



Control# ACX GCG 540000

For: Infinity Turbine LLC

Certified by:
Gregory Giese / President / Infinity Turbine LLC

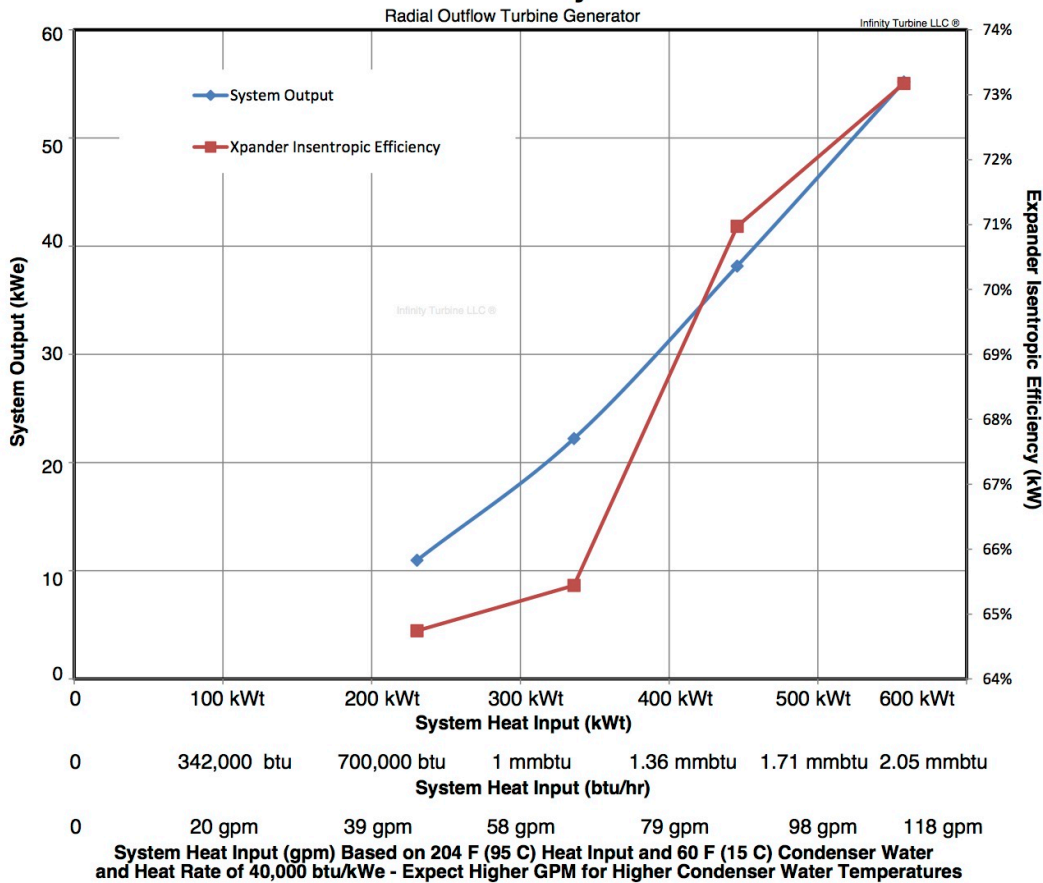
Seller Contact Information:
contact: Greg Giese
Infinity Turbine LLC
P.O. Box 5617
Madison, WI 53705
TEL: 608-238-6001
FAX: (240) 525-2445



Scope of Supply Description



IT50 R245fa System Curve



Scope of Supply

IT50 - North America Version (50 hz Option Available)

IT50 GENERATOR SET 60 kWe, 460/600 volt, 3 Phase, 60 Hz SCOPE OF SUPPLY

SCOPE OF SUPPLY 60 kWe (net output) HEAT RECOVERY GENERATOR SET

This Scope of Supply is for the supply of a generator set with a net output of 60 kWe with power provided by an Organic Rankine Cycle (ORC) engine. A Model IT50 Heat Recovery Generator Set in continuous operation reduces Greenhouse Gas Emissions (CO₂) by at least 350 tonnes per year.



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A 60 kWe net electrical output heat recovery generator (HRG) set that utilizes an Organic Rankine Cycle engine. The unit accepts a liquid waste heat source and is water cooled.

The heat recovery generator set is a skid mounted non-enclosed assembly consisting of a shell and tube evaporator, a shell and tube condenser, a turbine/generator assembly, a working fluid circulation pump and a microprocessor based control system. The turbine/generator assembly consists of a single element Radial Outflow Turbine connected directly to a AC generator.

This heat recovery generator set converts moderate temperature liquid heat sources to electricity through the vaporization and expansion of a working fluid in a closed system. The working fluids (not included in purchase price) to be used in this piece of equipment include R134a and R245fa. The default design is for R245fa (seals).

Performance Range

This heat recovery generator is designed to operate utilizing liquid waste heat source temperatures of up to 140 degrees C. Under ISO conditions, with a liquid waste heat temperature of 95 degrees C and a flow of 130 US gpm, the HRG delivers a full load output of 63.0 kWe (+/- 5%). Part load performance down to 16.0 kWe.

Inputs and Outputs

Design Criteria

Generator Type - Synchronous or Induction, 3,600 rpm nominal Net Electricity Output - up to 60 kWe Voltage - 460- 600 volt AC, 3 phase Frequency - 60 Hz
Power Factor - .8 Heat Source - Liquid, not otherwise specified, Cooling Source - water 18 C to 125 C
Operation - Guarded plant or unattended Controls - Microprocessor based, with safety shutdowns Remote monitoring - available
Plumbing - ASME standard

Dimensions

Electrical - NEMA 3R
Protective Relays - Field supplied by others
Noise - Less than 80 dBA at 10 metres (32 feet)
Overall length - 86 inches Overall width - 36 inches Overall Height - 50 inches
Dry Weight - 3,000 lbs (1,360 kg) target
Evaporator/Condenser - Two pass, ASME Section VIII compliant. (ASME stamped)



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Delivery Condition

Nitrogen purged, main components assembled and pressure tested. Working fluid (refrigerant) is provided by the end user. Unit ships without any working fluid.

COMPONENT DESCRIPTION

This generator set is built to have the capability of delivering a gross output of 60 kW_e, being the useful load plus the energy required to drive the working fluid circulation pump. The turbine/gearbox/generator (TGG) assembly is about 67.0 percent efficient so the minimum thermal energy load required to be passed to the impeller is 102.9 kW_t. 6.0 kW_t are allowed for thermal losses due to radiation and conduction.

The effectiveness of an Organic Rankine Cycle engine is determined by the temperature difference between the heat source and the cooling medium. For design purposes, the cooling medium is assumed to be water at a temperature of 18 C (65 F).

It is estimated that a R134 working fluid flow of 360 lbs per minute is required to support full load operation. Approximately the same for R245fa.

Evaporator

The evaporator is a two pass shell and tube heat exchanger with fixed tubes and removable end caps. The waste heat source flows through the tubes while the working fluid is contained in the shell. Maximum shell side working pressure is 400 psia. Tubes are copper while the balance of the components are carbon steel.

The evaporator is equipped with an internal inlet distribution rail and two inlet ports to allow for even flow of the entering liquid working fluid throughout the evaporators length.

- Heat Transfer Capability: from 2.1 million btus/hour [at 203 degrees F (95 C) and heat source flow of 5 feet per second] to 4 million btus/hr
- Tubes: finned copper .750 inch outside diameter, heat transfer rate minimum 1317 btu/hr/deg F/ft².
- Shell: carbon steel seamless tubing, over all length 72.0 inches, outside diameter 10 inches, wall thickness .375 inch
- Insulation: one inch semi rigid with an aluminum wrap. Insulation includes the evaporator to turbine manifold.
- Typical requirement of liquid heat source 115 to 150 US gpm.

Turbine/Expander

The turbine/expander is a Radial Outflow Turbine.



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Generator: The generator is a synchronous or induction A.C. three phase unit with integral regulator to provide continuous output as follows:
60 Hz, 460 - 600 volt, .8 PF, 3,600 rpm, full load output 60 kWe minimum,

Condenser

The condenser is a two pass shell and tube heat exchanger with fixed tubes and removable end caps. The cooling water flows through the tubes while the working fluid is contained in the shell. Maximum shell side working pressure is 400 psia. Tubes are copper while the balance of the components are carbon steel.

The condenser is equipped with an internal liquid accumulator.

- Heat Transfer Capability: from 1.8 million btus/hour [at 64 degrees F (18 C) and cooling water flow of 3 feet per second] to 4 million btus/hr,
- Tubes, finned copper .750 inch outside diameter, heat transfer rate minimum 1864 btu/hr/deg F/ft²
- Shell, carbon steel seamless tubing, over all length 72.0 inches, outside diameter 12 inches, wall thickness .375 inch
- Typical requirement for cooling water 200 to 480 US gpm.

Working Fluid Pump

The working fluid pump is a multi-stage centrifugal device that provides up to 43 US gpm of working fluid at a pressure that is 20 to 30 psi greater than the turbine entry pressure. It provides fluid to the evaporator and the turbine liquid seal.

Frame

Manufactured from light structural carbon steel shapes. It includes two slots to accommodate fork lift truck use. It integrates the evaporator and condenser for structural rigidity. All of the generator set components are mounted within the frame. All steel components are cleaned and painted with a two part epoxy coating prior to shipment.

Control

The control package includes:

- one superheat controller, PLC
- one turbine inlet temperature sensor (RTD),
- one turbine inlet pressure transducer,
- one motorized flow control valve,
- one working fluid pump outlet pressure transducer,
- one condenser cooling water inlet flow switch,
- one turbine by-pass solenoid operated valve, ASCO or equivalent, NO,
- one Stop button manually resettable.



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The turbine inlet temperature sensor and pressure transducer provide inputs to the superheat controller.

The superheat controller is set to provide vaporized working fluid to the turbine at a superheat of 5 to 7 degrees F. It maintains this condition by varying the flow of working fluid into the evaporator. This is done by utilizing the flow control valve which is commanded by a 4 to 20 ma output signal from the superheat controller.

The superheat controller also receives a supplementary input from a speed sensor on the generator shaft which is used to maintain the engine at a fixed speed relative to the generator outputs. The superheat controller provides an operating signal to the turbine by-pass solenoid operated valve.

The turbine by-pass valve returns to its normally open (NO) state whenever unsafe operating conditions or outside of parameter operation is detected. The condenser cooling water inlet flow switch must detect a certain minimum of coolant mass flow for operation to be enabled.

End User Supplied

Infinity Turbine strongly recommends that the end user include an automatic shut off valve and/or a by-pass loop in the piping of the inlet and outlet of the evaporator. Protective relays and sensors that may be required by a local utility are the responsibility of the end user.

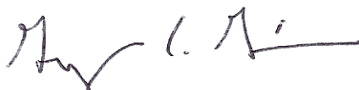
Disclaimer: Infinity Turbine is not responsible for confirming the suitability of this proposed generator set for any specific application or any specific jurisdiction. Individual design elements may be changed without notice or prior consent as long as the overall performance of the end product is not adversely effected.

END OF SCOPE OF SUPPLY



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