Discussion of Engine Generator System for the IWsESS
10 November 2004
8:30 am – 3:00 pm

Participants

Carnegie Mellon
David Archer, John Wiss, Ming Qu, Chaoqin Zhai, Max Dorosa
Dr. Steve Rogers (ISR)

Milwaukee School of Engineering,& Sierra Nevada College
Chris Damm, Anthony Sclafani, Fred Betz

Phil Carpenter, Kraft Power Systems

Introductions

The project objectives were outlined by David Archer. He emphasized that due to the small size of this system the economics will not be favorable, but that the main purpose is to educate the team in preparation for the larger BAPP project. to use the IW installation as a demonstration of what can be done on a small scale. to develop a framework for the operating system of building ESS and ED2S systems.

For this project, the IW has been divided in half. The system is for the southern half, the IWs. This choice was made because a 16 kW absorption chiller was donated to the project. This chiller has sufficient capacity to cool ½ of the IW.

Dr. Archer mentioned that negotiations to acquire a fuel cell continue.

IWs ESS: Estimated Power, Heat Requirements: CMU

- Power: lighting; office equipment; building, HVAC equipment; operation on grid
- Heat: summer; chiller steam, ventilator (dehumidifier) hot water, domestic hot water; winter: fan coil, PEM, radiant panel hot water; mullion hot water

Discussion: appropriate basis for engine generator/heat recovery system design/selection; power - heat, compromise.

CMU provided information on the peak thermal and electrical loads for the IWs. The total peak thermal load for summer is approximately 50 kW, with 17.4 kW required for cooling. The total peak thermal load in winter is 52 kW (11.4 kW for space heating, 28.0 kW for ventilation heating (sensible) and 12.6 kW for humidification (latent).

The absorption chiller has a peak “thermal flux” of 15.8 kW and COP of 1.1 to 1.2. It requires saturated steam at 6 bar (159 C).

The team discussed options for load matching (Should we size system for electrical, thermal, or part of the thermal load?). A consensus was reached to size the system to match the thermal load of the chiller. The reasons were:

- We will have one matched pair (Gen-set and Chiller)
- It will be less costly than sizing for the entire thermal load.
- There are space restrictions that limit us to a smaller system.

A 20-25 kW gen-set (near full load operation) will provide enough high-temp (exhaust) heat to meet the thermal load of the chiller. For example, the Olympian 18kW (Diesel, Perkins) provides 18 kW of high temp heat (exhaust temp. 510 C) and 17 kW of low temp heat (to coolant). A Guardian 11 kW (prime power, natural gas generator, generac) provides 12 kW of high temp heat (exhaust temp. 593 C) and 15 kW of low temp. heat.

An advantage of using a natural gas generator is the slightly greater ratio of high temp heat to power. This may allow us to use a smaller generator to meet the thermal load of the chiller.

The Olympian generator has a 78 inch by 32 inch footprint.

Engine Choice; Fuel Choice; Alternatives: MSOE/SNC, CMU

- Spark ignition; natural gas; gasoline; dual fuel?
- Diesel; Diesel oil; bioDiesel; natural gas, dual fuel
- Waste fuels, liquid and gaseous?

Appropriate suppliers: integrated system (engine, generator, heat recovery, operation controls) components

The team agreed to continue to explore both a natural gas and a diesel option. Dr. Damm pointed out that an advantage of choosing the diesel option is the potential to use biodiesel as a fuel. There was a brief discussion regarding the use of biodiesel (cost, generator warranty issues, necessary alterations to the engine). The group agreed that biodiesel use requires no engine modification and would probably not void a generator warranty. However, "biodiesel" in its common usage refers to B20 (20% biodiesel in standard diesel fuel, by volume). If burning B100 there may be some problems with engine seals and minor engine modification.

Volker Hartkopf joined the meeting and mentioned work at DRI (Roger Jacobsen) that may be of interest. Dr. Damm will be at DRI in December and will meet with Dr. Jacobsen to learn more about the efforts there.

Dr. Hartkopf mentioned ties at Daimler and at Bosch. He agreed to explore whether Daimler and/or Bosch may be able to help with this project or the BAPP project.

Dr. Hartkopf mentioned to Dr. Damm that Vector Cogen products should be considered as Robert Preger has ties to Vector Cogen.

Microturbines were mentioned as a possible solution. Dr. Archer expressed that, as there are no microturbines under 30 kW, we should not pursue this option. DOE has an interest in residential CHP systems (approx. 15 kW). Also, microturbines are more expensive than engines.

Phil Carpenter indicated that he would explore fuel delivery issues for the diesel option.

The campus fire marshal informed Kristine Wilbrecht that natural gas generators for prime power were prohibited on the campus (see fax to Dr. Archer from Kristine on Nov. 10 addressing this issue). CMU indicated that this is probably not an insurmountable obstacle.

Heat Recovery Issues: MSOE/SNC

Ultimate form: steam, hot water (temperature, pressure) Engine coolant: water (pressurized?), glycol solution, other Exchangers: types Auxiliaries: water treatment, etc Appropriate suppliers

Phil Carpenter will explore heat exchanger options for both the diesel and natural gas generators.

For the small project, a radiator with fan will work as a heat dump. In the larger BAPP project there may be a volcanic water bed under the building that could be a reservoir for a heat dump.

MSOE will work with Kraft and also contact other heat exchanger manufacturers to find the most appropriate heat recovery solution.

There is a feedwater system installed for the auxiliary boiler (electric 24 kW).

Operation; Control; Instrumentation; Data Acquisition, Analysis Special instrumentation, supplier PC, Microcontroller based; centralized, decentralized Communicating, stand alone Software/hardware, suppliers

The issue of communications compatibility was identified as being very important.

The engine gen-set will follow the SAE communication protocol. All other systems should be able to use this protocol.

Dr. Archer mentioned Logical Automation (or Automated Logic) as providing the chiller instrumentation. MSOE has worked with Engage Networks to provide the instrumentation for a microturbine cogeneration installation.

MSOE will provide a list of needed instrumentation.

Dr. Archer mentioned that operational strategies should be explored. · How do we operate the system? · How do we control it? · How do we test it? · What are the advantages and disadvantages for each strategy?

Deliverables

Recommended system identification

- components, system: supplier(s) recommendation(s)
- flow diagram
- material and energy balances
- T-q diagrams
- equipment descriptions, specifications
- process and instrumentation diagram
- operational description
- tart up, commissioning, operating
- test program, data analysis
- General layout: platform, ground based
- Schedule: procurement, installation, operation
- Budget
- Special considerations: environmental, space requirements,

Assignments: MSOE/SNC, CMU, Astorino

A task list was put together with a tentative timetable. Dr. Archer summarized the tasks very well in a 11/12/04 email included below.

Edited from Dr. Archer's email:

Our targets, mutually established, are

- an engine generator with heat recovery installation complete at IW in May 2005;
- delivered from MSOE, by mid January 2005
- flow diagrams (Could you do these in Microsoft Visio?),
- spread sheet (Excel) material and energy balance sheets,
- instrumentation diagrams (You indicate sensors and actuators on the flow diagram.)
- equipment descriptions,
- descriptions of operation (start up, load follow, shut down, test, and evaluation performance),
- preliminary equipment layouts

for both a Diesel and a spark ignition based engine installation.

Phil Carpenter, Kraft Power Systems, identify for Chris, Fred, and Tony and for us at CMU

- possible engine generators,
- appropriate heat transfer equipment suppliers,
- possible overall system suppliers,

for our proposed installations here at CMU, both .in the IW and eventually in our new building (the Building as Power Plant, which has power, cooling, and heating loads about 25 times that of the IW).

Other items:

Fire code at CMU—Does it allow natural gas fueled prime power generators?

Dr. Hartkof's discussions with Daimler and Bosch.

Adjournment

D. H. Archer, H. Yin
4 November 2004
Chris Damm
1 December 2004