# SEWON CELLONTECH

# TUBULAR HEAT EXCHANGER



| | |
|---|---|
| CUSTOMER | MEG Energy Corp. |
| LOCATION | CANADA |
| JOB NO. | 511036 |
| SERVICE | MP Blowdown / Glycol Exchanger |
| ITEM NO. | 3A-E-324A/B (Max Duty Case) |

| REV | MADE BY | CHECKED BY | APPROVED BY | DATE |
|---|---|---|---|---|
| 0 | - | - | - | 07-01-2013 |
| 1 | - | - | - | 08-14-2013 |

Total 2 Shells, Connected in 1 Parallel 2 Series Shells | Install ■ Hor. □ Vert. | Size 850.0 ID - 4,877.0 L

Code ASME Sec.VIII Div.1 (STAMP), TEMA, API660 TEMA Type AET | TEMA Class R | Effective Area 129.43 m² /Shell

## PERFORMANCE OF ONE BATTERY

| | | | SHELL SIDE | | TUBE SIDE | |
|---|---|---|---|---|---|---|
| | | | INLET | OUTLET | INLET | OUTLET |
| Fluid Circulated | | | TEG/Water (60/40 wt%) | | MP Blowdown | |
| Total Fluid | kg/hr | | 433727 | | 207611 | |
| Vapor | kg/hr | MW | | | | |
| Liquid | kg/hr | MW | 433727 | 433727 | 207611 | 207611 |
| Steam | kg/hr | | | | | |
| Water | kg/hr | | | | 207611 | 207611 |
| Noncondendable | kg/hr | MW | | | | |
| Operating Temperature | ℃ | | 40.00 | 105.00 | 200.00 | 95.00 |
| Operating Pressure | kPaa | | 994.015 | | 1555.02 | |
| Density | kg/m3 | L / V | 1078.0 | 1026.0 | 864.65 | 962.53 |
| Viscosity | cP | L / V | 4.6640 | 1.3460 | 0.1343 | 0.2976 |
| Thermal Conductivity | W/m·℃ | L / V | 0.3281 | 0.3401 | 0.0635 | 0.0765 |
| Specific Heat | kJ/kg·℃ | L / V | 3.2231 | 3.4561 | 4.4941 | 4.2075 |
| Latent Heat | kJ/kg | | | | | |
| Bubble / Dew Point | ℃ | | / | / | / | / |
| Critical Press. / Temp. | kPaa / ℃ | | / | / | / | / |
| Velocity | m/sec | | 1.07 | | 2.01 | |
| Pressure Drop | kPa. | | Allow. 100.000 | Calc. 86.141 | Allow. 120.000 | Calc. 109.825 |
| Fouling Resistance | m2·℃/kW | | 0.088 | | 0.176 | |
| Film Coefficient | W/m2·K | | 4,194.01 | | 13,243.20 | |
| Overall Coefficient | W/m2·K | | Clean 2704.25 | Calc. 1492.13 | Design 1458.15 | |
| Heat Duty | KW | | 26,147.00 | | LMTD ℃ | MTD 69.3 ℃ |

## CONSTRUCTION

| | | | |
|---|---|---|---|
| Design Pressure / Design Temperature | 1500.0 / FV kPa.G | -29 / 214 ℃ | 1950.0 / FV kPa.G | -29 / 214 ℃ |
| No. of Passes | 1 | | 4 | |

Tubes No. 352 / Shell, Size 25.40 mm, Thickness 2.11 (Min.) mm ( BWG : 14 ) Length 4,877.0 mm

Shell 850 mm ID | Tube Pitch 31.75 mm, Layout angle 90 °, Leffective - mm

Baffles Cross Baffle 8+1S (Note 9) ea / Shell, Type Single Seg. (Hori.), Cut 25.0 % Dia., Spacing c/c 450.0 mm, End - mm

| | | | | | |
|---|---|---|---|---|---|
| ρv² | Inlet Nozzle | 2,870.52, Entrance 3,098.62, Outlet Nozzle 3,016.01 kg/m·sec2 | | Impingement plate | Circular Plate |
| Material | Tube | SA 179 Seamless | Shell & Cover SA 516 GR. 70N | Channel & Cover | SA 516 GR. 70N |
| | Tube Sheet | SA 266 Gr.2 | Baffle Carbon Steel | Expansion Joint | N/A |
| Estimated Weight | Empty Weight kg | | Bundle Weight - kg | Full Water Weight | kg |
| Corrosion Allowance | Shell side 3.2 mm | | Tube side 3.2 mm | Tube Joints : | Rolled (two grooves) and Expanded |
| Insulation | Shell side 64 mm | | Tube side 64 mm | | |

| MEAN METAL TEMPERATURE | Temperature, ℃ | | Pressure, kPa.G | |
|---|---|---|---|---|
| | Shell | Tube | Shell | Tube |
| Normal Operating | - | - | - | - |
| Startup | - | - | - | - |

| NOZZLE | SHELL SIDE | | | | TUBE SIDE | | | |
|---|---|---|---|---|---|---|---|---|
| | Tag | No | NPS | Remarks | Tag | No | NPS | Remarks |
| Inlet | S1 | 1 | 12 | | T1 | 1 | 8 | |
| Outlet | S2 | 1 | 12 | | T2 | 1 | 8 | |
| Vent | | | | (Note 8) | | | | (Note 8) |
| Drain | | | | (Note 8) | | | | (Note 8) |
| | | | | | | | | |
| Thermowell | | | | | | | | |
| Util. Con. | | | | | | | | |
| RATING | RFWN 300# | | | | RFWN 300# | | | |

Remarks

1) Seller shall verify and guarantee thermal rating of the unit.
2) Ribbon flow pass arrangement shall be used.
3) Unit shell side inlet nozzle is located near the channel head.
4) Exchanger is to be designed for future field hydrotest in the fully corroded condition.
5) Exchangers to be designed for liquid full condition at S.G. = 1.079.
6) Seller is to design and install electrical heat tracing for hold temperature of 10℃. CSA approval is required for electric components and installation. The exchanger is located in a non-hazardous area.
7) Seller is to supply and install 64mm thick mineral fiber insulation.
8) Each process nozzle shall be provided with one 1" 300# RFLWN (complete with blind flange, gasket, bolts & nuts).
9) Seller to provide floating head support plate.
10) Exchangers shall be stacked. Per API 660, exchangers shall be hydrotested stacked.
11) EHT design shall use voltage of 277 VAC.

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# TUBULAR HEAT EXCHANGER

SHEET 3 OF 21

| | | REV | MADE BY | CHECKED BY | APPROVED BY | DATE |
|---|---|---|---|---|---|---|
| CUSTOMER | MEG Energy Corp. | | | | | |
| LOCATION | CANADA | 0 | - | - | - | 07-01-2013 |
| JOB NO. | 511036 | 1 | - | - | - | 08-14-2013 |
| SERVICE | MP Blowdown / Glycol Exchanger | | | | | |
| ITEM NO. | 3A-E-324A/B (Min Duty Case) | | | | | |

| | | | |
|---|---|---|---|
| Total 2 Shells, Connected in 1 Parallel 2 Series Shells | Install ■ Hor. □ Vert. | Size | 850.0 ID - 4,877.0 L |
| Code ASME Sec.VIII Div.1 (STAMP), TEMA, API660 TEMA Type AET | TEMA Class R | Effective Area | 129.43 m² /Shell |

## PERFORMANCE OF ONE BATTERY

| | | | SHELL SIDE | | TUBE SIDE | |
|---|---|---|---|---|---|---|
| | | | INLET | OUTLET | INLET | OUTLET |
| Fluid Circulated | | | TEG/Water (60/40 wt%) | | MP Blowdown | |
| Total Fluid | kg/hr | | 322586 | | 154412 | |
| Vapor | kg/hr | MW | | | | |
| Liquid | kg/hr | MW | 322586 | 322586 | 154412 | 154412 |
| Steam | kg/hr | | | | | |
| Water | kg/hr | | | | 154412 | 154412 |
| Noncondendable | kg/hr | MW | | | | |
| Operating Temperature | ℃ | | 40.00 | 105.00 | 200.00 | 95.00 |
| Operating Pressure | kPaa | | 994.015 | | 1555.02 | |
| Density | kg/m3 | L / V | 1078.0 | 1026.0 | 864.65 | 962.54 |
| Viscosity | cP | L / V | 4.6610 | 1.3460 | 0.1343 | 0.2976 |
| Thermal Conductivity | W/m·℃ | L / V | 0.3281 | 0.3401 | 0.6635 | 0.6765 |
| Specific Heat | kJ/kg·℃ | L / V | 3.2231 | 3.4561 | 4.4941 | 4.2074 |
| Latent Heat | kJ/kg | | | | | |
| Bubble / Dew Point | ℃ | | / | / | / | / |
| Critical Press. / Temp. | kPaa / ℃ | | / | / | / | / |
| Velocity | m/sec | | 0.81 | | 1.50 | |
| Pressure Drop | kPa. | | Allow. 100.000 | Calc. 49.135 | Allow. 120.000 | Calc. 62.423 |
| Fouling Resistance | m2·℃/kW | | 0.088 | | 0.176 | |
| Film Coefficient | W/m2·K | | 3,458.90 | | 10,464.30 | |
| Overall Coefficient | W/m2·K | | Clean 2251.73 | Calc. 1342.45 | Design 1084.37 | |
| Heat Duty | KW | | 19,447.00 | | LMTD ℃ | MTD 69.3 ℃ |

## CONSTRUCTION

| | | | | | |
|---|---|---|---|---|---|
| Design Pressure | Design Temperature | / kPa.G | / ℃ | / kPa.G | / ℃ |
| No. of Passes | | | | | |

Tubes No. / Shell, Size mm , Thickness (Min.) mm ( BWG : ) Length mm

Shell mm ID Tube Pitch mm , Layout angle ° , Leffective - mm

Baffles Cross Baffle ea / Shell , Type , Cut - % Dia. , Spacing c/c mm , End - mm

| | | | | | |
|---|---|---|---|---|---|
| pv² | Inlet Nozzle | 1,587.89 , Entrance 1,713.76 , Outlet Nozzle 1,668.36 kg/m·sec2 | | | Impingement plate |
| Material | Tube | | Shell & Cover | | Channel & Cover |
| | Tube Sheet | | Baffle | | Expansion Joint |
| Estimated Weight | Empty Weight kg | | Bundle Weight kg | | Full Water Weight kg |
| Corrosion Allowance | Shell side mm | | Tube side mm | | Tube Joints : |
| Insulation | Shell side mm | | Tube side mm | | |

| MEAN METAL TEMPERATURE | Temperature, ℃ Shell | Temperature, ℃ Tube | Pressure, kPa.G Shell | Pressure, kPa.G Tube |
|---|---|---|---|---|
| Normal Operating | - | - | - | - |
| Startup | - | - | - | - |

| NOZZLE | SHELL SIDE Tag | No | NPS | Remarks | TUBE SIDE Tag | No | NPS | Remarks |
|---|---|---|---|---|---|---|---|---|
| Inlet | | | | | | | | |
| Outlet | | | | | | | | |
| Vent | | | | | | | | |
| Drain | | | | | | | | |
| Liquid Outlet | | | | | | | | |
| Thermowell | | | | | | | | |
| Util. Con. | | | | | | | | |
| RATING | | | | | | | | |

**Blowdown Water Analysis**

| Water Analysis (mg/l as ion unless noted) | Normal | Max. |
|---|---|---|
| $Ca^{++}$ | 0.36 | 0.44 |
| $Mg^{++}$ | 0.36 | 0.44 |
| $Na^{+}$ | 3707 | 10709 |
| $K^{+}$ | 5.82 | 36.12 |
| $Fe^{++}$ | 4.47 | 8.29 |
| $Mn^{++}$ | 0.22 | 0.75 |
| $Ba^{++}$ | 0.31 | 3.04 |
| $Sr^{++}$ | 0.89 | 8.22 |
| $HCO_3^-$ | 0.0 | 0.0 |
| $CO_3^-$ | 127 | 333 |
| $OH^-$ | 305 | 775 |
| $SO_4^-$ | 18.81 | 39.60 |
| $Cl^-$ | 4929 | 14529 |
| Silica ppm as $SiO_2$ | 214.1 | 262.1 |
| Sulphides ppm as $S^-$ | 0.0 | 0.0 |
| TOC ppm as TOC | 0.48 | 4.83 |
| TDS ppm as ion | 9314 | 26706 |
| TSS ppm TSS | 0.0 | 0.0 |
| Oil & Grease ppm oil in water | 0.0 | 0.0 |
| Total Hardness ppm as $CaCO_3$ | 2.36 | 2.89 |
| P-Alk (ppm as $CaCO_3$) | 1004 | 2559 |
| M-Alk (ppm as $CaCO_3$) | 1111 | 2837 |
| Dissolved $O_2$ | - | - |
| Estimated pH | 12.16 | 12.61 |