Utility Consumption List

CO_2 Capture Facility

Kårstø, Norway

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Contents

1.0 UTILITY CONSUMPTION

The Utility requirements for the Karsto CO_2 Capture and Compression (CCC) Plant are summarized in Table 1. These estimated demands are based on the use of 35% MEA solvent and the heat and mass balances in document 25474-000-M4-CN-00001 and other design factors.

TABLE 1

UTILITY REQUIREMENTS

COMMODITY	DEMAND	UNITS	COMMENTS
LP Steam	200	tonnes/hr	See 1.1
HP Steam	12	tonnes/hr	See 1.2 During reclaimer operation
Low Pressure Condensate	153	tonnes/hr	See 1.3
Seawater Cooling Water	17,340	m^3/hr	See 1.4
Potable Water	35	m^3/hr	See 1.5 Intermittent
Fuel Gas	1500	kg/hr	See 1.6 Intermittent
Compressed Air			See 1.7
Instrument Air	185	Nm^3/hr	Continuous (400 Nm^3/hr Intermittent)
Plant Air	85	Nm^3/hr	Intermittent (maintenance tools)
Nitrogen Gas	85	Nm^3/hr	See 1.8 Intermittent
Firewater	340	m^3/hr	See 1.9 Intermittent
Raw (Softened) Water	9	m^3/hr	See 1.10 Intermittent
Demineralized Water	1	m^3/hr	See 1.11

Information on each of the utilities is noted below:

1.1 LOW PRESSURE STEAM

Low pressure (LP) steam is supplied by Gassnova from the CCPP LP steam turbine cross-over piping to an interface at the CCC Plant battery limit (B/L).

The LP steam conditions at the B/L are 2.2 barg and 270°C and the maximum quantity of steam available from the CCPP is 165 tonnes/hr. The LP steam piping that is routed from the interface point contains a pressure reducing and desuperheating station to reduce the LP steam temperature to approximately 135°C.

During certain plant operating scenarios, the quantity of LP steam required exceeds the 165 tonnes/hr available from the CCPP. During these operating scenarios, the CCC Plant auxiliary boiler is used to supplement the LP steam demands to the stripper reboilers. The auxiliary boiler is sized for approximately 20 tonnes/hr of saturated steam to meet the LP steam conditions.

1.2 HIGH PRESSURE STEAM

High pressure (HP) steam is supplied by Gassnova from the CCPP auxiliary boiler to an interface at the CCC Plant B/L.

The HP steam conditions at the B/L are 7 barg at approximately 165°C (saturated). The quantity of HP steam available from the CCPP auxiliary boiler is approximately 12 tonnes/hr and is only available when not required by Naturkraft's internal use. HP steam is used for amine reclamation at the CCC Plant in the thermal reclaimer. The CCC Plant amine reclaimation is not a continuous process. It is anticipated that mutually agreed upon schedules can easily be developed for the use of the CCPP auxiliary boiler An HP steam flow control valve is provided on the inlet piping to the reclaimer. Steam line drains are provided throughout the system as required and routed to the LP blowdown tank. In addition, a manual globe valve is provided in the HP steam line near the reclaimer to facilitate cleaning or aid in reclaimer waste removal.

1.3 LOW PRESSURE CONDENSATE

Low pressure condensate is produced in the stripper reboilers. This LP condensate is piped from the reboilers to an LP condensate blowdown tank. HP condensate is produced from the amine reclaimer and piped to the LP blowdown tank. In addition, small quantities of blowdown from the CO_2 compressor 1st, 2nd, and 3rd stage steam generators are routed to the LP blowdown tank. Some of the LP and HP condensate flashes in the blowdown tank which is vented to the stripper column. The remaining condensate in the LP blowdown tank is used as follows:

- Spray water for the LP steam desuperheater
- LP condensate supply to the three CO_2 compressor steam generators
- LP condensate return to the CCC Plant B/L (return to CCPP condenser)
- Supply to the CCC Plant auxiliary boiler

- Reject to the process water surge tank, as required

1.4 SEA WATER COOLING

Sea water cooling water is used as the cooling medium for all of the heat exchangers in the CCC Plant via a once-through direct cooling water system.

The sea water cooling system design is based on a sea water supply and return temperatures of 11°C and 21°C, respectively. The CCC Plant permit limit for cooling water return temperature to the sea is 25°C. The combined heat duty of approximately 183,000 kW for all of the CCC Plant heat exchangers that operate with sea water cooling results in the required flow rate of approximately 17,340 m^3/hr.

1.5 POTABLE WATER

The potable water is supplied by Gassnova at an interface at CCC Plant B/L. The potable water is supplied in accordance with the Norwegian potable water quality standard and at 5.0 barg pressure and ambient temperature at the B/L. Potable water is used for sanitary needs, emergency safety showers (ES), utility stations, and raw water (softening) system to meet additional water needs. A hose connection for potable water is provided at each of the seven utility stations. The total potable water demand is based on the raw (softening) water and demineralized water systems needs, simultaneous use of all sanitary water users, and assuming two ES operating simultaneously.

1.6 FUEL GAS

Fuel (natural) gas is supplied by Gassnova to an interface at the CCC Plant B/L. The fuel gas conditions at the B/L are 4.9 barA and 20°C. This system is designed to convey fuel gas to the CCC Plant auxiliary boiler. The estimated fuel gas flow to the auxiliary boiler is 1500 kg/hr.

1.7 COMPRESSED AIR

The Karsto CCC Plant will be self sufficient for its compressed air needs. The compressed air system (PA) will supply instrument air (IA) and service air (SA) for all consumers within CCC plant.

The continuous IA requirement is based on the modulating control valves in service and the on/off valves not stroking. For the intermittent IA demand, the flow rate is based on typical sizing flow rate assuming time averaged stroking activity for the control valves, including dryer purge air, plus a 10% allowance . For plant air, the demand is based on an estimate of using a few pneumatic tools during maintenance.

1.8 NITROGEN GAS

The Karsto CCC Plant will be self sufficient for its nitrogen gas needs with the gas bottles supplied by Gassnova. The nitrogen will be used for system and equipment

lay-up as needed. The amine (concentrated) storage tank and the 35% MEA storage tank will have nitrogen blanketing. A nitrogen connection is provided in each of the seven utility stations located in the CCC Plant. The nitrogen gas system supply header pressure to the utility stations is controlled to approximately 5 barg. The nitrogen gas system supply header pressure to the storage tanks is controlled to approximately 2 barg.

1.9 FIRE WATER

The fire water is supplied by Gassnova at two separate interfaces at the CCC Plant B/L. The fire water supplied by Gassnova will be at 11.7 barg and at ambient temperature. The system will supply the design maximum water demand for any automatic suppression system plus 114 m^3/hr of flow for fire hydrants based on the National Fire Protection Association (NFPA) requirements. The only automatic suppression system is the wet pipe sprinkler system covering the CO_2 compressor area.

1.10 RAW (SOFTENED) WATER

Raw (softened) water is required to produce 35% MEA for the amine system and provide additional makeup water to the amine system, as needed, if the system is slightly out of water balance. It is also supplied to the LP condensate blowdown tank for initial fill/startup and to the demineralized water system. Potable water is the supply source for the raw water system. The design capacity of the raw water system is approximately 9 m^3/hr.

1.11 DEMINERALIZED WATER

Demineralized water is required for makeup to the CCC Plant auxiliary boiler. Raw (softened) water is the supply source for the demineralized water system. The design capacity of the demineralized water system is 1.0 m^3/hr which is sufficient to cover the CCC Plant auxiliary boiler blowdown losses.