

## Fermentation Plant #444



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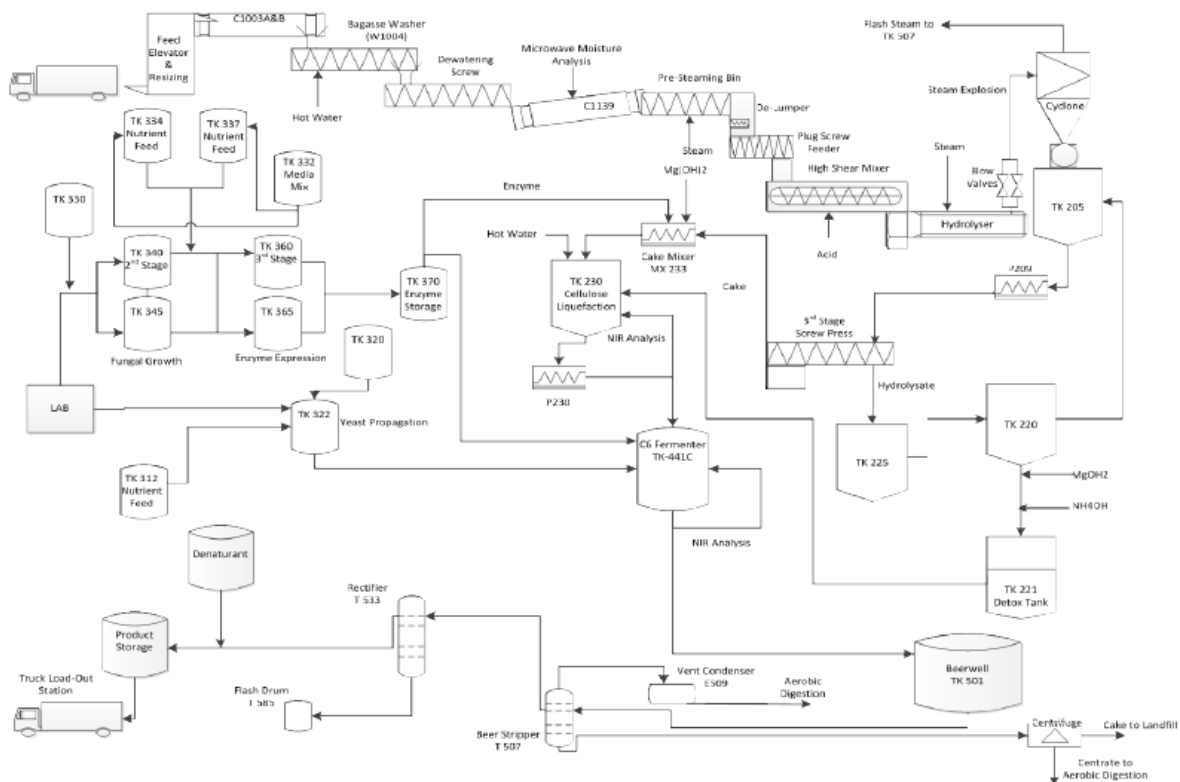
## 1. Executive Summary

This fermentation facility, located in Jennings, Louisiana, consists of a pilot plant and a demonstration plant, and is for sale with the real estate (approximately 110 acres). The plants were originally designed to produce lignocellulosic ethanol (LCE). The demonstration plant was successfully started in 2009 with production capacity of 1.4 million gallons per year. The demonstration plant conducted 76 batch operation campaigns until 2015. The demonstration plant operated on feedstocks including: (1) common sugar cane, (2) purpose grown energy cane, (3) sorghum, and most recently, (4) bagasse. The pilot plant was used to develop LCE technology.

## 2. Plant Configuration

The demonstration plant includes the following process sections:

- Feedstock handling
- Feedstock transfer
- Feedstock preparation
- Hydrolysis
- Liquefaction
- Yeast and enzyme propagation
- C5, C6 co-fermentation
- Ethanol recovery



Initially the demonstration plant was purposely configured with the following capabilities:

- outdoor, open air, piled feedstock storage,
- pile-to-plant feedstock movement via front end loader,
- surface contact ambient water wash to remove grit,
- dewatering via screw press prior to acid hydrolysis,
- dilute acid hydrolysis (horizontal digestion) with single stream steam explosion,
- 3-stage, water wash screw press liquid/solid separation of hemicellulose and cellulose,
- hemicellulose sugar (C5) base-addition detoxification,
- fungal growth and enzyme expression production,
- C5 sugar fermentation with bacteria,
- sequential saccharification fermentation of cellulose (C6 sugars) with bacteria,
- carbon steel, conical bottom fermenters with limited heat transfer/mixing capability (sugar cane ethanol),
- 140 DegF caustic CIP capability of fermenters,
- ethanol/water/solids separation via distillation w/ mole sieve dehydration,
- solids separation from wastewater via horizontal decanting with solids disposal via landfill,
- utilities (gas fired steam generation, instrument air, sparge air, cooling tower, chilled water),
- direct contact, water absorption air emissions control,
- ethanol storage, denaturing, and truck loading,
- UF/RO wastewater treatment,
- integrated Rockwell PLC based control hardware,
- and analytical, wet chemistry and biology laboratories.

With continual development of the fermenting organism platform came integrated simplification of the process for a low capex and optimum opex design. Coupled with improvement of fundamental engineering and reliability issues of the original plant construct, the demonstration plant was the recipient of significant investment in capex, namely:

- polyethylene agricultural bag storage of feedstock (store 1-2 yrs. with negligible degradation),
- feedstock classification and foreign object removal via horizontal trammel sifter,
- rare earth magnet removal of ferrous metal,
- hot water wash to remove surface organic acids and residual sugars,
- on-line microwave moisture analysis,
- plug screw feeding of biomass to acid hydrolysis digester,
- dual redundancy of steam explosion,
- in-line dilute acid mixing for acid hydrolysis,
- single fermenting yeast platform for both C5 and C6 sugars,
- stainless steel, ASME elliptical dished head fermenters
- fit-for-purpose fermentation mixing and heat transfer capability,
- 180 °F CIP and 220 °F SIP capability for fermentation,
- multi-stage yeast propagation,

- cellulose liquefaction prior to fermentation,
- on-line NIR (mid-infrared refractometry) for fermentation ethanol and residual sugars,
- mass spectrometry vapor space analysis of fermenters, propagators and enzyme production,
- refit-for-purpose steam generation and upgraded air capabilities,
- natural gas fired thermal oxidizer for fermenting vessel emissions,
- refit for purpose water scrubber for non-fermenting vessel emissions,
- aerated, activated sludge wastewater treatment,
- wastewater holding tankage,
- integrated lab information management system (LIMS),
- and state based, batch managed process control logic.

### 3. Highlights of Major Equipment

- 55,000 Gallon SS Fermenter, 18' dia x 25'
- (3) 54,000 Gallon CS Fermenter, 19' dia, cone bottom
- 18,200 Gallon SS Fermenter, 10 psi, 12' dia x 19'
- (3) 18,200 Gallon CS Fermenter, 13' dia, cone bottom
- (4) 6,594 Gallon 316L SS Fermenters, 30 psi, with control skid
- Hydrolyzer - 1" thick SS with inco lining
- Alfa Laval Centrisys
- (2) FKC Screw Presses
- Rectifier
- Beer Stripper
- Thermal Oxidizer
- FKC Dewatering Press
- Texas Power Screen, manufactured by Phoenix (A Terex company), mobile
- TK-205 (Replacement) - Blow down tank for hydrolyzer, Approx 20,000 gal 316L SS Pressure Vessel, designed for 150 psi, 10' dia x 24'
- Unused DAF System

### 4. Equipment List

| ID #   | Equipment                              |
|--------|--|
| TK-207 | HYDROLYZER EXPANSION TANK              |
| MX-271 | HYDROLYZER RETENSION SCREW             |
| TK-205 | 1st STAGE SCREW PRESS FEED TANK        |
| TK-206 | BLOW CYCLONE AND FLASH VESSEL          |
| TK-222 | 2ND STAGE SCREW PRESS. TK.             |
| TK-220 | 1ST STAGE PRESS. FILTRATE TK.          |
| TK-224 | 3RD STG SCREW PRESS TK.                |
| TK-223 | 2ND STG PRESS FILTRATE TK.             |
| TK-225 | 3RD STG. PRESS FILTRATE TK             |
| TK-910 | FOAM STORAGE TANK                      |
| LR-248 | COMPRESSION PISTON HYDROSTATIC BEARING |
| LR-248 | LUBE OIL RESERVOIR                     |

|         |  |
|---------|--|
| LR-256  | CRANKSHAFT                                   |
| LR-256  | LUBE OIL RESERVOIR                           |
| TK-221  | C-5 NEUTRALIZATION TANK                      |
| TK-230  | C-6 CAKE MIX TANK                            |
| TK-312  | KO11 2ND STAGE REACTOR                       |
| TK-314B | INOCULATION VESSEL                           |
| TK-314A | ANTI-FOAM ADDITION VESSEL                    |
| TK-314B | INOCULATION VESSEL                           |
| TK-314A | ANTI-FOAM ADDITION VESSEL                    |
| TK-312  | KO11 2ND STAGE REACTOR                       |
| TK-320  | BW34 2ND STAGE MEDIA TANK                    |
| TK-324B | INOCULUM VESSEL                              |
| TK-324A | ANTI-FOAM ADDITION VESSEL                    |
| TK-322  | BW 2ND STAGE REACTOR                         |
| TK-327  | C6 MEDIA TANK                                |
| TK-330  | TR 2ND STAGE MEDIA TANK                      |
| TK-332  | TR 3RD STAGE MEDIA TANK                      |
| TK-334  | TR 3RD STAGE NUTRIENT TANK A                 |
| TK-336  | TR 3RD STAGE NUTRIENT TANK A EXPANSION TANK  |
| TK-337  | TR 3RD STAGE NUTRIENT TANK B                 |
| TK-339  | TR 3RD STAGE NUTRIENT TANK B EXP. TK.        |
| TK-428  | CIP TANK 3,000 GAL 8'Ø X 11' SS              |
| TK-436  | FERMENTER WASHINGS TANK                      |
| TK-224  | CORN STEEP TANK                              |
| TK-501  | BEERWELL                                     |
| T-507   | BEER STRIPPER AND STRIPPER TRAYS #1 THRU #90 |
| T-533   | STRIPPER/RECTIFIER & TRAYS #1 THRU #46       |
| TK-601  | STILLAGE CENTRATE TANK                       |
| TK-714  | SLAKED LIME SLURRY TANK                      |
| TK-720  | GLUCOSE TANK                                 |
| TK-730  | ANHYDROUS AMMONIA                            |
| TK-920  | 98% SULFURIC ACID TANK                       |
| TK-905  | FIREWATER/PROCESS WATER STR. TK.             |
| TK-906  | PROCESS HOT WATER TANK                       |
| R-960   | IPT AIR RECEIVER                             |
| TK-945  | KILLTANK                                     |
| TK-935  | WASTE NEUTRALIZATION                         |
| E-221H  | TK-221 RECIRC HEATER                         |
| E-221C  | TK-221 RECYCLE COOLER                        |
| HX-316  | VENT GAS HEATER                              |
| HX-315  | SPARGE GAS HEATER                            |
| HX-313B | RECIRCULATION SEAL POT                       |
| HX-313A | KO 2ND REACTOR COOLER                        |
| HX-325  | BW34 SPARGE HEATER                           |
| HX-326  | VENT HEATER                                  |
| HX-323B | RECIRCULATION SEAL POT                       |
| HX-323A | BW 2ND STAGE REACTOR COOLER                  |

|         |   |
|---------|---|
| HX-336B | TR 3RD STAGE NUTRIENT TANK A JACKET HEATER    |
| HX-336A | TR 3RD STAGE NUTRIENT TANK A JACKET COOLER    |
| HX-339B | TR 3RD STAGE NUTRIENT TANK B JACKET HTR       |
| HX-339A | TR 3RD STAGE NUTRIENT TANK B JACKET COOLER    |
| HX-343  | SPARGE GAS HEATER                             |
| HX-344  | VENT GAS HEATER                               |
| HX-341B | RECIRCULATION PUMP SEAL POT                   |
| HX-341A | PROCESS STREAM COOLER                         |
| HX-348  | SPARGE GAS HEATER                             |
| HX-349  | VENT GAS HEATER                               |
| HX-346B | RECIRCULATION PUMP SEAL POT                   |
| HX-346A | PROCESS STREAM COOLER                         |
| HX-353  | SPARGE GAS HEATER                             |
| HX-354  | VENT GAS HEATER                               |
| HX-351B | RECIRCULATION PUMP SEAL POT                   |
| HX-351A | PROCESS STREAM COOLER                         |
| HX-358  | SPARGE GAS HEATER                             |
| HX-359  | VENT GAS HEATER                               |
| HX-356B | RECIRCULATION PUMP SEAL POT                   |
| HX-356A | PROCESS STREAM COOLER                         |
| HX-363  | SPARGE GAS HEATER                             |
| HX-364  | VENT GAS HEATER                               |
| HX-361B | RECIRCULATION PUMP SEAL POT                   |
| HX-361A | PROCESS STREAM COOLER                         |
| HX-369  | VENT GAS HEATER                               |
| HX-366B | RECIRCULATION PUMP SEAL POT                   |
| HX-366A | PROCESS STREAM COOLER                         |
| HX-382  | SHELL AND TUBE HEAT EXCHANGER                 |
| HX-387  | SHELL AND TUBE HEAT EXCHANGER                 |
| E-404B  | C-5 FERMENTER NO. 2 COOLER                    |
| E-404C  | C-5 FERMENTER No. 3 COOLER                    |
| E-404D  | C-5 FERMENTER NO.4 COOLER                     |
| E-444A  | C-6 FERMENTER No. 1 COOLER                    |
| E-444B  | C-6 FERMENTER NO. 2 COOLER                    |
| E-444C  | C-6 No. 3 FERMENTER CIRCULATION COOLER SPIRAL |
| E-444D  | C-6 FERMENTER\ PNO. 4 COOLER                  |
| E-475X  | FERMENTER FEED COOLER                         |
| E-471   | NUTRIENT HEATER                               |
| E-472   | NUTRIENT STERILIZING COIL                     |
| HX-371  | HEAT EXCHANGER                                |
| HX-372  | HEAT EXCHANGER                                |
| E-433   | CIP HEATER                                    |
| E-512   | HEADS VACUUM PUMP SEAL LIQUID COOLER          |
| E-509   | VENT CONDENSER                                |
| E-504   | BEER PREHEATER No.1                           |
| E-520   | FINAL CONDENSER                               |
| E-518   | BEER STRIPPER REBOILER                        |

|         |                                       |
|---------|---------------------------------------|
| E-543   | STRIPPER/RECTIFIER FEED               |
| E-532   | STRIPPER/RECTIFIER FEED               |
| E-539   | STRIPPER/RECTIFIER REBOILER           |
| E-537   | FUSSEL OIL COOLER                     |
| E-599   | ETHANOL PRODUCT COOLER                |
| E-587   | MOL SIEVE VENT CONDENSER              |
| E-584   | MOL SIEVE CONDENSER                   |
| E-580   | MOL SIEVE SUPERHEATER                 |
| E-593   | MOL SIEVE RE-CIRCULATION COOLER       |
| E-589   | MOL SIEVE REGENERANT CONDENSER        |
| AG-222  | 2ND STG SCREW PRESS TK. AGITATOR      |
| AG-224  | 3RD STG SCREW PRESS TK. AGITATOR      |
| AG-230  | C-6 CAKE MIX TK AGITATOR              |
| AG-312  | TK-312 AGITATOR                       |
| AG-322  | BW 2ND STAGE REACTOR AGITATOR         |
| AG-334  | TR 3RD STAGE NUTRIENT TANK A AGITATOR |
| AG-337  | TR 3RD STAGE NUTRIENT TANK B AGITATOR |
| AG-340  | TK-340 AGITATOR                       |
| AG-345  | TK-345 AGITATOR                       |
| AG-350  | TK-350 AGITATOR                       |
| AG-355  | TK-355 AGITATOR                       |
| AG-360  | TK-360 AGITATOR                       |
| AG-365  | TK-365 AGITATOR                       |
| AG-370  | TR PRODUCT TANK AGITATOR              |
| AG-401A | AGITATOR                              |
| AF-441A | C-6 FERMENTER AGITATOR                |
| AG-441B | C-6 FERMENTER AGITATOR                |
| AG-441C | C-6 FERMENTER AGITATOR                |
| AG-440  | CLEAN CAUSTIC TANK AGITATOR           |
| AG-431  | 20% CAUSTIC STORAGE TANK AGITATOR     |
| AG-423B | CORN STEEP TANK AGITATOR              |
| AG-423A | CORN STEEP TANK AGITATOR              |
| AG-715  | LIME SLURRY TANK AGITATOR             |
| AG-722  | GLUCOSE TANK AGITATOR                 |
| AG-943  | KILL TANK AGITATOR                    |
| AG-938  | WASTE NEUTRALIZATION TANK AGITATOR    |

- See attachment for detailed equipment specifications.

***For more details or to discuss this plant, contact:***

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| EQUIP # | EQUIP DESCRIPTION                           | DESIGN PRESS                   | DESIGN TEMP  | SIZE                             | CAPACITY            | DRAWING #  |
|---------|---|--------------------------------|--------------|----------------------------------|---------------------|------------|
| TK-207  | HYDROLYZER EXPANSION TANK                   |                                |              | 10'Øx30'L                        |                     | 200-001A   |
| MX-271  | HYDROLYZER RETENSION SCREW                  | 3.3 MP EFF                     | 250°         | 10'Øx 30'L                       |                     | 200-001A   |
| TK-205  | 1st STAGE SCREW PRESS FEED TANK             | ATM                            | 190°F        | 8Ø'x8 'x2' CONE                  |                     | 200-001A   |
| TK-206  | BLOW CYCLONE AND FLASH VESSEL               | 100#                           | 400°F        | 10'9"x4 '6"                      |                     | 200-001A   |
| TK-222  | 2ND STAGE SCREW PRESS. TK.                  | ATM                            | 150°MAX      | 8'ØX8'HX2' CONE                  | 3000 GAL.           | 200-001B   |
| TK-220  | 1ST STAGE PRESS. FILTRATE TK.               | ATM                            | 190°MAX.     | 8'ØX8'H                          | 2056 GAL.           | 200-001B   |
| TK-224  | 3RD STG SCREW PRESS TK.                     | ATM                            | 180°MAX      | 8'ØX8'H                          | 3000 GAL            | 200-001B-1 |
| TK-223  | 2ND STG PRESS FILTRATE TK.                  | ATM                            | 190°MAX      | 8'ØX8'H                          | 2056 GAL            | 200-001B-1 |
| TK-225  | 3RD STG. PRESS FILTRATE TK                  | ATM                            | 190°MAX      | 8'ØX8'H                          | 3000 GAL.           | 200-001C   |
| TK-910  | FOAM STORAGE TANK                           |                                |              |                                  |                     | 500-008    |
| LR-248  | COMPRESSION PISTON HYDROSTATIC BEARING      |                                |              |                                  |                     | 200-001D   |
| LR-248  | LUBE OIL RESERVOIR                          |                                |              |                                  |                     | 200-001D   |
| LR-256  | CRANKSHAFT                                  |                                |              |                                  |                     | 200-001D   |
| LR-256  | LUBE OIL RESERVOIR                          |                                |              |                                  |                     | 200-001D   |
| TK-221  | C-5 NEUTRALIZATION TANK                     | 6" SKIRT, 14PSIG@FV            | 300°F-304SS  | 4'ØX18'H                         | 2000 GAL.           | 200-002    |
| TK-230  | C-6 CAKE MIX TANK                           | ATM                            | 212°F        | 6'ØX8'H, 2' CONE, 1870 GAL.      |                     | 200-003    |
| TK-312  | KO11 2ND STAGE REACTOR                      | 15 PSIG/-10 PSIG VAC @300°F    | 300°F        | (60" DIA. x 62" TT) 304L SS      | 910 GAL. CAPACITY   | 300-312A   |
| TK-314B | INOCULATION VESSEL                          | 150 PSIG/FV @ 300°F, ASME CODE | 300°F        | (9" DIA.x15" HT) 316L SS         | 3 GAL. CAPACITY     | 300-312A   |
| TK-314A | ANTI-FOAM ADDITION VESSEL                   | 150 PSIG/ FV @300°F, ASME CODE | 300°F        | (9" DIA. x15 HT) 316L SS         | 3 GAL CAPACITY      | 300-312A   |
| TK-314B | INOCULATION VESSEL                          | 150 PSIG/FV @ 300°F, ASME CODE | 300°F        | (9" DIA.x15" HT) 316L SS         | 3 GAL. CAPACITY     | 300-312A   |
| TK-314A | ANTI-FOAM ADDITION VESSEL                   | 150 PSIG/ FV @300°F, ASME CODE | 300°F        | (9" DIA. x15 HT) 316L SS         | 3 GAL CAPACITY      | 300-312A   |
| TK-312  | KO11 2ND STAGE REACTOR                      | 15 PSIG/-10 PSIG VAC @300°F    | 300°F        | (60" DIA. x 62" TT) 304L SS      | 910 GAL. CAPACITY   | 300-312A   |
| TK-320  | BW34 2ND STAGE MEDIA TANK                   | 180°F DESIGN                   |              | (84" ID x 100" SS) FIBERGLASS    | 2500 GAL. CAPACITY  | 300-320    |
| TK-324B | INOCULUM VESSEL                             | 150 PSIG                       | 300°         | 9"Øx15" TT                       | 3 GAL.              | 300-322A   |
| TK-324A | ANTI-FOAM ADDITION VESSEL                   | 150 PSIG                       | 300°         | 9"Øx15" TT                       | 3 GAL               | 300-322A   |
| TK-322  | BW 2ND STAGE REACTOR                        | 14.9 PSIG/-10 PSIG VAC         | 300°         | 78"Ø116" TT                      | 2720 GAL.           | 300-322A   |
| TK-327  | C6 MEDIA TANK                               | 180°F DESIGN                   |              |                                  | 1000 GAL NOMINAL    | 300-327    |
| TK-330  | TR 2ND STAGE MEDIA TANK                     | +6"/-6" WC DESIGN              | 180°F DESIGN | (42" ID x 86" SS)FIBERGLASS      | 299 GAL NOMINAL     | 300-330    |
| TK-332  | TR 3RD STAGE MEDIA TANK                     | +6"/-6" WC DESIGN              | 180°F DESIGN | (84" ID x 100" SS) FIBERGLASS    | 3701 GAL NOMINAL    | 300-332    |
| TK-334  | TR 3RD STAGE NUTRIENT TANK A                | 45 PSIG/FV 300°F, ASME CODE    |              | (102" DIA. x 114"TT) 316 SS      | 4,700 GAL. CAPACITY | 300-334    |
| TK-336  | TR 3RD STAGE NUTRIENT TANK A EXPANSION TANK | 100 PSIG @ 120°F               |              | (18 DIA.x20 TT) BUTYL BLADDER/CS | 20 GAL. CAPACITY    | 300-334    |
| TK-337  | TR 3RD STAGE NUTRIENT TANK B                | 45 PSIG/FV 300°F, ASME CODE    |              | (102 DIA. x 144" TT) 316 SS      | 4,700 GAL. CAPACITY | 300-337    |
| TK-339  | TR 3RD STAGE NUTRIENT TANK B EXP. TK.       | 100 PSIG @ 120°F, NON-CODE     |              | (18 DIA.x20 TT)                  | 20 GAL. CAPACITY    | 300-337    |



|         |                                   |                                    |                         |                             |                     |          |
|---------|-----------------------------------|------------------------------------|-------------------------|-----------------------------|---------------------|----------|
| TK-342A | ANTI-FOAM ADDITION VESSEL         | 150 PSIG/FV @ 300°F , ASME CODE    |                         | (9"DIA.x15" TT) 304L SS     | 3 GAL CAPACITY      | 300-340A |
| TK-340  | TR-1 2ND STAGE REACTOR            | PSIG/FULL VAC @HOLD, ASME CODE     |                         | (30"DIA.x144" TT) 316L SS   | 460 GAL. CAPACITY   | 300-340A |
| TK-342B | INOCULUM VESSEL                   | 150 PSIG/FV @300°F, ASME CODE      |                         | (9"DIA.x15" TT) 304L SS     | 3 GAL. CAPACITY     | 300-340A |
| TK-347A | ANTI-FOAM ADDITION VESSEL         | 50 PSIG/FV @ 300%%DF, ASME CODE    |                         | (9"DIA.x15" TT) 304L SS     | 3 GAL CAPACITY      | 300-345A |
| TK-345  | TR-1 2ND STAGE REACTOR            | PSIG/FULL VAC @HOLD, ASME CODE     |                         | (30"DIA.x144" TT) 316L SS   | 460 GAL. CAPACITY   | 300-345A |
| TK-347B | INOCULUM VESSEL                   | 50 PSIG/FV @300%%DF, ASME CODE     |                         | (9"DIA.x15" TT) 304L SS     | 3 GAL. CAPACITY     | 300-345A |
| TK-352A | ANTI-FOAM ADDITION VESSEL         | 150 PSIG/FV @ 300°F , ASME CODE    |                         | (9"DIA.x15" TT) 316L SS     | 3 GAL CAPACITY      | 300-350A |
| TK-350  | TR-1 3RD STAGE REACTOR            | PSIG/-10 PSIG VAC@300°F, ASME CODE |                         | (76"DIA.x320" TT) 316L SS   | 6,594 GAL. CAPACITY | 300-350A |
| TK-357A | ANTI-FOAM ADDITION VESSEL         | 150 PSIG/FV @ 300°F , ASME CODE    |                         | (9"DIA.x15" TT) 316L SS     | 3 GAL CAPACITY      | 300-355A |
| TK-355  | TR-1 3RD STAGE REACTOR            | PSIG/-10 PSIG VAC@300°F, ASME CODE |                         | (76"DIA.x320" TT) 316L SS   | 6,594 GAL. CAPACITY | 300-355A |
| TK-362A | ANTI-FOAM ADDITION VESSEL         | 150 PSIG/FV @ 300°F , ASME CODE    |                         | (9"DIA.x15" TT) 316L SS     | 3 GAL CAPACITY      | 300-360A |
| TK-360  | TR-1 3RD STAGE REACTOR            | PSIG/-10 PSIG VAC@300°F, ASME CODE |                         | (76"DIA.x320" TT) 316L SS   | 6,594 GAL. CAPACITY | 300-360A |
| TK-367A | ANTI-FOAM ADDITION VESSEL         | 150 PSIG/FV @ 300°F , ASME CODE    |                         | (9"DIA.x15" TT) 316L SS     | 3 GAL CAPACITY      | 300-365A |
| TK-365  | TR-1 3RD STAGE REACTOR            | 30 PSIG/-10 PSIG VAC@300°F, ASME   |                         | (76"DIA.x320" TT) 316L SS   | 6,594 GAL. CAPACITY | 300-365A |
| TK-370  | TR PRODUCT STORAGE TANK           |                                    |                         |                             | 3100 GAL/45PSIG FV  | 300-370  |
| TK-381  | CIP RECIRCULATION TANK            |                                    |                         | 48" ID - 61"S/S             | 1500L               | 300-380  |
| TK-380  | RO RINSE HOLD TANK                |                                    |                         | 44" ID - 61"S/S             | 1500L               | 300-380  |
| TK-385  | RO RINSE HOLD TANK                |                                    |                         | 44" ID - 43"S/S             |                     | 300-385  |
| TK-386  | CIP RECIRCULATION TANK            |                                    |                         | 44" ID - 43"S/S             |                     | 300-385  |
| TK-396A | ANTISCALANT TANK                  |                                    |                         |                             | 10 GAL              | 300-390  |
| TK-396B | ANTISCALANT TANK                  |                                    |                         |                             | 15 GAL              | 300-390  |
| TK-393  | RO WATER STORAGE TANK             |                                    | ATM/200°F               | 120" DIA.x168" TT           | 8,000 GAL. CAPACITY | 300-393  |
| TK-401A | C-5 FERMENTER NO. 1               | 10PSIG/-20 IN. W.C.                |                         | 12'Øx19'TL                  | 18,200 GAL          | 400-001A |
| TK-401B | C-5 FERMENTER NO.2 CONE BOTTOM TK |                                    |                         | 13'Øx17'SS, 4' CONE BOTTOM  | 18,204 GALS.        | 400-001B |
| TK-401C | C-5 FERMENTER NO.3 CONE BOTTOM    |                                    |                         | 13'Ø X17'SS,4' CONE BOTTOM  | 18,204 GALS.        | 400-001C |
| TK-401D | C-5 FERMENTER NO.4 CONE BOTTOM    |                                    |                         | 13'Ø X17'SS,4' CONE BOTTOM  | 18,204 GAL.         | 400-001D |
| TK-441A | C-6 FERMENTER NO.1                |                                    |                         | 19'Ø.X24'SS, 5' CONE BOTTOM | 54,441GAL           | 400-002A |
| TK-441B | C-6 FERMENTER NO. 2               |                                    |                         | 19'ØX24'SS,5' CONE BOTTOM   | 54,441 GAL.         | 400-002B |
| TK-441C | C-6 FERMENTER NO.3                |                                    |                         | 18'ØX25' TL                 | 55,000GAL           | 400-002C |
| TK-441D | C-6 FERMENTER NO. 4               |                                    |                         | 19'Ø.X24'SS, 5' CONE BOTTOM | 54,441 GAL          | 400-002D |
|         | 3% SULFURIC ACID TANK 3% SOLUTION |                                    |                         | 6'x10', 3000 GAL            |                     | 400-003A |
| TK-430  | 20% CAUSTIC STORAGE TANK          |                                    |                         | 10 FTØ X 12'                | 7000GAL             | 400-003B |
| TK-438  | CLEAN CAUSTIC TANK                |                                    | Demo'd Per MOC JN-12-00 | 4 FT Ø X 6' H               | 5000GAL             | 400-003B |
| TK-430  |                                   |                                    |                         |                             |                     | 400-003B |

|        |  |              |                      |                             |             |          |
|--------|--|--------------|----------------------|-----------------------------|-------------|----------|
| TK-428 | CIP TANK 3,000 GAL 8'Ø X 11' SS              |              |                      |                             |             | 400-004  |
| TK-436 | FERMENTER WASHINGS TANK                      |              |                      | 11'-6"Ø X 12FT SS X 3' CONE | 10,000GAL   | 400-004  |
| TK-224 | CORN STEEP TANK                              |              |                      | 10FTØX 17FT H               | 10,000GAL   | 400-005B |
| TK-501 | BEERWELL                                     | +1/-0.5 PSIG | 200°F                | 24FTØ x 33FT H x 4FT CONE   | 110,000GAL. | 500-001A |
| T-507  | BEER STRIPPER AND STRIPPER TRAYS #1 THRU #90 | 30 PSIG      | 203°F                | 42'SS H & 12' SKIRT, 3'-6"Ø |             | 500-003A |
| T-533  | STRIPPER/RECTIFIER & TRAYS #1 THRU #46       | 65 PSIG      | 264°F                | 2'Ø x 58'-3"                |             | 500-003B |
| TK-601 | STILLAGE CENTRATE TANK                       | ATMOSPHERIC  | 212°F                | 13FT D X 17FT H,            | 17,000 GAL  | 600-001  |
| TK-714 | SLAKED LIME SLURRY TANK                      |              |                      | 14FTØx18FTH                 | 20,000 GAL  | 700-001  |
| TK-720 | GLUCOSE TANK                                 | ATM          | 140°F                |                             | 12,000 GAL  | 700-002  |
| TK-730 | ANHYDROUS AMMONIA                            |              |                      | 4'Øx22'L                    | 2000 GAL    | 700-002  |
| TK-920 | 98% SULFURIC ACID TANK                       | ATMOSPHERIC  | 100°F                | 11'-11"Ø X 10'-1"H          | 6,600 GAL   | 900-004  |
| TK-905 | FIREWATER/PROCESS WATER STR. TK.             | ATMOSPHERIC  | 90°F                 | 34' DIA. x 25' H.           |             | 900-005  |
| TK-906 | PROCESS HOT WATER TANK                       | ATMOSPHERIC  | 200°F                | 8' DIA. x 14' H.            |             | 900-005  |
| R-960  | IPT AIR RECEIVER                             | 150 PSIG     |                      | 5.5'Ø x 12'H                | 2,033 GAL.  | 900-006  |
| TK-945 | KILLTANK                                     |              |                      | 8FT X 14FT H, 5,000 GAL     |             | 900-007A |
| TK-935 |  |              | WASTE NEUTRALIZATION | 14FT X 15FT H, 15,000 GAL   |             | 900-007B |

| EQUIP # | EQUIP DESCRIPTION                          | DESIGN PRESS                         | DESIGN TEMP      | CAPACITY         | DRAWING # |
|---------|--|--------------------------------------|------------------|------------------|-----------|
| E-221H  | TK-221 RECIRC HEATER                       | 1.2MM BTU/HR                         |                  |                  | 200-002A  |
| E-221C  | TK-221 RECYCLE COOLER                      | 1.33MM BTU/HR                        |                  |                  | 200-002A  |
| HX-316  | VENT GAS HEATER                            |                                      |                  |                  | 300-312B  |
| HX-315  | SPARGE GAS HEATER                          |                                      |                  |                  | 300-312B  |
| HX-313B | RECIRCULATION SEAL POT                     |                                      |                  |                  | 300-312C  |
| HX-313A | KO 2ND REACTOR COOLER                      | 150 PSIG                             | 300F             |                  | 300-312C  |
| HX-325  | BW34 SPARGE HEATER                         | 150 PSIG                             | 300F             |                  | 300-322B  |
| HX-326  | VENT HEATER                                |                                      |                  |                  | 300-322B  |
| HX-323B | RECIRCULATION SEAL POT                     |                                      |                  |                  | 300-322C  |
| HX-323A | BW 2ND STAGE REACTOR COOLER                | 150 PSIG/150 PSIG                    | 300F             |                  | 300-322C  |
| HX-336B | TR 3RD STAGE NUTRIENT TANK A JACKET HEATER | 150 PSIG/150 PSIG @ 300°F, ASME CODE |                  |                  | 300-334   |
| HX-336A | TR 3RD STAGE NUTRIENT TANK A JACKET COOLER | 150 PSIG/ 150 PIG @ 300°F, ASME CODE | 2,000,000 BTU/HR |                  | 300-334   |
| HX-339B | TR 3RD STAGE NUTRIENT TANK B JACKET HTR    | 150 PSIG/150 PSIG @ 300°F, ASME CODE |                  |                  | 300-337   |
| HX-339A | TR 3RD STAGE NUTRIENT TANK B JACKET COOLER | 150 PSIG/ 150 PIG @ 300°F, ASME CODE |                  | 2,000,000 BTU/HR | 300-337   |
| HX-343  | SPARGE GAS HEATER                          |                                      |                  |                  | 300-340B  |
| HX-344  | VENT GAS HEATER                            |                                      |                  |                  | 300-340B  |
| HX-341B | RECIRCULATION PUMP SEAL POT                |                                      |                  |                  | 300-340C  |
| HX-341A | PROCESS STREAM COOLER                      | 150 PSIG/150 PSIG @ 300°F, ASME CODE |                  |                  | 300-340C  |
| HX-348  | SPARGE GAS HEATER                          |                                      |                  |                  | 300-345B  |
| HX-349  | VENT GAS HEATER                            |                                      |                  |                  | 300-345B  |
| HX-346B | RECIRCULATION PUMP SEAL POT                |                                      |                  |                  | 300-345C  |
| HX-346A | PROCESS STREAM COOLER                      | 150 PSIG/150 PSIG @ 300F, ASME CODE  |                  |                  | 300-345C  |
| HX-353  | SPARGE GAS HEATER                          |                                      |                  |                  | 300-350B  |
| HX-354  | VENT GAS HEATER                            |                                      |                  |                  | 300-350B  |
| HX-351B | RECIRCULATION PUMP SEAL POT                |                                      |                  |                  | 300-350C  |
| HX-351A | PROCESS STREAM COOLER                      | 150 PSIG @ 375F, ASME CODE           |                  |                  | 300-350C  |
| HX-358  | SPARGE GAS HEATER                          |                                      |                  |                  | 300-355B  |
| HX-359  | VENT GAS HEATER                            |                                      |                  |                  | 300-355B  |
| HX-356B | RECIRCULATION PUMP SEAL POT                |                                      |                  |                  | 300-355C  |
| HX-356A | PROCESS STREAM COOLER                      | 150 PSIG @ 375F, ASME CODE           |                  | 2.3 MBTU/HR      | 300-355C  |
| HX-363  | SPARGE GAS HEATER                          |                                      |                  |                  | 300-360B  |
| HX-364  | VENT GAS HEATER                            |                                      |                  |                  | 300-360B  |
| HX-361B | RECIRCULATION PUMP SEAL POT                |                                      |                  |                  | 300-360C  |
| HX-361A | PROCESS STREAM COOLER                      | 150 PSIG @ 375F, ASME CODE           |                  | 2.3 MBTU/HR      | 300-360C  |
| HX-369  | VENT GAS HEATER                            |                                      |                  |                  | 300-365B  |

|         |   |                             |                        |                             |            |
|---------|---|-----------------------------|------------------------|-----------------------------|------------|
| HX-366B | RECIRCULATION PUMP SEAL POT                   |                             |                        |                             | 300-365C   |
| HX-366A | PROCESS STREAM COOLER                         | 150 PSIG @ 375°F, ASME CODE |                        | 2.3 MBTU/HR                 | 300-365C   |
| HX-382  | SHELL AND TUBE HEAT EXCHANGER                 | 150 PSIG @ 300°F            |                        |                             | 300-380    |
| HX-387  | SHELL AND TUBE HEAT EXCHANGER                 |                             |                        | 150 PSIG @ 300°F/150 PSIG @ | 300-385    |
| E-404B  | C-5 FERMENTER NO. 2 COOLER                    | 100 PSIG                    | MIN 40°F/MA X250°F     |                             | 400-001B   |
| E-404C  | C-5 FERMENTER No. 3 COOLER                    | 100 PSIG                    | MIN 40°F/MAX 250°F     |                             | 400-001C   |
| E-404D  | C-5 FERMENTER NO.4 COOLER                     | 100PSIG                     | MIN40°F/MAX250°F       |                             | 400-001D   |
| E-444A  | C-6 FERMENTER No. 1 COOLER                    |                             |                        |                             | 400-002A   |
| E-444B  | C-6 FERMENTER NO. 2 COOLER                    |                             |                        |                             | 400-002B   |
| E-444C  | C-6 No. 3 FERMENTER CIRCULATION COOLER SPIRAL |                             |                        | 1,780 SQ. FT.               | 400-002C-1 |
| E-444D  | C-6 FERMENTER\ PNO. 4 COOLER                  |                             |                        |                             | 400-002D   |
| E-475X  | FERMENTER FEED COOLER                         | 150 PSIG                    | 300ØF                  |                             | 400-005A   |
| E-471   | NUTRIENT HEATER                               |                             |                        |                             | 400-005B   |
| E-472   | NUTRIENT STERILIZING COIL                     |                             |                        |                             | 400-005B   |
| E-XXX   |   |                             |                        |                             | 400-005B   |
| HX-371  | HEAT EXCHANGER                                | 175PSIG                     | 170F                   | 1.5MM BTM/HR                | 400-006    |
| HX-372  | HEAT EXCHANGER                                | 170PSIG                     | 325F                   | 3.3MM BTM/HR                | 400-006    |
| E-433   | CIP HEATER                                    |                             |                        | 170 SQ. FT.                 | 400-010    |
| E-512   | HEADS VACUUM PUMP SEAL LIQUID COOLER          |                             |                        |                             | 500-001B   |
| E-509   | VENT CONDENSER                                |                             |                        |                             | 500-001B   |
| E-504   | BEER PREHEATER No.1                           |                             |                        |                             | 500-002    |
| E-520   | FINAL CONDENSER                               |                             |                        |                             | 500-002    |
| E-518   | BEER STRIPPER REBOILER                        |                             |                        |                             | 500-003A   |
| E-543   | STRIPPER/RECTIFIER FEED                       | SHELL 195 PSIG/TUBE PSIG    | 400F                   | 9 FT.                       | 500-003B   |
| E-532   | STRIPPER/RECTIFIER FEED                       | SHELL 195 PSIG/TUBE PSIG    | 400F                   | 9 FT.                       | 500-003B   |
| E-539   | STRIPPER/RECTIFIER REBOILER                   | SHELL 200 PSIG/TUBE PSIG    | 400F                   | 192FT.                      | 500-003B   |
| E-537   | FUSSEL OIL COOLER                             | 150 PSIG                    | 400F                   |                             | 500-003C   |
| E-599   | ETHANOL PRODUCT COOLER                        | 150 PSIG                    | 195°F                  | 16.2 FT²                    | 500-004A   |
| E-587   | MOL SIEVE VENT CONDENSER                      | TUBE 150 PSIG/100PSIG       | TUBE 250F/SHELL 500° F | 58 FT²                      | 500-004A   |
| E-584   | MOL SIEVE CONDENSER                           | TUBE 80 PSIG/100PSIG        | TUBE 325F/SHELL 500° F | 153 FT²                     | 500-004A   |
| E-580   | MOL SIEVE SUPERHEATER                         | SHELL 195 PSIG/TUBE 150PSIG | 400°F                  | 47 FT.                      | 500-004B   |
| E-593   | MOL SIEVE RE-CIRCULATION COOLER               | 195 PSIG                    | 150F                   | 32.3 FT.                    | 500-005    |
| E-589   | MOL SIEVE REGENERANT CONDENSER                | SHELL 150 PSIG/TUBE 150PSIG | SHELL 500F/TUBE250F    | 119 FT.                     | 500-005    |

| EQUIP # | HP/RPM                      | EQUIP DESCRIPTION                     | PUMP DIFF HEAD   | DESIGN PRESS              |
|---------|-----------------------------|---------------------------------------|------------------|---------------------------|
| AG-222  |                             | 2ND STG SCREW PRESS TK. AGITATOR      |                  |                           |
| AG-224  | 15 HP, 1800 RPM             | 3RD STG SCREW PRESS TK. AGITATOR      |                  |                           |
| AG-221  | 1453-3MHP LIGHTNIN, 125 RPM |                                       | TK-221 AGITATOR  |                           |
| AG-230  |                             | C-6 CAKE MIX TK AGITATOR              |                  |                           |
| AG-312  | MOTOR 3HP/ 1750 RPM         | TK-312 AGITATOR                       |                  | 316 SS                    |
| AG-322  | 7.5 HP/ 1750 RPM            | BW 2ND STAGE REACTOR AGITATOR         |                  |                           |
| AG-334  | 3HP @ 1750RPM               | TR 3RD STAGE NUTRIENT TANK A AGITATOR |                  |                           |
| AG-337  | 3HP @ 1750RPM               | TR 3RD STAGE NUTRIENT TANK B AGITATOR | 460VAC/3PH       |                           |
| AG-340  | MOTOR 7.5HP/1750 RPM        | TK-340 AGITATOR                       | 230/460 VAC      |                           |
| AG-345  | MOTOR 7.5HP/1750 RPM        | TK-345 AGITATOR                       |                  | 230/460 VAC /3 PH         |
| AG-350  | MOTOR 40 HP/1750 RPM        | TK-350 AGITATOR                       | 230/460 VAC /3PH |                           |
| AG-355  | MOTOR 40 HP/1750 RPM        | TK-355 AGITATOR                       | 230/460 VAC /3PH |                           |
| AG-360  | MOTOR 40 HP/1750 RPM        | TK-360 AGITATOR                       | 230/460 VAC /3PH |                           |
| AG-365  | MOTOR 40 HP/1750 RPM        | TK-365 AGITATOR                       | 230/460 VAC /3PH |                           |
| AG-370  | 2HP /1750RPM                | TR PRODUCT TANK AGITATOR              | 460 VAC /3PH     |                           |
| AG-401A |                             | AGITATOR                              |                  |                           |
| AF-441A | 20HP/1200RPM                | C-6 FERMENTER AGITATOR                |                  |                           |
| AG-441B | 20 HP, 1200 RPM             | C-6 FERMENTER AGITATOR                |                  |                           |
| AG-441C | 25 HP, 31 RPM               | C-6 FERMENTER AGITATOR                |                  |                           |
| AG-440  | 3 HP, 1800 RPM              | CLEAN CAUSTIC TANK AGITATOR           |                  | Demo'd Per MOC JN-12-0082 |
| AG-431  | 1 HP, 1800 RPM              | '20% CAUSTIC STORAGE TANK AGITATOR    |                  |                           |
| AG-423B |                             | CORN STEEP TANK AGITATOR              |                  |                           |
| AG-423A |                             | CORN STEEP TANK AGITATOR              |                  |                           |
| AG-715  | HP/RPM: 2 HP / 1800 RPM     | LIME SLURRY TANK AGITATOR             |                  |                           |
| AG-722  | 1.5 HP / 1800 RPM           | GLUCOSE TANK AGITATOR                 |                  |                           |
| AG-943  | 2 HP / 1800 RPM             | KILL TANK AGITATOR                    |                  |                           |
| AG-938  | 1.5 HP / 1800 RPM           | WASTE NEUTRALIZATION TANK AGITATOR    |                  |                           |