TeleConference Notes

Date: October 27, 2009,
Time: 0900 MDT

Attendees:
Howden UK
Alan Rough
Paul Meiklejohn
Louie Macari

Battelle Energy Alliance

Stephanie Austad	Component Test Capability Project Engineer
Brian Castle	NGNP Heat Transport Engineer
John Collins	NGNP Systems Engineering Manager
Bill Landman	NGNP Sr Project Engineer
Lee Nelson	NGNP Sr Project Engineer
Bill Phoenix	NGNP Instrumentation & Controls
Vince Tonc	NGNP Engineering Director

Howden designs and manufactures air and gas handling equipment, including industrial fans, process gas compressors and rotary heat exchangers. Howden UK has particular expertise in large gas circulators, has supplied carbon dioxide circulators for the Advanced Gas Reactors, and has developed designs for high temperature helium reactors.

Circulator Questions

1. Is there a circulator size (in terms of power) that is considered "off-the-shelf" as compared to a larger one that would require substantially more development?
There is no “off-the-shelf” helium circulator of the capacity NGNP might be considering. Any design will require some development and full scale testing. Howden would be very comfortable with a 4 to 6 MW design. No one has ever built a 16 MW design.

2. Are there practical limits on the inlet temperature for these circulators?
The 350^{o}C inlet temperature is no problem. Temperatures on the order of 500^{o}C maybe feasible but have not been investigated in detail. High temperature materials like Inconels are typically heavier, which causes mechanical problems. At one point, they considered titanium impellers but these would have a limited life. Cooling would be an issue.

3. What is the state of the art of impeller design? Is the combination of modern computer codes and experience such that the full scale impellers could be designed directly or would a reduced scale impeller be designed and tested to verify performance before going to the full scale?
Howden has various impeller designs that they have developed over the years. Those designs, coupled with CFD for the diffuser and other components give them a high confidence that they understand the aerodynamic performance of the impeller. The mechanical design of the impeller and rotor is much more challenging, and they use finite element analyses for that.

4. What is the state of the bearing design?

a. *Have magnetic bearings advanced to the point that they could be used in these applications?*

Yes, magnetic bearing would be the first choice over oil, for instance. Catcher bearings are provided as part of the complete bearing design. In response to a question regarding spin-down of the circulator and the associated wear on the catcher, Howden noted that they would use the VFD as a brake to reduce the spin time on the catcher bearing.
Bearing mfrs to consider would be SKF, S2M, and Waukesha.

b. *Would bearing tests in a dedicated test set-up be needed or is the technology sufficiently understood that the bearing could be tested on the first full scale unit?*

Given a close working relationship between Howden, the motor mgr, and the bearing mfr, Howden believes that the magnetic bearing could be tested on the full scale unit. There may be some insulation testing of the bearing that could be performed separately.

5. Seals - similar to questions on bearings.
Howden did not see seals between the process and the motor cavity as an issue and would not use a labyrinth seal on these machines. Electrical penetrations are something that would be tested.

6. Would Howden provide a performance guarantee with their bid?
Howden did provide such a guarantee with a recent design/construct contract with the Chinese on a 6 MW circulator for the HTR PM (pebble bed modular) but the contract was not completed due to intellectual property issues. Typically, Howden provides a guarantee of performance and performs a factory test of the unit.
Howden would have to build a test facility for a 6MW circulator.

7. Are there any component or reduced scale tests that could be performed before design starts or while design is progressing?
Howden suggested the following tests that could be performed in the near future:

- Thermal insulation testing – cycle insulation materials through pressure transients
- Motor and bearing insulation testing

8. Does Howden have any concerns about static electricity build-up on the rotor?
Howden is not aware of any static electricity build-up issues but they have been asked the question several times.

Miscellaneous Info:

1. The rotor for a 6 MW machine would be about 3 to 4 tonnes.
2. Testing – Howden would probably not do a separate motor test. Instead, they would test “motorettes” to investigate insulation and arcing issues. Motorettes are one or two windings from the motor that are placed in ovens, helium atmosphere, etc, and tested.

3. The motor is rated for 200^{o}C, the cavity is maintained around 100^{o}C in normal operation.
4. Noise levels: The AGR machines may be as loud as 160 dB. PBMR's 450 kw machine runs about 100 dB
5. Howden is very much in favor of a collaborative effort between the machine designer, the motor designer, and the bearing designer.
6. The Torness and Heysham II (Advanced Gas Reactors) carbon dioxide circulators run at 11 kV and weigh 30 tons.
7. The circulator inlet (flapper) valve is not in Howden's scope. That would be a buy-out. Howden did not see an issue with this valve as they have something similar in their inlet vanes.
8. Howden has done some studies on 4 x 4 MW vs 1 x 16 MW machines

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