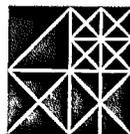


# *Technical and Economic Evaluation Wood to Ethanol Process*

*A report prepared for Solar Energy Research Institute  
August 1990*



**CHEM SYSTEMS**

Chem Systems Inc.  
303 South Broadway  
Tarrytown, New York 10591  
Telephone: (914) 631-2828 Telex: 221844 Facsimile (914) 631-8851

APPENDIXA. Steam Boiler

Type of quote: Verbal.

Contact: Andy Sefcik, A.B.B. (201) 992-2392.

Conditions:

## 1. Boiler Fuel

<u>Boiler Fuel</u>	<u>Btu/Lb</u> (LVH)	<u>Lb/Hr</u>	<u>Btu/Hr</u>
Water	0	83,963	0
Cellulose	6,960	8,588	59,772,480
Xylan.	6,510	525	3,417,750
Soluble solids	-	1,093	0
Ash	-	39	0
Lignin	10,650	38,401	408,970,650
Xylose	6,510	513	3,339,630
HMF	6,510	7	45,570
Gypsum (soluble)	-	1,189	0
Gypsum (insoluble)	-	4,765	0
CO <sub>2</sub>	0	6,797	0
Cellulose	6,960	44	306,240
Glycerol	-	231	0
Cell Mass	5,000	9,669	48,345,000
Methane	21,500	5,538	119,067,000
		<b>160,362</b>	<b>643,264,320</b>

## 2. Exit Pressure

Exit pressure: 1,100 psia @ 857°F (300°F of superheat).

Cost (1990): \$19,800,000 installed.

Note: A.B.B. subsidiaries include the company that produces Flakt type dryers. Therefore, quote encompasses same type of design as in the earlier Badger report.

B. Steam Turbine

Type of quote: Verbal.

Contact: Bill Krohner, A.B.B. (203) 673-7463.

Conditions:

Steam turbine feed: 433,878/hr of steam, 1,100 psia with 300°F of superheat (875°F).

Extraction @ 150 psig: 41,354 lbs/hr

Extraction @ 50 psig: 222,853 lbs/hr

Steam turbine exit pressure: 89 MM Hg

Cooling water @ 90°F

Chilled water @ 50°F

Cost (1990): \$6,500,000 bare equipment. Includes turbine and condensor. Not included are foundation, erection and supervision, electrical package, piping, extraction and expansion valves.

Note: According to Mr. Krohner, given the above conditions, a turbine of this type should be able to produce approximately 36 MW of power.

C. Disk Refiner

Type of quote: Written, non-binding. Quote is attached.

Contact: David Kenamond, A.B.B. Sprout-Bauer, (717) 546-1517.

Conditions: 2,000 T/D of hardwood chips.

Cost (1990): \$370,900 per machine. Four machines needed.



July 30, 1990

ChemSystems  
303 S. Broadway  
Tarrytown, New York 10591

Attention: Mr. Don Bari

Reference: Sprout-Bauer Proposal No. 90-21-1P-2129

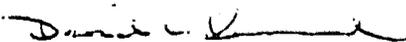
Gentlemen:

ABB Sprout-Bauer is pleased to submit a budget proposal for the supply of equipment only for the purpose of shredding 2000 T/D (O.D.) of hardwood chips as a preparatory step in your proposed ethanol processing system. Equipment is selected to permit the application of up to 5.0 HPD/T specific energy and of sufficient volumetric capacity to suit your needs. The requirement is then four (4) 45-lB Refiners.

The refiners must be fed a uniformly metered supply of chips (equipment by others) and will discharge atmospherically into a discharge conveyor or similar device (equipment by others).

At this early stage in this initiative, it would be very prudent to consider running trials in our Springfield, Ohio facility to verify process parameters for your specific furnish and product requirements. Please do not hesitate to contact Mr. Richard Pakulski, Product Manager - High Consistency Refiners, or myself directly if you require clarification of any issues.

Cordially,



David L. Kensmond

Director - Project Engineering

DLK/11  
Encl.

CC - John Hickson  
2144 Gilbride Road  
Martinsville, N.J. 08836  
Phone: (201) 469-8478

Thomas Bridge  
2084 Dayron Circle, N. E.  
Marietta, GA 30062  
Phone: (404) 977-4909

ABB Sprout-Bauer Inc.

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Pulp & Paper Division  
Sherman Street  
Muncy, PA 17758

Telephone:  
(717) 548-8211

Teletax:  
(717) 548-1555

## 45-1B ATMOSPHERIC, SINGLE ROTATING DISC REFINER

Sprout-Bauer Model 45-1B Atmospheric, Single Rotating Disc Refiner, consisting of:

- Casing:** Swing door type casing designed for easy access to refining zone for inspection or plate changing. 316L stainless steel construction on all wetted areas. Designed for atmospheric operation.
- Frame:** Rugged fabrication of carbon steel construction, which contains a built-in lubrication tank.
- Disc:** 15-5 pH stainless steel forging mating to shaft with keyed-tapered fit and disc nut.
- Shaft:** Cold rolled 1045 grade steel, sealed from the process with a stainless steel shaft sleeve.
- Shaft Seal:** Air seal which consists of an air flange, a shaft mounted sleeve and disc mounted fan blades.
- Bearing Assembly:** Consists of feed end and tail end spherical roller bearings and a Kingsbury single trust bearing. Oil lubricated.
- Motor:** Refiner main motor is built in, with standard features as follows:
- Reversible squirrel cage, four pole induction motor, 2500 HP, 1800 KPM, 3 phase, 60 Hertz, 2300 volt. Rotor mounted on refiner shaft. Motor has VPI sealed insulation system, 1.15 service factor, winding RTD's, space heaters, copper bar construction, and bi-directional fan. Stator frame to Sprout-Bauer specifications.
- Electro-Mechanical Plate Adjustment System:** Consists of a screw jack mounted on thrust flange. Plate adjustment by two speed 1.5/.375 HP reversing gearmotor with transmission through gear train to screw jack. Jactuator overload protection provided by a shear pin.
- Ribbon Feeder:** Ribbon type Throat Screw Feeder, 20.5" diameter, of 316L stainless steel construction. Complete with 20 HP, 1800 RPM, TEFC motor and drive. (Customer to specify secondary electrical characteristics).

45-1B ATMOSPHERIC, SINGLE ROTATING DISC REFINER- Con't.

Lubrication System: System is completely contained within the machine frame, which consists of 100 gallon tank, oil to water heat exchangers with temperature controlled regulating valve, gear pump and coupled 2 HP, 1200 RPM motor and a self-cleaning oil filter. Each bearing lube flow is monitored by flow and temperature switches.

Plates: One (1) set of ( ) refiner plates, Pattern ( ).

Terminal Box: All electrical connections are wired to a machine mounted terminal box.

LIST PRICE, F.O.B., POINT OF MANUFACTURE  
IN U. S. DOLLARS . . . . . \$370,900 (each)

Quantity (4) Four . . . . . \$1,483,600.00

AIR/WATER HEAT EXCHANGER  
Gravity Discharge Refiner Application  
(With Integral Motor)

Air/Water  
Heat  
Exchanger

Consisting of a bank of multi-pass RCP Type "N" L/D (leak-detector type) tri-metal coils, 0.049" wall x 5/8" O.D., with cupro-nickel liners; complete with integral aluminum, Series 8 fins; and carbon steel headers and tubesheets.

Headers to be provided with air vents and water drain plugs, and cooler to be provided with trough-shaped casings and drains for the collection of condensate.

A leak detector indicator (suitable for wiring to an alarm) is also included.

Cooler to be pre-fit, but shipped apart from the refiner, for field mounting to the top of the refiner motor.

After receipt of data on the user's cooling water temperature and supply pressure (not to exceed 100 PSI), cooling water flow rate required will be furnished to user. Cooling water temperature not to exceed 75 degrees F. (Nominal water requirement 100 U.S. GPM)

LIST PRICE, F.O.B., POINT OF MANUFACTURE,  
IN U. S. DOLLARS . . . . . (Included)

CONTROL PANEL, ATMOSPHERIC REFINERS

Control  
Panel:  
(Standard)

For single disc, gravity discharge refiners. Includes:  
All necessary pushbuttons, selector switches, indicating  
lights (all Allen-Bradley 800T-series), G.E. Series One  
Plug PLC for starting, stopping, alarming, and sequencing  
to control refiner in a manual mode. All wiring to  
terminal blocks for field connections. Included also is  
a meter relay with dual (low/high) setpoints for motor  
load indication and alarming. Shipped loose for customer  
mounting is a two element watts transducer 120 vac/5A  
inputs and 4-20 ma output, R.I.S. PCE-20 (PT's and CT's  
by customer).

Enclosure to be NEMA 12, 48H x 30W x 10D mounted on 24  
inch legs, carbon steel construction and painted.

LIST PRICE, F.O.B. POINT OF MANUFACTURE  
IN U. S. DOLLARS . . . . .(Included)

SPROUT-BAUER PROPOSAL NO. 90-21-1P-2129

TERMS & CONDITIONS

Your attention is directed to the attached ABB Sprout-Bauer Standard Terms and Conditions of Sale.

This quotation is for budget and information purposes only and is not an offer for sale. Should this project proceed, ABB Sprout-Bauer will prepare a final proposal.

PRICING CONSIDERATIONS

Prices are in U. S. funds. Prices do not include any sales and use taxes or duties and, if applicable, are to be paid by the purchaser.

TERMS OF PAYMENT

15% of the contract price with order  
20% of the contract price with 90 days after order  
25% of the contract price with 180 days after order  
40% of the contract price with partial and/or final shipment of equipment. Partial shipment of main equipment will be invoiced at time of shipment.

Payments not made within thirty (30) days of the date when due and payable shall bear interest at the lower of either 1.5% per month or the highest interest rate allowed by law.

DELIVERY

Equipment delivery will be complete 36 - 40 weeks after receipt of purchase order with final specifications. A firm delivery schedule will be established shortly after the order is received.

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Mark McCollister  
Vice President - Sales

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David L. Kenamond  
Director - Project Engineering

TCD

## STANDARD TERMS AND CONDITIONS OF SALE

**ARTICLE 1. Definitions.**

- 1.1 The words "we", "our", "ours", and "us" mean the Seller.
- 1.2 The words "you", "your", and "yours" mean the Purchaser.
- 1.3 The word "Agreement" means the agreement under which we provide you with goods, equipment and/or services, and which includes these Standard Terms and Conditions of Sale together with all documents expressly incorporated by reference and all attachments.
- 1.4 The word "Goods" means the goods or equipment which we will provide to you under the Agreement.
- 1.5 The word "Services" means installation, start up, training, supervision, engineering and/or other services which we will provide to you under the Agreement.
- 1.6 The word "Affiliate" means any entity which controls or is controlled by or is under common control with us.

**ARTICLE 2. Duration of Proposal; Effect.**

- 2.1 We may withdraw any Proposal at any time until we receive your written acceptance.
- 2.2 If we do not receive your written acceptance within 30 days of the date of any Proposal, that Proposal will expire and be void.
- 2.3 Any changes which you wish to make to any Proposal must be expressly accepted by us in writing; otherwise those changes will be void.

**ARTICLE 3. Shipment and Delivery.**

- 3.1 Our proposed shipping schedule depends on the date on which you accept our Proposal.
- 3.2 If you do not provide us promptly with all drawings, information, and approvals, then you will be responsible if we fail to meet our proposed shipping schedule.
- 3.3 We will deliver the Goods F.O.B. points of shipment. This will be the only delivery which we are required to make to you. Title and risk of loss will pass to you when we make this delivery.

**ARTICLE 4. Termination.**

- 4.1 You may not terminate or cancel the Agreement except by giving us written notice.
- 4.2 If you terminate or cancel, you must pay us for our costs of labor, material, engineering, administration, and overhead incurred up to the date we receive your notice, together with a reasonable profit on these costs. These costs include any termination or cancellation charges from our vendors. If you request, we will provide you with documentation in support of these costs.

**ARTICLE 5. Delay.**

- 5.1 We will not be in default and we will not be liable to you for loss or damage which results from delay or failure to perform any of our obligations, if this delay or failure is caused by one or more circumstances beyond our reasonable control ("Force Majeure").
- 5.2 Force Majeure includes, without limitation, acts of God, war, acts of public enemy, civil disorder, riot, sabotage, governmental action or law or regulation, strikes or labor shortage or other labor problems, fire, flood, earthquakes, severe weather, health and safety considerations, embargoes, transportation shortages or delays, fuel or material shortages, failure of performance by a vendor or subcontractor, and your delay or failure in the performance of your obligations including giving timely approval and comment to documents.
- 5.3 Our time of performance will be extended by the length of any delay caused by Force Majeure plus a reasonable time to resume our normal operations.
- 5.4 If we are ready to ship, but shipment is delayed through no fault of ours, then the date on which we are ready to ship will be regarded as the date of shipment and delivery for all purposes, including payment. You will be responsible for the cost and risks of storage and handling commencing with that date.

**ARTICLE 6. Limited Warranty.**

- 6.1 We warrant to you that the Goods will be delivered free from defects in material and workmanship.
- 6.2 If you discover a defect in material or workmanship during the Warranty Period (defined below), you must give us written notice within 10 days. We will, at our option, either deliver to you a replacement part, F.O.B. point of shipment, and installation thereof shall be your responsibility, or repair the defect in place or elsewhere. You will provide work area, utilities, and access and agree to enable us to perform our obligations under this Section 6.2.
- 6.3 The Warranty Period will expire at the earlier of either 12 months from initial operation or 18 months from date of delivery.
- 6.4 We will have no obligations to you under Sections 6.1 and 6.2 if:
  - (i) you fail to operate or maintain the Goods in accordance with generally approved industry practice; or
  - (ii) you fail to operate or maintain the Goods in accordance with instructions from us; or
  - (iii) you fail to give us written notice within 10 days of your discovery of a defect; or
  - (iv) The Goods have been altered or repaired by someone other than us.
- 6.5 We warrant to you that at delivery, the Goods will be

free of any liens or encumbrances. If there are any such liens or encumbrances, we will cause them to be discharged promptly after you have notified us of their existence.

- 6.6 We warrant to you that the Services, if any, will be performed in a good and workmanlike manner. If within the Warranty Period you discover that any portion of the Services was not performed in a good and workmanlike manner, you must give us notice within 10 days of your discovery and we will perform again that portion of the Services.
- 6.7 We make no warranty or warranty of the performance of the Goods except as may be expressly set forth as a Performance Guarantee elsewhere in the Agreement. Any other data and information pertaining to the performance of the Goods, whether stated in the Agreement or elsewhere, are for purposes of illustration or estimate only, and are not guaranteed.
- 6.8 THE EXPRESS WARRANTIES WE MAKE TO YOU IN THIS ARTICLE 6 AND THE PERFORMANCE GUARANTEE, IF ANY, REFERRED TO IN SECTION 6.7 ARE THE ONLY WARRANTIES AND GUARANTEES WE WILL MAKE. THERE ARE NO OTHER WARRANTIES OR GUARANTEES, WHETHER STATUTORY, ORAL, WRITTEN, EXPRESS, OR IMPLIED. IN PARTICULAR, THERE ARE NO IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. THERE ARE NO STATUTORY, ORAL, OR IMPLIED CONDITIONS.
- 6.9 The remedies we provide to you in Sections 6.2, 6.5 and 6.8 and the remedies we expressly provide in connection with the Performance Guarantee, if any, as referred to in Section 6.7 are the only remedies you will have in the event of a breach of warranty or Performance Guarantee.

**ARTICLE 7. Limitation of Liability.**

- 7.1 For purposes of this Article 7, the words "we", "our", "ours", and "us" mean the Seller and its Affiliates, and their employees, agents, subcontractors, and suppliers.
- 7.2 Our liability to you under the Agreement or under any cause of action relating to the subject matter of the Agreement, whether based on contract, warranty, tort (including negligence), strict liability, indemnity, or otherwise, will not exceed the price of the Goods and Services.
- 7.3 We will not be liable to you under the Agreement or under any cause of action relating to the subject matter of the Agreement, whether based on contract, warranty, tort (including negligence), strict liability, indemnity, or otherwise, for loss of profits or revenue or business opportunity, loss by reason of shutdowns of your facilities or inability to operate your facilities at full capacity, cost of obtaining other means for performing the function of the Goods, claims of your customers, or incidental or consequential damages of any nature.
- 7.4 We will not be liable to you for any loss or damage relating to any portion or component of the Goods or Services which you sustain after the expiration of the Warranty Period pertaining to such portion or component of the Goods or Services.
- 7.5 You will have waived your right to sue us at law or in equity unless you commence your suit within one year from the date on which you sustain the loss or damage which is the subject of your suit.
- 7.6 The provisions of this Article 7 shall prevail over any inconsistent provisions elsewhere in the Agreement.

**ARTICLE 8. Permits; Environmental and Safety Responsibilities.**

- 8.1 You will (at your expense) obtain and maintain in force all permits and approvals necessary for the installation and operation of the Goods, and the disposal of waste products.
- 8.2 If you fail to perform your obligations under Section 8.1, or if you fail to do the following:
  - (i) operate the Goods in compliance with all applicable laws, rules, regulations, permits, and approvals, and with operating instructions (including safety-related instructions) which we issue from time to time;
  - (ii) dispose of any waste products in compliance with all applicable laws, rules, regulations, permits and approvals;
  - (iii) in operating the Goods and disposing of the waste products, avoid contributing to air or water pollution or any condition which is hazardous to health;
 then you will indemnify us and hold us harmless and defend us at your expense from any claim, suit, or liability or penalty which may result from such failure.

**ARTICLE 9. Taxes.**

- 9.1 You will pay only sales, use, value added, excise, and other taxes which may be levied or assessed on the transfer of the Goods to you or the performance of the Services, or on the Agreement, or on our performance under the Agreement. Our price to you does not include any such taxes.

**ARTICLE 10. Patents.**

- 10.1 We will defend you against any suit which claims that the Goods infringe any United States or Canadian patent. We will satisfy any judgment for damages entered against you in such suit. If such judgment enjoins you from using the Goods, then we shall at our option:

- (i) obtain for you the right to continue using the Goods; or
  - (ii) eliminate the infringement by replacing or modifying all or part of the Goods; or
  - (iii) take back the Goods and refund to you all payments on the price which we have received. In this event, neither you nor we will have any claim against the other under the Agreement or arising out of the subject matter of the Agreement.
- 10.2 We will have no obligation under this Article 10 if you fail to notify us promptly of any claim or suit for infringement or if you fail to cooperate with us in conducting the defense, or if infringement results from:
    - (i) use of the Goods except in accordance with our instructions to you; or
    - (ii) any change made to the Goods after we make delivery; or
    - (iii) any portion of the Goods made pursuant to your design.
  - 10.2 The remedies which we provide to you in this Article 10 are the only remedies you will have in the event of any infringement claim.

**ARTICLE 11. Changes.**

- 11.1 We will not make changes in the Goods unless you and we have executed a written Change Order for such change.
- 11.2 The Change Order will include a price adjustment for any added costs of the change plus a reasonable profit.
- 11.3 If the change impairs our ability to satisfy our obligations to you, including meeting delivery schedules and performance guarantees, the Change Order will include appropriate modifications to the Agreement.
- 11.4 If after the date of the Agreement new or revised governmental or code requirements shall require a change in the Goods, the change will be the subject of a Change Order pursuant to this Article 11.

**ARTICLE 12. Confidentiality; Use of Drawings.**

- 12.1 You acknowledge that the information which we submit to you in connection with any Proposal or this Agreement includes our confidential and proprietary information, both of a technical and commercial nature.
- 12.2 You will not disclose our confidential and proprietary information to third parties without our prior written consent.
- 12.3 You will not permit any third party to fabricate components of the Goods from our drawings. You will indemnify us and hold us harmless and defend us from any claim, suit, or liability based on personal injury (including death) or property damage related to any component of the Goods which is fabricated by a third party without our prior written consent.
- 12.4 The Goods may contain software and related instructions and other materials which we and our suppliers have provided. Your use thereof shall be subject to license conditions and other restrictions which we or our suppliers may impose as required to maintain confidentiality.

**ARTICLE 13. EEO Compliance.**

- 13.1 We shall at all times comply with the requirements of Executive Order 11246.

**ARTICLE 14. End User.**

- 14.1 If you are not the End User of the Goods or Services, then you will use your best efforts to obtain the End User's consent to be bound to us by the provisions of Article 6, Article 7, and Article 8 ("End User Consent").
- 14.2 If you do not obtain such End User Consent, then you shall indemnify us and our agents, employees, subcontractors, or suppliers from any liability, cost, loss or expense for which we would not have been liable or from which we would have been indemnified if you had obtained the End User Consent.

**ARTICLE 15. Entire Agreement.**

- 15.1 The Agreement contains the entire understanding between you and us, and supersedes any prior oral and written understandings between you and us concerning the Goods or Services, including any documents which are not expressly incorporated by reference into this Agreement.
- 15.2 No modification to the Agreement will be effective unless in writing duly executed by you and us.
- 15.3 The Agreement is binding on the parties and their respective successors and assigns.

**ARTICLE 16. Invalidity.**

- 16.1 If a final decision of a court of competent jurisdiction holds invalid a portion of any sentence of this Agreement, or a sentence of any section of this Agreement, or a section of any Article, or any Article of this Agreement, the remainder of such sentence or section or Article or this Agreement, as the case may be, shall be valid.

**ARTICLE 17. Governing Law.**

- 17.1 The Agreement will be governed by and construed according to the laws of the Commonwealth of Pennsylvania unless you are located in Canada, in which case the Agreement will be governed by and construed according to the laws of the Province of Ontario.