

Power Plant Pumps

September 11th Webinar focused on efficiency of pumps in combined cycle operation and creation of a new knowledge system

September 11 Agenda

- This recorded webinar is available free of charge to power plants around the world
- The format is collaborative

Speakers

- Overview Bob Mcilvaine, Mcilvaine Company
- Variable Speed Pumping, William Livoti, WEG
- Considerations relative to minimum Flow, Randall Ferman, Ekwestrel
- Variable Frequency Drives for Cooling towers to meet 216B- Jason Hoover, Siemens (from his desktop).

Presentations in absentia

- Jerry DiOrio of Siemens has created an excellent tutorial on steam drivers for BFP. He could not join us today but is available to answer questions. His paper is posted in the site at [Tutorial on Steam Turbine Drivers for Fossil and Nuclear Feed Pump Applications](#)
- This paper presents an overview of the operation and design of steam turbines used for driving reactor and boiler feed pumps.

Revision Date: 9/8/2014

Tags: 221112 - Fossil Fuel 化石燃料, 221113 - Nuclear Electric Power Generation , Siemens, Steam Turbine, Pump

- Previous webinar on power plant pumps focused on the pump designs with presentations by pump manufacturers.

Processes

- As William Livoti will tell you, pump standards are only part of the specification requirement. Understanding of the process is the key to correct selection.
- Coal-fired, gas turbine combined cycle. Nuclear, and concentrated solar power plants all use the same technologies for purifying the water which is converted to steam to drive the electric generator.
- The major difference is that only a portion of the power is derived from steam generation in gas turbine combined cycle plants. However, there is a unique additional need for ultrapure water in some gas turbine plants. In dry hot climates water is introduced through fogging nozzles to reduce the inlet air temperature to the turbine. Nuclear plants use water for reactor cooling
- Pumps are used in a series of processes starting with purification of the raw water through transport of condensed steam.

Process variables for combined cycle power plants

- Rapid cycling and load variations make it challenging to operate pumps at optimum efficiency
- Cooling can be with seawater, treated municipal wastewater as well as from a water source
- Changes from once-through to recirculation of cooling water
- Challenge to use existing pumping systems when installing gas turbine at existing coal plant site
- Zero liquid discharge has additional pumping requirements

Knowledge System Concept

- Free services are now available to power plants around the world
- [Gas Turbine and Combined Cycle Decisions](#) is one of the complete knowledge systems which includes pump analysis.
- Pump analysis is also included in free websites
- [Degasification and Demineralization - Continuous Analysis](#)
- [Power Plant Cooling - Continuous Analyses](#)
- [Steam Generator - Continuous Analyses](#)
- [CCR and Effluent - Continuous Analyses](#)
- [Wet Calcium FGD - Continuous Analyses](#)

Function of Knowledge Systems

- Empower power plants to select the best products and services
- Provide international knowledge and experience to developing countries
- Share knowledge among disparate geographies, technologies, and job functions
- Identify niche experts
- Cultivate greater expertise in narrower niches
- Lead power plants to other resources such as conferences, magazines, associations, and government services

Decisive Classification of all options in Chinese and English

: Catalyst Maintenance

| Major Class | Descriptor | Chinese Descriptor | Definition |
|-------------|-----------------------|--------------------|--|
| Product | Cleaning Catalyst | 催化? 除灰 | A dry process that utilizes vacuum and compressed air to mechanically remove as much of the fly ash accumulation as possible. |
| Product | Regeneration Catalyst | 催化? 再生 | "Catalyst cleaning" followed by a wet chemical process to remove decay compounds plus re-impregnation of the catalytic compound(s). |
| Product | Rejuvenation Catalyst | 催化? 复原 | "Catalyst cleaning" followed by a wet chemical process to remove some decay compounds with minimum removal of catalytic compound(s). There is no re-impregnation of the catalytic compound(s). |

Identify every pump user and supplier with corporate identifier

| Beijing Guodian Longyuan Environmental Engineering | | 1274 | 北京国电龙源环境工程有限公司 |
|--|--|------|----------------|
| Beijing Guohua Renyuan Environmental Engineering | | 1275 | 北京国华荏原环境工程有限公司 |
| Beijing Jingming Powder Metallurgy | | 754 | 北京精明粉末冶金有限公司 |
| Beijing Longyuan Cooling Technology | | 2382 | |
| Beijing Maoxiuxuri Environmental Filter | | 785 | 北京懋修旭日环保滤材有限公司 |
| Beijing Origin Water Technology | | 3639 | |
| Beijing Scinor Membrane Technology | | 3640 | |
| Beijing Tri-High Membrane Technology Company | | 3641 | |
| Beijing Ziquan Energy Environment Technology | | 1276 | 北京紫泉能源环境技术有限公司 |

Use of the websites and webinars

- The knowledge systems are continually updated
- Online discussions supplement recorded webinars
- Recorded webinars can be used for training as well as current decision making.
- Basic training by other groups (e.g., HI Power Plant Pumps with William Livoti) can be complemented by use of the recordings and knowledge systems to provide continuous training systems and mentoring.
- We need to identify niche experts (e.g., Ronald Ferman) who can provide high level advice but also mentoring support for continuous training programs.
- Custom websites are being created for utility customers with information on all their plants as well as links to facilitate use of the knowledge systems
- Major operators of GTCC plants already using our plant tracking systems to determine GTCC construction strategies

Associations

- EPRI has continuing important efforts.
- VGB has a reach beyond Germany and Europe to some Asian countries as well
- Western Turbine Users, 7F Users, Combined Cycle Users, D5-5A Users , Frame 6A users, 7EA users, ACC Users, 501F Users, 501 G users, Australian HRSG Users, HRSG Users.
- User group activities are well reported in CCJ.
- HI is a major resource (William Livoti of WEG conducted an extensive power plant pump webinar in August.)

Specialized Journals and Conferences

- Combined Cycle Journal <http://www.ccj-online.com/>
- World Pumps (Elsevier)
- Power Engineering
- Power
- Empowering Pumps has very current information
<http://empoweringpumps.com/>
- Pump Engineer <http://www.pumpengineer.net/>
- Pump Summit (Dusseldorf Dec 2,3 2014)
- Pump Turbo Symposia <http://10times.com/pump-turbo-symposia-expo>
Sept 22-25
- VGB conferences and magazine
- Chinese conferences and magazines

Using the Intelligence System

- **Product** Products are clearly defined
- **Process** Processes are less important on this subsidiary site but very important on the main site.
- **Corporations** So Goulds would show under ITT. You need to click on subsidiaries to see the same info under Goulds.
- **General Subjects** markets, maintenance, etc.
- **Locations** Countries, states and cities
- **Applications** Sorted by NAICS code and Chinese descriptors

Other search tools

- [Global Search](#) - Search by any keyword
- [Person](#) Search by last name first
- [Subsidiary](#) So Goulds instead of ITT
- [Format of Information](#) presentations vs. articles
- [McIlvaine Keyword Search](#) - Search by any text word in summary.
- [Publication](#) - Search by publication name
- [Publication Date](#)
- [Title](#) Very important because all articles are listed in chronological order and you can check for the latest inputs.
- [Calendar of Events](#)

Background data has action tags

- [VFD at the Hainan Yangpu 220 MW GTCC](#)
- This article covers the application of variable frequency in the high-pressure water feeding system of boiler erected in the #11-13 combined cycled unit of Hainan Yangpu Thermal Power Plant. This 220 MW unit was the largest in China when it was installed in 2003. The article is written by the plant engineer responsible for operation and maintenance. High-pressure water feeding pump are manufactured by KSB, model HGB4/10 rated, the operation mode is one in operation and one in standby. The pneumatic water feeding adjusting valve was designed by SIEMENS, manufactured by an Indian company. In the first year of operation there were severe problems with the valve caused in part by inability to measure the outlet pressure of the BFP system. It was determined that a solution lay with replacing the hydraulic coupling with VFD. 2 units of HARSVERT-A06/130 VFD systems manufactured by Beijing Leader & Harvest Electric Co., Ltd. were selected. With the installation of the VFD the energy consumption was greatly reduced and the vibration in the high pressure feedline was eliminated
- **Action:** How has this plant functioned since 2004? Has similar technology been employed on more recent Chinese GTCC plants? We need to contact the author and utility to find out the latest.
- **Revision Date:** 9/8/2014
- **Tags:** 221112 - Fossil Fuel 化石燃料, Siemens, KSB, Pump, Flow Control, Steam Cycle, China

Primary pumps in a GTCC plant

- Primary Pump Systems include:
 - Boiler Feed Pumps (primary and startup)
 - Condensate Pump
 - Cooling Water Circulation Pump
 - Cooling Water Make-up Pump
 - Heater Drain Pumps
- Boiler Feed Pumps
 - High pressure, high flow barrel type multi-stage centrifugal pumps rated ~5000 gpm and 2400 psi for major utility power plant systems (pressures will vary for subcritical vs. supercritical).
- Condensate Pumps
 - High flow centrifugal pumps rated ~5000 gpm to move condensate from the condenser hot well to a deaerator and back to the feed water stream ahead of the boiler.
- Once-through Systems
 - Pump surface water through cooling unit and directly back to source (lake, river or ocean).
- Loop Systems
 - Circulating Pumps
 - Large centrifugals rated 100,000 gpm or more. Total coolant flow more than 200,000 gpm for a 400 MW plant.
 - Makeup Water Pumps
 - Large centrifugals rated 5,000 gpm. Makeup is typically two percent to three percent of total flow and is required to replace water lost to windage, evaporation, and blowdown.

Secondary Pumps in GTCC plant

- Secondary Pumps include:
 - Chemical Feed Pumps
 - Chemical Transfer Pumps
 - Fuel Transfer Pumps
 - Fuel Injection Pumps
 - Slurry Pumps and De-watering Pumps (used in zero liquid discharge systems)
 - Lubrication Pumps
 - Service Water Pumps, Fire Service Pumps, others.
 - Fogging nozzles
 - Ammonia injection for NO_x control

Power plant pump revenues by pump type \$ millions

| Subject | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---------------|----------|----------|----------|----------|----------|----------|----------|
| All | 2,878.60 | 3,028.39 | 3,180.10 | 3,362.57 | 3,548.27 | 3,728.59 | 3,948.67 |
| Centrifugal | 1,916.33 | 2,016.02 | 2,116.99 | 2,238.45 | 2,362.05 | 2,482.06 | 2,628.56 |
| Diaphragm | 331.63 | 348.90 | 366.40 | 387.42 | 408.83 | 429.63 | 454.99 |
| Reciprocating | 271.34 | 285.47 | 299.79 | 317.00 | 334.51 | 351.53 | 372.28 |
| Rotary | 359.31 | 378.00 | 396.93 | 419.70 | 442.88 | 465.38 | 492.85 |

Power Plant pump revenues by region

\$ millions

| World Region | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|-------------------------|----------|----------|----------|----------|----------|----------|
| All | 3,028.39 | 3,180.10 | 3,362.57 | 3,548.27 | 3,728.59 | 3,948.67 |
| Africa | 82.94 | 90.00 | 97.27 | 103.74 | 109.43 | 113.41 |
| CIS | 90.23 | 92.09 | 93.88 | 95.96 | 98.37 | 100.37 |
| East Asia | 1,505.78 | 1,614.34 | 1,730.52 | 1,846.48 | 1,961.08 | 2,076.27 |
| Eastern Europe | 88.10 | 91.95 | 95.27 | 100.58 | 104.78 | 109.57 |
| Middle East | 101.14 | 108.07 | 114.49 | 121.62 | 129.00 | 136.56 |
| NAFTA | 401.57 | 389.78 | 394.03 | 400.31 | 407.94 | 415.59 |
| South & Central America | 55.55 | 58.22 | 61.37 | 64.83 | 68.83 | 72.97 |
| West Asia | 435.32 | 463.66 | 498.24 | 531.91 | 578.72 | 626.49 |
| Western Europe | 267.76 | 271.99 | 277.50 | 282.84 | 270.44 | 297.45 |