1. OVERVIEW

Rosenblad Design Group, Inc. (RDG) is pleased to offer our revised proposal for the supply, manufacture, delivery, and installation assistance of a new Multiple Effect Evaporator (MEE) system for processing specialty wheat straw pulping liquor.

This system has been designed with use of RDG's patented falling film plate technology for continuous concentration of customer's specialty weak liquor solution. Our experience with full system design and manufacturing of evaporation plants in the pulp and paper industry, has allowed us to offer a complete system arranged for optimal efficiency and long term problem free operation. Along with our standard system features, we have incorporated the following special operational functions:

Automatic Wash Cycle - Our automatic wash cycle system provides proper controls, equipment, and sequencing logic for in-operation single evaporator washing. This wash cycle process includes evaporator pump down, liquor transfer with enthalpy equalization, and liquor bypass lines for continuous operation during wash cycles.

Foul Condensate Segregation – The RDG patented evaporator technology allows effective and efficient separation of methanol and Non-Condensable Gases (NCG's) from recycled process vapors, which can be strategically collected from various stages in the system for final concentration and processing.

Methanol / NCG Collection – The RDG Stripper-Condenser unit allows complete and efficient separation of our final process vapor and condensate streams to provide, three output streams: 1) Clean condensate, 2) high purity liquid methanol, and 3) NCG's. This patent technology achieves this total separation without any additional consumption of live steam.

Methanol / NCG Destruction – The convenience of processing a high purity liquid methanol discharge from the Stripper-Condenser greatly simplifies the thermal oxidizing process for both the methanol and the NCGs, as these conditions allow for a virtually "fuel free" operation of the thermal oxidizer / burner.

3. SCOPE OF SUPPLY

The scope of the project consists of a new MEE evaporation plant with Stripper-Condenser. The new system will do 152,169 lbs/hr of evaporation of 12.0% TDS liquor to achieve a final concentration discharge of 50% TDS. This evaporation plant will consist of (4) effects using falling film plate type evaporators with a bottom steam inlet design.

The evaporation plant supply includes fabrication of evaporators and stripper-condenser vessels, all small condensate and liquor flash tanks, vacuum system, pumps, instruments, control valves, hand valves, process and utility piping and associated supports inside the battery limit of the new plant. Evaporator equipment platforms, platform ladders, and support legs for the vessels are included. All site installation and insulation services are to be done by others.

Commissioning and 1 week of start-up assistance is included in the scope of supply. Rosenblad's engineering services will include P&ID drawings, lamella package drawings, general equipment layout drawings, foundation loading requirements, vessel outline drawings, pump list, conceptual piping layouts, instrument lists, interlock and control logic information.

All site installation work, insulation of equipment, civil work, electrical supply, service media connections, lighting, external control systems, and any building work is excluded from the scope of RDG's supply. All storage tanks, piping, instruments, and all other project work outside the immediate evaporator battery limit are excluded from RDG's scope of work.

4. PROCESS FLOW DESCRIPTION

4.1 Liquor Flow

The proposed evaporators are of falling film type using ROSENBLAD® lamella plate type heating surface. Liquor flows over the lamella plate heating surface using circulation pumps and a distribution tray system for each evaporator effect. Liquor is heated to its boiling temperature by the lamella plate heating surface as it flows down the outside of the plate in an even thin film. The boiling liquor releases water vapor and the liquor is then collected in a sump at the bottom of the vessel. The liquor distribution system consists of a liquor header that spans over the width of the lamella elements, a distribution box tray, with a bottom perforated distribution plate, that is located above the top of the lamella plates, and distribution tubes that are attached to the top edge of the lamella plates to provide an even distribution to both sides of each plate.

Liquor flows from the circulation pipe to the liquor header located within the distribution tray. The header has larger holes cut out at the top and a splash shroud over the header. From the distribution header, the liquor flows into and across the distribution tray above the lamella plates. The tray's bottom perforated plate drains liquor to the distribution tubes attached to the top edge of each lamella plate. The distribution tubes spread the liquor evenly over the top of the lamella plate.

The liquor follows a strategic feed flow pattern, with weak liquor being fed to the 3rd Effect. The 3rd Effect outlet liquor goes to the 4th Effect on liquor sump level control using its circulation pumps. The 4th Effect outlet liquor goes to the 2nd Effect, and then to the 1st effect in the same manner. The liquor is evaporated to its final concentration before being discharged on level control.

4.2 Steam and Vapor

The steam inlet headers for effects 2 & 3 are located in the bottom of the plate's vertical side. The bottom steam inlet design allows for proper foul condensate segregation and processing of NCG's in the final stripper-condenser unit.

Low pressure steam enters into the steam inlet header of the 1st Effect. The steam flow to the 1st Effect is controlled to maintain the 50% TDS product concentration. The vapor from the First Effect leaves the top of the vessels to supply the 2nd Effect. The vapor is the heat source for the 2nd Effect to do evaporation. Vapor leaving the 2nd Effect goes to the steam inlet of the 3rd Effect and then to the 4th Effect. The 4th Effect vapor is condensed in the stripper-condenser system by use of cooling water.

The vapor produced in each effect contains liquor mist droplets. These droplets must be removed in order to obtain high purity clear vapor which in turn will be process condensate in the next effect evaporator. To obtain this purity, high efficiency chevron type mist eliminators are installed in each vessel. Internal spray wash nozzles are provided for using clean condensate or water periodically to clean them.

Venting is necessary in an evaporator to remove non-condensable gases that reduce the heat transfer efficiency. Each effect's NCG gas vent pipe has an orifice plate with a bypass valve to regulate the vent rate. Live steam non-condensable gas flow is relatively small from the 1st Effect, and is normally vented to the atmosphere through flow restriction orifices.

The 2nd, 3rd, and 4th Effects' vent lines are combined into a common header and are condensed in the stripper-condenser. The stripper-condenser will sub-cool the vent gases to reduce the water vapor and non-condensable gas flow to the vacuum system.

4.3 Condensate

Steam condensate from the 1st Effect is drained on level control to the Live Steam Condensate Flash Tank and flashed to the Second Effect. The condensate level is maintained below the steam entry level.

The process condensate from the 2nd, and 3rd Effects flashes in a dedicated section of the 3rd and 4th Effects before going to the Process Condensate Tank where it is joined by the condensate from the 4th Effect and the stripper-condenser.

5. PERFORMANCE AND UTILITIES

The system as described in this proposal is designed according to the following parameters:

Item	Data
Capacity	
Evaporation Rate	152,169 lbs/hr
Feed Liquor	
Feed Liquor Flow Rate	220,200 lbs/hr
Feed Liquor Concentration	12.0%
Feed Liquor Temperature	175 °F
Product Liquor	
Product Liquor Flow Rate	48,031 lbs/hr
Product Liquor Concentration	50%
Product Liquor Temperature	214.0 °F
Steam Consumption and Economy	
Steam to the First Effect	41,950 lbs/hr
Steam pressure (Minimum)	21.8 PSIA
Steam Temperature	233.0 °F
Steam Economy	3.63
Cooling Water Supply and Return	
Cooling Water Flow Rate	2,564 gpm
Cooling Water Inlet Temperature	80 °F
Cooling Water Outlet Temperature	113 °F
Compressed Air	
Air pressure for automated valves (Min)	90 PSIG
Power Consumption	
Power Consumption for Pumps	178.85 kW

The basis for the values provide in the table above, can be viewed in more detail in Appendix A, Heat and Material Balance.

5.1 Overall System Size

Overall Dimensions	Width	Length	Height
	20 ft	60 ft	50 ft

6. EQUIPMENT SPECIFICATIONS

6.1 Evaporator Vessels

The proposed evaporator system consists of 4 effects for wheat straw liquor concentration. All evaporator bodies utilize ROSENBLAD® lamella plate falling film type heating surface. All of the Evaporator Effects utilize 4' x 28' plates and are arranged in a single rectangular banks. The ROSENBLAD® heating surface will be laser beam welded, with double circle welds at the dimples and double edge welds. The laser beam welding provides for stronger elements and a smaller heat affected zone at the weld locations.

System Effect	Tank OD	Tank Side Wall	Active HTS Area	Plate Quantity	Plate Thickness	Plate Size	Material
1	8 ft	33 ft	9,603 ft²	45	18 Ga.	4ft x 28ft	304L S/S
2	7.5 ft	33 ft	8,536 ft²	40	18 Ga.	4ft x 28ft	304L S/S
3	8 ft	33 ft	7,042 ft²	33	18 Ga.	4ft x 28ft	304L S/S
4	9 ft	33 ft	7,042 ft²	33	18 Ga.	4ft x 28ft	304L S/S

The evaporator bodies are designed for an operating pressure of 14.9 psig and full vacuum at 300F, in accordance with ASME Section VIII, Division 1, latest addendum (Not stamped). No evaporator will exceed a 50ft. overall vertical height restriction.

All Evaporator vessels are furnished complete with necessary nozzles for process connections and instruments, internal liquor distribution trays, manways for access to both the liquor and steam side of the vessels, sight glasses, chevron mist eliminators, wash piping and spray nozzles, internal liquor circulation piping, internal platforms between the manway and distribution trays, insulation, vacuum rings, and support legs.

6.2 Stripper-Condenser

Section	Section ID	Section Height	HTS Area	Tube Quantity	Tube OD	Tube Length	Material
Condenser	6 ft	24ft-4in	4,668 ft²	248	3 inch	25 ft	304L S/S
Methanol Enrichment	3 ft	18ft–10in	748 ft²	84	2 inch	17 ft	304L S/S

Maximum allowable equipment height = 50 ft. This unit, as currently offered, would require a 5 foot deep mounting pit / elevation. Unit overall height approximately 54 ft.

A conventional stripper system is in most current modern mills built with a concept of taking vapor from the evaporation plant (normally the first effect) to clean the foul condensate from the evaporation plant, condenser and digesters. The normal ratio for the vapor versus the condensate will differ from mill to mill and system to system. The conventional stripper is built using trays with condensate flowing from the top, meeting the steam coming from the bottom of the stripper. The ratio of steam and condensate will mainly be affected by the required cleanliness of the condensate, temperature of vapor and number of trays. With the vapor taken from the first effect, being hotter than the back end, the separation of NCG's and Methanol from the Condensate will not be as efficient as if you would have a lower pressure in the system.

The Stripper-Condenser, which is a proprietary product of Rosenblad Design Group, Inc. and a Patented Technology, will combine the functions of the Stripper and the Condenser. The unit also has a Methanol Enrichment System, that is equal in performance to stand alone units, but utilizing the vapor from the last effect, which normally would be condensed, and the excess amount of vapor being fed to the Stripper-Condenser enables the unit to outperform any conventional unit in terms of amount of condensate that can be treated.

Since the Stripper-Condenser will be working in the back end of the evaporation plant, and will condense the steam at 135°F, the unit will be working with vapor that needs vacuum in order to evaporate the liquor in the last effect. The operating pressure of the unit is negative 0.8 – negative 0.84 bar. At this pressure, the vapor to liquid Methanol ratio is about 12 to 1. At atmospheric pressure, the vapor to liquid Methanol ratio is about 7 to 1. Removing the Methanol in a negative pressure environment is therefore more efficient than at a higher pressure. Increasing the pressure above atmospheric, will increase the difficulty to remove the Methanol as well.

6.3 Thermal Oxidizer System

The thermal oxidizer system included in this offer has been designed to destroy 99.9% the separated methanol and NCG streams discharged from evaporation plant. This system will be fully integrated into the evaporation plant controls, and will meet all required local codes and permitting requirements.

The convenience of processing a high purity liquid methanol discharge from the Stripper-Condenser greatly simplifies the thermal oxidizing process for both the methanol and the NCGs, as these conditions allow for a virtually "fuel free" operation of the thermal oxidizer / burner.

6.4 Pump & Motor List

Pumps listed below will be complete with standard baseplates, double mechanical seal, coupling and coupling guard, non-overloading motor, and safematic seal water control.

Item	Flow (gpm)	Head (ft)	Spec. Gravity	Temp. (°F)	Motor Power (kW)	Brake Power (hp)	Materials
Effect 1 Circulation	2,300	50	1.35	214.8	48.8	65.5	316SS
Effect 2 Circulation	1,400	50	1.15	184.6	25.3	34.0	316SS
Effect 3 Circulation	990	50	1.05	160.5	16.3	21.9	316SS
Effect 4 Circulation	990	50	1.08	137.3	16.8	22.5	316SS
Liquor Flash Tank 1	700	50	1.35	214.8	14.9	20.0	316SS
Liquor Flask Tank 2	500	50	1.05	160.5	8.25	11.1	316SS
Process Condensate	307	60	1.0	144.2	5.8	7.8	316SS
Live Steam Condensate	86	90	1.0	204.1	2.4	3.26	316SS
Cooling Water Return	2,564	50	1.0	113	40.3	54.1	Duct. Iron

All process pumps above will be of the following specifications:

Manufacture: Goulds
Model: 3196 ANSI Process Pumps
Wetted Materials: 316 Stainless steel
Mechanical Seal: John Crane Double Bellows
Seal Flush: External Flush with Safematic flow control system
Base plate: Chemical Resistant – ChemBase
Coupling: Woods Flexible Spacer
Motor: Severe Duty, Premium Efficient, TEFC
Utility: 3 phase / 60 Hz / 460 Volt

Cooling water return pump will be a Pulsafeeder Eastern series end suction centrifugal pump.

All specified brands have been preselected for their indicated services, during final engineering substitutions may be made with equivalent brands. All brand and model types will be submitted during the design approval stage for customer review.

6.5 Instrumentation and Valves

Instrumentation and process valves integral to the equipment will be provided to allow automatic operation and washing of the evaporator plant from the customer's DCS control system. Control loop and logic description and diagrams will be provided by Rosenblad for programming the DCS configuration.

The evaporator is fed on flow rate control, and product from each evaporator is removed on level control. Steam is flow controlled to the 1st Effect or to the 2nd during wash cycle of the first effect. All piping and valves have been designed to allow for individual washing of each evaporator.

General Valve and Control Selections:

Valve Selection Types

Service	Valve type	Trim Material	Mounting	Brand
Steam / Vapor	Butterfly	316Lss	Flange 150#	ABZ
Liquor	Ball	316Lss	Flange 150#	Habonim
Condensates	Ball	316Lss	Flange 150#	Habonim
Cooling Water	Ball	C/S – S/S	Flange 150#	Habonim

Actuator Selection Types

Control	Service	Stroke	Body Material	Brand
Flow	Pneumatic	Rack & Pinion	Aluminium	Habonim
On/Off	Pneumatic	Rack & Pinion	Aluminium	Habonim
Level	Pneumatic	Rack & Pinion	Aluminium	Habonim
Pressure	Pneumatic	Rack & Pinion	Aluminium	Habonim

Positioner Selection Types

Function	Motion	Feedback	Communication	Brand
On / Off	¼ turn	Proximity	HART	StoneL
Modulating	Full	4-20mA	HART	PMV

All specified brands have been preselected for their indicated services, during final engineering substitutions may be made with equivalent brands. All brand and model types will be submitted during the design approval stage for customer review.

6.6 Vapor Ducting and Piping

All required vapor ducting will be provided as part of the “4 Effect MEE System” line item in section 8.0. The ducting will be assembly into segments as per “Process piping and Ducting Prefabrication” line item in section 8.0 and then shipping to site and installed by others.
All ducting will be fabricated from SA240-304Lss sheet material.

All required Piping will be provided as part of the “Process Piping” line item in section 8.0. The piping will be assembly into sub-assemblies as per “Process piping and Ducting Prefabrication” line item in section 8.0 and then shipping to site and installed by others.
All ducting will be fabricated from SA240-304Lss sheet material.

The “Process piping and Ducting Prefabrication” line item in section 8.0 will provide prefabrication of approximately 75% of all required piping and ducting weld joints.

7. GUARANTEES

7.1 Mechanical Guarantee

Rosenblad Design Group, Inc. warrants that the equipment included in the tender corresponds to the highest present industrial standards regarding material selection, machinery design, construction and workmanship, including all sub-suppliers. Our warranty covers mechanical failures of raw materials and service, except those specifically indicated and/or provided by the Purchaser, and offers a guarantee period of twenty-four (**24**) months from date of shipment or eighteen (**18**) months from date of completed installation, whichever occurs first.

7.2 Performance Guarantee

Rosenblad Design Group, Inc. guarantees that the proposed system will perform as tabulated under Performance and Utilities in Section 5. Specifically, this pertains to the evaporation rate of 152,169 lbs/hr. The above guarantees are contingent upon the equipment being operated in accordance with the company’s instructions, and that feed and utilities are supplied as specified.

12. VALIDITY OF PROPOSAL

This proposal is valid for a period of maximum 30 days, production and shipping schedule will need to be coordinated at time of order.

Material prices are based on current stainless steel prices and surcharges and actual price may vary dependent on purchase date.

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We appreciate this opportunity to prepare a proposal and look forward to further discussions about this project. Should you have any questions regarding the above or need additional information, please do not hesitate to contact us by telephone or email. We are available for discussions and meetings.

Rosenblad Design Group Inc.

Phillip Kraft,
Sales Engineer