator = \( L = F \left( \frac{VH}{V_t} \right) d \)

\[ = 1.64 \times 14.95 \times 4 \]

\[ = 98 \text{ ft.} \]

Provide 100 ft.

Provide an A.P.I. Separator of 100 x 8 x 5.5 ft.

Minimum dimensions required for A.P.I. separator are 100 x 8 x 5.5 ft. (Considering industrial waste flow only)

3. Rate of B.O.D. Removals with Respect to Temperature

The 1st stage B.O.D. removals can be determined at any temperature by the equations:

\[ \log \frac{L-y}{L} = -K't \]

\( K'T = K'_{20} \left( 1.047^{37-20} \right) \)

Where \( L = \text{ultimate 1st stage B.O.D.} \)

\( y = \text{B.O.D. exerted in time } t \)

\( K'_{20} = \text{Reaction constant at } 20^\circ C \)

\( t = \text{Time in days} \)
\[ K'_{T} \] = Reaction constant at temp. \( T \, ^\circ C \)

The first stage B.O.D. removals can be determined at \( 20 \, ^\circ C \) by the equation:

\[ L_{T} = L_{20} \left( 1 + 0.02(T-20) \right) \]

where \( L_{T} \) = B.O.D. at temp. \( T \, ^\circ C \)

\[ L_{20} \] = B.O.D. at temp. \( 20 \, ^\circ C \)

\( T \) = any temp. in \( ^\circ C \).

The 5 day B.O.D. at \( 20 \, ^\circ C \) can be determined by the equation:

\[ \log \frac{L - X_{t}}{L} = -K't \]

where \( X_{t} \) = B.O.D.\(_{5}\) in mg/l at \( 20 \, ^\circ C \)

**Sample Calculations**

For 40 \( \, ^\circ F \) (4.44)

Assume the initial B.O.D.\(_{5}\) of 100 mg/l in the effluent at \( 20 \, ^\circ C \)

Let reaction constant at \( 20 \, ^\circ C \) = 0.1

Now B.O.D. at \( 20 \, ^\circ C \) = 100 mg/l

(1) 1st Stage B.O.D. at \( 20 \, ^\circ C \)

\[ \log \frac{L - X_{t}}{L} = -K't \]

\[ \log \frac{L - 100}{L} = -0.1003 \times 5 \]

\[ = 0.5015 \]

\[ = 0.4985 - 1 \]
\[
\frac{L - 100}{L} = 0.3152
\]

\[L = 146.5 \text{ mg/l at } 20^\circ \text{C}\]

(2) 1st Stage B.O.D. at \(-4.44^\circ \text{C}\)

\[
L (4.44 \text{ C}) = L_{20} 1 + 0.02 (T-20)
\]
\[= 146.5 1 + 0.02(4.44 - 20)\]
\[= 146.5 1 - 0.02 \times 15.56\]
\[= 146.5 1 - 0.3112\]
\[= 146.5 \times 0.6888 = 101 \text{ mg/l}\]

(3) 5 Day B.O.D. at Temp. \(-4.44^\circ \text{C}\)

\[
\log \frac{L (+4.44 \text{ C}) - Y}{L (+4.44 \text{ C})} = -K't
\]

ie \[
\log \frac{101 - Y}{101} = 0.1 \times 5 = 0.5 - 1
\]
\[
\frac{101 - Y}{101} = 0.1 \times 5 = 0.5 - 1
\]
\[
\frac{101 - Y}{101} = 0.3162 \quad Y = 69.2 \text{ mg/l}
\]

(B.O.D.\(_5\) at \(4.44^\circ \text{C}\))
Computation Table for the Rate of 5 Day B.O.D. Removals

<table>
<thead>
<tr>
<th>Reason</th>
<th>Temp. °F</th>
<th>Temp. °C</th>
<th>Reduction of B.O.D. in mg/l</th>
<th>Percentage Reduction</th>
<th>Reasonal Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>40</td>
<td>4.44</td>
<td>69.2</td>
<td>48.4</td>
<td>51.5%</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>10</td>
<td>78.2</td>
<td>54.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>15.15</td>
<td>91.4</td>
<td>64.0</td>
<td></td>
</tr>
<tr>
<td>Summer</td>
<td>68</td>
<td>20</td>
<td>100</td>
<td>70.0</td>
<td>76.6%</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>21.1</td>
<td>105.2</td>
<td>73.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>26.6</td>
<td>130.9</td>
<td>91.9</td>
<td></td>
</tr>
</tbody>
</table>

% Reduction of B.O.D. during Summer = 76.6
% Reduction of B.O.D. during Winter = 51.5
Difference in reduction = 25.1%

Temperature Chart
Salt Lake City, Utah
Average temperature in °F

<table>
<thead>
<tr>
<th>Year</th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>M</th>
<th>J</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972</td>
<td>29.8</td>
<td>37.8</td>
<td>46.9</td>
<td>48.1</td>
<td>60.5</td>
<td>71.9</td>
<td>77.2</td>
<td>75.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1971</td>
<td>32.4</td>
<td>34.9</td>
<td>40.4</td>
<td>48.2</td>
<td>56.6</td>
<td>67.5</td>
<td>76.4</td>
<td>76.9</td>
<td>59.8</td>
<td>47.5</td>
<td>37.6</td>
<td>26.9</td>
</tr>
<tr>
<td>1970</td>
<td>34.6</td>
<td>40.4</td>
<td>40.6</td>
<td>44.2</td>
<td>58.8</td>
<td>67.6</td>
<td>76.6</td>
<td>77.7</td>
<td>59</td>
<td>47.1</td>
<td>42.6</td>
<td>29.2</td>
</tr>
<tr>
<td>1969</td>
<td>32.2</td>
<td>28.7</td>
<td>38.4</td>
<td>50.4</td>
<td>64</td>
<td>64.8</td>
<td>76.6</td>
<td>77.6</td>
<td>69.7</td>
<td>47.7</td>
<td>39.5</td>
<td>32.4</td>
</tr>
<tr>
<td>1968</td>
<td>24.5</td>
<td>38.2</td>
<td>44.7</td>
<td>45.4</td>
<td>56.4</td>
<td>67.5</td>
<td>78.3</td>
<td>69.4</td>
<td>61.4</td>
<td>51.7</td>
<td>38.5</td>
<td>26.8</td>
</tr>
<tr>
<td>Ave.</td>
<td>30.7</td>
<td>36.0</td>
<td>42.2</td>
<td>47.2</td>
<td>59.3</td>
<td>67.8</td>
<td>77</td>
<td>75.5</td>
<td>62.5</td>
<td>48.5</td>
<td>39.5</td>
<td>28.8</td>
</tr>
</tbody>
</table>
According to the chart by Theriault, given on page 98 the following data is secured for the first stage carbonaceous matter reduction:

<table>
<thead>
<tr>
<th>Temp.</th>
<th>B.O.D. Reduction in Percentage of 5 day 20°C - B.O.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 Days 10 Days 15 Days 20 Days 30 Days 40 Days 50 Days 60 Days 70 Days</td>
</tr>
<tr>
<td>80°F</td>
<td>131 153 163 164 166 166 166 166 166</td>
</tr>
<tr>
<td>70°F</td>
<td>100 132 140 145 147 147 147 147 147</td>
</tr>
<tr>
<td>60°F</td>
<td>91.4 100 125 132 133 133 133 133 133</td>
</tr>
<tr>
<td>50°F</td>
<td>78.2 80 100 116 117 117 117 117 117</td>
</tr>
<tr>
<td>40°F</td>
<td>69.2 70 85 99 100 100 100 100 100</td>
</tr>
</tbody>
</table>

Also for the second stage Nitrogenous matter reduction can be obtained from the chart.

<table>
<thead>
<tr>
<th>Temp.</th>
<th>B.O.D. Reduction in Percentage of 5 day 20°C - B.O.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 Days 10 Days 15 Days 20 Days 30 Days 40 Days 50 Days 60 Days 70 Days</td>
</tr>
<tr>
<td>80°F</td>
<td>0 0 87 106 114 114 114 114 114</td>
</tr>
<tr>
<td>70°F</td>
<td>0 0 16 60 83 88 103 118 133</td>
</tr>
<tr>
<td>60°F</td>
<td>0 0 0 0 33 53 93 103 123</td>
</tr>
<tr>
<td>50°F</td>
<td>0 0 0 0 0 2 18 61 71</td>
</tr>
<tr>
<td>40°F</td>
<td>0 0 0 0 0 0 2 30 40</td>
</tr>
</tbody>
</table>
Total expected B.O.D. reduction in carbonaceous and nitrogenous matter is as follows:

<table>
<thead>
<tr>
<th>Temp.</th>
<th>B.O.D. Reduction in Percentage of 5 day 20°C B.O.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 Days</td>
</tr>
<tr>
<td>80°F</td>
<td>131</td>
</tr>
<tr>
<td>70°F</td>
<td>100</td>
</tr>
<tr>
<td>60°F</td>
<td>91.4</td>
</tr>
<tr>
<td>50°F</td>
<td>78.2</td>
</tr>
<tr>
<td>40°F</td>
<td>69.2</td>
</tr>
</tbody>
</table>

100 percent of the 5 day 20°C B.O.D. can be removed in:
(1) 5 days, when temperature is above 70°F; (2) 10 days, when temperature is above 60°F; (3) 15 days, when temperature is above 50°F and (4) 20 days, when temperature is above 40°F.

200 percent of the 5 day 20°C B.O.D. can be removed in:
(1) 15 days, when temperature is above 70°F; (2) 30 days, when temperature is above 60°F and (3) 60 days, when temperature is above 50°F.
B.O.D. reduction rate with respect to time and temperature, according to Theriault, taking the initial 5 day 20°C B.O.D. as 100 ppm as shown in the figure below:

(Refer "Engineering Management of Water Quality", by McGauhey, P.H.).