GEORGETOWN SEAFOODS LTD.

GEORGETOWN, P.E.I.

RE-STUDY OF WASTE TREATMENT

J.A. DELANEY & ASSOCIATES

CONSULTING ENGINEERS INGENIEURS-CONSEILS

MONTREAL 9, QUEBEC

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J. A. Delaney & Associates

CONSULTING ENGINEERS
MUNICIPAL & INDUSTRIAL PROJECTS

August 16, 1971.

RE - STUDY
of
METHOD
for
WASTE DISPOSAL

(PREVIOUS REPORT NOVEMBER 30th, 1970)

at
GEORGETOWN SEAFOODS LTD.

GEORGETOWN

PRINCE EDWARD ISLAND

for

DEPARTMENT OF REGIONAL

ECONOMIC EXPANSION

OTTAWA, ONTARIO

INDEX

1200 ST. AMOUR STREET
ST. LAURENT, MONTREAL 384, QUE.

J. A. Delaney & Associates
CONSULTING ENGINEERS
MUNICIPAL & INDUSTRIAL PROJECTS

August 16, 1971.

Canada
Department of Regional
Economic Expansion
161 Laurier Avenue West
Ottawa 4, Ontario

Attention: Mr. Garnet T. Page
Director General
Implementation Services

Re: Re-Study of Waste Disposal
Georgetown, P.E.I.

Dear Sir:

Since the completion of our original and first study on Waste Treatment for Georgetown Seafoods Ltd., Georgetown, P.E.I. and the submission of this report on November 16th 1970, many interesting questions have been raised in Mr. Hiscock's letter of January 18th 1971 presumably as a result of his study of our report and subsequent letters on the subject.

In essence, as far as we can decipher Mr. Hiscock's comments, he is concerned in regard to the maximum recovery of all fish wastes from Georgetown Seafoods Ltd. as a means of:

1) Providing a recovery system that would pay for its capital and operating costs.

2) By so doing, this would reduce the load to our proposed biological treatment system (as proposed in our report) and thus reduce the cost of this facility.

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Department of Regional
Economic Expansion
Mr. G.T. Page

August 16, 1971

As a point of interest, our original and primary objective, as directed by your department, was the minimizing of capital and operating costs as the basis for our original study. We were and are always concerned when a usable and potentially recoverable material is allowed to be wasted to a sanitary sewer, thus adding to the overall capital and operating costs to dispose of a waste material of very marginal value even when used for land disposal or fertilization.

As a result of Mr. Hiscock's interest he contacted the Maritime representative of a Danish firm " P Borup Sorensen" who specialize in chemical treatment and "Air Floatation" of fish plant wastes in order to recover protein and fish oil from fish plant effluent streams. He obtained a quotation dated March 29th 1971 (copy enclosed in this report) for a recovery system.

At Georgetown Seafoods Ltd., a rotary screen exists and functions to separate and recover the fish offal and fish particles from the total fish plant effluent. This material is conveyed to their existing reduction plant for protein and oil recovery.

Obviously, the soluble materials in the effluent are not removed by screening, and in addition, some small fish particles do pass through the screen.

Mr. Hiscock envisioned that the above material, that passes the screens could be economically recovered, thus resulting in his recommendation that the foregoing "Air Floatation" recovery method be further investigated.

During subsequent discussions with your department it was decided to investigate "Air Floatation" on its merits as a possible adjunct or replacement for the biological system outlined in our original report.

In addition to the above and in order to verify the recommendations of our original report we asked permission from your department to consult Dr. Ross E. McKinney for a review of our report and to submit his unbiased recommendations. On receipt of your authorization, we forwarded all pertinent documentation to Dr. McKinney on April 20th, 1971.

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Department of Regional
Economic Expansion
Mr. G.T.Page

Further, since the writer had planned a trip to Europe starting May 13th 1971, it was felt appropriate to ask your department for authorization to visit the firm of " P Borup Sorensen" in Denmark and to visit a number of their operating facilities in Europe on similar wastes, using "Air Floatation" as a recovery method.

We received your written authorization dated May 20th 1971 (copy enclosed).

Dr. McKinney submitted his report dated June 9th 1971 in which he critically reviewed our recommendations and the alternative system of "Air Floatation" and protein recovery.

In the enclosed re-study, you will find a detailed analysis of all facets related to the foregoing, and we hope that this "Re-Study" will be informative to all concerned.

Yours truly

J. A. DELANEY & ASSOCIATES

J. A. Delaney, Eng.

JAD/ac
Encls.

CORRESPONDENCE b)

PROVINCE OF PRINCE EDWARD ISLAND

THE PRINCE EDWARD ISLAND WATER AUTHORITY

AREA CODE 902
TEL.: 892-5562

P.O. BOX 2000
CHARLOTTETOWN, P.E.I.

JAN 21 1971
REC'D.

18 January 1971

Mr. R.P. Harrison,
Director,
Technical Services Branch.
Implementation Services Division,
161 Laurier Avenue West,
OTTAWA 4, Ontario.

Re: STUDY GEORGETOWN SEAFOODS LIMITED

Dear Sir:

I wish to acknowledge, with thanks, your letter of 15 January 1971, together with a copy of Mr. Delaney's letter of 6 January 1971 addressed to Mr. Page.

The following comments are forwarded:

(a) My feeling relating to Mr. Ruggles' letter of 31 December 1970 were expressed in my letter of 5 January 1971.

(b) With regards to the daily water consumption at Georgetown Seafoods, I was not questioning the amount, only the Consultant's use of an eight-hour day to determine the gallons per minute rate. This rate would have a bearing on the sizing of treatment facilities and the 1250 gpm is high.

(c) I still have some reservations on tube settlers, and these reservations have been confirmed by Mr. R.S. McKittrick, P. Eng., Micro Floc Division, Neptune Meters Limited, Toronto. The design parameters, such as solids loading to the clarifier, must be carefully considered. Also, operating problems have been encountered and it is reasonable that a client should be aware of these problems.

. . . 2

(d) With regards to item (f) of my 9 December 1970 letter, I have been advised by the Plan Managers to include Georgetown in the Industrial Waste Treatment Program under the Development Plan. My reference was to funding under the Development Plan.

(e) With regards to item (g) of your letter, may I suggest that since the Province owns the pumping station and force main, that the title be "Modifications to Existing Provincially-Owned Utility".

With your personal involvement in this Project, initially with A.D.B. and now with D.R.E.E., I am amazed at the views expressed in the last three paragraphs of your letter.

You are well aware of the concern expressed initially by Dr. John Bates and later by the writer, regarding the high cost of treatment which was proposed by L.A. Coles, and went as far as a Tender Call before being halted. Many times we have expressed ourselves as to the degree of treatment and by-product recovery at Georgetown.

It is also noted that during discussions with this Consultant, various alternatives including fine screening of industrial wastes, use of air floatation on the industrial waste, and treatment of domestic sewage only was submitted by the Water Authority as worthy of consideration. The Consultant certainly has the right to make any recommendation he wishes, but as stated in my 5 January 1971 letter, he has <u>not</u> reviewed the various alternatives.

Investigations by the Water Authority confirm that by-product recovery of oil and protein from the process water is very realistic, but the Consultant has ignored this alternative. Not only air floatation, but the Sorensen process could be applied here.

From Mr. Ruggles' letter I had the feeling that his Department had reservations on the Consultant's recommendation. Also, could you please advise me at what location and in what Provinces is the degree of treatment, as recommended by the Consultant, <u>a normal requirement of Provincial and Federal Governments</u> for existing fish processing plants?

If our comments are belated, it may be a reflection on our ways and means of communications on this Project. I do not consider the report adequate for our needs, and if you are not prepared to have the alternative methods of disposal investigated by your Consultant, please advise so that I can request the necessary funds from the Plan Managers to have the work carried out.

Sincerely yours,

A.J. HISCOCK,
Manager.

AJH/gl
cc Mr. L.E. Pratt

P. BORUP SORENSEN

ADDRESS: P. BORUP SORENSEN SKAGEN DENMARK
TELEPHONE: (08) 44 10 39
TELEGRAM: BORUPWATER-SKAGEN
TELEX: 37 87
BANKERS: SKAGENS BANK

(CANADA) COMPANY, P.O. BOX 140 MAHONE BAY, N.S.

YOUR REF. OUR REF. DATE 29 Mar 71

The Prince Edward Island Water Authority,
P.O. Box 2000,
Charlottetown, P.E.I.

Attention: Mr. A. Hiscocks, manager

Dear Mr. Hiscocks:

AMINODAN SYSTEM FOR GEORGETOWN

Further to our earlier discussions, we have pleasure in submitting a preliminary proposal for the Aminodan system to treat the fish plant effluent from Georgetown, stated to be 900 igpm, plus any herring pumping water that will be used to pump a maximum of 150 tons of herring per day into the reduction plant.

The full Aminodan system that will comprise

a) 2 flotation cells with all ancilliary pumps chemical storage, chemical mixing tanks, air compressor, high pressure dispersion water tank, etc.

b) recovered sludge treatment equipment including sludge mixing tank, heat exchangers, super D-canter, centrifuge, pumps, piping, lye cleanout system, etc. is priced at $241,000.00 Canadian, cif East Coast POE, duty and taxes extra.

Not included in this price is the cost of foundations and building, concrete day-tank, erection (one supervisor is included) and any costs incurred in service connections and effluent piping to and from the Aminodan system.

In order to provide a total cost picture, we can draw upon representative costs for the extra items from other proposals. The building, which will need to be 105' x 36' x 18' high (inside dimensions) has been estimated by an engineering consultant in Canada to be $40,000.00 including foundations and drainage. The effluent day-tank needs to have a capacity of 50,000 gallons and can be constructed in concrete. Estimated cost of $35,000.00. Erection, because most piping is pre-cut and all material is supplied, will consist of labour costs and $15,000.00 is budgeted for this. Service connections, effluent piping is estimated at $6,000.00.

The total estimated installed cost would then be as follows:

a) Aminodan system	$241,000.00
b) Building, incl foundations, etc.	40,000.00
c) Daytank	35,000.00
d) Erection labour	15,000.00
e) Service connections	6,000.00
	$337,000.00

We wish to remind you that all of these figures are only budgetory at this time but they do indicate the total capital cost figure. The Aminodan system, for example, includes a PH correction unit that costs $10,000.00. If you will approve the release of an effluent of a PH of approx. 4.2 into the ocean, then this unit will not be required.

We have estimated maximum costs on all of the Aminodan system and we feel confident that prices can be reduced as firm specifications are evolved.

The hourly running costs of the complete Aminodan system are as follows:

Chemicals	5.00	(less if PH adj. not reqd)
Labour	2.00	(not reqd. full time)
Electricity 30 KW @ 2¢	0.60	
Stema	2.50	
	10.10	

For the volume of water stated, the plant will operate for 10 to 12 hours per day, thus giving a daily running cost of approx. $110.00. If the fish plant operates at reduced capacity however, only one flotation line need be used with a consequent reduction in operating costs.

We will offer a guarantee with the Aminodan system that will specify a minimum reduction of 60% in the BOD and a minimum reduction of 90% in the oil. This is our standard guarantee and actual operating reductions are in excess of these figures. With these reductions in BOD and oil come the attendant recovery of products.

From the herring pumping water, we expect to recover approx 60 tons of fishmeal and 20 tons of oil from each 10,000 tons of herring pumped. Information from Georgetown indicated that the plant wished to receive 150 tons of herring per day for the duration of the available herring season. This would be a minimum. of 100 days. Therefore, recovery on 15,000 tons of herring would be 90 tons of fishmeal and 30 tons of oil.

Recovery from the fish filleting lines is estimated to be 200 lbs/hr of protein material and 80 lbs/hr of oil. For a normal day of operation of the Aminodan system the recovery will be 1 ton of protein material and 800 lbs oil.

Total annual recovery from the use of the Aminodan system can, therefore, be very considerable and, based on the herring operation specified above and a fish filleting operation of 5 months 25 day/month duration at full capacity, the recoveries will be:

Protein material	90	ton from herring pumping
	125	ton from fish plant
	215	tons /year
Oil	30	tons from herring pumping
	50	tons from fish plant
	80	tons /year.

We submit that the use of an Aminodan system, therefore, will not only achieve the pollution abatement results desired but will also offer the opportunity of appreciable product recovery. Should you find this preliminary proposal of interest, please let us know so that we may follow-up with a formal, detailed proposal that could form the basis of a contract.

Kindest personal regards.

Yours very truly,

P. BORUP SORENSEN CANADA COMPANY

David Pyle

D. Pyle

DP:dc

1200 ST. AMOUR STREET
ST. LAURENT, MONTREAL 384, QUE.

CORRESPONDENCE d)

J. A. Delaney & Associates
CONSULTING ENGINEERS
MUNICIPAL & INDUSTRIAL PROJECTS

April 20, 1971

Dr. Ross E. McKinney
Dean
Environmental Engineering Dept.
University of Kansas
Lawrence
Kansas, U.S.A.

Re: Georgetown Seafoods Ltd.
Georgetown, P.E.I.

Dear Dr. McKinney,

I am writing this letter to you in order to transmit a copy of my report of November 30th 1970 on our proposed treatment for a fish plant wastes at the location mentioned above as discussed with you over the telephone, yesterday, April 19th, 1971.

Altogether, you will find enclosed:

a) One copy of J.A. Delaney & Associates report dated November 30th, 1970.

b) One copy of my letter of January 6th, 1971 to the Department of Regional Economic Expansion.

c) One copy of a covering letter from Mr. R.P. Harrison, Director, Technical Services, Canada Department of Regional Economic Expansion, which encloses a copy of a proposal for this same Seafoods plant usine the "Aminodan" system from a company called P. Borup Sorensen (Canada) Co.

I would appreciate if you would review all three enclosures and write your comments in regard to your consideration of the most efficient and economical method for the treatment of the wastes from this plant. Your honest evaluation for the system as a preliminary design with modifications if you deem necessary would be most welcome.

As you will note in our report:

1) We conceived a system that would be as inexpensive as possible and simple to operate.

2). The plant uses fresh water for their processing, but intend to use some salt water for unloading herring from ships. Although I see no objection to a small quantity of salt water mixed with the fresh water effluent (see letter Jan.6/71), as an alternative should this relationship of salt water to fresh water become excessive the plant would find it mandatory to use fresh water for unloading herring instead of sea water, in order to protect the biota in the treatment plant.

3) You will note in our report (plans are included in a pocket on the back cover) that we have included the town of Georgetown for two purposes:

a) As a source of seed for the biological process

b) Because of the small population (about 1000) and subsequently the small biological load in comparison to the much higher fish plant wastes both would be treated simultaneously.

4) You will find under section No.1 "Laboratory Analysis" the actual analysis on grab samples taken when the plant was unloading "Red Fish" and the plant was filleting at their normal capacity of about 50,000 lbs per day. "Red Fish" are normally mechanically descaled prior to filleting. Because of the extreme variability of production from day to day we chose this particular day for sampling, yet we are not certain that the values we obtained are an average representation of the strength of the wastes.

You will find under chapter 5 Section "System Treatment Criteria" p 5-1 an elevated B.O.D. and S.S. which wefelt necessary to augment because of the grab sample technique and the additional load that could be imposed by solid fish material, which we could have missed and in addition these values are more in line with those from similar plants.

5) You will also note that in order to keep costs to a minimum we are <u>not</u> providing primary treatment but instead we are providing adequate communition (two in series). We also are using the terrain in order to build the 24 hour extended aeration lagoon and 10 day aerobic digester. We have also included 2-speed surface aerators in order to prevent over-aeration.

6) Your verbal suggestion concerning a holding and drying lagoon for the aerobically digested sludge is a welcome suggestion for land spreading of the dried solids.

7) We suggested a rotary type screen on the effluent from the plant where the wastes are de-watered and the offal goes to a reduction plant with the liquid wastes then mixing with the town sanitary wastes to be pumped to the proposed treatment plant. We felt that this was sufficient in terms of economy and that the remaining materials in the waste water would be biologically degraded in the treatment plant.

8) The inclusinn of the "Aminodan"system seems to us to be an added complication for the following reasons:

a) This process attempts to reduce the protein content of the waste water by acidification to pH4.2 in order to precipitate or denature the complex organic constituents in the waste water.

By reference to "Fieser & Fieser Advanced Organic Chemistry" "Reinhold" page 1015, table 31.1, the iso-electric point for amino acids and proteins varies from a high of pH 10.6 to a low of pH 2.77 and according to page 1016 (last paragraph) these organic molecules will remain in solution unless the exact iso-electric point is maintained. I can visualize that this system may work relatively well, if one were dealing with only one amino acid or protein at a constant consistency and flow.

b) This process will require a pH influent control and a mandatory pH effluent control since one cannot discharge water at a pH of 4.2 either into a municipal system or into the ocean. This requirement alone would require full time attendance by an instrument technician because pH signals are notorious for emitting a drifting signal as the glass electrode and calomel cell become coated with extraneous material. I have found that it is less than useless to install pH control equipment unless one has a competent crew to constantly scan the system for pH errors.

c) The value of 60% B.O.D. reduction by the "Aminodan System" particularly in this instance is in my opinion greatly over-rated because of the wide variety of amino acids and proteins in the wastes. If one were to believe that 60% were attainable, then further treatment would, in my opinion, be required, therefore by deduction the "aminodan system", is performing the function of a glorified primary system at a cost equal to or greater than the proposed biological treatment plant.

9) At this point you will realize that the points put forward in the preceeding paragraphs are my opinions only and not intended to influence your reply in any way, since my reasoning could be exceedingly incorrect.

10) The intent of this letter is to elicit your criticisms, approval or alternative suggestions.

I hope that I have given you an accurate summary of the existing situation, and I have been authorized to ask you to write a report to me on the material I am forwarding to you, and you are asked to enclose your invoice for professional services which will be paid for, by my office.

I find this small project to be extremely challenging from a theoretical point of view, and I do hope that you will find time to answer this request as soon as possible.

Yours truly

J.A. DELANEY & ASSOCIATES

J.A. Delaney, Eng.

JAD/ac
Encl.

cc: Canada
Department of Regional
Economic Expansion
Mr. R.P. Harrison
Technical Director

CANADA
DEPARTMENT OF REGIONAL
ECONOMIC EXPANSION

MINISTÈRE DE L'EXPANSION
ÉCONOMIQUE RÉGIONALE

CORRESPONDENCE e)

OTTAWA K1A 0M4,
May 20, 1971.

Mr. J. A. Delaney,
J. A. Delaney & Associates Ltd.,
1200 St. Amour Street,
Montreal 384,
Quebec.

Re: Industrial Waste Treatment, Georgetown, P.E.I.

Dear Mr. Delaney:

This will refer to your letters of April 20th and May 3, 1971 concerning review of your report on your study and the two Sorensen proposals for the above project.

I have since received a letter from Mr. A. J. Hiscock, Chairman of the Prince Edward Island Water Authority and had a short meeting with him on May 19th in connection with the project. In this regard, I am enclosing a copy of my letter of this date to Mr. Hiscock concerning a tentative meeting in Charlottetown on or about June 9th. I would expect by this time you would have received comments from Dr. McKinney, and would have sufficient time to prepare your comments for a meeting with Mr. Hiscock and the plant operators in Prince Edward Island.

This will also serve as your authority to use the services of Dr. McKinney as your associate and also authority for your trip from Paris to Copenhagen and return, together with applicable expenses incurred on the trip.

If for some reason you will be unable to attend the proposed meeting in Charlottetown, would you please advise me immediately.

Yours sincerely,

R. P. Harrison, P.Eng.,
Director,
Technical Services Branch.

EVALUATION OF PROPOSED WASTEWATER TREATMENT SYSTEM FOR GEORGETOWN SEAFOOD, LTD. PREPARED BY J.A. DELANEY & ASSOCIATES

FOR
J.A. DELANEY
J.A. DELANEY & ASSOCIATES
MONTREAL, QUEBEC
CANADA

by
Ross E. McKinney

ENVIRONMENTAL POLLUTION CONTROL SERVICES, INC.
LAWRENCE, KANSAS

June 9, 1971

EVALUATION OF PROPOSED WASTEWATER TREATMENT
SYSTEM FOR GEORGETOWN SEAFOOD, LTD,
PREPARED BY
J.A. DELANEY AND ASSOCIATES

PURPOSE:

The purpose of this report is to review the proposed wastewater treatment system for Georgetown Seafood, Ltd., as prepared by J.A. Delaney and Associates.

WASTE CHARACTERISTICS

Accurate waste characteristics from fish processing plants are difficult to obtain. Fish processing plants normally do not operate with a uniform input of uniform material. They operate on an intermittent basis as ships bring fish to the processing plant. The fish must be removed from the trawlers and transferred to the processing plant. This process requires definite operational procedures which affect the waste production. The operational pattern at the Georgetown Seafood, Ltd. plant, appears normal in this regard. In effect, this operational pattern would produce a heavy load on the treatment plant over approximately 10 hours of the operating day. There would be definite variation in waste load from day to day.

The waste characteristics for the fish wastes appear to be normal for average conditions. The BOD_5 of 540 mg/L and a 480 mg/L suspended solids concentration can be considered as long term averages. In all probability, variations of at least 100% will be experienced. It is important that the treatment plant be designed to handle both the variation in organic load but also the limited time release. Both of these factors will have a serious impact on the treatment plant.

With regards to future loads, it would appear that water consumption would not increase significantly as indicated in the report. Excess water useage at the present is keeping the consumption high. As the plant approaches maximum capacity, water useage will be more productive. Since the waste organic losses are related primarily to the quantity of fish produced rather than to water consumption, it would probably be better to calculate the wastes on a unit weight per ton of fish processed. This would mean a three fold increase in BOD and suspended solids for a three fold increase in production. Without more accurate data, the future load should be based on maximum possible conditions.

The studies by Chun, Young and Burbank on tuna packing wastes reported at the Purdue Industrial Waste Conference indicated a problem in determining accurate BOD data. It was felt that the high salt content of the wastes inhibited the accurate determination of BOD data. In tuna wastes, approximately 37% of the total solids was organic and the remainder was salt. It should be recognized that the wastewaters from the Georgetown Seafood, Ltd., plant will contain considerable salt even though fresh water is used for washing. The salt content of the wastewaters should be evaluated as it could affect both the BOD test and oxygen transfer in the biological process. Analyses by the Water Technology Laboratory indicated a total solids concentration of 1390 mg/L in the sewer to the sea with 500 mg/L of inorganics. It is somewhat surprising that the salt content of this water would be so low considering the fact that the fish was grown in a salt water environment. As the fish is washed and cleaned, the soluble salt should appear in the wastewaters. The high volume of water being used for washing could be responsible for the low salt content. At the levels indicated, salt would not pose a problem for BOD data. A series of serial dilutions could easily demonstrate if the wastes were toxic in the BOD bottle. If all samples in the series of increasing sample dilution give the same BOD values, ± 10%, there would be no problem. On the other hand, if the more dilute samples gave higher BOD values, than one could suspect a toxicity problem.

TREATMENT PROCESS

The town of Georgetown is small and produces a limited quantity of wastewaters. It is only natural that the wastewaters from the fish processing wastes be combined with the town sewage into a single treatment plant. The combined treatment plant will present an easier control for all wastes from Georgetown. The waste analyses by Water Technology Laboratory indicated an excess of nitrogen in the fish processing wastes. In view of the high protein content of these wastes, this high nitrogen content is to be expected. Although the analyses for phosphorus were not made, it is expected that adequate phosphorus exists in the fish processing wastes. It is doubtful if the town sewage is needed to develop good biological treatment but it would be foolish not to combine both wastes into a single system. Normal variations in the fish processing wastes will exceed the load imposed by the town sewage.

The completely mixed activated sludge process is the most efficient biological treatment system in use today. It can take an influent of any organic concentration and produce an effluent of any desired organic concentration without complex operations. One of the important modification of the CMAS system is the extended aeration process with its 24 hour aeration period. The 24 hour aeration period is important in absorbing shock loads and in producing a high quality effluent. The fact that both the town and the fish processing plant operate on a 24 hour frequency makes the 24 hour aeration period capable of handling one complete cycle each retention period, easing the operational variability quite considerably. Current concepts of CMAS makes it possible to evaluate the treatment process mathematically.

1. Unmetabolized BOD_5

$$F = \frac{Fi}{Kmt+1} = \frac{470}{360+1} = 1.3 \text{ mg/L}$$

2. Mixed Liquor Suspended Solids

a. Active microbial mass

$$Ma = \frac{KsF}{\frac{1}{t_s} + Ke} = \frac{(250)(1.3)}{360+1} = 560 \text{ mg/L}$$

b. Endogenous mass

$$Me = 0.2\ KeMat_s = 0.2(0.48)(560)(10) = 540 \text{ mg/L}$$

c. Inert mass

$$\text{Assume } Mi + Mii = 0.25\ (TSS)$$

$$Mi + Mii = 0.25(450)(10) + 0.1(560+540)$$

$$= 1120 + 110 = 1230 \text{ mg/L}$$

d. Total MLSS

$$M_T = Ma + Me + Mi + Mii$$

$$= 560 + 540 + 1230 = 2330 \text{ mg/L}$$

3. Oxygen Uptake Rate

$$\frac{dO}{dt} = \frac{1.5(Fi-F)}{t} - \frac{1.42(Ma+Me)}{t_s}$$

$$= \frac{1.5(470)}{24} - \frac{1.42(560+540)}{24(10)}$$

$$= 29.3 - 6.5$$

$$= 22.8 \text{ mg/L/hr}$$

4. Effluent BOD_5

$$\text{Eff. } BOD_5 = F + 0.8\, Ma_e$$

$$= 1.3 + 0.8(20)\left(\frac{560}{2330}\right)$$

$$= 1.3 + 3.8$$

$$= 5.1 \text{ mg/L}$$

5. Waste Activated Sludge

$$WAS = (M_T - Ma_e)Q/ts$$

$$= (2330-20)(690{,}000/10^6)$$

$$= 1{,}600 \text{ lbs/day}$$

The above analysis was made for a wastewater temperature of 20°C. It shows that with normal MLSS and conventional operational parameters, the system could produce a high quality effluent with a relatively low oxygen uptake rate. The key to the high quality effluent will lie in the solids separation. The effluent BOD will be directly proportional to the effluent suspended solids.

The ten day sludge turnover time requires a daily wasting of 1,600 pounds during operation of the fish processing plant. Endogenous respiration over the weekend will reduce the quantity of solids to be wasted. It may well be that four days wasting will produce a balanced system. Only experience will prove this concept.

Mechanical surface aerators, properly designed, can meet the oxygen requirements. Since the fish processing load will be discharged over a 10 hour period, the aeration equipment must be able to handle the peak hourly load for both the fish processing plant and the town wastes. For practical purposes consider the peak hourly load as twice the normal load considered over a 10 hour period in contrast to the 24 hour period.

$$\frac{dO}{dt} = \frac{0.5(2)(Fi)}{10} + 0.02\, Ma$$

$$= \frac{(0.5(2)(470)}{10} + 0.02(560)$$

$$= 47 + 11 = 58 \text{ mg/L/hr}$$

The use of two speed motors will permit time clock operation of the high speed during daytime flow over 12 hours and the low speed at night and on the weekend. It should be recognized that while the 24 hour average oxygen demand rate is 22.8 mg/L/hrs, the average daily rate will be 34 mg/L/hr and the average night rate will be approximately 12/mg/L/hr. It should be recognized that the proteins and fats in the wastewaters reduces the oxygen transfer characteristics. If it is assumed that the oxygen transfer is 0.8 of that is pure water, the extended aeration plant will probably require two 50 HP dual speed mechanical surface aerators rather than the two 25 HP units originally recommended. The 25 HP units would be fine if the load was uniform over the 24 hour period but the operation schedule of the fish processing plant prevents use of a uniform loading rate.

The high protein characteristics of these wastes and the long aeration period will produce periodic nitrification. This will result in some denitrification in the final clarifier unless the solids are quickly returned to the aeration tank. The tube settler probably should not be used in this system since rising sludge will plug the tubes and create serious operational problems. A small circular clarifier with conventional sludge scraping mechanism and surface skimming should be used. The surface skimmer will collect the floating sludge and return it to the aeration system. All sludge wasting should be from the sludge return system and not from the floating sludge.

The clarifier would have to be designed to treat the flow over a 12 hour period since the fish processing plant would control. This would require a unit with a 345 IPD/sq.ft. surface overflow rate. The clarifier should be 50 ft in diameter with a 12 ft. water depth. The average retention time would be 5.2 hours but during daytime flows it will be less than 2.6 hours. The return sludge rate should be between 30 and 50% of the raw waste flow. It is important to have easy control on the sludge recirculation with the capacity to return at 100% raw waste flow. For simplicity, the return flow rate can be set at 30% and should produce the MLSS indicated. Sludge wasting should be from the return sludge on a constant basis, approximately 21,000 IGPD. By wasting on a constant basis, the system does not suffer from a shock removal and it can easily be controlled.

The 55,000 cf aerobic digester would have a theoretical retention period of 16.5 days at the wasting rate indicated. The aerobic digester would reduce the active microbial mass from 1900 mg/L to 210 mg/L at 20°C. The reduction in solids will be from 7800 mg/L to 6100 mg/L. This material will be concentrable to about 2% with sedimentation in a storage pond during the winter. Ultimately, the solid must be dewatered on drying beds during the warm weather and then returned to the land.

The oxygen demand rate will be uniform at 4.9 mg/L/hr, 16.7 lbs/hr. A 40 HP mechanical surface aerator would be adequate for this unit. Actually, by constructing two cells in series it would be possible to reduce the active mass to 80 mg/L. The first cell would require 80% of the air while the second cell would require 20%. Actually, a 30 HP unit on the first cell and a 10 HP unit on the second cell would probably work satisfactorily.

With the suggested modifications and the operational concepts indicated, the proposed treatment plant should easily produce 90-95% BOD reduction. With good operation the BOD reduction could approach 97 to 98%. It should produce a quality effluent with a minimum of operational attention since the treatment system floats on the waste line, adjusting automatically to variations in flow and load.

AMINODAN SYSTEM

It has been known for a long time that proteins can be precipitated by heavy metals, heat, acid, salt and alcohols. In most wastes, the concentration of specific proteins is not high enough to warrant this form of treatment. In mixed wastes, the precipitation will be dependent upon the chemical characteristics.

Heavy metal precipitation with iron, aluminum or organic polyelectrolytes appear reasonable for mixed proteins. This precipitation reaction is carried out on the basic side of the isoelectric point. Alum flocculation is more effective around a pH of 7-8 while iron flocculation is more effective at a pH of 5.5-6.5. The nature of the carriage water and the wastes are such that either material should produce precipitation. It is possible to remove 90-95% of the suspended solids. The 60% BOD_5 reduction with fresh fish wastes should be easily attained. The only problem is the large quantity of sludge for disposal. It is proposed that the solids be concentrated and recovered as protein. One should recognize that the protein-heavy metal precipitate has no value unless the heavy metal is removed. The iron or aluminum content of this material definitely limits its value and requires further processing to obtain a recoverable material.

Acid precipitation has the advantage that the protein material is in a useable form without contamination. The problem with acid precipitation is that the removal of protein is not as complete as with heavy metal precipitation. The precipitate is entirely organic and is removed with difficulty. If economic recovery of protein is desired, I would expect that the acid precipitaton method would be required. Needless to say, acid precipitation would require special equipment and careful process control.

The letter to Mr. Hiscocks indicates the basic requirements for the Aminodan system using acid precipitation. They are talking about a pH of 4.2 for precipitation which is about normal. The acid treatment will not only precipitate the protein but will also break oil emulsions. On the other hand the Aminodan system proposed in the letter to Mr. Delaney is for heavy metal precipitation. It is proposed that alum and lime be used to precipitate the protein. The estimated chemical doseage is 275 mg/L alum plus 190 mg/L lime. The chemicals alone will weigh 2,800 lbs/day for the 10 hour operating period. Considering the protein sludge, the system could produce around 3,000 to 4,000 lbs of sludge per hour. This sludge will be hard to handle and the value of this material will definitely be "subject for discussion." It will be of negative value in this form and will require considerable processing before ultimate disposal. This part of the problem is not included in the Aminodan process.

It should be recognized that 60% BOD reduction leaves 220 mg/L BOD remaining, about the strength of raw domestic sewage. In view of the current pollution problems, this level of treatment is not adequate for disposal to the harbor. The Aminodan process would leave the town sewage untreated also. The net effect is only a partial solution to the problem.

In this day of sophisticated ideas, engineers are intrigued with new gadgets and new technology. Yet, one should recognize that all new ideas do not produce the solutions desired. Chemical treatment will require a never ending source of chemicals, over a ton a day, over 300 tons per year from now on. The sludge must be returned to the land in a safe fashion. Even if the protein is recovered, what of the chemicals?

There are no magic answers for waste treatment. Frankly, it would appear that while the Aminodan process would work in some areas, the best solution for Georgetown is biological treatment as originally proposed.

Canada
Department of Regional
Economic Expansion
161 Laurier Avenue West,
Ottawa 4, Ontario

Att.: Mr. Garnet T. Page
Director General
Implementation Services

January 6th, 1971.

Re: Georgetown Seafoods Ltd.

Dear Sir:

To answer Mr. P. Harrison's verbal questions regarding the following remarks made by Mr. A. Hiscock, Chairman of the P.E.I. Water Authority, we wish to reply to these questions formally since we have done so verbally on a number of occasions. The questions that require our response are:

1) The effect on the biological Treatment, proposed in our report of November 16th, 1970, of the use of sea water for unloading Herring as proposed by Mr. E. Kaiser of Georgetown Seafoods Ltd. and as stated in Mr. Hiscocks telegram of November 18th, 1970.
2) Water consumption values as determined during our survey.
3) The question of allowing condenser cooling water as presently used for the condensation of the vapors from the "Stick Water Evaporator" at Georgetown Seafoods Ltd.

We have considered all three questions as stated above before writing our report, however we will elaborate on these questions as follows:

1) Salt Water unloading of Herring

During our discussions with Mr. E. Kaiser, we were informed that at some future date their company would contemplate the use of chilled salt water for unloading Herring from the holds of their trawlers. Mr. Kaiser advised us, that they already had the necessary pumps and a chilled sea-water tank having a capacity of 3,000 cubic feet (19,000 Imp. Gals.).

According to our calculations, the biological system can accept up to 450 ppm of salt water without adverse effects. Based on the capacity of their chilled salt water tank and the concentration of Sodium Chloride in sea-water and on the basis of 600,000 Imp. Gals. per day, this would allow the use of the chilled sea-water tank 4 times per day to reach a equilibrium level of 450 ppm, during their regular work period of 8 to 10 hours per day. Mr. Kaiser indicated during our discussions that maybe one tankfull of chilled sea-water would be required in one day. On this basis we would have no objection to the direct dumping of this quantity into their waste process water system. However should their requirements necessitate more than one tank (19,000 Imp. Gals.) per day but not more than 4 tanks per day (i.e. 2, 3 or 4 tanks/day) it would be necessary for them to dewater and hold this used chilled sea-water in a holding tank for gradual disposal to the sewer system over the full work period.

The foregoing assumptions are made on the basis that Georgetown Seafoods Ltd. would also use at least 600,000 Gals. per day of fresh water for dilution purposses. If no fresh water or very little were used then Georgetown Seafoods would be required to hold in suitable reservoirs the used chilled sea-water until sufficient fresh water were being used to dilute the chilled sea-water.

It must be emphasised that it would be detrimental to the biological process to allow slugs of sea-water to drain directly to the waste treatment plant without dilution.

In essence, we would not object to one tank of sea-water being dumped to wastes providing that sufficient fresh waste water is also being used to provide the required dilution. If more than one tank is used during a working day, holding tanks will be required, with subsequent release on a controlled basis with fresh water so that the concentration of sea-water does not exceed 450 ppm. Under no circumstances should the contents of their proposed chilled sea-water tank be dumped in the sewer without fresh water dilution.

2) Daily Water Consumption.

We used the readings provided by the Neptune Meter installed in the incoming Raw Water Line to Georgetown Seafoods Ltd. Plant. This meter is normally quite accurate and if anything the readings would be either exact or on the low side, depending on the condition of the meter itself. (See Chapter 4, Page 1). If these readings are considered to be incorrect, then we suggest that the plant ask for a verification of the meter by the manufacturer.

3) Condenser Cooling Water.

During our visits to Georgetown Seafoods Ltd. we paid deliberate attention to their fish-meal plant operations, since this is the most likely source of strong wastes. There are two cooling water condensers used in the fish-meal plant as follows:

a) De-odorizer condenser

This unit is a spray type, open condenser, that condenses the vapors from the rotary kiln. The estimated water consumption is in the order of 50 GPM. The water from this condenser has a significant odor and contributes to the B.O.D. of the sea (See sample No. 3 - Water Technology Laboratory Inc. tests). Without doubt this stream must be directed to the sewer for treatment.

b) Stick-water Vapor Condenser

We examined this condenser externally (without having it opened up) and we were also told by the operating personnel that this unit is also an open type direct vapor condenser. That is, the vapors from the Stick-water Evaporator are directly condensed with cooling water by direct contact. The estimated volume of flow is about 50 GPM. In this case, there is no other alternative but to send this water to the sewer. However, if, unknown to us, should this condenser be a closed system of coils, then we agree that this cooling water may be allowed to exit direct to the sea. The only objection we would have would be the possibility of a leak in the coils and subsequent contamination. For these reasons, we would prefer to have both condenser streams directed to the sewer, since the volume is very small.

We trust that the foregoing explanation will clearly provide our interpretation of the three (3) questions previously outlined.

The question of using sea-water for fluming had been raised during our visits to Georgetown by Mr. E. Kaiser. We must advise you that if this alternative were exercised, then the biological treatment plant proposed in our report would not function, since it is based on fresh-water biological organisms for the destruction of organic matter. A salt-water bio-system would require significant research to determine the operating norms, however, theoretically, it is not impossible, but we do not know of any such system in operation at this time. During the initial stages of our investigations we were advised by all concerned that fresh-water was to be used for fluming and no one suggested that a change-over would be made except for a chance remark by Mr. E. Kaiser of Georgetown Seafoods Ltd.

Yours truly

J. A. Delaney & Associates

J. A. Delaney, Eng.

CORRESPONDENCE h)

ADDRESS: P. BORUP SORENSEN SKAGEN DENMARK
TELEPHONE: (08) 44 10 39
TELEGRAM: BORUPWATER · SKAGEN
TELEX: 37 67
BANKERS: SKAGENS BANK

P BORUP SORENSEN

(CANADA) COMPANY P.O.Box 140 Mahone Bay N.S.

YOUR REF. OUR REF. DATE

1 May 71

J.A.Delaney & Associates Ltd.
1200 St. Amour Street,
Montreal 384
Quebec.

Attn: Mr.J.A.Delaney, P.Eng

Dear Mr. Delaney,

AMINODAN SYSTEM FOR GEORGETOWN SEAFOODS LTD.

Further to our long telephone discussion and my telegram dated 22 April, we take great pleasure in submitting the following revised letter quotation for an Aminodan system for Georgetown Seafoods Ltd.

Please find enclosed copies of two drawings. One shows the typical plant layout and the other shows the process flow. The drawings are numbered 405-03 and 405-06 respectively.

We offer One Aminodan Water Purification System, sized to treat 900 IGPM of fishplant effluent plus the pumping water that will be used to unload 150 tons of herring in any 24 hour period.
The price of this system is $165,000.00, Canadian funds,cif East Coast POE, taxes and duty extra. Terms to be arranged. Shipment approx. 8 months after receipt of order, subject to confirmation at time of order.

The equipment supplied for the Aminodan System will include:

Qty. 2	Raw water pumps
Qty. 1	Inclined vibrating screen
Qty. 1	Agitating system for daytank
Qty, 1	Flocculation chemicals mixing tank with turbomixer
Qty. 2	Flocculation tanks with 3 chambers, agitators and inspection windows. Solids recovery screws in bottom of chambers.
Qty. 2	Flotation tanks, scraper mechanisms, dewatering tables and catwalks
Qty.1	Sludge tank with agitator
Qty.1	Header tank
Qty.1	High pressure water pump
Qty.1	Air compressor
Qty.1	Silo for aluminum sulphate
Qty.1	Metering screw, mixing tank with agitator and dosing pump for adding aluminum sulphate solution to effluent
Qty. 1	Set of automated equipment for dosing
Qty.1	Silo for calcium hydroxide
Qty.1	Metering screw, air agitation system, mixing tank and dosing

pump for adding calcium hydroxide to effluent

Qty.2	Pumps for pH measuring systems
Qty.1	Agitator for the neutralization tank
Qty.1	Control panel, in process flow form, with all automatic controls, warning lights and audible alarm signal All piping, valves, flow meters. All low voltage wiring.

The following items are not included in the quoted price:

1 Preparation and installation of foundations and drainage.
2 Preparation and/or erection of a suitable building.
3 Equipment required to carry the waste water from the existing drains to the vibrating screen.
4 Installation of electrical mains, main switchboard and high voltage electrical wiring.
5 Labour costs for the erectio of the Aminodan plant, except that one supervisor is included in the quoted price.
6 Insurance against any hazard, after arrival of the plant onthe site.
7 Construction of the daytank, required capacity 50,000 galls. and construction of the neutralization tank, capacity 14,000 gall.

The operating requirements of the system are estimated to be as follows:

Electrical power 30 KW
Chemicals, when treating only fishplant water:
Al sulphate 55 lbs. per hour – 100 ppm.
Ca hydroxide 40 " – 72 ppm.
when treating fishplant water plus herring pumping water
Al sulphate 165 lbs. per hour
Ca hydroxide 115 "

We do not have current prices for these chemicals, therefore an hourly cost of operation cannot be calculated. We can discuss this when we meet.

The recovered material will be in the form of a sludge that will be deposited in the sludge tank. The quantity of this sludge is estimated to be 3 tons per hour, based on a BOD of the raw effluent of 400-500ppm. The sludge will have a dry substance content of beteen 8% and 10%. The value of this material will be, again, a subject for discussion.

The Aminodan system is offered with the following guarantee of minimum performance:
BOD reduction 60%
Fat reduction 90%
expressed as a percentage between the raw effluent supplied to the screen and the treated effluent leaving the Aminodan system. Higher reduction have been achieved in actual operation.

To reduce the overall cost of the total installation, we would like to explore the possibility of installing the Aminodan system in existing buildings. The layout, as shown in dwg.nr. 405-03, can be modified to some extent should existing space be available.

Definition of the complete system will only come through discussion and, when all factors have been resolved, a formal contract will be drawn up and drawings prepared for this particular project.

We trust that this letter will provide you the information that you immediately require

I look forward to meeting with you and discussing the project in detail. I can assure you that we are very interested in working with you to make this a successful Aminodan installation.

Yours very truly,

P.BORUP SORENSEN (CANADA) CO.

David Pyle.

D.Pyle
Manager

Encls.2

ROSS E. McKINNEY
CONSULTING ENGINEER
2617 OXFORD ROAD
LAWRENCE, KANSAS 66044

CORRESPONDENCE i

July 22, 1971

July 22/71

Mr. J.A. Delaney
J.A. Delaney and Associates
1200 St. Amour St.
St. Laurent, m ontreal 384
Quebec, CANADA

Dear Al:

With regard to the question of growing activated sludge in sea water, there have been a number of studies made on this subject. Initial impetus for these studies came from research on small extended activated sludge systems for use on ocean going vessels. The lack of enough fresh water prompted the question as to the use of sea water. Perry McCarty at MIT back in 1960 found that he could get 90% BOD removal with activated sludge systems having either 12 or 24 hours aeration when loaded at 40 lbs BOD/ 1000 cf/day. In 1965 Ludzack published an article in the Journal of Water Pollution Control Federation on a study of activated sludge grown in varying salt environments. He found that 23,000 mg/l salt was not detrimental to activated sludge once the system was acclimated. In 1966 Gaudy at Oklahoma State published a paper on the effect of slug shifts in salt in activated sludge. There was no doubt that activated sludge can be produced in sea water the same as in fresh water.

The basic problems with a high saline activated sludge are osmotic pressure in the aeration units and density currents in the final sedimentation tank. A sharp change in salinity can produce abrupt changes in osmotic pressure and loss of microbial efficiency. Maintenance of a relatively constant salt content will permit normal operations. Effluent recirculation can be used to help maintain a constant saline level if necessary. The high salt concentration can produce density currents that affect sedimentation. Proper design of the sedimentation tank can compensate for the higher density of the salt water.

If you have any further questions, do not hesitate to contact me.

Sincerely yours,

Ross E. McKinney

Ross E. McKinney

RE - STUDY

GEORGETOWN SEAFOODS LTD.

GEORGETOWN, P.E.I.

CHAPTER 1

SURVEY of SORENSEN AIR FLOATATION PLANTS IN EUROPE

The author arrived in Denmark on May 14th 1971 and in the company of officials and engineers of the P Borup Sorensen Company of Denmark, we visited the following plants:

1) SORØ ANDELSSVINESLAGTERI COMPANY
SORØ, DENMARK

a) Owner - Danish Meat Co-operative Institute

b) Animal slaughterhouse

c) Waste Volume = 440 I.G.P.M. for an 8 hour day

d) Flocculant - Sulfuric acid and Lignosulfonic acid

e) This waste treatment plant was under construction during my visit, and was about 90% complete. The slaughterhouse had been in operation for many,many years without waste treatment.

f) The type of equipment being installed appeared to be excellent and of superior quality.

g) This waste treatment facility was designed and erected by the " P Borup Sorensen Company for the owner.

h) Since it was not operative at the time of my visit, it was impossible to obtain results.

2) P. ANTHONISEN P/A
HERRING FILLETING PLANT
SKAGEN, DENMARK

a) Owner - P. Anthonisen

b) The entire wastes water flow from this plant goes through the "Sorensen Air Floatation System" where protein and fish oil is recovered. The offal is separately screened before the waste flow enters the plant and this offal is transported by truck to a central protein recovery plant (Reduction Plant) located approximately one mile from the Anthonisen plant.

c) Raw fish capacity, entering the P. Anthonisen plant, varies between 150,000 and 200,000 lbs/day and this plant operates intermittently depending on the availability of herring.

An interesting feature of this plant is the dry handling of the herring during processing. The iced herring are brought to the plant in boxes by fork lift truck and transported by a vertical bucket elevator to two conveyor belts which have side outlets which exit to about 20 automatic filleting machines. Very little chlorinated water is used at each outlet from the conveyor to the machine, through a ½ inch diameter hose, to assist the free flow of the fish to the machine. The machine uses some water in their operations but this is extremely small in volume.

d) Because of the"Dry-Line" method of filleting operation, enquiries were made of the management of P. Anthonisen in regard to the unit volume of water used in their operations and it is interesting to compare these values with the water consumption at Georgetown Seafoods Ltd.:

i) <u>P. ANTHONISEN PLANT</u>

Water used - 30 tons/hour
Raw Fish Processed - 12 tons/hour

Hence $\frac{30}{12}$ = <u>2.5 tons water/ton fish</u>

ii) <u>GEORGETOWN SEAFOODS LTD.</u>

Basis: (water used in Filleting Operations and unloading only - this does not include the Reduction Plant)

<u>Existing</u>
Water used - 420,000 I.G.P.D. = 210 tons/day
Raw Fish - 50,000 lbs/day = 25 tons/day
Hence $\frac{210}{50}$ = <u>8.4 tons water/ton Raw Fish</u>

Future

Water usage	- 1,080,000 I.G.P.D.	=	540 tons/day
Raw Fish	- 150,000 lbs/day	=	75 tons/day

Hence $\frac{540}{75}$ = 7.2 tons water/ton Raw Fish

111) Comparison

It is interesting to note the comparison of a Dry and Wet fish processing method:

Basis Existing Production at Georgetown Seafoods Ltd.

$$\frac{8.4 \text{ (Georgetown)}}{2.5 \text{ (Denmark)}} = 3.3$$

The Wet processing method uses more water by a factor of 3.3

Basis Future Production at Georgetown Seafoods Ltd.

$$\frac{7.2 \text{ (Georgetown)}}{2.5 \text{ (Denmark)}} = 2.9$$

Similarly for the future, there is a large difference in the quantity of water used.

e) On the basis of data supplied by the firm of P. Anthonisen P/A their waste flow is:

30 tons/hr = 100 I.G.P.M.
= 48,000 Gals/Day

From independent laboratory tests (copy included in the appendix of this report) the:

Raw Water B.O.D. = 10,800 mg/l

Raw Water after Screening = 5,450 mg/l

Raw Water after Treatment = 1,800 mg/l

% B.O.D. Reduction $\frac{5450 - 1800}{5450} \times 100 = 67\%$

It will be obvious, that, the treated effluent from this process at 1800 mg/l could not be directed to a receiving body of water without further treatment, preferably a biological system to reduce the strength of this effluent.

f) This plant at P. Anthonisen P/A was installed in 1966 and was the first commercial plant manufactured and erected by P. Borup Sorensen Company. It is located some 100 yards from Sorensen's office in Skagen and is used as a demonstration plant.

3) SOPRORGA S/A
PARIS, FRANCE
Bone Degreasing (Rendering Plant)

(This plant was visited on May 18/71)

a) Owner - SOPRORGA S/A

b) Operation - rendering plant which operates 24 hours/day and was in full operation during my visit.

c) Processing - 80% Bones
20% Offal (Cows and Pigs)

d) Waste Treatment Process - includes one (1) air floatation tank 30 ft long by 10 ft.wide and 10 ft deep plus two (2) centrifuge, tankage controls and all ancillary equipment. Reported cost for plant including erection (inside of building by owner) and start-up about $ 300,000.00 (Can.).

e) Waste Flow to Treatment Plant

Peak - 110 I.G.P.M.
Average- 73 I.G.P.M.

Waste Strength B.O.D.

DATE	INFLUENT mg/l	EFFLUENT mg/l	B.O.D. REDUCTION %
31-3-71	16,080	6,190	61.5
1-4-71	16,900	2,830	83.4
2-4-71	16,900	2,220	86.7

It is again obvious, that, the effluent from this facility requires further biological treatment before disposal to a receiving body of water.

In this case Soprorga S/A are dumping the effluent into the City of Paris sewers for which they will be charged for treatment. I was told that Soprorga intend to build their biological treatment plant in order to reduce their costs to the City of Paris.

f) All wastes from this large plant are treated in the Sorensen system except:

  1) Water of evaporation (Dryers)
 11) Wash water (Machine Cleaning)
111) Plant sanitary wastes

Solids from initial screening together with unusable solids from the plant proper are sent to another factory for further processing and disposal.

g) <u>Recovery System</u>

Fat Recovery - 1.4 to 1.7 tons/day

Protein " - unknown

It was reported that the fat recovery alone was sufficient to pay the amortization and operating costs, over a five year period.

h) This plant appeared to operate very satisfactorily and from discussions with the operating personnel maintenance appeared minimal. The layout and equipment appeared to be excellent from a design point of view. Two operators were in attendance constantly although it was claimed by Sorensen that one full time operator would suffice.

CHAPTER 2

DESCRIPTION OF THE SORENSEN AIR FLOATATION (AMINODAN) PROCESS

The " AMINODAN " process is characterized into three (3) types by Sorensen and a typical flow sheet is shown in Sketch No.1 (Appendix No.2):

1) Float - A - Meat

2) Float - A - Fish

3) Float - A - Fat

The above three types may be further divided into:

A) PRIMARY SYSTEM

Where air alone is used for recovery and floatation, no chemicals are used.

B) COMPLETE SYSTEM

Where chemicals of various types are used to precipitate the proteinaceous material from the water carrier (either fresh or salt water) and to concentrate this solid material by air floatation. This system consists of the following unit operations:

a) PRE-SCREENING

This step is designed to dewater and remove the large solid particles, screen openings are generally about 1/8 inch in diameter depending on application.

b) DAY-TANK

This tank is used as a surge buffer in order to even out the flow to the following portion of the system over a 24 hour period, due to the uneven flow characteristics found in most of the basic food industries where this system is applied. However where the waste flow is constant, or relatively so, then this portion would not be required.

c) AIR FLOATATION TANK AND ACCESSORIES

This portion of the system consists of the chemical storage and feeding systems. These chemicals are added to the influent screened raw water in a chemical mixing tank, thence to the main air floatation tank where the mixture goes through three (3) paddle flocculator sections before being aerated. The flocculator sections are intended to permit residence time for precipitation of the proteins into discreet particles which will float in the presence of extremely small diffused air bubbles. The resulting precipitated material which floats on the surface is raked off the surface into a sludge tank by a "Rake Mechanism" operated on a time cycle basis.

When we refer to "PROTEINS" as in the above, a wide spectrum of organic molecules are involved including AMINO ACIDS, POLYPEPTIDES NUCLEOTIDES and PROTEINS).

Air from an air compressor is forced into solution under pressure into an Air Water Mix Tank using relatively clear water from the base of the floatation tank, this water air-mixture is re-cycled back to the Air Floatation tank and the pressure issuddenly decreased to nearly atmospheric pressure in the bottom portion of the Air Floatation tank as shown in Sketch No.1.

d) HEATER, DECANTER AND CENTRIFUGE

This part of the system receives the thickened sludge (5 to 15% solids, dry weight basis) from the Sludge Tank where this combined, water protein and oils or fats are heated to 80-100°C in order to further modify and consolidate the proteinaceous materials and to liquify the oil and fats. The fat and proteins are separated in the DECANTER and the sludge from the bottom of the DECANTER now contains about 30% solids. The liquid material which exists from the top of the DECANTER is a mixture of oil, liquid fat, water and proteins. This stream is again heated to 70-110°C to maintain the oil and fats in a liquid state then sent to a CENTRIFUGE.

The CENTRIFUGE separates the three (3) fractions, water - oil - sludge. The water is sent back to the process and the oil is recovered. The combined sludge from the DECANTER and CENTRIFUGE is sent to a DRUM or SPRAY DRYER for further processing into a saleable fish-meal product. The DRUM or SPRAY DRYER is not shown or included in the Sorensen system.

The clear water from the base of the AIR FLOATATION tank is sent to a "Floatation Tank Level Regulation Basin, where lime is added for neutralization before the final effluent is sent to a municipal sewer or other biological Treatment.

The chemicals used as flocculants are normally:

1) Sulphuric Acid pH 4.5

11) Alum or Ferric Chloride

111) Lignosulfonic Acid

1V) Kremodan (a proprietary item)

Mr. Borup Sorensen (the owner of P Borup Sorensen Company and the originator of the AMINODAN PROCESS) stated that the type of fish being processed had a great bearing on the expected results, for instance:

a) Non-Oily Fish, such as cod, flatfish etc. the protein recovery with acid alone would be in the order of 20 to 30% but would increase to about 60% if Kremodan were used along with the acid.

KREMODAN, is a proprietary product that would cost in the order of about 4 cents/lb in Canada, however the dosage is 1 lb/ton of waste water or 500 p.p.m. costing approximately an additional $200.00 per million gallons of waste treated. Mr. Sorensen did not believe that it would be economically attractive to use Kremodan unless the wastes contained large quantities of protein and oil (or fat).

Alum or Ferric Chloride, however was a more attractive flocculant in the case of non-oily fish, and he considered that a 60% (or better) protein recovery could be achieved.

b) OILY FISH, such as herring etc. would produce 60% or up to 80% protein recovery with the use of acid alone. However, Alum or Ferric Chloride would also achieve similar results.

The use of LIGNOSULFONIC ACID as a flocculant aid has been appraised by Claggett and Wong as described in their paper "Salmon Canning Waste-Water Clarification, Part 11", Feb. 1969, Fisheries Research Board of Canada, Circular No.42, (copy attached to this report, Appendix No.4) and on page 7 they state that the essential difficulties of adding the correct amount of this material for optimum results.

From the initiation of protein recovery by air floatation in 1966 in Denmark and later (1968) in Canada it appears that Alum is the most attractive flocculant for all types of fish in order to achieve optimum results.

Claggett and Wong, cited above, experimented on wastes with a B.O.D. which varied between 1500 and 3000 mg/l and they obtained an average of 60% protein recovery and an average B.O.D. reduction of about 75%.

It is interesting to note in their paper (Appendix 2) they give an Economic Analysis on the basis of 1.0 million gallons per day of waste-water containing approximately 1500 p.p.m. of protein and on a capital investment of only $100,000.00 and a Protein value of $60.00 per ton to the reduction plant they end up with an Operating Loss of $100.00 per day.

CHAPTER 3

APPLICATION OF THE SORENSEN AIR FLOATATION (AMINODAN) PROCESS AT GEORGETOWN SEAFOODS LTD.

In consideration of the data presented in Chapter 1 and 2, where the waste-water strength is in the order of 15,000 p.p.m. in Europe and 1500 to 3000 p.p.m. in Canada, it is now appropriate to study the economic implications of considering this process at Georgetown Seafoods Ltd.

From a personal communication with Mr. R. Nickerson, a principal officer of Georgetown Seafoods Ltd, we obtained the following information, which is relevant to the economics of such an installation and reflects the actual economic status and capacity of this industry, at the present time, to treat the normal waste-water from their filleting operations.

Mr. Nickerson stated that the data presented herewith is approximate since prices fluctuate almost daily, but that these figures represent realistic economic parameters:

a) Fish offal - $7.00 to $9.00/ton fob plant

b) Fishmeal - $115.00 to $120.00/ton fob plant

c) Value of Recovered Protein (To the Reduction Plant) - $ 20.00/ton (upper limit)

It is now interesting to make some comparisons:

i) Whereas, we found a B.O.D. of the waste-water from the filleting to be only 140 p.p.m. we used 200 p.p.m. for existing conditiond and 600 p.p.m. for future conditions. We based this increase on more efficient usage of water in the future and on the basis of a comprehension study which was done on fish plants in New Brunswick where 500 to 600 p.p.m. of B.O.D. was normal for the waste-water.

ii) Whereas, Claggett and Wong were treating wastes having a B.O.D. between 1500 to 3000 p.p.m.

111) Whereas, Sorensen plants in Europe are treating wastes having 15,000 to 30,000 p.p.m. B.O.D.

1V) Whereas, Claggett and Wong, used $60.00/ton for the value of recovered protein to the reduction plant, we have used in our calculations $20.00 per/ton based on Mr. Nickerson's estimate.

V) Whereas, Claggett and Wong used a capital expenditure, for a 1.0 million gallon per day plant, of $100,000.00 and we have a firm quoted price and calculated extras amounting to a total of $ 336,000.00 (See Table No.2 following) for approximately the same size of plant as used by Claggett and Wong in their economic analysis. (Appendix 2, Their report).

V1) Whereas, we used a 50% protein recovery based on B.O.D. on the advice of Mr. Sorensen from his experience, and Claggett and Wong used 60% protein recovery.

We now present our calculations from Table No.1 to Table No.4 inclusive, in the following pages.

We are assuming that herring unloading by the use or pumping with fresh or salt water will be disallowed on the following basis:

a) Herring unloading by pumping adds an enormous amount of wastes (30,000 p.p.m. or more) to the water to be treated,

b) Dry unloading of herring for the reduction plant can be accomplished thus eliminating further water usage and contamination by the use of a dry-unloader manufactured in Denmark and available in Canada at a cost of about $5,500.00 (Can) fob nearest port, duty paid, which has a capacity of 40 tons/hour. The largest vessel to unload at Georgetown had 300,000 lbs of fish or 150 tons, this would take only 4 to 6 hours to dry-unload..

In view of the foregoing, it would be criminal to permit unloading by pumping. If a capacity greater than 40 tons/hr is desired, it is a simple matter to order a larger unit.

TABLE No. 1

CALCULATIONS

PROTEIN AND FISH OIL RECOVERY FROM PLANT EFFLUENT

		EXISTING	FUTURE
Raw Fish Processed	lbs/day	50,000	150,000
Raw Fish Processed	tons/yr	6,250	18,750
Length of Work Day	hrs	10	18
Waste Flow	I.G.P.M.	700	1,000
Number Working Days	days/yr	250	250
Total Waste Flow	gals/day	420,000	1,080,000
Total Waste Flow	M.*gals/yr	105	270
B.O.D. of Wastes (avg)	p.p.m.	200	600
B.O.D. of Wastes	tons/yr	105	810
Protein Recovery (1) 50% of B.O.D.	tons/yr	52	405
Fish Oil Recovery 10% of Protein Recovery	tons/yr	5.2	40.5
Protein (2) Value to Reduction Plant	$/ton	20	20
Fish Oil (2) Value to Reduction Plant	$/ton	20	20
Yearly Protein Recovery	$/yr	1,040	8,100
Yearly Fish Oil Recovery	$/yr	104	810
Total Annual Revenue	$/yr	1,144	8,910

* M = Million

(1) Value stated by Borup Sorensen

(2) Value stated by R. Nickerson as upper limit

TABLE No. 2

COST TABULATION

FOR THE AMINODAN PROCESS

A)	Mechanical and other Equipment supplied by Sorensen	
	as per quotation May 1/71	$ 165,000.00
	1) Duty 15% on estimated $ 90,000 equipment content	13,000.00
		$ 178,000.00
B)	Items not included in quoted price	
1)	Preparation & installation of foundations, floor and drainage for 1-building and 2-tanks plus yard piping (calculated)	$ 27,000.00
2)	Supply and erection of building 110 feet x 40 feet x 12 feet high insulated with vapor barrier doors and windows complete	$ 30,000.00
3)	Pumping station to carry water to vibrating screens including installation (1200 G.P.M.)	$ 15,000.00
4)	Supply and installation of electrical equipment for all electrical requirements (estimated)	$ 8,000.00
5)	Labour costs to erect Aminodan Process, i.e. the equipment in part A) above, (25% of equip. costs)	$ 25,000.00
6)	Supply and erection of 50,000 gal. day-tank including supporting concrete slab	$ 13,000.00
7)	Supply and erection of 14,000 gal. neutralizing tank	$ 5,000.00
8)	Supply and install building heating and lighting	$ 3,000.00
	TOTAL COSTS	$ 306,000.00
9)	10% contingency, administration & other costs	$ 30,000.00
	GRAND TOTAL	$ 336,000.00

TABLE No. 3

SORENSEN PROCESS

CAPITAL AND OPERATING COSTS

Capital costs of equipment supplied by Sorensen plus equipment and labour as per Table No.2 (See Table No.1)			$ 336,000.00
		EXISTING	FUTURE
Amortization (8% - 10 yrs)	$/yr	50,000	50,000
Chemical Costs fob Georgetown			
Alum	$/ton	82	82
Lime	$/ton	46	46
Alum (4.1 cts/lb)	p.p.m.	100	150
Consumption	tons/yr	52	202
Costs	$/yr	4,300	16,000
Lime (2.3 cts/lb)	p.p.m.	40	60
Consumption	tons/yr	21	81
Costs	$/yr	1,800	3,700
Labour		Negligible	Negligible
Maintenance (2% of investment)		$ 7,000	$ 8,000
Electrical (60 H.P.) (approx. $600/month)	$/yr	7,200	8,000
Total Annual Cost		$ 70,300	$ 85,700
Total Annual Revenue (See Table No.1)		1,144	8,910
Annual Net Loss		$ 69,156	$ 76,790
Daily Loss (250 Work Days/yr)		$ 274.00	$ 304.00

TABLE No. 4

CALCULATION OF ALUMINUM CONTENT OF FISH MEAL PRODUCTION

		BASIS FUTURE PRODUCTION
Fish Protein Recovery	tons/yr	486
Alum consumption (as $Al_2(SO_4)_3$ 18 H_2O)	tons/yr	202
Aluminum Hydroxide Sludge as $Al(OH)_3$	tons/yr	47.3
Aluminum (as Al) in Sludge	tons/yr	16.5
Average Fish Meal Production		
Basis: 100 tons/day for 250 days/yr	tons/yr	25,000
Average Aluminum (as Al) content of Total Fish Meal Production	%	0.065

From Table No.1, the protein and fish oil recovery is certainly minimal even for future operations, this is due to two (2) factors:

a) The weak strength (B.O.D.) of the waste-water

b) The value of the protein and fish oil recovered to the reduction plant of $20.00 per ton.

From Table No.2, it is extremely misleading to use the quoted price of $165,000 as a basis for comparative costs. Although during our meeting in Georgetown on June 17th 1971 on this subject, we used an estimated $225,000.00 for the total installation, in fact this was in error being a casual estimate only, and a detailed study as presented in Table No.2 has elevated the completed installation to $336,000.00. The building for this installation is shown on the Sorensen drawings as being 110 feet long by 49 feet wide with a side wall height of 12 feet, in our calculations we used a pre-fabricated metal building 110 ft x 40 ft x 12 ft and the quotation from a local supplier is enclosed as appendix No.6. We believe the other items are realistic.

Table No.3 shows the <u>TOTAL ANNUAL COST</u> reduced by the expected <u>Annual Revenue</u>, demonstrating an Annual Net Loss of about $70,000 per year. The cost of chemicals delivered to Georgetown, P.E.I. was obtained as follows:

Alum: Allied Chemical Co.
Montreal, Que.
<u>Delivery from Dalhousie, N.B.</u>

Lime: Domtar Chemicals Ltd.
Lime Division
Montreal, Que.
<u>Delivery from Joliette, Que.</u>

It is obvious that the strength of the wastes is too weak for application of the Sorensen process at Georgetown Seafoods Ltd. and if the strength of the wastes were sufficiently high in protein content to offset the capital and operating costs of the Sorensen process, then the residual B.O.D. in the effluent from the Sorensen process would require biological treatment.

As a matter of fact, by simple calculation it is possible to determine that an absolute minimum of 3500 tons/year of protein and fish oil must be recovered in order to pay the $70,000 annual amortization and operating costs. On the basis of future full operations of 150,000 lbs of Raw Fish per day for 250 working days per year it would be necessary that the wastes contain about 6000 p.p.m. of B.O.D. This is a ten (10) fold increase of the waste water B.O.D. and the only method we can visualize, would require that the water consumption be reduced from 1.0 million gallons/day to 100,000 gallons/day. Even if such a condition were to be realized, the effluent from the Sorensen process would contain some 1500 to 1800 p.p.m. of B.O.D., which again would require biological treatment.

CHAPTER 4

DISCUSSION OF DR. ROSS MCKINNEY'S REPORT DATED JUNE 9th, 1971

In order to clear-up any discrepancy between the context of our report of November 30th 1970 and the evaluation of this report by Dr. Ross McKinney of June 9th 1971, (Dr. McKinney Report is included herein under Correspondence part F) we wish to point out that our initial design with one aeration basin was designed to handle the Existing load, see Chapter 6 page 6.2 and Chapter 8 pages 8.1 and 8.2. Since we had selected an average B.O.D. of 540 mg/l for the fish plant we realized in selecting this value that it was considerably higher than the 140 mg/l that we found from the fish plant effluent (see Water Technology Laboratory Inc. analysis of October 23rd 1970) and for this reason we selected one basin with two 25 H.P. aerators and for our purposes, considering the higher strength wastes we used, we wished first to determine the efficiency of treatment whereas, in contrast, Dr. McKinney envisioned a more efficient use of water thus requiring only one Aeration Basin for the future and because of possible sudden loading he preferred to use two 50 H.P. (2 speed) motors in case of oxygen sag. His reasoning is sound however our approach was different.

Further, his suggestion of dividing the proposed aerobic digester into two (2) cells is an excellent suggestion. The total horsepower requirements however remain the same as those proposed by us.

Dr. McKinney further suggests Sand Drying beds for sludge drying, instead of liquid cartage, as a more economical and easier method of disposal. As an adjunct to the above proposal, he suggested a small Holding Pond for wintertime operations. In the winter this would freeze over but with the advent of warm weather, this material would be dewatered on the sand beds.

The extra for the sand beds and small Holding Pond should not exceed $50,000, but this investment would in effect reduce operating costs considerably.

CHAPTER 5

CONTEMPLATED PROCESS WATER

CHANGE TO SALT WATER

At the recent meeting held in the offices of Georgetown Seafoods Ltd, it was stated by the officials of Georgetown Seafoods Ltd that they were contemplating the use of Sea water for fluming and processing instead of using fresh water from a system owned by the P.E. Island Government. This possibility was confirmed by Mr. A. Hiscock, Manager of the P.E.I. Water Authority.

Dr. McKinney has confirmed in his letter of July 22nd 1971 (See Index-Correspondence No.i) that the biological system as designed would work very well with of course different species of biota and that the salinity must be maintained within a range of 2.0 to 2.5% as compared to seawater of 3.5%.

The biggest change would involve making all equipment corrosion resistant. We would expect relatively severe corrosion in the existing 14 inch cast iron forcemain, and/or any other metallic sewer line.

These corrosion resistant precautions would also apply to all proposed works in the plant as outlined in our report.

CHAPTER 6

FINAL REVIEW

From the data presented in Chapter 1 to 5 inclusive the following conclusions can be deducted:

1) The proposition as presented by Sorensen for Protein and Fish Oil recovery is not economically feasible.

2) The strength of the waste-water from Georgetown Seafoods Ltd is not sufficiently high to justify recovery.

3) If the strength of the waste-water from Georgetown Seafoods Ltd was in the order of 6000 p.p.m. B.O.D. instead of the projected 600 p.p.m., recovery would be justifiable, but the residual B.O.D. in the effluent from such a process would require biological treatment.

4) It is assumed that wet unloading of herring for the reduction plant would be disallowed.

5) There is a remote possibility that a Canadian facility of the same type would be lower in cost, but this is not likely as we have built a plant of exactly the same capacity in 1969, in Montreal, using exactly the same process and methods and the completed plant cost $ 375,000.00.

6) The projected change-over of the process water from fresh to salt water will not effect the operation of the proposed biological plant within salinity limits that would be automatically controlled. Some addition to our original concept would be necessary to de-water the sludge in order to reduce liquid sludge handling.

7) The biological system as proposed in our November 30th report would effectively treat the combined fish plant and Town of Georgetown wastes with an expected efficiency approaching 90 to 95% B.O.D.

removal, and insure the treatment of accidental or other spills of "Stickwater" from the reduction plant.

8) The extra cost for power to operate two (2) 50 H.P. motors on the aerators instead of two (2) 25 H.P. motors would amount to an additional annual operation cost of approximately $1,800.00 per year for electrical costs. It must be realized that these two (2) 50 H.P. motors would operate only for a short period each operating day then they would automatically step down to 25 H.P.

The theory and practice of protein precipitation by acid caustic or floculants together with air floatation has been known for decades and practiced by the pharmaceutical manufacturers. To our knowledge Sorensen was the first to apply this method to the recovery of usable products from waste water and one of his principal application is to the fish processing industry.

Whether one follows the route of recovery or biological treatment as a general type of treatment for the fish industry in Canada, one is faced with a substantial capital investment for in effect no return on the investment. Because, in order to make the recovery method economically feasible, a relatively strong waste is mandatory which would, in effect, also make it mandatory to follow such a facility with biological treatment. So that what is <u>gained</u> by recovery would be <u>lost</u> in biological treatment.

It is unfortunate that since the inception of the fish processing industry in Canada, large quantities of water have and are being used, thus resulting in a major problem to treat, in some manner, these liquid wastes in order to permit disposal of the treated effluent into a receiving body of water.

We feel that some determined research should be carried out in order to provide the proper directives to fish plant owners on the means best suited for fish processing. By this we mean research efforts possibly could be directed along the follow guide lines:

A) That all unloading and handling of the raw fish and finished product should be carried out on a dry handling basis in order to reduce water consumption to a minimum. Any water used for this purpose and/or for cleaning-up operations should be collected and evaporated to recover usable material, in the reduction plant.

B) The by-products of fish de-scaling and fish roe would become a part of the recovered material cited in A) above.

C) It might be advantageous from a sanitary viewpoint to scrub all incoming fish in weak caustic baths in order to remove the protective slimy proteinaceous layer (common to all fish). These caustic ($NaOH$) bath solutions could be neutralized with hydrochloric acid (HCl) and evaporated to dryness for complete material recovery as in A) above. The caustic bath would serve an additional function of acting as a germicidal agent. The $NaOH$ in solution could be converted to salt $NaCl$ by using hydrochloric acid (HCl).

D) For further protective sanitary measures, as the fish advanced from the caustic bath to the dry conveyor belt, passage through a rotating drum having ultra-violet radiation would insure their asceptic condition before machine or manual filleting.

E) As an additional precautionary sanitary measure, the cut fillets could also be passed through an ultra-violet rotating drum.

It will be noted that the foregoing, although only suggestions, provides for a closed loop system with no liquid wastes except cooling and evaporated water.

From the point of view of a technical challenge, the existing common problem for the fish industry is strictly academic but would require the consent and enthusiasm of all Government departments concerned with this industry.

Because of the nature of the fish industry with its fundamentally insecure supply of raw material and the fluctuating market prices, added to the demands of the Fisheries Department Inspection Branch, has resulted in a complete stalemate in improving their method of fish processing and a continuation of outdated handling procedures.

Finally, in order to complete this Re-Study, a question was brought forward by Mr. A. Hiscock, manager of the P.E.Island Water Authority in regard to Air Floatation without the use of chemicals, at the June 17th, 1971 meeting in Georgetown.

On the basis of the data presented in Table No.2 and Table No.3 revised, we are able to estimate the CAPITAL and OPERATING costs for such a facility as follows:

CAPITAL COSTS

Air Floatation equipment complete but without chemical feeding equipment, Foundations, Day Tank, Building, Pumping station, labour for erection, heating and lighting and including 10% contingency	$ 240,000.00

OPERATING COSTS

Amortization, maintenance and electrical costs	
Total Annual Operating Costs	$ 52,000.00

It is anticipated that the recovery would be about 10% of the protein in the wastes since air floatation without chemicals would recover only the fish particles that would float and leave untouched the colloidal and dissolved organic wastes.

It is again obvious that this alternative would not be economically sound.

APPENDIX 1)

STEINS
ANALYTISK-KEMISKE **LABORATORIUM** ✶ NØRREVOLDGADE 12, 1358 KØBENHAVN K

OPRETTET 1857

Statsautoriseret til kemiske undersøgelser af mejeriprodukter, foder- og gødningsstoffer, grundforbedringsmidler, karotinbestemmelser i lucernemel samt A-vitamin i tran og andet. Medlem af den danske afdeling af „Union Internationale des Laboratoires Indépendants". Den ansvarlige i henhold til autorisationen er ikke ansat i eller økonomisk interesseret i nogen virksomhed, der tilvirker, forhandler, importerer eller eksporterer de af autorisationen omfattede artikler.

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Dato	3.12.197o

ANTHONSEN Plant

Resultat af undersøgelse

af 3 prøver spildevand,

modtaget d. 24' f.m., indsendt af firma P. Norup Sørensen, 9990 Skagen.

24.11.70

Forsegling: ---

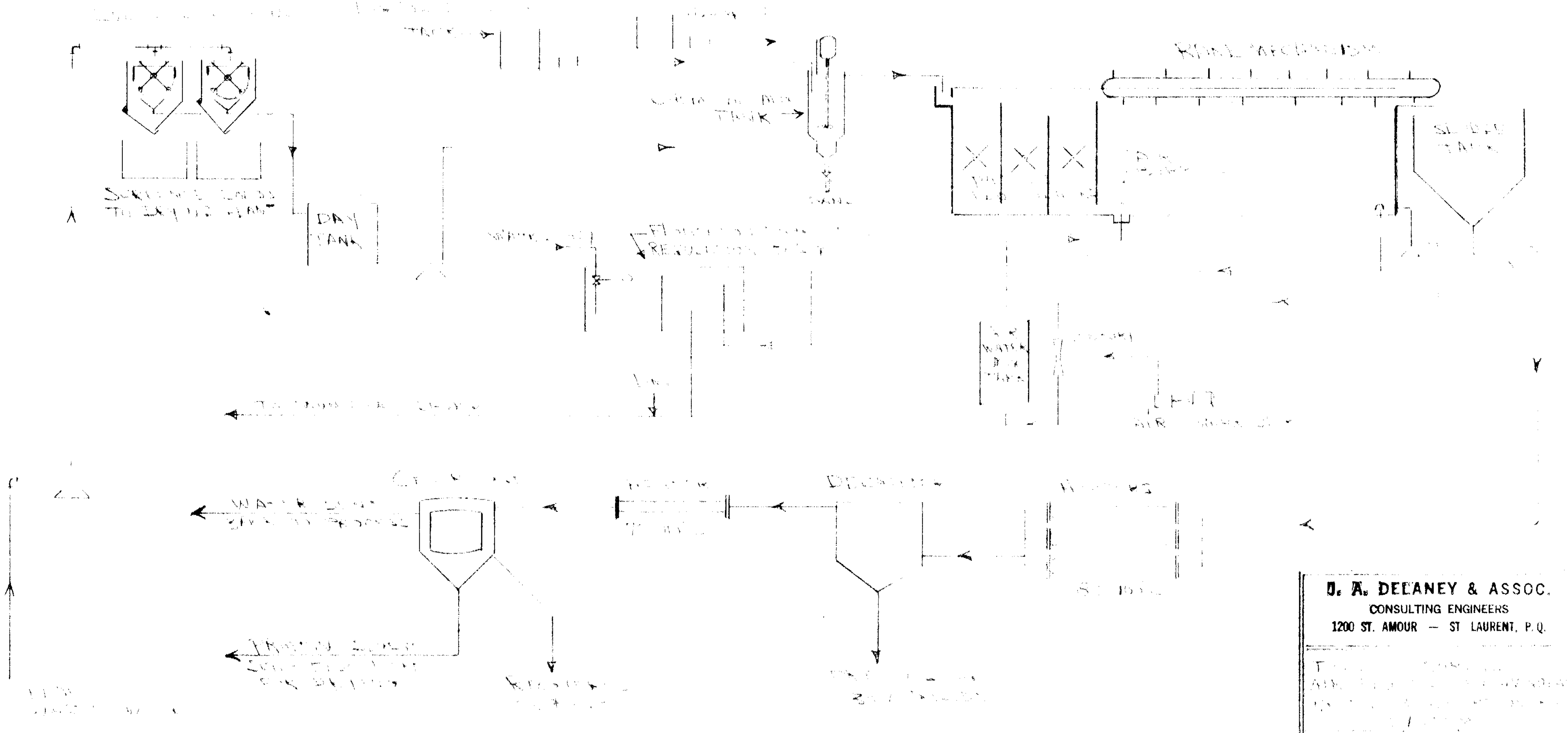
P.A. anlæg

Mærke: 1) råvand fra dagtank (Raw water)
2) renset vand uden kemikalier (Purified water without chemicals)
3) renset vand med kemikalier (Purified water with chemicals)

		1	2	3
Tørstof, mg/l	bundfald	324o	152o	44o
	filtrat	618o	332o	26oo
	bundfald + filtrat	942o	484o	3o4o
Glødningstab, mg/l	bundfald	316o	144o	40o
	filtrat	542o	272o	186o
	bundfald + filtrat	855o	416o	226o
Bundfald efter 2 timers henstand ml/l		o,2	o,4	26
Reaktionstal (pH)		6,6	6,4	6,2
Iltforbrug med kaliumpermanganat, ufiltreret KMnO4 mg/l		6113	2528	117o
5 døgns biokemisk iltforbrug, ufiltreret BOD "		108oo	545o 53%	18oo 83%
Kvælstof (N), ufiltreret "		784	448	28o
Nitrit (N) "		o	o	o
Nitrat (N) "		o	o	o
Affarvning af methylenblå, ufiltreret		straks	2 timer	18 tim

679 Red BOD

Ved reklamering med de af laboratoriet nustedte erklæringer, attester m. v. skal indholdet af disse samt datoen anføres.



J. A. DELANEY & ASSOC.
CONSULTING ENGINEERS
1200 ST. AMOUR — ST LAURENT, P.Q.

1

APPENDIX 2)

3767 sorup dk

soprorg sdeni

20.4.1971.

att. mr sorensen.

we give you here after bod nal/sis results.

in the whole they seem satisfactorily.

31.3.1971. inlet effluent 16.080 > 61.5% B.O.D. Reduction
outlet effl. 6.190
61,5 0/0

1.4.1971. inlet effluent 16.900 > 83.4% BOD Reduction
outlet effl. 2.830
83,4 0/0

2.4.1971. inlet effluent 16.900 > 86.7% BOD Reduction
outlet effl. 2.220
86,7 0/0.

as we have already told you, only the analysis results for grease outlet the titan, rema n unsastisfactory.

could you aware us of mr denc er's arrival as soon as possible please.

regards.

m.parel.

PLANT No 11

soprorg sdeni

3767 sorup dkt

FISHERIES RESEARCH BOARD OF CANADA

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B.C.

CIRCULAR NO. 42

SALMON CANNING WASTE-WATER CLARIFICATION

PART II

A Comparison of Various Arrangements for Flotation
and some Observations concerning Sedimentation
and Herring Pump Water Clarification

By

F.G. Claggett and J. Wong

February, 1969

Introduction

The investigation of suitable methods of clarifying salmon canning waste water which was begun in 1967 (Clagget and Wong, 1968) was continued during the 1968 canning season.

The initial investigation showed that flotation was a feasible method of attacking the problem, and that aluminum sulphate and F-FLOK[1] showed promise as flocculants. Some difficulty with floc carry over was encountered, and the pilot plant in use did not lend itself to investigation of partial pressurization of the feed or recycling of a portion of the effluent. More information on fine screening of the waste water, and the ability of the flotation cell to handle the pump water from herring unloading was desired, so it was decided to continue the investigation using a more flexible flotation unit.

Description of the Flotation Pilot Plant

The flotation pilot plant obtained for the 1968 season was a "Favair"[2] unit supplied by Permutit of Canada. It had a rectilinear cell of approximately 5 ft. by 12 ft. by 4 ft. deep, and was rated for a flow of 50 USGPM. It differed from the unit used in the previous study in that the air was injected by compressor rather than by aspirator, and that auxiliary equipment was supplied to allow recycling of effluent from the unit and partial pressurization of the feed stream.

The plant layout is shown in Figure 1.

Description of Test Screens

Two types of screens were tested for use in further removal of solids after rough screening with a 4 mesh trommel screen. The two screen types are shown in Figures 2 and 3, and described below.

A. Rotary Sewage Screen

The North Sewage Screen[3] is a cylinder panelled with the appropriate size of stainless steel mesh screen (in these tests, 34 meshes to the inch)

---

[1] "F-FLOK" is the trade mark of the Georgia Pacific Corporation, Bellingham, Washington, U.S.A. for flocculants derived from lignosulphonic acid.

[2] "Favair" is the trade mark of Permutit of Canada, 285 Raleigh Avenue, Scarborough, Ontario.

[3] The North Sewage Screen was provided by Green Bay Foundries Ltd., Green Bay, Wisconsin, U.S.A.

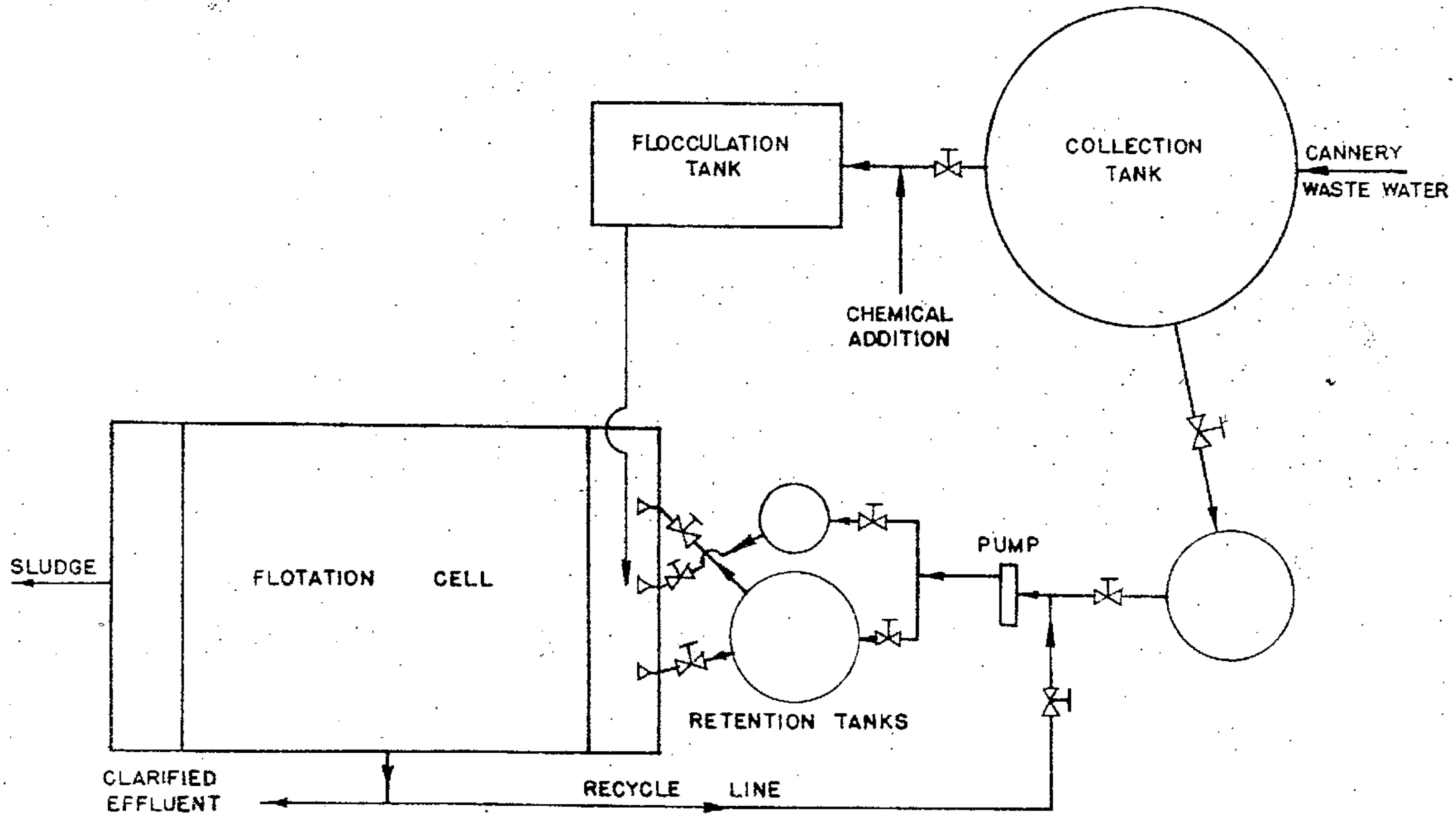

FIGURE I FLOTATION CELL ARRANGEMENT

and rotating about its axis in an enclosed box. The screen rotates with the lower edge slightly submerged. The water is introduced inside the cylinder, and screened water is withdrawn from the bottom of the box. The interior edge of the cylinder has flanges which pick up solids, carries them to the top of the cycle, and drops them into a trough on the axis of the cylinder. Here a screw conveyor carries them over a drainage section and out to a collecting point. As the cylinder rotates it is subjected to a high pressure water spray from the outside which cleans the screens. An auxiliary spray is provided for extra cleaning capacity, and a steam spray is provided for intermittent use and cleaning after operation. The screen used was a 4 foot model, rated at 100 USGPM on equivalent service.

B. Tangential Screen

The DSM screen[4] consists of a stationary screen housing equipped with a concave wedge bar type screen. In operation, the feed enters the box and is fed tangentially over the weir onto the upper surface of the screen. Flowing down the concave surface at right angles to the openings between the wedge bars, undersize fraction and liquid pass through these apertures and are collected in the screen box. Dewatered oversize material flows down the screen surface to the oversize discharge.

The screen tested had a 1 sq. ft. surface area, and the actual screening surfaces used were equivalent to 20 and 40 meshes to the inch. Corresponding operating capacities were about 20 and 35 USGPM.

Where blinding may lead to reduced capacities, as in this operation, the suppliers recommend that a modified version, called a Rapifine DSM screen, be used. This is a tangential screen incorporating a motorized rapping device. This periodically hammers the undersize of the screen surface, thereby dislodging any blinding solids.

Properties of Coagulants

A. Choice of Coagulants

During the season several aluminum sulphate plus electrolyte systems were investigated with little success. There are a large number of such systems yet to be tested. The additives which showed the best potential were precipitated aluminum hydroxide, and a modified form of F-FLOCK.

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4 "DSM" is a trade mark of the Dorr-Oliver Company, and the screen was provided by Dorr-Oliver-Long Ltd., Vancouver, B.C.

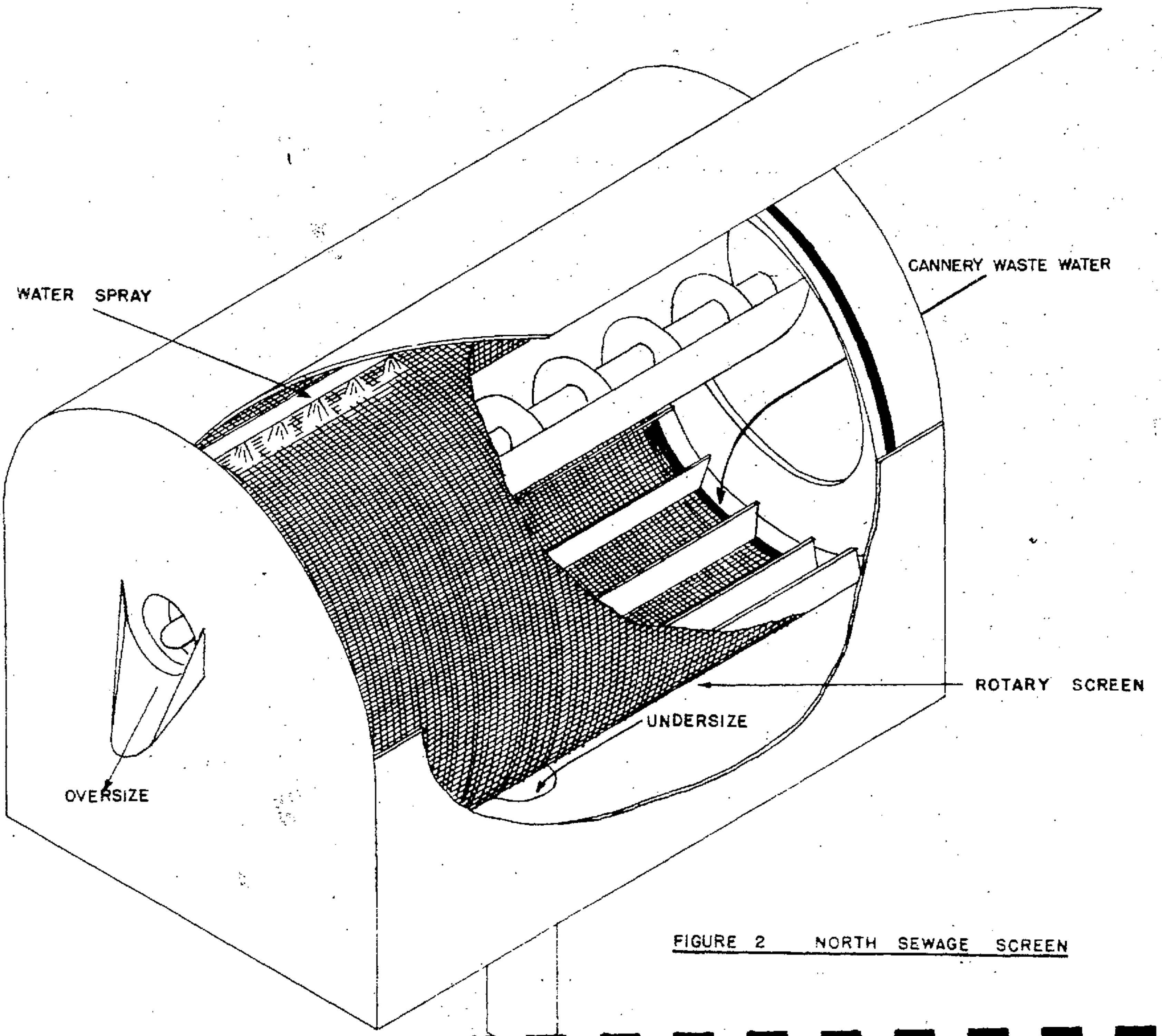

FIGURE 2 NORTH SEWAGE SCREEN

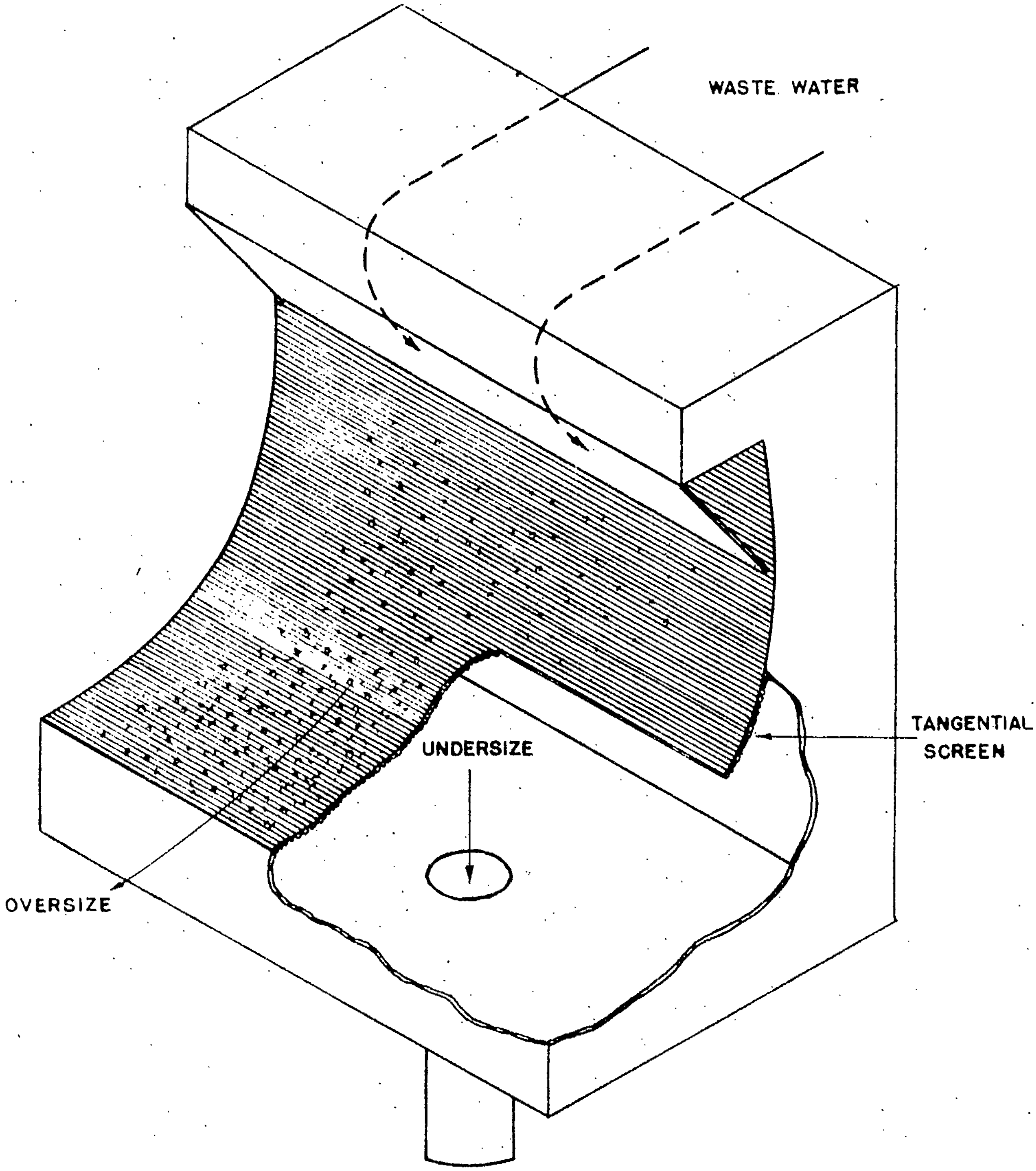

FIGURE 3 D S M TANGENTIAL SCREEN

B. Precipitated Aluminum Hydroxide

Where aluminum sulphate is added to water under basic conditions the reaction is

$$Al_2(SO_4)_3.18H_2O + 6NaOH \longrightarrow 3Na_2SO_4 + 2Al(OH)_3 + 18H_2O$$

Aluminum hydroxide has the general formula $Al_2O_3.xH_2O$ and is amphoteric. Under basic conditions the hydrated aluminum oxide dissociates:

$$Al_2O_3 + 2OH^- \rightleftharpoons 2AlO_2^- + H_2O$$

$$(AlO_2^-)(H^+) = 4 \times 10^{-13} \quad \text{(dissociation constant)}$$

At pH 9.0, 10 mg/l of aluminum are in solution. The floc is least soluble at a pH of approximately 7.0. The floc charge is positive below 7.6 and negative above pH 8.2.

The mode of action is explained (Echenfelder, 1966) as follows: sodium hydroxide is added to convert the charge on the colloids (proteins, flesh particles and oil drops) to negative. As aluminum sulphate is added the cations are attracted by the opposing charges, thus "coating" the colloid. Microflocs are then formed which retain a positive charge in the acid range because of the absorption of hydrogen ions. Flocculation agglomerates the colloids with a hydrous oxide floc. In this phase surface adsorption is also active. Colloids not initially adsorbed are removed by enmeshment in the floc.

Since the soluble proteins begin to precipitate as the pH is lowered (at least until their isolectric range) the more aluminum sulphate that is added, the more soluble solids will be removed. However, in the course of jar tests it was found that below a pH of 5.0, the microfloc took considerable time to agglomerate. The optimum conditions seemed to be addition of alkali to pH 9.2, and then addition of aluminum sulphate to lower the pH to 5.2. A curdy floc was formed which floated readily in the presence of air bubbles. It appeared that the source of alkalinity (i.e. sodium hydroxide, ammonium hydroxide, lime or soda ash) was immaterial.

C. Lignosulphonic Acid Derivatives (F-FLOK)

For the action of F-FLOK for the recovery of proteins, sulphuric acid is required to adjust the pH of the system below the isolectric point of the proteins present. In the range of pH of 3.8 to 4.2, the F-FLOK enters into either a true chemical reaction or a close electron bond action with the protein to form a precipitate which flocculates by bridging action, (i.e. the F-FLOK also acts as a polyelectrolyte). Since there is a quantitative reaction, the amount of F-FLOK is usually added in proportion to the amount of protein present. The dosage has been found to be in the range 8 to 12 per cent of the total solids present where the solids are about 50 per cent protein. The dosage rate has been the major problem to date in the use of this material, since for correct addition it is necessary to know the approximate content of the water. As the ratio varies further from the correct one, the rate of flocculation decreases resulting in floc appearing in the cell effluent. For most applications the protein content of the water is in proportion to the total solids content and hence to the buffering capacity of the solution, so it should be possible to add the F-FLOK in a direct ratio to the amount of sulphuric acid required to lower the pH to 4.0. This has proven to be the case for both salmon and herring waste waters.

Test Procedure

A. Sampling and Testing

Since the waste water was found to vary widely in solids content throughout the day due to changes in plant operation, it was found necessary to make composite samples over periods of no longer than one-half hour. In most cases the procedure was to take a 100 ml sample every 5 minutes from the required streams at about 11.00 a.m. or 2.00 p.m. on a normal operating day. Samples were taken from the feed, effluent and sludge streams.

The analyses made and procedures used were as follows:

1. Insoluble solids.

Four tared 50 ml centrifuge tubes were filled with a sample to be tested and spun at 1800 r.p.m. for 10 minutes on a laboratory centrifuge with an eight inch diameter rotor. The clear liquid was carefully decanted, and the tubes were dried in a vacuum oven at 103°C for one hour. The increase in weight times five was taken as mg. per l. insoluble solids.

2. Soluble solids.

A 100 ml sample of the decanted liquid from the insoluble solids test was evaporated to dryness in a tared flask, first on a hot plate, then in the vacuum oven. The increase in weight times ten was taken as the mg. per l. soluble solids.

3. Protein nitrogen, 5-day biochemical oxygen demand and turbidity.

The procedures followed were those described by the American Public Health Association (Anon, 1965), except that a Beckman dissolved oxygen meter was used in the BOD tests. Consequently, the accuracy of BOD determinations below 100 mg/l is limited.

B. Pilot Plant Operation (See Figure 4)

1. Caustic-Alum System.

Raw water was pumped through the screen under test and collected in the surge tank. The water was fed by gravity to a small constant-head tank at the suction of the pressurizing pump. Here caustic was added to raise the pH to 9.2. The centrifugal pump passed the water to a retention tank where it was mixed with 2 per cent by volume of air at 40 psi. The pressure was maintained by suitable throttling of the valves on the discharge of the retention tank. The flow through the unit was regulated at about 50 gpm by throttling the pump discharge. Undissolved air build-up in the retention tank was avoided by slightly opening a valved line in the top of the retention tank.

As the water passed from the retention tank through the two throttling valves, alum was introduced so as to reduce the pH to 5.2. Both caustic and alum were metered in order to determine the precise rates of addition.

The flotation cell was operated so that a maximum concentration of the solids in the overflow sludge was obtained. That is, the scrapers were operated with as low a speed as possible, and the operating water level was kept low.

The clarified water discharge was over a weir, so that the flow rate through the unit could be measured by knowing the liquid height above the weir. The sludge discharge was either by gravity to the river, or by rotary pump to a collection tank in the reduction plant. The collected sludge was heated to boiling, and the solids were removed by screening through a 60 mesh vibrating screen. Several tests were made to determine the ability of the solids to be removed by basket centrifuge.

The recovered solids were sent to a fines press,and then dried in a pilot model fish meal plant. The meal was sent to the Poultry Science Department of the University of British Columbia for testing of nutritive value of the protein and possible toxicity of the aluminum compounds. Several tests were made with an activated animal glue (Zetol A)[5] to determine if it would make the system less subject to precise pH limits, or would improve solids removal.

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[5] Zetol A is the trade name of an animal glue. Supplier's name given on request.

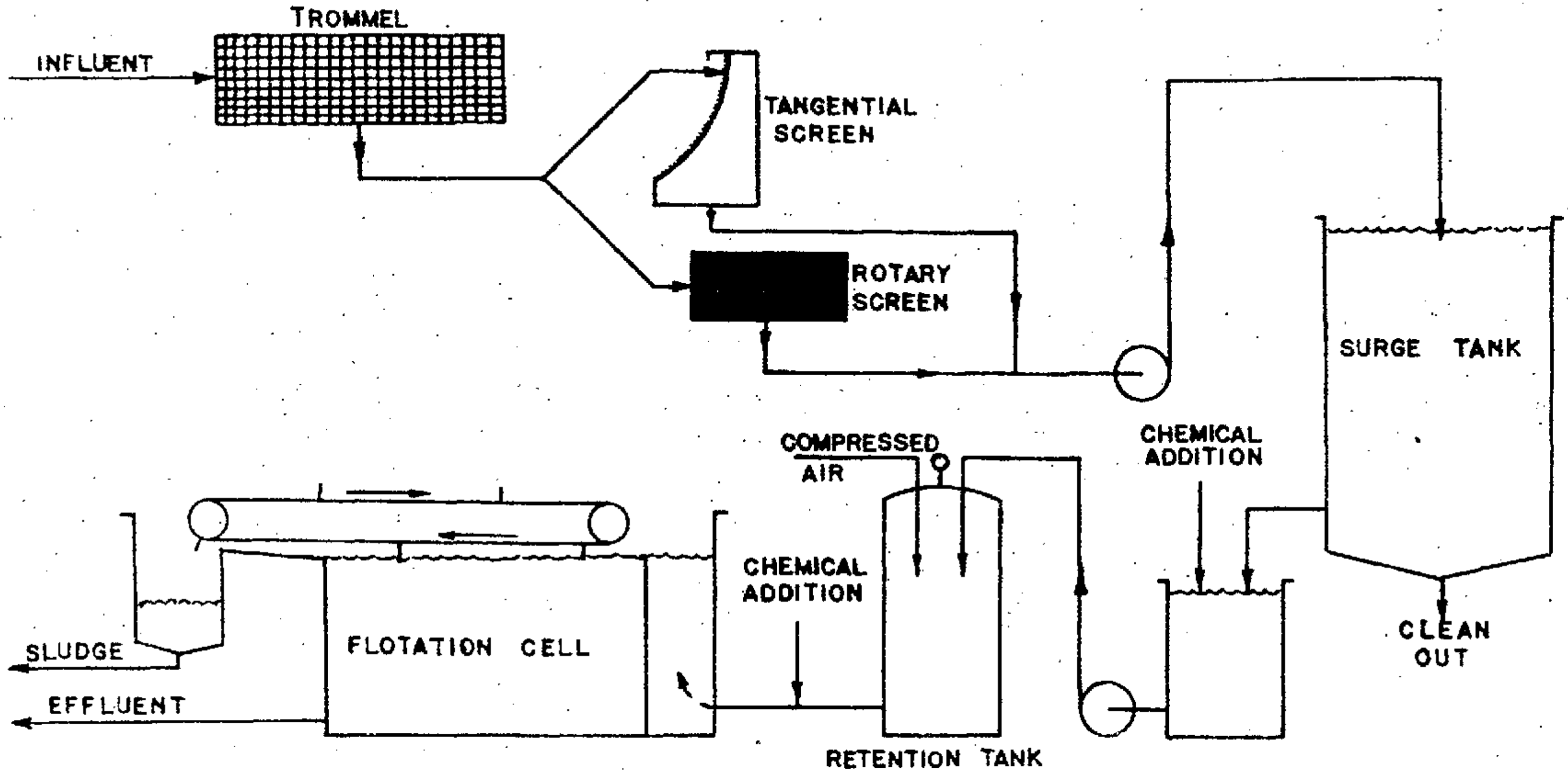

FIGURE 4 PILOT PLANT LAYOUT

When this unit was used to handle the heavily loaded salmon stick-water stream, about 25 gallons per minute of clarified effluent was recycled to the pump suction where it was mixed with the incoming feed. This could be used easily any time high solids levels were encountered.

2. F-FLOK Operation.

The floc produced by this material is rather fragile and slow forming. It was found that a longer retention time was necessary for high efficiency of solids removal. In order to operate at lower than rated flows, the feed from the pump was passed through the small retention tank. The feed rate was adjusted at flows from 10 to 30 gpm, and samples taken to determine the efficiency.

Two forms of the F-FLOK, denoted as F-FLOK, and F-FLOK 98 were tested for use with the flotation cell.

When a fragile or slow forming floc is encountered in flotation, it is often possible to form the floc fully, in a reaction vessel and feed this by gravity to the flotation cell. In this case air is introduced into a recycle stream of clarified liquid which is pressurized through the small retention tank. This water-air solution is introduced underneath the incoming flocculated feed. This system was tested using the F-FLOK at various rates of feed input.

Results

A. Screening

Both the tangential and rotary screens worked well on salmon canning waste water. Only primary flush water was required by the rotary screen. Some improvement in solids concentration in the oversize of the DSM screen could be expected with use of a rapper. The analyses of the various streams to and from the screens may be seen in Table 1.

Table 1

Solids Removal from Salmon Waste Water by Screening

DSM 40 mesh screen	Total Solids (G/L)	North 34 mesh screen	Total Solids (G/L)
Feed	4.5	Feed	4.2
Undersize	2.5	Undersize	2.4
Oversize	164	Oversize	105.1

B. Flotation

Both flocculants tested work well in flotation, but with the F-FLOK 98 showing an advantage in protein removal. Total solids removal by the F-FLOK was not substantially improved due to some floc carry over. It was not possible to test the F-FLOK at flow rates of higher than 35 USGPM due to the lack of metering capacity, but it is probable that floc carry over would increase at higher rates.

The precipitated aluminum hydroxide system worked well physically, with little floc carry over, even at rates exceeding by 25 per cent the rated capacity of the unit. The effluent water was clear, with only a slight yellowish tinge remaining. The dosage rates over the total test period averaged at 375 mg/l aluminum sulphate and 75 mg/l of sodium hydroxide. Although other forms of alkalinity appear to work well within this system, sodium hydroxide would still be the choice on the basis of cost and ease of handling. The animal glue tested did not affect the flotation to any extent, but it did appear to aid in the screening of the heated sludge.

Table II

Flotation with Precipitated Aluminum Hydroxide

Stream	Insoluble solids (mg/l)		Soluble solids (mg/l)		Total solids (mg/l)		Protein (mg/l)		BOD (mg/l)	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
Influent	640	250	2045	675	2685	790	1440	395	1775	915
Effluent	180	70	1305	505	1505	450	485	240	475	315
% removal	70	12	38	17	44	14	65	18	73	23

1. $\bar{x}$ is the mean, s is the standard deviation.
2. The data is obtained from 8 test runs.

Table III

Flotation with Precipitated Aluminum Hydroxide and Zetol A

Stream	Insoluble solids (mg/l)		Soluble solids (mg/l)		Total solids (mg/l)		Protein (mg/l)		BOD (mg/l)	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
Influent	697	303	1744	685	2441	607	1020	215	1275	646
Effluent	200	34	1425	646	1625	653	505	120	381	332
% removal	66	14.5	19	9.8	34	15	50	6	70	18

1. Zetol A added at 1 mg/l.
2. The data is obtained from 4 test runs.

Table IV

Flotation with Aluminum Sulphate and Lime

Stream	Insoluble solids (mg/l)		Soluble solids (mg/l)		Total solids (mg/l)		Protein (mg/l)		BOD (mg/l)	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
Influent	1993	1263	2775	428	4268	1250	1982	317	2833	895
Effluent	397	303	1764	74	2162	380	830	104	633	421
% removal	73	24	20	16.8	46	22	57	8	79	10

1. The data is obtained from 4 test runs.

Table V

Analysis of Overflow Sludge from Flotation

Treatment	Insoluble Solids	Soluble Solids	Total Solids
1. $Al(OH)_3$	3.3 mg/l	0.3 mg/l	3.6 mg/l
2 $Al(OH)_3$	4.0 mg/l	0.4 mg/l	4.4 mg/l

In Table VII, the rate listed as 14 USGPM is that using a pressurized recycle and a flocculating tank prior to the flotation cell. It can be seen that some improvement is obtained by this system, but at a large sacrifice of throughput.

Table VI

Analysis of Solids Recovered by Flotation using Aluminum Hydroxide

Protein (N x 6.25)	50.5%
Ash	10.9%
Moisture	7.7%
Fat	16.5%
Total	85.6%
Aluminum	0.5%

Note:- it is assumed that the balance is water of hydration.

Table VII

Flotation with F-FLOK and F-FLOK 98

Flow Rate (USGPM)	Treatment	Feed Concentration (mg/l)	Total Solids Recovery (%)	Protein Recovery (%)	BOD (mg/l)
30	F-FLOK	2320	44	66	-
14	F-FLOK 98	2260	42	76	125
36	F-FLOK 98	1560	50	70	100

At this point it would appear that a flotation cell could be designed into a system operating on salmon canning waste water using either flocculating system. A longer residence time and an altered method of feed distribution to the flotation cell will improve the recovery with F-FLOK.

The system could be designed to use either screening or centrifuging for dewatering the thickened sludge. In both cases the clarified liquid should be recycled to the surge tank. Pressing of the recovered solids could be improved by mixing this stream with the cooked solids from the screening operation.

By referring to Appendix 2, one can see that for a plant having a 500 USGPM waste-water flow, a 60-day season and an estimated capital cost of the treatment plant of $100,000, the net operating loss on a 10 year pay-off would be about $100 a day. Some savings could be achieved by using as much of the existing reduction plant equipment as possible.

If a reduction plant operation of about 10,000 tons of meal a year is included, and the pump water from the unloading operation is processed, it is possible that the plant could be written off in 5 years. Another factor which could affect the economics of the system would be processing the refrigerated sea water from the salmon packing vessels.

The report of the Poultry Science Department of the University of British Columbia on the nutritive value of the meal and possible toxicity of the aluminum compounds is found in Appendix 3. With regard to F-FLOK, the U.S. Food and Drug Administration approves the use of such material in animal feeds at levels up to 4 per cent.

A commercial drum seiner was chartered to fish herring in limited quantities so that tests could be performed using the equipment on herring pump water. The results of these tests are given in Appendix 1.

Some data is included in Appendix 4 on sedimentation using F-FLOK. It would appear that this is a distinct possibility which merits further investigation.

Conclusions

A fifty per cent or more reduction in solids loading of salmon canning waste water or herring pump water may be achieved by using screens of the type tested. For herring operation the tangential screen must have a rapper, and the rotary screen must have steam cleaning lines. The cost of these can be written off rapidly from the value of the solids recovered.

Flotation using precipitated aluminum hydroxide, or F-FLOK will treat the plant effluent to where it is readily acceptable to municipal sewers, and perhaps to the river courses, depending on the regulations in effect. The F-FLOK does a better cleaning job, but at a sacrifice in capacity.

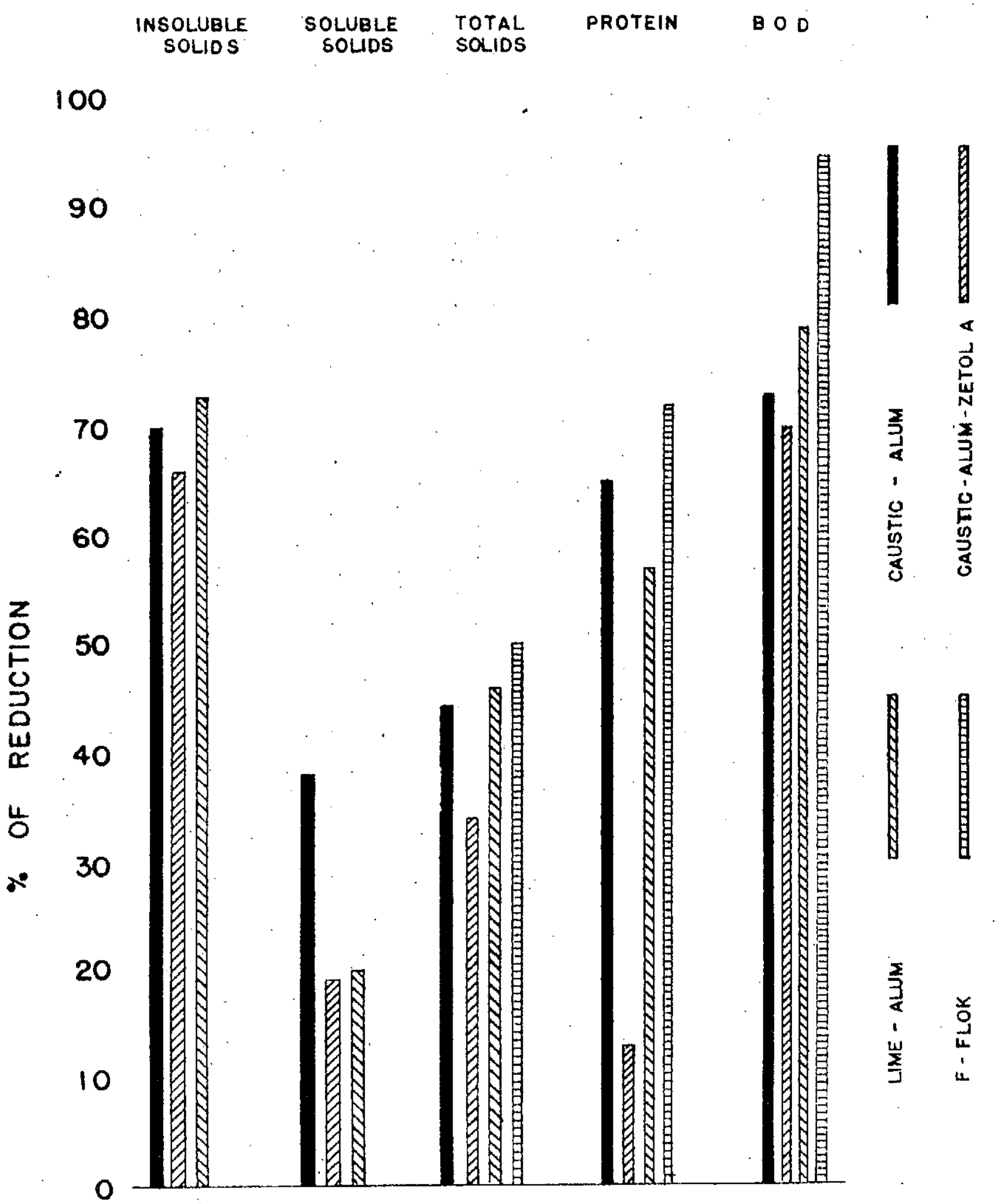

FIGURE 5 COMPARISON OF FLOCCULANT EFFICIENCIES

For herring pump water it is possible that screening and flotation may be worked into a closed circuit system, thereby eliminating problems of neutralization of flotation plant effluent and the BOD load of the remaining soluble protein. Further tests are required to determine the proper size of flotation cell for herring pump water from herring in all seasons of the year.

For salmon plants operating on relatively short seasons, a loss will be sustained. However, if the unit can be used in a second fishing operation such as herring, groundfish filletting, tuna, etc., thereby extending the length of time used per year, the unit may be written off in less than 10 years.

The results of biological tests on the recovered meal, as shown in Appendix 2 indicates that the aluminum hydroxide had little effect in rations when the recovered meal was fed at up to 5 per cent. The poorer biological value of the recovered solids is not unexpected as similar results have been obtained in South Africa (Dreosti, 1968). These results would dictate that this meal be mixed with the recovered solids from the screens, and possibly with the regular meal production.

ACKNOWLEDGMENTS

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APPENDIX 1

The Utilization of Fine Screening and Flotation for Clarifying Herring Pump Water

Several herring trips were unloaded during November of 1968, and the pump water was passed through the screens and flotation cell for test purposes. In general the solids level in the pump water was low, with the exception of the one run in which the herring contained red feed.

The screens all worked well, although the DSM screen definitely needed the rapper, and the rotary screen appeared to have some reduction in capacity. The analyses of the streams to and from the screens are given in the following table.

Table I

Solids Removal from Herring Pump Water by Rotary and Tangential Screens

Stream	Total Solids (G/l)	Stream	Total Solids (gm/l)
DSM feed	6.91	North feed	7.36
Undersize	4.58	Undersize	3.56
Oversize	143.06	Oversize	111.04

Table II

Solids Removal from Herring Pump Water by the North Rotary Screen During Unloading of "Feedy" Herring

Stream	Total Solids (gm/l)
Feed	22.24
Undersize	16.54
Oversize	120.00

The results of the tests on operation of the flotation cell on the pump water are as follows:

Table III

The effect on Herring Pump Water of Flotation* with Caustic-Alum

Stream	Total Solids (non-salt)	Protein
Influent	4500	2500
Effluent	1500	400
% removal	67%	84%

1. *flow rate of 50 GPM.
2. Aluminum sulphate rate of 475 mg/l, sodium hydroxide rate of 125 mg/l.

During the test with "feedy" herring containing 13,600 mg/l non-salt solids, flocculation was still achieved by caustic and alum, but it was necessary to introduce a 30 per cent recycle. It would appear that under heavy solids loading there is considerable interference between individual flocs, leading to a slow rise rate. Since for salmon and herring operations combined in one plant a flotation cell would be chosen on the basis of the salmon waste water flow, there would appear to be little problem in using a recycle for the herring operation and still maintaining an adequate flow. However, more work should be performed before a flotation cell is chosen for a reduction plant alone.

Table IV

The Effect on Herring Pump Water of Flotation with F-FLOK*

Stream	Total Solids (non-salt) mg/l	Protein (N x 6.25) mg/l
Influent	2200	1150
Effluent	1100	320
% removal	50	72

Flow rate of 30 GPM
*These figures are not based on steady state conditions.

APPENDIX 2

Economic Analysis of Flotation

A. BASIS: One million U.S. gallons of salmon cannery waste water of the following analysis:

Effluent from trommel screen:	4500 mg/l total solids
Effluent from fine screen:	2700 mg/l total solids
	1440 mg/l protein
Effluent from flotation cell:	485 mg/l protein

Estimated Costs of:

Steam:	\$ 1.25	per 1000 lb.
Alum:	\$45.00	per ton
Caustic:	\$113.00	per ton
Protein:	\$60.00	per ton
(value to reduction plant)		
Oil:	\$60.00	per ton
(value to reduction Plant)		

Analysis of salmon flesh (Dry basis):

protein	60%
fat	20%
ash	20%

CALCULATIONS:

Wt. of protein recovered = wt. from screens + wt. from flotation

$$= \frac{(4500 - 2700)}{10^6}(10^6 \times 8)(0.60) + \frac{(1440 - 485)}{10^6}(10^6 \times 8)$$

$$= (4500 - 2700)(4.8) + (8)(1440 - 485)$$

$$= (1800)(4.8) + (8)(955)$$

$$= 8600 + 7640$$

$$= 8.1 \text{ tons}$$

Value of protein recovery = \$486.00

Oil recovery (based on 10% oil in recovered meal) $= 8.1 \left(\frac{10}{60}\right)$

$= 1.35$ tons

Value of recovered oil = \$81.00

Total recovered value = \$567.00

Chemical costs, at 375 ppm alum, 75 ppm caustic.

$$= \frac{375\ (8)}{2000} \times 45 + \frac{75\ (8)}{2000}\ (113)$$

$$= \$68.00 + \$34.00$$

$$= \$102.00$$

Steam costs, based on a 10% sludge flow, and a 1/3 post concentration

$$= \frac{(67000)(8)(150)}{(1000)(1000)} \times 1.25$$

$$= \$100$$

Operating man-hours at 500 GPM $= \frac{10^6}{500 \times 60}$

$= 33$

At a rate of \$4.00 per hour, this is \$132

Estimated electrical cost = \$25.00

Direct operating costs = 102 + 100 + 132 + 25

= 359

Fixed capital costs, including a 10 year write-off of a \$100,000 capital investiment, insurance, taxes, etc., might be \$10,000 per year. If the plant operates at 250,000 U.S. gallons per day for 60 days, this would be 15 million U.S. gallons per year, or a fixed cost of \$670 per million gallons. Therefore, the balance is

Total costs = 670 + 360

= \$1030 per million gallons

Income = \$567 per million gallons

Operating loss = \$463 per million gallons

or approximately \$100 per day.

B. BASIS: 1,000,000 U.S. gallons of herring pump water analyzed as follows

Stream	Total Solids (mg/l)	Protein (mg/l)	Oil (mg/l)
Before screen	8700	5000	2500
After screen	4500	2500	1400
After flotation	1500	400	-

wt. of protein recovered = (5000 - 2500)8 + (2500 - 400)8
= 20,000 + 15,200
= 17.6 tons.

Value of protein recovered = 17.6 x 60
= $1056

wt. of oil recovered = 2500(8) - oil left in meal
= 20,000 - 7000
= 6.5 tons

Value of oil recovered = 6.5 x 60
= $390

Total value recovered $1450

Operating costs (assuming slightly higher solids than for salmon) may be $500. Therefore, operating profit is $950 per million gallons.

If the reduction plant handles 15 million gallons of pump water then the operating profit is $14,200. For the combined plant, the operating profit is $3000 + $14,200 for a total of $17,200. This would allow the payoff of a $100,000 investment in less than 6 years.

APPENDIX 3

The Nutritional Evaluation of the Recovered Solids in Poultry Rations.

The following is a report submitted by Mrs. B.E. March, Poultry Science Department, University of British Columbia.

A sample of meal made from material recovered from salmon cannery waste water was tested as a supplement in chick-starting diets. The meal was included at levels of 2.5, 5.0 and 15.84 percent and was substituted isonitrogenously for herring meal plus glucose in the control diet.

Because of the possible adverse effect of alum present in the meal, diets containing alum (the same product used in the preparation of meal) at levels of 0.5 and 1.0% were fed in the experiment.

Each experimental diet was fed to triplicate lots of eighteen 1-week old white Leghorn cockerel chicks for a 4 week period.

The data show that, in a diet in which herring meal is the source of supplementary protein, 2.5 or 5.0 percent of the sample of recovery meal could be included without adverse effect on growth rate. Feed efficiency was slightly poorer when 5 percent of the product was fed, but the effect cannot be assessed conclusively on the basis of this single experiment. When the recovery meal was tested as a total replacement for herring meal in the diet, there was a marked reduction in both growth rate and efficiency with which the diet was utilized.

The inclusion of alum at either the 0.5 or 1.0 percent level in the diet did not significantly affect growth rate or efficiency of feed utilization.

Table I

Body weights and feed efficiency of chicks fed the experimental diet for 4 weeks.

		Average weight	Feed/gain (1-4 weeks)
1.	control diet	365 gm.	2.17
2.	2.5% recovery meal	365 gm.	2.18
3.	5.0% recovery meal	365 gm.	2.22
4.	15.8% recovery meal	300 gm.	2.49
5.	0.5% alum	363 gm.	2.18
6.	1.0% alum	358 gm.	2.19

Check analysis of the mixed diets for protein

1. 20.9
2. 21.1
3. 21.3
4. 21.1