Clean Burn Fuels
Quadruple Effect Stillage Evaporator
PO# A1326-07-0111
Anhydro Ref # 319
Book 1

Book 1

Clean Burn Fuels
Quadruple Effect Stillage Evaporator
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Book 2

Book 3

Book 4

Clean Burn Fuels
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Book 1

Book 5

Paget

E-701A – Heat Exchanger
E-701B – Heat Exchanger
E-705 – Heat Exchanger
E-709 – Heat Exchanger
E-713 – Heat Exchanger

Book 6

Paget

D-703A – Separator
D-703B – Separator
D-707 – Separator
D-711 – Separator
D-715 – Separator

Book 7

Paget

E-720 – Surface Condenser
E-721 – Surface Condenser
E-719 – Flash Cooler

CAPACITY AND UTILITIES

The evaporator is designed in accordance with the following:
Based on Katzen's specification for Job# WH 1100-01 Rev. 0 Issue 8/17/07

	Maximum	Average
Feed Stock	CORN	CORN
Feed Rate – LBS/HR	264,495	240,450
Feed % Total Solids	7.81	7.81
Feed % Dissolved Solids	6.57	6.57
Feed % Suspended Solids	1.24	1.24
Feed Temperature - °F	182	182
Product Rate – LBS/HR	59,020	53,655
Product % Total Solids	35.0	35.0
Product Temperature - °F	180	180
Evaporation Rate – LBS/HR	205,475	186,795
Steam Rate to First Effect – LBS/HR	35,200	29,800
Steam Pressure – PSI ABS @ Inlet flange (Dry & Saturated)	14.696	14.696
Flash Process Water Vapor Rate – LBS/HR	25,610	25,610
Temperature °F Saturated (At Evaporator Flange Connection)	185	185
Process Water Rate - LBS/HR	63,090	63,090
Process Water Liquid Temperature - °F At Evaporator Flange Connection	194	194
Auxiliary Flash Process Water Vapor	N/A	N/A
Condensers Water Rate – GPM	10,200	9,000
Condenser Water Temperature Inlet °F	90	90
Condenser Water Temperature Outlet °F from SC-2	105	105

Note: Evaporator sizing and capacity is based on typical Katzen International dry mill Corn stillage with properly operating centrifuges performing within Katzen Standards.

Dedert Corporation, 20000 Governors Drive
Olympia Fields, IL 60461-1074
Website: http://www.dedert.com
Email: dales@dedert.com
Telephone: 708/747-7000 Fax: 708/755-8815

December 22, 2006

Dilling Mechanical
Logansport, IN

Attention: Gerry Bunn

Reference: Evaporator System for Ford Heights, IL
Corn Stillage Evaporator (EV-700)
Katzen Spec. WH-1088-02, Rev. A
Dedert File 06-7369 Rev. 0

Dear Mr. Bunn,

Attached, please find our budget quotation for the above referenced project. What I have done is state Dedert's normal scope of supply, based upon our typical standards, and practices generally accepted on past projects where we have worked with Katzen International.

A. System Design

This evaporator is designed as a quadruple effect using live steam, flash process vapor, and process water as the heating medium. The first effect is designed using forced circulation type heat transfer surface. The 2nd, 3rd and 4th effects are designed using recirculated falling film type heat transfer surface. The final vapors from the 4th effect are condensed in a shell and tube type condenser supplemented by a vacuum pumps and motor. In addition, an auxiliary condenser is provided for use exclusively and only to condense available flash water vapors energy and the process water while the evaporator is not processing corn stillage and the evaporator is down for CIP cleaning.

B. Materials of Construction, Codes and Standards

The fabricated evaporator components are constructed of Type 304L stainless steel for all parts in contact with the liquor, vapor, condensate and cooling water. The vapor separators, steam chests, condenser, vapor duct, and liquor circulating piping are constructed of mill finish plate or sheet; all welds are power wire brushed. External reinforcing is carbon steel.

All fabricated components with external carbon steel parts will include one coat of primer.

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B. Materials of Construction, Codes and Standards

The pressure vessels (chests, separators, flash cooler and condensers) are designed in accordance with ASME Section VIII (latest edition) for an internal pressure of 30.0 PSI gauge and full vacuum at 275°F. In addition, the tube section of the 1st effect chest is designed for 75 PSI and full vacuum at 250°F; and the tube sections of the surface condensers are stamped for 100 PSI gauge and full vacuum at 250°F.

Vapor duct and liquor circulation pipe will be designed in accordance with Dedert standards for their class service.

All necessary instrument connections are provided on the equipment within the scope of supply of the Dedert Corporation.

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C. Capacity and Utility Requirements

The evaporator is designed in accordance with the following per Katzen International Specification WH 1088-02 Rev. A:

	Maximum
Feed Stock	Corn
Feed Rate – LBS/HR	254980
Feed % Total Solids	7.76
Feed % Dissolved Solids	Not given
Feed % Suspended Solids	Not given
Feed Temperature - °F	182
Product Rate – LBS/HR	56533
Product % Total Solids	35.0
Evaporation Rate – KG/HR	198,447
Steam Rate – KG/HR	**30,330**
Steam Pressure – PSIA (Dry & Saturated) (At Inlet Flange)	14.7
Flash Process Water Vapor Rate – LBS/HR	25330
Temperature °C Saturated (At Evaporator Flange Connection)	185
Process Water Rate - LB/HR	61480
Process Water Temperature - °F At Evaporator Flange Connection	194
Condensers In Series Water Rate – GPM	**9315**
Condenser Water Temperature Inlet °F To E-720A	90
Condenser Water Temperature Outlet °C From E-720B(no load on condenser E-720B)	105
Consumed Pump Power – BHP (Basis 4 Circulation Pumps and 1 Vacuum Pump) Approximate	900

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C. Capacity and Utility Requirements

Space requirements: The evaporator system should fit comfortably in a 25 x 90 foot area. It is assumed that vessels will be supported off of structural steel members with major support elevation of 36'.0 meter to maintain proper NPSH requirements on circulation pumps. **Note:** Skirt mounting for the three large falling film vessels should be considered as an option.

D. Scope of Supply Included

The following items and only those items are included in the scope of supply as defined by the selling price:

- Evaporator bodies and vapor separators
- Major vapor duct (prefabricated with field welds for field adjustment and installation) to connect evaporator bodies to separators and surface condenser.
- Major liquor circulation piping (prefabricated with field welds for field adjustment and installation) to connect evaporator bodies to circulation pumps.
- Surface condenser for condensing vapors from last effect.
- Auxiliary condenser
- One total recirculation vacuum pump and motor package
- Five circulation pumps and motors with Plan 53 type flush systems
- Two condensate pumps and motors with Plan 53 type flush systems
- One product pump and motor with Plan 53 type flush system
- One CIP return pump and motor with Plan 53 type flush system
- Field instrumentation and control valves within battery limits
- Documentation as follows:
    - Process flow diagram
    - General arrangement drawing
    - Start-up, operation and shut down instructions
    - Vessel maintenance drawings
    - Standard manufacturers drawings and literature as is available from auxiliary component manufacturers (pumps and motors)
    - Three manuals
    - Fifteen (15) days commissioning services.
    - General column/beam layout location, platform stairs and ladder location.

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E. Shipment

General arrangement and P & ID drawings will be submitted 6 weeks after order. Two weeks minimum should be scheduled for approval. At this time, shipment is generally fifty two (52) weeks from order.

- At time of order Dedert is permitted to proceed with placement of orders for all raw materials and placement of orders with all subcontractors.
- Any customer generated changes to drawings after approved drawing return are subject to cost additions and/or shipment delay if changes affect scope of supply, manufacturing cycle or component completion.
- Partial shipments and billings permitted.

F. Terms of Payment

- 15% with order
- 25% on proof of purchase of major equipment
- 25% on submittal of certified P & ID and GA drawings
- 30% upon shipment or evidence of readiness to ship
- 5% upon start up or 180 days from final shipment, whichever occurs first.

G. Budget Selling Price

- Based upon the scope of supply as outlined and the terms of payment stated, the budget selling price is.....$ 4,980.000.00 US
  FOB Shipping Point

We have specifically excluded installation, insulation, the structure or foundation design, motor control centers, electrical supply or its wiring, DCS, tankage (feed, product or CIP), utility piping, liquor transfer piping, and spare parts. A more detailed understanding of Katzen's and Customer requirements is necessary to complete this pricing.

If you have any questions, please do not hesitate to contact us.

Sincerely,

Dale Stenning
Evaporation Division

DPS
DIVERSIFIED PIPING SYSTEMS, LLC
2340 Hwy. 101 South, Greer, SC 29651

CLEAN BURN FUELS, LLC
60MM/GPY FUEL ETHANOL FACILITY
RAEFORD, NC

PURCHASE ORDER

NO.: **A1326-07-0109** **REV. 0** **DATE: 01-23-08**

TO: **Anhydro/Dedert**
2000 Governors Drive
Olympia Fields, IL 60462
(708)-747-7000
ATTN: Dale Stennings

SHIP TO: **CLEAN BURN FUELS, LLC**
269 PATE RD.
RAEFORD, NC 28376
(910) 868-5686
ATTN: **Greg Carlisle**
Justin Hamm

In accordance with Terms and Conditions set forth in documents below and attached herewith, please process the following Purchase Order as described below:

QTY.	COST CODE	ITEMS OR DESCRIPTION	PRICE	FREIGHT	TAX	TOTALS
1	07-14000.2000	EV-700 Evaporation System	$5,220,000			
		Reference Applicable Documents:				
		1. DPS RFQ No. CBF-07-108 2. Anhydro/Dedert (1/23/08) Quotation 07-7440 3. DPS Terms & Conditions 4. Site Conditions Data Sheet 5. Katzen Spec. WH-1100-01, Rev. 1				
		Subtotal Equipment:	$5,220,000			$5,220,000
1	09-99.0000	Subtotal Freight:		$0		$0
		Subtotal Taxes:			$0	$0
		Purchase Order Total >>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>				**$5,220,000**
		Down Payment with Order				**$522,000**
		Net Due Seller (See Payment Terms)				**$4,698,000**
F.O.B. Job Site SHIP VIA: Best Way		TERMS: 15% w/Order/ (see payment schedule for remainder) Net 30 after delivery	REQUIRED ARRIVAL DATE: August 5, 2008			

SEND BILL OF LADING TO JOB SITE AS ADDRESSED ABOVE
SEND SHIPPING NOTICES AND TECHNICAL DOCUMENTS TO:

DIVERSIFIED PIPING SYSTEMS
2340 Hwy 101, Greer, SC 29651
Attn: Steven Martin

ACCEPTED BY: _____

VENDOR: _____

TITLE: _____

DATE: _____

APPROVED FOR: CLEAN BURN FUELS, LLC

BY: _____

TITLE: _____

DATE: _____

Dustin Wiethoff
Houston Sales Office
12510 Sugar Ridge Blvd.
Stafford, TX 77477
Ph: (281) 504-6377
Fx: (281) 504-6397
Email:
dustin.wiethoff@itt.com

May 20, 2008

PRICE SUMMARY

Customer : ANHYDRO INC
Inquiry No: 07-7440-E Rev 0
Proposal No: HODW08-04-03 01
App.Engineer: Dustin Wiethoff
Salesman: KANG CHOI (282000)

Main Offer

ITEM NO	QTY	MODEL	SIZE	CONSTRUCTION	RATING@RPM/FRAME	PUMP	TESTING	DRIVER	BOXING	FREIGHT	UNIT TOTAL	GRAND TOTAL
P-1A & P-1B	2	3180	10x12-16 L	316SS	150.0 hp @ 1200/447T	24,260	0	6,672	0	0	30,932 ✓	61,864
P-2	1	3196	8x10-16H X17	316SS	125.0 hp @ 1200/445T	15,519	0	5,988	0	0	21,507 ✓	21,507
P-3	1	3196	8x10-16H X17	316SS	125.0 hp @ 1200/445T	15,519	0	5,988	0	0	21,507	21,507
P-4	1	3196	8x10-16H X17	316SS	125.0 hp @ 1200/445T	15,519	0	5,988	0	0	21,507	21,507
P-5	1	3196	1.5x3-13 MTX	316SS	20.0 hp @ 1800/256T	5,380	0	884	0	0	6,264	6,264
P-6	1	3196	1.5x3-10 MTX	316SS	7.5 hp @ 1800/213T	4,784	0	447	0	0	5,231	5,231
P-7	1	3196	4x6-17 X17	316SS	100.0 hp @ 1800/405T	14,288	0	3,743	0	0	18,031	18,031
P-8	1	3196	4x6-17 X17	316SS	30.0 hp @ 1200/326T	14,006	0	1,720	0	0	15,726	15,726
TOTAL 9 units (Main offer) in US						**133,535**	**0**	**38,102**	**0**	**0**		**171,637**

anhydro

SPECIFICATIONS OF A CORN THIN STILLAGE EVAPORATOR

GENERAL

This evaporator is designed as a quadruple effect using live steam, flash process vapor, and process water as the heating medium. The unit is designed to operate in a counter current mode (backflow 4th to 3rd to 2nd to 1st effect). The first effect (finished product effect) is designed using **two completely separate stages** of forced circulation type heat transfer surface. Either of these two conservatively designed first effect stages (C-1A or C-1B) is able to be taken offline during operation for cleaning resulting in only a modest turndown from normal operation. The 2nd, 3rd and 4th effects are designed using recirculated falling film type heat transfer surface. The final vapors from the 4th effect are condensed in a shell and tube type condenser supplemented by two vacuum pumps and motors (duplex system). In addition, an auxiliary condenser is provided to condense liquefaction flash vapors and continue cooking operation during evaporator CIP.

The fabricated evaporator components are constructed of Type 304L stainless steel for all parts in contact with the liquor, vapor and condensate. The vapor separators, steam chests, condenser, vapor duct, and liquor circulating piping are constructed of mill finish plate or sheet; all welds are power wire brushed. External reinforcing is carbon steel. When vessel shell thickness is less than 3/16" then a 304L stainless steel poison pad will be used. All carbon steel parts are prime painted and finish painted (1 coat).

The pressure vessels (chests, separators, flash cooler and condensers) are designed in accordance with the ASME code for unfired pressure vessels, Section VIII, latest edition for an internal pressure of 30 psig and full vacuum at 275°F. In addition, the tube sections of the 1st effect chests (C-1A and C-1B) are designed for 75 psig gauge and full vacuum at 275°F; and the tube sections of the surface condensers (SC-1 and SC-2) are stamped for 150 psig gauge and full vacuum at 250°F.

The wall thickness for the prefabricated vapor duct and liquor circulating pipe is based on ASME code not stamped.

All necessary and reasonable instrument connections will be provided per Customer.

EQUIPMENT SCOPE

The scope of supply as outlined is based on the use of Anhydro/Dedert standard practices and quality and the use of Anhydro mechanical design standards expected by our experience for this application.

CHESTS C-1 A and C-1B

The vertical 1st effect steam chests (heat exchangers) are 53" diameter by 34'-4" overall length of the forced circulation design. The material of construction is Type 304L stainless steel for the shellsides and Type 304L stainless steel for the tubesides. The external reinforcing bars are of carbon steel.

Each chest contains 1 ½" diameter by 30'-0" long welded and annealed Type 304L, 18 gauge stainless steel tubes rolled into Type 304L stainless steel tubesheets. **The chests are designed for four-pass liquor flow.**

The chests are complete with flanged liquor chamber covers, baffled steam inlets, condensate outlets, condensate level glasses, liquor connections, vents, gauges and drain connections and support lugs.

CHESTS C-2, C-3, AND C-4

The vertical 2nd, 3rd, and 4th steam chests are 85", 85" and 98" diameter respectively by 87'-11" overall length of the recirculated falling film design. The material of construction is Type 304L stainless steel for the shellside and Type 304L stainless steel for the tubeside. The external reinforcing bars are of carbon steel.

Chests C-2 and C-3 contain 1 ½" diameter by 42'-0" long welded and annealed Type 304L, 18 gauge stainless steel tubes rolled into Type 304L stainless steel tubesheets. Chest C-4 contains 2" diameter by 42' long tubes. **The chests are designed for one-stage liquor flow.**

Each chest is complete with flanged top liquor chamber cover, quick-opening manholes, sight glasses, baffled vapor inlet, condensate outlet, condensate flash inlet where required, condensate level glass, circulating liquor connections, liquor distributor, vent, gauge and drain connections and 24'-5" support skirts.

VAPOR SEPARATORS S-1A AND S-1B

The vertical 1st effect vapor separators (forced circulation effect) are 90" diameter by 16'-0" on the straight side closed at the top and bottom with dished heads. The material of construction is Type 304L stainless steel with external carbon steel reinforcing bars. The separators are supplied with sight glasses, 6'-8" support skirts, quick-opening manhole, baffled liquor inlet, liquor outlet, vapor outlet, internal centrifugal entrainment separator, instrument and gauge connections.

VAPOR SEPARATOR S-2

The vertical centrifugal style 2nd effect vapor separator (recirculated falling film effects) is 111" diameter by 19'-6" on the straight side. The separator is closed at the top with a dished head and at the bottom with simulated reversed dished head. The material of construction is Type 304L stainless steel with external carbon steel reinforcing bars. The separator is complete with sight glasses, quick opening manhole, centrifugal vapor inlet, vapor outlet, instrument and gauge connections, liquor drain and 3'-10" support skirt.

VAPOR SEPARATOR S-3

The vertical centrifugal style 3rd effect vapor separator (recirculated falling film effects) is 120" diameter by 21'-0" on the straight side. The separator is closed at the top with a dished head and at the bottom with simulated reversed dished head. The material of construction is Type 304L stainless steel with external carbon steel reinforcing bars. The separator is complete with sight glasses, quick opening manhole, centrifugal vapor inlet, vapor outlet, instrument and gauge connections, liquor drain and 3'-4" support leg skirt.

VAPOR SEPARATOR S-4

The vertical centrifugal style 4th effect vapor separator (recirculated falling film effects) is 156" diameter by 26'-0" on the straight side. The separator is closed at the top with a dished head and at the bottom with simulated reversed dished heads. The material of construction is Type 304L stainless steel with external carbon steel reinforcing bars. The separator is complete with sight glasses, quick opening manhole, centrifugal vapor inlet, vapor outlet, instrument and gauge connections, liquor drain and support lugs.

CONDENSER SC-1 (Main)

The vertical surface condenser is 84" diameter by 31'-5" overall length. The material of construction is Type 304L stainless steel for the shellside and tubeside. The external reinforcing bars are of carbon steel.

The condenser contains 1" diameter by 26'-0" long welded and annealed Type 304L, 18 gauge stainless steel tubes rolled into Type 304L stainless steel tubesheets. **The tubes are arranged for four-pass water flow.**

The surface condenser is complete with flanged water box covers, baffled vapor inlet, condensate outlet, condensate level glass, water connections, vent gauge and drain connections and support lugs.

CONDENSER SC-2 (Auxiliary)

The vertical surface condenser is 36" diameter by 35'-6" overall length. The material of construction is Type 304L stainless steel for the shellside and tubeside. The external reinforcing bars are of carbon steel.

The condenser contains 1 ½" diameter by 26'-0" long welded and annealed Type 304L, 18 gauge stainless steel tubes rolled into Type 304L stainless steel tubesheets. **The tubes are arranged for one-pass water flow.**

The surface condenser is complete with flanged water box covers, baffled vapor inlet, condensate outlet, condensate level glass, water connections, vent gauge and drain connections and support lugs.

FLASH COOLER FC-1

The vertical flash cooler is 4'-0" diameter by 8' -0" on the straight side, closed at the top with a dished head and at the bottom with a conical outlet. The material of construction is Type 304L stainless steel with external carbon steel reinforcing bars. The flash cooler is complete with sight glasses, a quick-opening manhole, tangential baffled vapor inlet, vapor outlet, instrument and gauge connections, baffled liquor outlet and support lugs.

INTERCONNECTING DUCT/PIPING

Vapor duct of Type 304L stainless steel is supplied to interconnect the separators, chests and condenser. Also, vapor duct is provided to connect liquefaction vapors and process water liquid flash to the 2nd, 3rd, and 4th effect chests and auxiliary condenser. NOTE: This duct is sized for normal direction flow. This duct is prefabricated with a minimum number of field welds as required for proper alignment of the assemblies.

The supply of the vapor isolation valves (between the battery limits and vessels) for the flash vapor ductwork has been included in this scope of supply.

The supply of steam flash isolation valves to isolate either of the first effect steam chests (C-1A and C-1B) are included.

Anhydro Inc. will provide flanged connections at the battery limits to permit acceptance of "flash process water vapors" into system. All vapor duct required to permit "flash process water vapors" to enter or bypass evaporator bodies is included in scope of supply. The resulting flash vapor from the exit of the flash cooler to the liquefaction header **is** included.

Circulating piping is supplied of Type 304L stainless steel to interconnect the circulating pumps with the steam chests and separators. Drain lines and transfer lines are not in this scope. This piping is prefabricated with a minimum number of field welds as required for proper alignment of the assemblies. In addition, expansion joints will be supplied for each of the five liquor circulating pipe loops to reduce effect of thermal expansion.

VACUUM PUMP(S) AND MOTOR(S)

The vacuum system is of the closed loop, total recirculation design. Indirect cooling is provided using cooling water for the heat exchanger. The Sihi liquid ring vacuum pump is of stainless steel construction complete with motor, baseplate, separator, oversized plate heat exchanger, gauges, seal water regulating valve and level glass. The motor has a TEFC enclosure, suitable for 3-phase/60 Hz/460 Volt current.

The pump assembly is manufacturer's standard for entire assembly for class of service required.

FIELD INSTRUMENTATION AND AUTOMATIC CONTROLS

The scope of supply is based on the use of Yokogawa transmitters and Fisher control valves except as noted. Pressure gauges and temperature gauges are Anhydro's standards. All control valves are stainless steel unless otherwise noted. Transmitters will have local indication provided.

The following are provided as scope of supply:

One (1)	Product density transmitter (manufacturer Micro Motion).
One (1)	Combined condensate flow transmitter.
One (1)	Steam condensate flow transmitter
Two (2)	Condenser pressure control loops consisting of transmitters, I/P converters and stainless steel pressure control valves.
Four (4)	Stillage liquid level control loops (product transfer between effects 4^{th} to 3^{rd}, 3^{rd} to 2^{nd}, 2^{nd} to 1B, 1B to 1A) consisting of filled capsule style level transmitter, I/P converter and stainless steel control valve.
Seven (7)	Temperature transmitters.
Three (3)	Process condensate level control loops, consisting of filled capsule style level transmitters, I/P converters and stainless control valves i.e., Steam condensate, combined condensate, and vacuum pump service liquid.
Twenty-nine (29)	Pressure / Vacuum gauges
Ten (10)	Temperature gauges (Thermowell)
Four (4)	Liquefaction flash water vapor on/off
Two (2)	Vapor separator isolation valves S-1A/S-1B
Two (2)	Steam inlet isolation valves for C-1A and C-1B (carbon steel)
One (1)	Stripper bottom pressure relief valve.
Five (5)	Level switches (Rosemount/Emerson)

DOCUMENTATION

Anhydro Inc. will provide the following documentation as part of its equipment scope of supply.

- Plan and elevation General Arrangement Drawings showing major centerlines, generic vessel dimensions, nozzle locations and empty and water flooded weights of pressure vessels and pumps included in Anhydro's scope of supply, in accordance with Dedert's standards.
- Column/beam layout location, platform, stairs and ladder location.
- Process flow diagram in accordance with Anhydro standards showing mass flows and pump design.
- P & ID diagram.
- Equipment and instrumentation list.
- Instrument and Control Sequence Diagrams
- Job Specific Pump Documentation
- Maintenance drawings for pressure vessels included in Anhydro's scope of supply in lieu of fabrication drawings.
- All certified documentation for all Anhydro Sub vendors.
- All appropriate documentation as required by ASME Section VIII
- Three (3) operation and maintenance manuals.
- Operating control diagrams

NOTES:

1. All documentation will be done in the English language. English dimensions and units will be used unless directed to do otherwise. All custom project based drawings will be produced in English using Auto Cad 2000 for electronic transmission.
2. For auxiliary components (buy out items) such as pumps, motors, expansion joints, instruments, controls, automatic and manual valves, control valves, etc. the documentation supplied will be manufacturer's standard in the manufacturer's standard transmittal form.
3. Generic start-up, shut-down and operating procedures will be provided.

SPARE PARTS

Recommended spare parts for start-up and two (2) years of operation included in scope of supply.

Vacuum Pump

Recommended spare parts for 2 years operation

1- Set mechanical seals
1- Set of bearings
1- Spare solenoid coil and piston assembly

Pressure Vessels

Recommended spare parts for 2 years operation

1- Set of gasket material for each heat exchanger
4- Sight glasses
4- Sets of sight glass gaskets
4- Manway gaskets

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ANHYDRO INC
OPERATING INSTRUCTIONS
FOR
CLEAN BURN FUELS
319
QUADRUPLE EFFECT CORN
STILLAGE EVAPORATOR
Rev. 0

These instructions are preliminary and should be revised after the unit is operational.

It is important that all vendor manuals be read before proceeding. The process flow diagram should be reviewed. The system piping and control concept is outlined on Anhydro Drawing 319, Sheets 1A, & 1B, Revision 1 or later and 1C-1, 1C-2, and & 1C-3 Revision 1 or later.

PROCESS DESCRIPTION

This system is designed to operate on a corn stillage solution. The stillage will have a unique set of operating conditions relative to effect pressures, temperatures, and product concentrations while maintaining a backward feed flow scheme fourth effect (i.e. 4-3-2-1B-1A) through to the first effect.

In terms of evaporator configuration, this evaporator would be considered a five body, four effect or quadruple effect evaporator. The first effect bodies are steam heated effects. Because this is a back flow evaporator, these are also the finishing bodies, C-1A and C-1B (Vessel E-701A and Vessel E-701B). These two first effect bodies employ forced circulation type heat transfer equipment. The second, third and fourth effects consist of external recirculated falling film type heat transfer equipment.

The corn feed enters the fourth effect chest C-4 (E-713). After flashing off excess heat, the liquor joins the fourth effect recirculation system. In each recirculated effect (C-2, C-3 & C-4), the liquor is pumped to the top of the chest, distributed by sprays across the tubesheets, and allowed to fall down the tubes. A portion of the partially concentrated liquor is then pumped by P-4 (P-716) to the third effect C-3 (E-709) recirculation system. There, upon entering the recirculation loop, the liquor is pumped to the top of the chest and allowed to fall down the tubes. A portion of recirculated liquor is then pumped on the second effect C-2 (E-705) and finally to the first effect C-1B (E-701B) finishing in C-1A (E-701A). Final product at 35 % T.S. is pumped from the first effect by the product pump P-5 (P-706) to the syrup storage tank TK-724.

The main operating difference of the two first effect bodies and the other three effects is where the boiling takes place. The two first effect bodies C-1A and C-1B (E-701A and E-701B) try not to allow boiling in the tubes, but rather flash off its evaporation in the separator. The first effect separators maintain a level at their bottom sight glass and the heat exchangers C-1A and C-1B (E-701A and E-701B) are purposely completely full of liquor. The second, third and fourth effect chests allow the liquor to boil down the tubes as the liquor falls. The vapor separators on these three effects are empty. The level in these effects is maintained at the lower sight glass on the heat exchangers.

The main driving force or heating medium for the evaporator is flash steam. It is provided from the steam flash drum (D-585) and is sent to the shell side of the first effect chests C-1A (E-701A) and C-1B (E-701B). The steam is condensed and the condensate is collected, controlled by level control (LV-706) and sent back to the flash drum via pump P-6 (P-702).

There are two other sources of waste heat to drive the evaporator. There are substantial "cooker vapors" or flash water vapor saturated at 185°F coming from liquefaction that are sent to the second effect chest C-2 (E-705). There is also a small amount of hot process condensate (rectifier bottoms) that is flashed off via flash cooler FC-1 (D-719) and also sent to the second effect chest C-2 (E-705). These vapors and condensate are contaminated and cannot be used in the first effect.

The evaporated water that is boiled off in the dual first effect bodies is de-entrained (vapor separators D-703A and D-703B) of liquid before entering the shell side of the second effect chest C-2 (E-705). There it is condensed. As it is condensed outside the tubes the liquor boils inside the tubes. The evaporated water from the second effect is de-entrained in vapor separator S-2 (D-707) and sent to the shell side of the third effect. This vapor is likewise condensed outside the tubes and boils off more water from the liquor inside the tubes. Its vapor is sent to the fourth effect and this sequence happens again.

From the second effect chest C-2 (E-705) position on, all condensate is slightly contaminated. However, some of the heat can be reclaimed by flashing it to the next lower pressure effect which is the third effect. This process continues from the third to the fourth effect C-4 (E-713). Remember, each effect is at a lower pressure from front to back of the evaporator. The condensate is combined at the fourth effect with the surface condenser condensate, level controlled (LIT-717) and sent to the process condensate tank (TK-721).

The evaporator pressure is controlled at the back of the evaporator. There is a main surface condenser SC-1 (E-720) and a vacuum pump assembly P-9A and P-9B (P-719A and P-719B) that generate a vacuum. The vacuum pump assembly is made up of two vacuum pumps, a plate heat exchanger and an overflow drum. The entire vacuum pump assembly (both pumps), is intended to be operated to meet the vacuum duty. Each pump receives its own liquid ring seal water and is intended to do half of the required duty. Liquid ring seal water passes through the pump overflowing to the vacuum drum D-722. The level in the drum will be maintained by level control loop LIC-719. When the evaporator is down for cleaning, it is possible to run only one pump and maintain vacuum for liquefaction.

A pressure controller (PIC-720) maintains pressure by air bleed into the vacuum pump. The evaporator fourth effect vapor temperature is designed to operate at 115°F and a set point of 1.471 PSIA. Cooling water at 90°F is provided to condense the vapors from the fourth effect. There is a secondary or auxiliary condenser tagged as SC-2 (E-721). This condenser is designed to handle the cooker vapors and process water flash when the entire evaporator is down for cleaning. The condenser pressure will operate at approximately 3.7 PSIA and be controlled by PIC-721.

The monitoring and control system consists of the following:

NOTE: Some of these instruments as noted are by Clean Burn Fuels.

a) Steam flow measurement (FIT-585) and control (FV-585) for First Effect Chests C-1A (E-701A) and C-1B (E-701B). NOTE: FIT-585 and FV-585 are by Clean Burn Fuels.

b) Feed flow rate measurement (FIT-609) and control (FV-609). NOTE: FIT-609 and FV-609 are by Clean Burn Fuels.

c) Liquor level measurement and control for Effects 4, 3, 2 1A and 1B: LIT-713/LV-713, LIT-709/LV-709, LIT-705/LV-705, LIT-703B/LV-703B and LIT-703A/LV-700-2, LV-700-3. NOTE: LV-700-2 and LV-700-3 are by Clean Burn Fuels.

d) Syrup final product density measurement DIT-701 can provide a remote set-point for either steam flow (FIC-585) to first effect or feed flow (FIC-609) to C-4 (E-713). Initially, the remote set-point will be set to control the steam flow. NOTE: FIC-585 and FIC-609 are by Clean Burn Fuels.

e) Steam condensate liquid measurement (LIT-706) and control (LV-706).

f) Condensate liquid measurement (LIT-717) and control (LV-700-1). NOTE: LV-700-1 is by Clean Burn Fuels.

g) Temperature measurement of First Effects C-1A (E-701A), C-1B (E-701B) and vapor separators TI-703A, TI-703B, TI-707, TI-711 and TI-715.

h) Pressure measurement and control for Main Condenser SC-1 (PIC-720) and pressure measurement and control for Auxiliary Condenser SC-2 (PIC-721).

i) The vacuum pump package includes its own two flow switches FS-719A and FS-719B, two temperature switches TS-719A and TS-719B and two flow valves XV-719A and XV-719B.

NOTE: Product density will provide a remote set point for steam flow adjustment.

SYSTEM LEAK TESTING

After installation of all equipment including piping, pumps, vacuum pump, gauges and instrumentation, and before equipment is insulated, the evaporator system should be completely checked for leaks. These can occur at vessel body flanges, piping flanges, threaded connections, sight glasses, valve stems, pump seals, and even welded connections. Once leaks are located and fixed, the evaporator can be insulated. The system is considered tight when vacuum loss is less than 1" to 2" of Hg per hour.

NOTE: Here are three possible methods for leak testing:

Vacuum Test

Isolate the system by closing all valves which can allow air to leak into the evaporator. These include all start-up vents, drains, and sample valves open to the atmosphere. All chest shellside non-condensable vent valves should be fully open, providing piping is routed to another part of the evaporator. Open the manual seal water block valve i.e. VB-755 feeding the vacuum pump and slightly open the manual flow control ball valve VB-848.

NOTE: Open the line 07321 from the process condensate tank TK-721 to allow water to condensate pump P-7 (P-717). This condensate pump provides seal water to the vacuum pumps. It should be interlocked to the vacuum pump. It must be started and a level maintained by LIT-717 in automatic control first before starting the vacuum pump.

Start the vacuum pumps P-9A (P-719A) and P-9B (P-719B) stepwise according to the manufacturer recommendations. The seal water inlet solenoid valve i.e. XV-719A will open/close with the start/stop of the pump. Adjust the ball water flow control valve to maintain 4" Hg on the inlet valve. At this point, the evaporator is being evacuated of air in the system. Once vacuum in the system reaches 27 inches Hg or 1.47 PSIA, turn off the vacuum pump and observe system vacuum. If the vacuum loss is more than 1 to 2 inches Hg per hour, look for and eliminate small air leaks. All leaks should be corrected prior to insulation and initial operation. Leaks can be identified by sound and/or an item such as shaving crème or a soap solution.

Water Leak Test

A) Open all vent valves
B) Fill the system with water
C) Check for leaks
D) Pump water to feed tank for later use
E) Fix leaks and repeat if necessary

NOTE: This procedure is slow if any welding is required and requires a large quantity of water.

NOTE: **This procedure will not work should the hydraulic head overcome the setpoint of any safety relief devices such as rupture disc or relief valves.**

Steam Leak Test

CAUTION: **Live steam is involved. Special care must be taken to insure personnel safety. Block in the evaporator so no steam can leave the evaporator and go elsewhere to equipment in the plant. All steam lines should be blown clean to remove foreign matter. A pressure gauge, steam strainer and trap should be located in the steam line to the evaporator.**

A) Add 5 to 8 PSIG steam. However, take precautions and attention to keep from over pressurizing the system. **BE CAREFULL AND SLOWLY CRACK OPEN THE STEAM VALVES! Remember, most of the system is only rated for 30 PSIG.** Do not exceed 8 PSIG.
B) Make sure the tubesides of the surface condenser are drained. This will save a lot of time. Leave drains open.
C) Open all pump drains. Since air is heavier than steam, the steam will force all the air in the system out of all the pump drains. The condensate will drain out of the system through the drains as well.
D) Once steam, not air, is blowing out of a drain close the valve until all of the valves are closed.
E) The system will pressurize and any leaks in the system will begin to blow steam.
F) Check the surface condenser cooling water system for leaks with water after the system has cooled.
G) Once system integrity has been proven, the insulation may be installed.

NOTE: Air may be substituted for steam. It will not be visible like steam but does make discernable noise.

NOTE: **At this point, temporary screens could possibly be installed at pump suctions to keep foreign material and construction debris from the pump impellers prior to operating the pumps. Experience has shown that the pump suction drains are large enough that several flushings with water should suffice and screens are not required. However, start up screens on the feed line from P-609 should be installed.**

INITIAL OPERATION ON WATER

Initial operation should be conducted using water to check all evaporator functions prior to operation on product.

A) Close all pump drains and make sure all pump seal pots are filled with barrier fluid. Fill feed tank with water. Check pumps for direction of rotation and verify action of all control valves.

B) Check the surface condensers SC-1 (E-720) and SC-2 (E-721) along with vacuum pumps P-719A and P-719B cooling water systems for leaks and proper action of any valves installed. Set approximate flow through the condensers. The condenser water is in series.

C) Blow down steam line to the first effect chests C-1A (E-701A), C-1B (E-701B) and C-2 (E-705) to remove all foreign matter from steam line and cooker vapor lines.

D) Review seal pots to all pumps, insuring ample barrier fluid and air pressure in the seal pots are being maintained. This shows that the seals or piping have no leaks.

E) Open all the level valves and close the product out valve manually and start the feed pump.

Admit feed and allow the evaporator to fill unilaterally until you get a level sufficient to allow the pumps to be started. This will be when the level is about 80% reading or the upper sight glass level on the 2nd 3rd and 4th effect chest.

At this point, close all the level control valves and continue to fill the 4th effect chest while starting the 4th effect liquor pump P-4 (P-716). The level will drop when the pump is started. This is due to the pump discharge filling up and a portion of the liquor is now falling down the tubes. As the fourth effect C-4 (E-713) level recovers note the percent % level at the lower sight glass of the C-4 chest, this should be approximately 50%. This is the desired level you wish to operate the pumps. Use this level as the setpoint and switch LIC-713 to automatic control. Slowly, continue to let the C-4 (E-713) body fill so the valve LV-713 opens and begins to fill C-3 (E-709). This is the third effect. Fill the third effect C-3 (E-709) to its top sight glass and start its pump P-3 (P-712). When the level recovers to the lower sight glass plate switch its level controller LIC-709 in auto and continue repeating the procedure.

The only exception is the levels maintained on the first effects are done so in the separators S-1A (D-703A) and S-1B (D-703B). The format is the same, fill to the second glass, start the pump and maintain operating level at the lower glass. This procedure is finalized when all the liquor pumps are running and the level controls are all operating in automatic.

At the same time as you are starting the liquor circulation, the vacuum pump can be started and the vacuum pulled down while you finish filling the evaporator. Remember,

arrangements must be made to have the condensate pump P-7 (P-717) provide seal water to the vacuum pump before it will run. Set point for the absolute pressure controller PIC-720 is 1.47 PSIA. All steam chest non-condensable vents should be 50% open (i.e. hand valves).

Once the evaporator is filled, all the pumps running the feed rate should be reduced so the evaporator is recycling as little feed back to the feed tank as possible.

NOTE: If preferred, the vacuum can be established first and then introduce the feed (water) to the system. This will take longer to pull design vacuum.

F) Set up product Pump P-5 (P-706) to discharge to the feed tank or sewer. Pump water through the system while maintaining vacuum, and with all liquor pumps in operation. Make sure the levels are maintained in the desired range and rates are within the capabilities of product pump P-5 (P-706).

G) You can now introduce steam into the evaporator slowly. At the same time you begin to make condensate, the first effect condensate pump P-6 (P-702) can be started. The combined condensate pump P-7 (P-717) can be switched off of the process condensate tank and onto evaporator condensate. The condensate flow can be observed through sight glasses located at the lower tubesheet of the heat exchangers.

The steam procedure should take place as follows:
Slowly (over a five minute period) open the steam valve to the first effect chests C-1A (E-701A) and C-1B (E-701B) to obtain a small steam flow. The evaporator pressure should remain at a high vacuum. Start the first effect steam condensate pump P-6 (P-702). Slowly increase the steam rates, observing a continuing increase in transfer water temperatures across all effects. The combined condensate pump P-7 (P-717) should now be running on evaporator condensate. Make sure the water through put rate is sufficient for steam rate being used. Note: Do not boil the evaporator dry!

In general, the evaporator feed rate is increased to the desired rate and the steam is increased proportionately to bring up density or in this case to allow the water run to boil. If to much steam is introduced into the evaporator, levels will drop and the feed rate will not keep up. You must then increase the feed rate or reduce the steam rate.

Adjust water flow from surface condenser SC-2 (E-721) so that water discharge temperature is approximately 105°F.

H) Care should be taken to make sure that the evaporator is always discharging water. Do not admit excessive steam as this will cavitate the circulation pumps, dry out the tubes and possibly cause scaling of the heat transfer surface. Operate the evaporator in a manner to adjust all controls. Discharge and steam rates can be adjusted upward and downward to gain experience with all evaporator functions. Changes in rates should be made slowly to insure that the bodies reach equilibrium and are not allowed to boil dry. Condensate sight gauges are provided for chest shellside level observation. Condensate systems should be checked to insure that condensate does not build up in the steam chests and surface condenser.

NOTE: The quality of water should be such that the tubes do not scale or build mineral deposits. Minimize the water boil to a few hours to reduce scaling if possible.

I) The evaporator is shutdown by first closing the steam valves to the first effect chests C-1A (E-701A), C-1B (E-701B) and C-2 (E-705) and then the feed valve. After stopping the pumps and vacuum pump systems, the contents of the bodies can be pumped out and drained.

J) Pump screens if installed should now be removed and pump suction lines drained and cleaned again.

START-UP ON LIQUOR

Operation on liquor should be quite similar to that above for initial operation on water. Note that flow rate through the system will usually be limited by the capacity of the product pump P-5 (P-706).

A) Set up product pump P-5 (P-706) to discharge back to feed tank.

B) Start feed liquor to system. Start liquor pumps P-4, P-3, P-2, P-1A/B and P-5, using the preceding procedure when sufficient operating levels are attained to satisfy the pumps individually. Make certain that the pump mechanical seal pots are operational.

NOTE: The operating levels will be as previously described and controlling in automatic mode.

C) Start evaporator vacuum pump system using the combined condensate pump P-7 (P-717). Start cooling water to the surface condenser SC-1 (E-720). Set the fourth effect absolute pressure control to 1.47 PSIA. Allow this vacuum to be attained.

D) Slowly start and increase the steam rate in increments to the approximate design rate. Allow all cooker vapors and waste heat available for the second effect to be fully used before adding more steam. Start condensate pump P-6 (P-702). Switch the condensate pump P-7 (P-717) to evaporator condensate.

E) With the first effect separator (D-703A) level control in automatic and maintaining a level just below its lowest liquor sight glass let the density increase while trying to keep the level valve LV-703A from opening. When the density reaches the desired value, discharge the product to the proper storage tank (stop recycle to feed tank). It will probably be necessary to adjust the feed and steam rates to obtain desired product density. If the density is high, increase feed or decrease steam rate. If the density is low, decrease feed or increase steam rate. Make all rate changes slowly. Try to run as much waste heat steam on C-2 (E-705) as possible and as little steam as possible on the first effect chests C-1A (E-701A) and C-1B (E-701B). This will help keep the evaporator running as economical as possible.

F) Make certain non-condensable vents are properly adjusted (approximately 50% is a safe position). Vent lines should be warm or hot to the touch.

G) Make certain condensate is being removed from steam chests.

H) Adjust water flow to surface condensers to give proper SC-2 (E-721) discharge water temperature of 105°F.

I) All of the preceding steps will be made with the feed and steam controls in manual mode. After the system has reached equilibrium at the design product density, switch controls to automatic mode.

J) If it is necessary to increase or decrease the liquor throughput rate of the system, the flow rate adjustment should be made slowly and in small increments. Study the liquor temperatures on each pump to follow the boiling and the impact of changes.

K) Continue to operate evaporator as long as the product density is in the specified range. If the correct product density cannot be maintained as a result of some malfunction, it will be necessary to divert the product discharge to the evaporator feed tank temporarily. Always try not to recycle high solids back to the evaporator feed tank.

SHUT DOWN OPERATION (FOR ENTIRE EVAPORATOR SHUTDOWN)

NOTE: Feed tank should always be at a low level to allow evaporator to be shutdown.

A) Shut off all heat sources (Steam, cooker vapor and rectifier condensate) to system and slow feed rate. Cooker vapors and rectifier condensate get by-passed to SC-2 (E-721).
   1. Shut XV-701A-1 and XV-701B-1
   2. Close XV-705, liquefaction to 2nd effect
   3. Open XV-721, liquefaction to auxiliary condenser
   4. Close XV-719-1, condensate to 2nd effect
   5. Open XV-719-2, condensate by-pass to P-7 (P-717)
   6. Turn on back-up water from TK-721 to P-717 by opening XV-700-6.

B) Stop steam condensate pump P-6 (P-702) and drain to floor.

C) Reduce feed rate from P-609 to 210 GPM and circulate through the system to dilute remaining product and cool evaporator.
   1. Push heavy product forward to tank TK-724 until density falls off to approximately 22%D.S.
   2. Change hand switch HS-700-2 to control level valve LV-700-3 and continue to push feed and thin out evaporator.

D) When evaporator is sufficiently thinned out and the heat exchanger and vapor separator temperatures are approximately equal, stop feed flow (FIT-609).

E) Close 4th effect condensate drain manually (VM-749).

F) Open auxiliary vent valve VB-754 to allow LIT-717 to vent to SC-2.

G) Change vacuum control from SC-1 to SC-2 by using PIT-721. New set point should be set at 3.7 PSIA.

H) Close main condenser SC-1 (E-720) condensate drain and vent (VM-748 and XV-722).

I) Open air bleed valve PV-720 and XV-720-2.

J) Reduce cooling water as required.

K) The evaporator can now be drained. Initially it is suggested to stop and drain one effect at a time using P-8 (P-710), beginning with the 4th effect (E-713).
   1. Configure pump P-8 (P-710) to be ready for service and open discharge valve VM-730.
   2. Configure Katzen by-pass valve XV-700-3 and line up to go to centrate surge tank TK-608.
   3. Individually shut down each recirculation pump, e.g. 4th effect P-716, and drain with P-8 (P-710). Product pump P-5 (P-706) can also be used to send stillage back to the feed tank to speed up the draining process. After each level goes to zero or the recirculation pump starts to cavitate, stop that pump and continue to drain.
   4. If the evaporator has been appropriately **cooled** before draining all pumps can be stopped, all drains opened and then pump out using P-8 (P-710). **Note:** It is not acceptable to dry out the tubes if the evaporator is still hot.
   5. The product pump and syrup recirculation line should be drained via the bottom of P-706.

L) Upon stopping the first effect, the product pump P-5 (P-706) should be shut down too. Valves should be allowed open to drain syrup header and prepare it for cleaning.

M) Evaporator should now be drained, atmospheric pressure, and ready for CIP rinse with water or CIP with caustic.

CLEANING OF EVAPORATOR (BOILOUT AS REQUIRED EVERY 7 DAYS)

This section refers to circulation of a cleaning (boil-out) solution such as water or a chemical (sulfamic acid) to remove the fouling constituents which have deposited on the product side of the tubes.

NOTE: **Anhydro recommends that delta T and the first effect shell side temperature dictate need for boilout. We advise that the maximum temperature on the shell side of C-1A/B (E-701A/B) not exceed 220°F.**

1. Make sure the evaporator system is shut down and ready for CIP per the preceding section.
2. Set all evaporator control and on/off valves to manual and close
3. Start CIP rinse pump P-732, open the condensate rinse discharge isolation valve (XV-732), and charge CIP header (07295).
4. Open all CIP spray balls and rinse for 10 minutes with water, check sight glasses for good flow.
5. After 10 minutes has passed, close all spray balls and stop CIP rinse pump P-732
6. Close condensate rinse discharge isolation valve (XV-732).
7. Drain system after rinse by opening all drains and running pump P-8 (P-710).
8. Once rinse is acceptable, stop pump P-8 (P-710), close P-710 discharge valve VM-730, and open CIP bypass valve XV-703B-3 to allow caustic to enter through main circulating pump suctions and product pump drains.
9. Open the caustic tank (TK-428) isolation valve (XV-730-2) and start pump P-730 to begin caustic CIP. Open valve XV-730 to allow caustic solution through the CIP header. Fill evaporator effects to 80% level through the bottom of each effect except the first effect. Level controllers should be closed and in manual.

NOTE: **First effect S-1A and S-1B (D-703A/B) can be back flushed while filling the first effect.**
a) Close hand valves VM-707 and VM-714 and open the 100mm CIP inlet XV-703A-2 and XV-703B-2
b) Fill both first effect bodies to 80% level this way and then reverse the valves. Weber will now be clean.

10. Start up the recirculation pumps and enable auto control of the liquor transfer level valves one effect at a time as done in evaporator start-up. **Note:** Pump suction drains should always be closed before starting the pump.
11. Circulate the caustic CIP for a minimum of 8 hours while maintaining temperature at 180°F. Circulate the caustic CIP through the evaporator, evaporator syrup header line 06122 and back to its source using evaporator line 07224 and 07343. Close XV-713-2 and open XV-704B-5, VM-747, and VM-741 to allow caustic CIP to be recycled through the CIP recycle line that ties into the feed line. VM-747 should be opened slowly to maintain proper level in the first effect. Opening VM-747 too quickly will allow the first effect separator D-703A to empty before level controllers can react.

NOTE: High operating levels during CIP will not hurt the evaporator. Set points can be raised during boilout. If too much caustic is observed in the evaporator you can bleed caustic off from the pump drain (XV-706) of P-706 and bring it back to the CIP tank with P-8 (P-710). Levels should be maintained at or above normal operating levels.

NOTE: Experience will dictate the proper boil-out or circulating time as well as effective cleaning temperatures. Add steam to maintain 180°F solution for cleaning effectiveness. Maintain the proper pH (>11) of the cleaning liquid per manufacturer's suggestions.

NOTE: Warn all personnel that they should not risk getting any caustic on their skin and should follow all safety guideline. Protective clothing and face shields should be utilized when handling CIP solutions of any kind.

12. After circulation is complete, stop all circulation pumps, open all drains, and start pump P-8 (P-710). Open valve XV-700-5 to allow for the caustic solution to return CIP tank TK-428 via line 07404.
13. Stop pump P-8 (P-710) after the system has been drained.
14. Rinse evaporator with fresh water as required to remove all cleaning solution residue. (Optional)

TROUBLESHOOTING

WHEN PERFORMANCE FALLS OFF, THE FOLLOWING SHOULD BE REVIEWED:

A) Is heating steam supply pressure at operating range and dry?

B) Is feed concentration or temperature below normal?

C) Is condenser vacuum reading within normal operating range? If higher pressure is observed (less vacuum), vacuum pump system and cooling water should be reviewed for proper operation, including cooling water flows and temperatures. Also check for air leaks in the system and proper operation of the main air bleed control valve.

D) Are condensate levels in chests properly low? If not, check operation of condensate pumps, transfer valves and flash orifices. The vent lines may be flooded.

E) Are chest shellside non-condensable vent valves at least partially open per operating instructions? If closed, they should be readjusted to normal positions.

F) If all seems normal, the unit may require cleaning, follow boil-out instructions above.

NOTE: Should you ever lose a pump or have a level control valve fail, immediately remove the steam and divert the heat to the evaporator. Next, make the appropriate steps to maintain the level for all the pumps still running.

NOTE: Before maintenance can be performed on any pumps the evaporator must be drained, locked and be approved by a supervisor.

PARTIAL CIP / CONTINUIOUS RUN GUIDELINES

NOTE: Systems modifications have been added to permit partial CIP (cleaning) while parts of the evaporator remain operational.

Cleaning C-1A and/or C-1B

This five (5) body quadruple effect is designed to run at reduced capacities and be able to clean C-1A (E-701A) or C-1B (E-701B) while in operation.

General Guidelines to clean C-1A (E-701A) while operating

Special Objective: To remove heat from heat exchanger before stopping circulation pump and draining.

1. Feed tank should be in position for partial CIP
2. Slowly reduce evaporator feed rate and steam rate to approximately 50% capacity
3. Close steam valve to C-1A (E-701A) valve XV-701A-1
4. Close vapor outlet of the effect 1A separator D-703A with valve XV-703A-3
5. Slowly stop steam to entire evaporator and shut off steam condensate pump P-6 (P-702)
6. Close effect 1A condensate outlet XV-701A-2
7. Slowly continue to push feed through the evaporator to thin out heavy liquor in S-1A (D-703A)
8. Once product concentration has dropped to approximately 25%DS, change "Hand Switch" mode HS-700-2 control from LV-700-2 to LV-700-3 to allow for recycle to centrate surge tank.
9. Thin to approximately 20% then stop feed and switch LV-703B, LV-705, LV-709, and LV-713 to manual control and close.
10. Close the liquor valves to and from product pump P-5 (P-706) valves XV-704A-1 and XV-704A-4 while opening XV-704B-1 and XV-704B-2. (Re-route density meter to effect 1B)
11. Close XV-704A-5 and open XV-704B-4 valve. (Re-route liquor return from TK-724 to effect 1B)
12. Close liquor inlet to effect 1A with valve XV-704A-2. (Level valve LV-703B is closed and idle)
13. Change "Hand Switch" HS-703B control from LV-703B to LV-700-2 to allow for separator 1B control of product.
14. At this point the rest of the evaporator can resume operation at a reduced capacity while effect 1A remains in CIP. Open XV-701B-1 and XV-705 and slowly increase steam and feed rates to a reduced capacity and the start steam condensate pump P-6 (P-702) should be started. Meanwhile, level control should be switched to auto control. Be sure to reduce the amount of steam added to effect 1B to keep the 2nd effect (E-705) falling film below 30%DS.
15. **QUICK EMPTY AND COOL:** Open effect 1A drain XV-704A-3. Run pump P-8 (P-710) and throttle the discharge valve (VM-730) while adding enough water through the CIP spray balls to maintain level at the lower sight glass in effect 1A separator D-703A. Continue circulating the liquor until effect 1A chest E-701A and separator D-703A have reached the same temperature.

16. Stop effect 1A circulation pump P-1A (P-704A) and spray ball water. The body C-1A (E-701A) and S-1A (D-703A) can now be completely drained by fully opening P-8 (P-710) and pumping out.
17. Depending on the final amount of solids in the dilute liquor, the first effect may or may not need to be rinsed with water using spray balls before administering the CIP solution. This will be determined from experience and is unnecessary if the amount of solids is low.
18. Immediately after draining, fill effect 1A with caustic CIP through pump suction with a 5%, 185°F CIP solution. Administer caustic CIP from TK-428 by opening XV-730-2 and starting P-730. Open valve XV-730 to allow the caustic into the CIP header. During filling, the top of the separator (Weber) can be washed by opening the 4" CIP drain line (valve XV-703A-2) and forcing the CIP up through VM-708 by closing VM-707.

NOTE: The top of the separators (Webers) of S-1A (D-703A) & S-1B (D-703B) should be cleaned at least every other boilout.

NOTE: Before the circulation pump is restarted the first effect should be vented (displace air from being empty) by opening air bleed line 07308 (VM-756).

19. With proper operating level and vent, start the circulation pump. Circulate pump for 8 hours.

    Liquor flow will now proceed through the evaporator as far as S-1B (D-703B) before being diverted to the product pump P-5 (P-706).

    Cleaning C-1B (E-701B) and S-1B (D-703B) will be similar. Vapors will be stopped from entering and leaving the effect. Liquor will then be diverted around effect 1B and go directly to the effect 1A. The same basic procedure and guidelines for cleaning effect 1A will be followed when cleaning effect 1B by itself.

General guide line for taking C-1B (E-701B) and S-1B (D-703B) off line and cleaning are as follows:

1. Feed tank should be in position for partial CIP
2. Slowly reduce evaporator feed rate and steam rate to approximately 50% capacity
3. Close steam valve to C-1B(E-701B) valve XV-701B-1
4. Close vapor outlet of separator S-1B (D-703B) with valve XV-703B-4
5. Slowly stop steam to entire evaporator and shut off steam condensate pump P-6 (P-702)
6. Close effect 1B condensate outlet XV-701B-2
7. Slowly continue to push feed through the evaporator to thin out concentration in S-1B (D-703B)
8. Once product concentration has dropped to approximately 25%DS, change "Hand Switch" mode HS-700-2 control from LV-700-2 to LV-700-3 to allow for recycle to centrate surge tank.
9. Thin to approximately 20% then stop feed and switch LV-703B, LV-705, LV-709, and LV-713 to manual control and close.
10. Close XV-702B-6B and open XV-702B-6A allowing liquor to by-pass effect 1B.

11. At this point the rest of the evaporator can resume operation at a reduced capacity while effect 1B remains in CIP. Open XV-701A-1 and XV-705 and slowly increase steam and feed rates to a reduced capacity and start steam condensate pump P-6 (P-702). Meanwhile, level control should be switched to auto control. Be sure to reduce the amount of steam added to effect 1A to keep the 2nd effect (E-705) falling film below 30%DS.
12. **QUICK EMPTY AND COOL:** Open effect 1B drain, valve XV-704B-3. Run pump P-8 (P-710) and throttle the discharge valve while adding enough water through the CIP spray balls to maintain level at the lower sight glass in S-1B (D-703B). Continue circulating until C-1B (E-701B) and S-1B (D-703B) have reached the same temperature.
13. Stop circulation pump P-1B (P-704B) and spray ball water. The body C-1B (E-701B) and S-1B (D-703B) can now be completely drained by fully opening P-8 (P-710) and pumping out.
14. Rinse with water if necessary using spray balls.
15. Immediately after draining, fill effect 1B with caustic CIP through pump suction with a 5%, 185°F CIP solution. Administer caustic CIP from TK-428 by opening XV-730-2 and starting P-730. Open valve XV-730 to allow the caustic into the CIP header. During filling, the top of the separator (Weber) can be washed by opening the 4" CIP drain line (valve XV-703B-2) and forcing the CIP up through VM-715 by closing VM-714.

NOTE: The top of the separators (Webers) of S-1A (D-703A) & S-1B (D-703B) should be cleaned at least every other boilout.

NOTE: Before the circulation pump is restarted the first effect should be vented (displace air from being empty) by opening air bleed line 07307 (VM-757).

16. With proper operating level and vent, start the circulation pump. Circulate pump for 8 hours.

VALVING AND PIPING HAVE BEEN ADDED TO ALLOW THE FOLLOWING:

A) Liquefaction cooking vapors to run continuously and to be condensed either in the evaporator or its auxiliary condenser at all times.

1. Cooker vapors can be added to the second effect steam chest (C-2, E-705) via 30" vapor duct and valve XV-705.
2. Cooker vapors can be added to the third effect steam chest (C-3, E-709) via 24" vapor duct and valve XV-709.
3. Cooker vapors van be added to the fourth effect steam chest (C-4, E-713) via 24" duct and valve XV-713-1.
4. Cooker vapors can be added directly to the auxiliary condenser (SC-2, E-721) via 24" duct and valve XV-721.

B) Rectifier bottoms condensate to be run continuously to the evaporator or its auxiliary condenser at all times.

1. Condensate can be flashed into flash cooler FC-1 (D-719) to produce flash vapor to the second effect C-2 (E-705).
2. All rectifier bottoms condensate can be flashed to the 24" cooker vapor header and introduced to the auxiliary condenser (SC-2, E-721).

SULFAMIC ACID BOILOUT

NOTE: It should be expected until some history is developed, that a 4-5 hour boilout with sulfamic acid be administered every third boilout. This should occur after a normal caustic boil is administered and follow the preceding guidelines and safety concerns. Sulfamic acid should be of a 4% solution to as high as 10% and pH less than 2. 10% sulfamic acid will not hurt your equipment.

NOTE: Sulfamic acid washes do not need to be done on every effect. They should only be done on effects exhibiting hard organic deposits.