**4EM70 A.2 Binary CHP plant – base design**

date

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\*Please include all group members

**PLEASE USE THE FOLLOWING NOTATION:**

* express values in the units as given in the tables
* separate the [integer](https://en.wikipedia.org/wiki/Integer) part from the [fractional](https://en.wikipedia.org/wiki/Fraction_(mathematics)) part of a [number](https://en.wikipedia.org/wiki/Number) by a **dot**; e.g. “4.56”
* use **“e”** to express powers of 10 in scientific notation; e.g. “4.6e3”
* separate multiples of 1000 etc by **spaces**; e.g. 3 467 176

**A.2.1 Heat-only plant**

**1 Calculated return water temperature:** 31.5686 °C

**2 Shell & tube Heat Exchanger:**

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| rationale |

**3 Capacity flow ratio:** 0.4188

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| rationale |

**4 Well water return temperature:** 52.7341 °C

Well water mass flow: 60 kgs-1

**5 Logarithmic mean temperature difference:** 59.9585 °C

**6 Heat exchanger design**

|  |  |  |
| --- | --- | --- |
|  | Well side | District Heating |
| Inlet temperature °C | 240 | 31.5686 |
| outlet temperature °C | 52.7341 | 110 |
| heat transferred kW | 50 000 | |
| logarithmic mean temperature difference °C | 59.9585 | |
| mass flow kgs-1 | 60 | 150 |
| average heat capacity Jkg-1K-1 | 4450 | 4250 |
| capacity flow WK-1 | 267 000 | 637 500 |
| average or bulk velocity ms-1 | value | value |
| average density kgm-3 | 1 000 | 1 000 |
| average dynamic viscosity Pa s | value | value |
| hydraulic diameter m | value | value |
| Reynolds number | value | value |
| average heat conductivity Wm-1K-1 | value | value |
| Nusselt number | value | value |
| heat transfer coefficient Wm-2K-1 | value | value |
| overall heat transfer coefficient Wm-2K-1 | value | |
| number of transfer units (NTU) | 3.1233 | |
| effectiveness () | 0.8985 | |
| capacity flow ratio (CR) | 0.4188 | |

**7 Heat exchanging surface:** value m2

**8 Investment for heat production**

|  |  |
| --- | --- |
| heat retail price US$/kWh | 0.03 |
| heat exchanger installed costs | value |
| installed costs per kWh heat produced US$/kWh | value |
| payback time in hours | value |

**A.2.2 Power cycle**

**1 Condensor pressure:** value bar

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| rationale |

**2 Pressure in the steam generator:** value bar

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| --- |
| rationale |

**3 State variables and heat/work exchange**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | bar | °C | kJkg-1 | kJkg-1K-1 | kJkg-1 | kJkg-1 |
| 1 saturated liquid (condensor heat) | value | value | value | value | value | X |
| 2 compressed liquid (pump work) | value | value | value | value | X | value |
| 3 saturated liquid (economizer heat) | value | value | value | value | value | X |
| 4 saturated vapour (evaporator heat) | value | value | value | value | value | X |
| 5 wet steam (turbine work) | value | value | value | value | X | value |

**4 steam mass flow:** value kgs-1

**6 steam quality @ turbine exit:** value

**7 thermal efficiency:** value

**8 Power output:** value MW

**9 Economizer design**

|  |  |  |
| --- | --- | --- |
| heat exchanger type | Well side | Rankine side |
| Inlet temperature °C | value | value |
| outlet temperature °C | value | value |
| heat transferred kW | value | |
| logarithmic mean temperature difference °C | value | |
| mass flow kgs-1 | value | value |
| average heat capacity Jkg-1K-1 | value | value |
| capacity flow WK-1 | value | value |
| average or bulk velocity ms-1 | value | value |
| average density kgm-3 | value | value |
| average dynamic viscosity Pa s | value | value |
| hydraulic diameter m | value | value |
| Reynolds number | value | value |
| average heat conductivity Wm-1K-1 | value | value |
| Nusselt number | value | value |
| heat transfer coefficient Wm-2K-1 | value | value |
| overall heat transfer coefficient Wm-2K-1 | value | |
| heat transferring surface m2 | value | |
| number of transfer units (NTU) |  | |
| effectiveness () |  | |
| capacity flow ratio (CR) |  | |

**10 Evaporator design**

|  |  |  |
| --- | --- | --- |
| heat exchanger type | Well side | Rankine side |
| Inlet temperature °C | value | value |
| outlet temperature °C | value |
| heat transferred kW | value | |
| logarithmic mean temperature difference °C | value | |
| mass flow kgs-1 | value | value |
| average heat capacity Jkg-1K-1 | value | - |
| capacity flow WK-1 | value |  |
| average or bulk velocity ms-1 | value | - |
| average density kgm-3 | value | - |
| average dynamic viscosity Pa s | value | - |
| hydraulic diameter m | value | - |
| Reynolds number | value | - |
| average heat conductivity Wm-1K-1 | value | - |
| Nusselt number | value |  |
| heat transfer coefficient Wm-2K-1 | value |  |
| overall heat transfer coefficient Wm-2K-1 | value | |
| heat transferring surface m2 | value | |
| number of transfer units (NTU) | value | |
| effectiveness () | value | |
| capacity flow ratio (CR) | value | |

**11 Condensor design**

|  |  |  |
| --- | --- | --- |
| heat exchanger type | District Heating | Rankine side |
| Inlet temperature °C | value | value |
| outlet temperature °C | value |
| heat transferred kW | value | |
| logarithmic mean temperature difference °C | value | |
| mass flow kgs-1 | value | value |
| average heat capacity Jkg-1K-1 | value | - |
| capacity flow WK-1 | value |  |
| average or bulk velocity ms-1 | value | - |
| average density kgm-3 | value | - |
| average dynamic viscosity Pa s | value | - |
| hydraulic diameter m | value | - |
| Reynolds number | value | - |
| average heat conductivity Wm-1K-1 | value | - |
| Nusselt number | value |  |
| heat transfer coefficient Wm-2K-1 | value |  |
| overall heat transfer coefficient Wm-2K-1 | value | |
| heat transferring surface m2 | value | |
| number of transfer units (NTU) | value | |
| effectiveness () | value | |
| capacity flow ratio (CR) | value | |

**12 Additional investment for electricity production**

|  |  |
| --- | --- |
| electricity retail price US$/kWh | 0.09 |

|  |  |
| --- | --- |
| pump installed costs US$ | value |
| turbine/condensor installed costs US$ | value |
| economizer installed costs US$ | value |
| evaporator installed costs US$ | value |
| total installed costs | value |

|  |  |
| --- | --- |
| additional costs for electricity production US$ | value |
| additional installed costs per kWh work produced US$/kWh | value |
| payback time in hours | value |

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| Pinch diagram for entire CHP plant (include saturation curve) |