Pumps Sept 10 webinar

Route Map and Summary of data in the Power Plant Pumps Decision Guide-Draft September 9

Table of contents

Overview

- This route map and summary can be used to guide the power plant decision makers as to the location of information on options and issues to help them make the best decisions relative to pumps
- The route map leads to detailed options in two free systems available to power plants. One covers coal and the other gas turbine combined cycle plants
- **Technical**
- 44I Power Plant Air Quality Decisions (Power Plant Decisions Orchard)
- 59D Gas Turbine and Combined Cycle Decisions
- The systems are continually updated with case histories, articles, and InterWebviews
- The fast cycling of gas turbine combined cycle systems and the high pressure demands of ultra-supercritcal coal fired plants are two examples of the continuing challenges facing pump suppliers
- The Use of treated municipal wastewater and the increasing popularity of ZLD are additional examples
- The new ELG for power plants in the U.S. is an example of the new issues caused by regulations

Knowledge systems for power plants

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

Subsidiary knowledge systems for processes

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**

Access data by descisive key words

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

Decisive key words (continued)

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 imputs.**
- **Calendar of Events**

Quick access to articles

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

Identifiers for users and suppliers

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	北京国华茬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

Generator types utilizing pumps

- Nuclear power
- Coal fired power
- Gas turbine combined cycle plants
- Geothermal
- Biomass
- Hydro
- Concentrated Solar
- Wind (lubrication)

Power Plant Pump Revenues, 2015 by pump type ($ millions)

Subject	2015
- Select All	3,007
Centrifugal	2,002
Diaphragm	346
Reciprocating	283
Rotary	375

Asia is the largest power plant pump purchaser

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

Major Pump Types in Power Industry

Basic Specifications & Performance Requirements

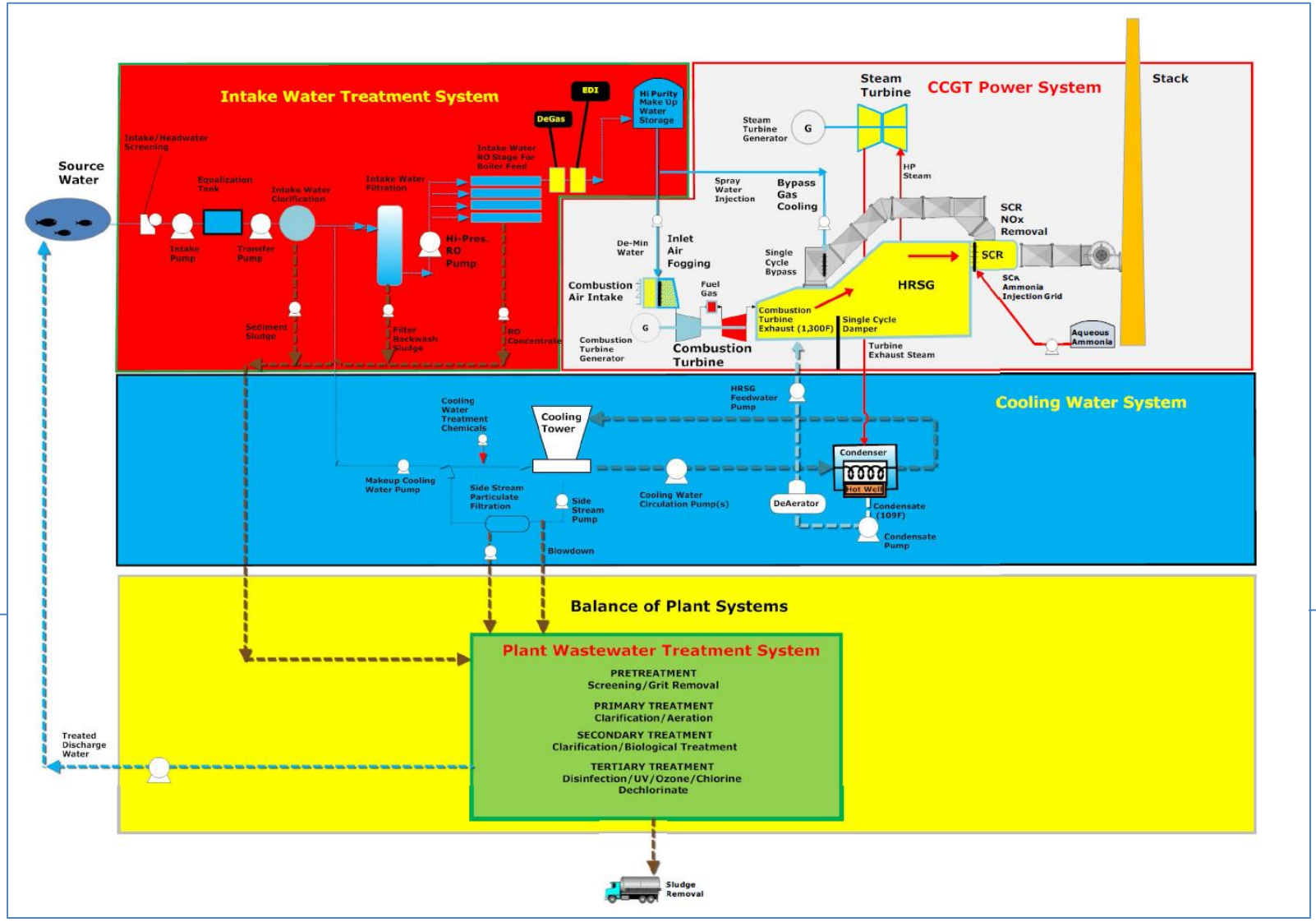
Power Plant Applications	Principal Pump Technologies	Pump Essential Performance Requirements
Raw Water Intake	Centrifugal	Hi flow/Low head
Cooling Water	Centrifugal	Hi flow/Low head
Boiler Feed Water	Multi-Stage Centrifugal	Hi pressure/Hi flow, Hi temperature
Condensate Water	Centrifugal	Hi flow/Low head
FGD Scrubber (circulation and makeup)	Lined or Hard Metal Centrifugal (sometimes diaphragm on makeup)	Hi flow/abrasive slurry
SCR ammonia injection	Centrifugal	Aggressive media
Ash Handling	Lined or Hard Metal Centrifugal	Abrasive slurry
Coal Storage Runoff	Centrifugal	Abrasive slurry
Drainage/Plant Runoff	Centrifugal	Dirty water
Wastewater	Centrifugal (mostly) diaphragm (some)	Dirty water
Service Water	Centrifugal	Hi flow/Low head
Fire Pumps	Centrifugal	Hi flow
HVAC	Centrifugal	Antifreeze, corrosion inhibitors
Chemical Metering	Diaphragm/Peristaltic/Piston/progressing cavity	Aggressive media
Chemical Transfer	Mag Drive Centrifugal or gear, or progressing cavity	Aggressive media
Fuel Oil	Screw (for burner injection), Vane or Gear (for loading or transport)	Hi viscosity, depending on grade

Processes

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

CCGT Power Plant
Process Flow Diagram



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

Secondary pumps in coal fired power plants

- Applications of secondary pumps in a power plant include:
  - Low-flow diaphragm, peristaltic, piston, and other metering pumps for water treatment chemicals;
  - Gear, vane and progressive-cavity pumps for fuel oil unloading and transfer;
  - Gear or lobe pumps for oil-lubrication systems of rotating equipment;
  - Rubber-lined or hard-metal centrifugal pumps or air-operated diaphragm pumps for liquid slurries;
  - Transfer pumps for movement of chemicals from bulk storage into day tanks; and
  - Miscellaneous pumps for service water, fire-suppression, HVAC, and other applications.

Metering Pumps (Tom Tschanz, Mcilvaine)

- Metering Pumps for Water Treatment: These pumps enjoy broad application for water treatment in power plants. Water treatment occurs in at least three areas, including boiler feed water, cooling water, and wastewater. Chemical treatments are required to protect the boiler, turbine and condenser from erosion, corrosion, scale, and biological buildup, as well as for wastewater treatment in scrubbing systems. Some common treatments include hydrazine or sodium sulfite for oxygen scavenging, amines and ammonium hydroxide for pH adjustment, phosphate or calcium hydroxide to inhibit scaling, bleach or sodium hypochlorite for disinfection and microbiological control, and sulfuric acid for pH control, particularly in cooling water. Other treatment regimes exist as well.

  The injection flowrates for metering pumps are typically low and are measured in gallons per hour. Electric solenoid and motor-driven pumps are commonly used. The motor-operated systems are generally used for higher-pressure deliveries in boiler feed water. Pump operating pressures can range from less than 50 PSI for cooling water or wastewater treatment to 6,000 PSI for direct injection of chemicals into the boiler drum. These chemical-metering systems play a critical role in the overall operation of the plant.

  Suppliers of chemical metering pumps to the industry include Grundfos Alldos (www.grundfosalldos.com), Chongqing (www.cqlcp.com), IDEX (www.idexcorp.com), Iwaki (www.iwakiamerica.com), Milton Roy (www.miltonroy.com), Lutz Jesco (www.jescoamerica.com), ProMinent (www.prominent.us), seepex (www.seepex.com), SPX Bran+Luebbe (www.bran luebbe.com), Verder (www.verder.com), Watson-Marlow (www.watson-marlow.com), etc. http://www.flowcontrolnetwork.com/pumping-power/

Fuel oil pumps (Tom Tschanz, Mcilvaine)

- Gear, Vane, and Progressive-Cavity Pumps for Fuel Oil: Nearly all power plants, regardless of primary fuel type (coal, oil, gas, nuclear, etc.), will utilize fuel oil for a variety of plant operations. These operations could include oil-fired startup of a pulverized-coal furnace or operation of diesel-driven fire pumps, compressors and generators. The oil-handling system requires unloading pumps and transfer pumps to handle deliveries from rail or over-the-road tankers to the plant. Separate pumps are required for injection of fuel into the furnace for boiler startup. For light fuel oils, gear or vane-type pumps can be employed. For heavy fuels or high-pressure deliveries to the furnace, progressive-cavity pumps are most commonly used. Flowrates can vary depending on application from less than 100 GPM to 1,000 GPM, or more.

  Suppliers of pumps for these applications include Allweiler (www.allweiler.com), Colfax (www.colfaxcorp.com) IDEX, Leistritz (www.leistritz.com), Roper (www.roperpumps.com), SPX Johnson (www.johnson-pump.com), SPX Plenty-Mirrlees (www.plentymirrleespumps.com), Tuthill (www.tuthill.com), Seemsan (www.seemsanpumps.com), Shanghai Huanggong, Verder, and others.
- http://www.flowcontrolnetwork.com/pumping-power/

Low flow gear pumps for lubrication

(Tom Tschanz , Mcilvaine)

- Low-Flow Gear Pumps for Lubrication Systems: Power generation is critically dependent upon the reliable lubrication of rotating equipment within the power plant. This rotating equipment includes, but is not necessarily limited to:
  - The primary steam turbine and generator, plus smaller steam turbines for operation of various pumps
  - Ancillary equipment including:
  - Coal conveyors & pulverizers
  - Limestone ball mills
  - Forced-draft fans for flue gas
  - Load-tap changers for transformers
  - Other miscellaneous systems

  Each of these systems requires a reliable supply of filtered lubricant to protect equipment bearings and to remove heat and contaminants (such as water) from the oil. These lubrication systems include an assemblage of components comprised of pumps, filters, reservoirs, piping and valves. The systems may be an integral part of the equipment or part of a separate skid-mounted system provided by OEMs specializing in oil filtration. The pumps used in these applications are usually gear-type pumps with flowrates on the order of 20 GPM or lower.

  Suppliers of pumps for these systems include Allweiler, Colfax (Tushaco, Imo), IDEX, Roper, Tuthill, Seemsan, Shanghai Huanggong, SPX Johnson, Verder, and others. Oil filtration OEMs include Kaydon (www.kaydon.com), Velcon (www.velcon.com), Oil Filtration Systems (www.oilfiltrationsystems.com), Hilliard (www.hilliardcorp.com), Elliot (www.fs-elliott.com), and others.
- http://www.flowcontrolnetwork.com/pumping-power/

Transfer Pumps for Water Treatment Chemicals- Tom Tschanz , Mcilvaine Company

- Transfer pumps are used in power plants to move liquids from outdoor bulk storage tanks to smaller day tanks located inside the building. Liquids commonly pumped include the numerous water treatment chemicals discussed earlier in this article. These pumps may be mag-drive centrifugal pumps, particularly in the case of corrosive treatment chemicals, to minimize the chance of leakage through conventional pump seals. Pump operation is usually intermittent rather than continuous.

  Suppliers include Almatec (www.almatec.de), CP-Pumpen (www.cp-pumps.com), Ebara (www.pumpsebara.com), Finish Thompson (www.finishthompson.com), Flowserve, Gorman Rupp (www.gormanrupp.com), ITT, Iwaki, March Manufacturing (www.marchpump.com), Munsch (www.munsch.de), Pan World (www.panworld.com.sg), Schmitt (www.schmitt-pumpen.de), Shanghai Liancheng Group (www.lcpumps.com), Verder, Wernert (www.wernert-pumpen.de), and others.
  http://www.flowcontrolnetwork.com/pumping-power/

Centrifugal or AOD pumps for slurry handling

- Centrifugal or Air-Operated Diaphragm (AOD) Pumps for Slurry Handling: Power plants include many pump applications for the transport and dewatering of ash, limestone and gypsum slurries. Ash in coal-fired plants is frequently transported away from the furnace by ash sluice pumps. Limestone slurry is commonly used in Flue Gas Desulfurization (FGD) scrubbing systems to remove SO2 from flue gas. Separate systems called Selective Catalytic Reduction (SCR) systems are used to remove NOx using various forms of ammonia in the presence of a catalyst. Diatomic nitrogen and water are byproducts.

  Pumps used in these slurry applications are usually rubber-lined or hard-metal centrifugal pumps, or AOD pumps that are suitable for handling slurries with high solids content. The flowrates for these pumps reflect the size of the plant (in megawatts) and can be in the range of 40,000 GPM or higher for slurry re-circulation in a typical FGD absorption tower. Lower flowrates in the range of 750 GPM apply for bleed slurry pumps. In a typical power plant, there may be four or more slurry recirculation pumps, and two bleed pumps. The number of pumps will vary with plant size and design.

  An increasing number of power plants situated in coastal areas are adopting seawater flue gas desulfurization (SWFGD) in lieu of the more traditional wet-limestone process. Advantages of SWFGD include lower cost (no limestone or limestone handling equipment is required), and there is no effluent other than the seawater, which requires minimal treatment other than pH balancing before re-introduction to the environment. High-capacity centrifugal pumps for handling seawater are used in the application.

  Suppliers of slurry pumps include Andritz (www.andritz.com), Duechting (www.duechting.com), Flowserve, ITT Goulds (www.gouldspumps.com), KSB, Sulzer, Weir Minerals (Warman, GEHO, Hazelton), Verder, and others.

- http://www.flowcontrolnetwork.com/pumping-power/

- This information and the FGD pump information have to be reconciled and brought up to date. WE can separate the FGD recycle slurry pumps which are very large from other applications such ball mill recycle and ash dewatering. Applications such as ammonia injection should also be addressed separately

FGD

- **Overview**

- **Recycle Slurry** : Limestone FGD systems are handling flows in excess of 20,000 gpm, at heads ranging from 13-20 meters often from several pumps. So the total could be more than 100,000 gpm demand
- **Feed streams .** – Concentrated limestone slurry feed from the ball mill is usually recirculated with a hydrocyclone being used to return the oversize material to the ball mill for further reduction
- **Fresh Water** - In a limestone FGD system, the most likely points at which fresh water would enter are the ball mills, pump seals, and the mist eliminator wash system
-
-

FGD pumps

Pumps - Overview

- Over the past twenty years, scrubber pumps have continued to grow in size and capacity, with individual units handling flows in excess of 20,000 gpm, at heads ranging from 13-20 meters. These large pumps are necessary in order to operate with a minimum number of pump units. Pumps must accommodate lower levels of operation due to unit outages or off-peak electrical demand. Today's pump net positive suction head (NPSH) is met by the normally high (10-15 meters) suction head. FGD pumps must be durable, able to withstand constant operation at specified conditions, able to accommodate a range of pipe loads and system transients and be virtually maintenance-free for at least 24,000 hours of continuous operation. FGD units use several types of pumps, three of which will be discussed below.

- **Feed Pumps** - Concentrated slurry feed is usually handled by rubber-lined centrifugal pumps. Positive displacement pumps with variable-speed drives are also applicable. Cast-iron, erosion-resistant alloy, and rubber-lined pumps are common in limestone systems. Some utilities prefer to use rubber-lined pumps from a single manufacturer for uniformity throughout the plant. Although centrifugal pumps are widely used, the screw pump that handles limestone slurry feed is a special type of rotary positive displacement pump in which the flow through the pumping elements is truly axial. Thus, the screw pump with its unique axial flow pattern and low internal velocities offers a number of advantages in those few applications where centrifugal pumps cannot be used.

- **Fresh Water Pumps** - In a limestone FGD system, the most likely points at which fresh water would enter are the ball mills, pump seals, and the mist eliminator wash system. A fresh water pump for this service can be a standard centrifugal pump. The important items to be specified are properties of the service water, available net positive suction head (NPSH), materials of construction, type of drive, and type and size of motor.

- **Recycle Slurry Pumps** - The typical slurry pump has many features that set it apart from the typical centrifugal pump used for clear liquids. Wall thicknesses of wetted-end parts (casing, impeller) are greater that in conventional centrifugal pumps. The cutwater, or volute tongue (the point on the casing at which the discharge nozzle diverges from the casing), is less pronounced in order to minimize the effects of abrasion. The radial and the axial-thrust bearing on the slurry pump are heavier, too, than those on standard centrifugal pumps.
-

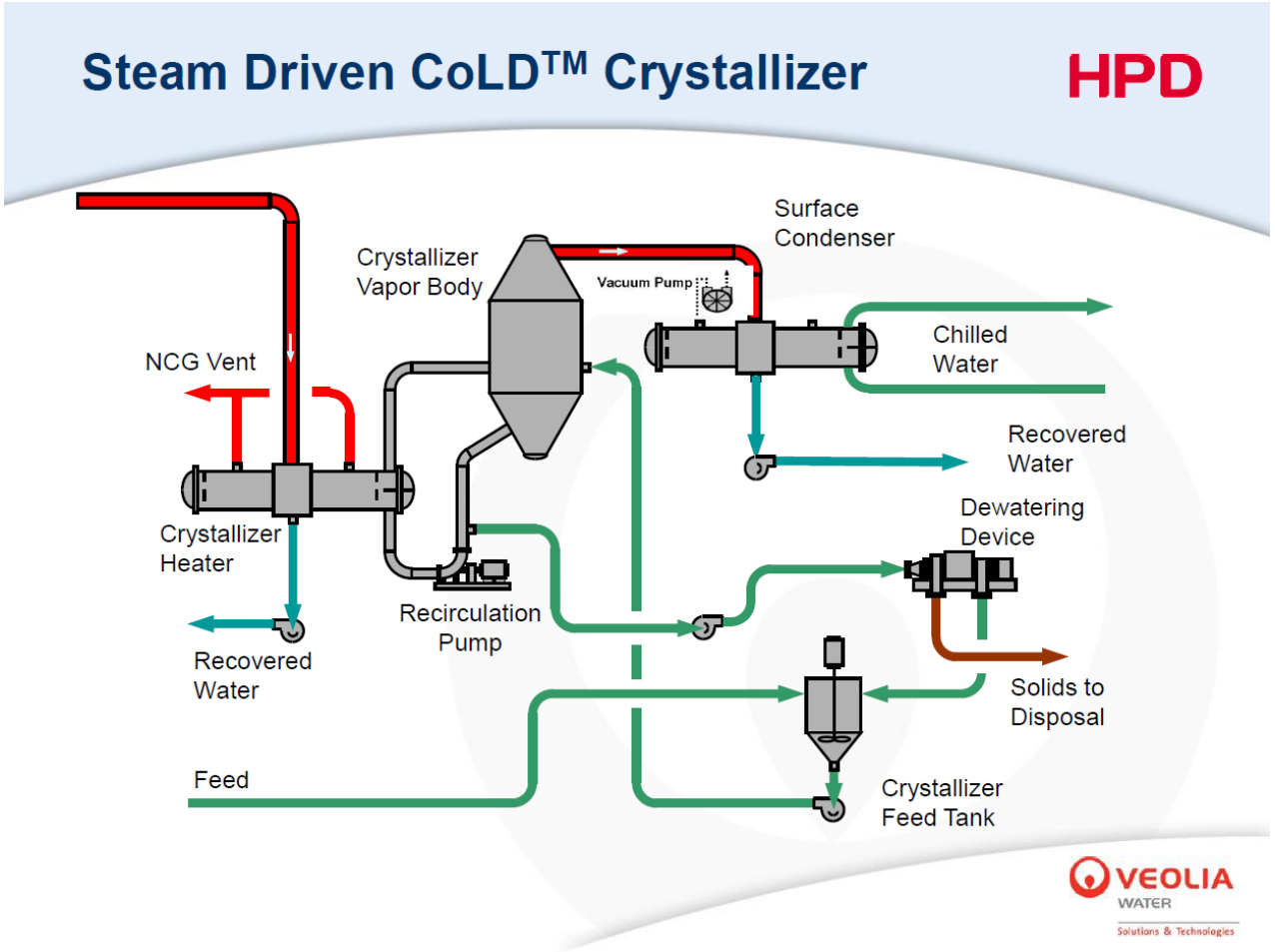
FGD pump materials

- **Materials of Construction** - Pumps are made in two types of materials: all-metal pumps and rubber-lined cast-iron pumps. European and American engineers have tended to use different materials of construction. American power plants have generally installed rubber-lined cast-iron pumps while European plants have generally installed all-metal pumps. Since the pump parts in contact with the slurry are subjected to abrasive-corrosive action, the "wetted" parts must be constructed of a corrosion-resistant material that is either harder than the slurry solids or resilient. As David Root observed in "New Technology Throws Down Challenge to Pump Industry," International Power Generation, March 1996, pp. 59-60, the hard iron pump is a single casing, back pull-out design that increases ease of maintenance. It is constructed of duplex stainless steel for highly abrasive media. The cast-iron pump casing is split vertically with through-bolting used to connect the halves as well as the piping to the suction and discharge nozzles.
-
- In the rubber-lined cast-iron pumps each casing half is lined with easily replaceable, bolted-in segmented rubber liners. A good design provides for 100 percent reinforcement of all liners. This approach precludes collapse of the liners if a vacuum is inadvertently created. Rubber has advantages for modern scrubber pumps because it offers excellent abrasion resistance, has natural corrosion resistance and effectively dampens hydraulic noise. Rubber liners are less expensive and weigh less than metal liners or cases, so they reduce the cost and allow for easier handling during maintenance.

- Most impellers today are metal. The advantage of metal is based on its durability and the fact that it allows for optimized pump efficiency through proper geometry. The maximum diameter impeller is employed regardless of the flow and head. This tactic is used to keep rotational and eye speeds at a minimum so wear life is enhanced and damage due to cavitation is minimized. Manufacturers of rubber-lined impellers claim impeller performance is maintained over 97 percent of the useful water life of the component while metal impellers slowly degrade over their working life. The selection of impeller metallurgy normally includes either duplex stainless steel (CD4MCU) or a high-chrome martensitic white iron. The latter is typically 27-28 percent nominal chrome content. Certain formulations with carbon content under two percent enhance resistance to slurries having a pH level exceeding three, with chloride content of 75,000 ppm and higher. While duplex stainless steel can be used over the widest range of pH and chloride levels, maximum hardness with heat treatment may be 325-340 Brinell, while the available white irons may range from 450 BHN to 600 BHN, based on carbon content and heat treatment.
-
- Generally, the advances made in elastomer compounds and metal alloys have resulted in typical wear life of five years for casing liners and three years for impellers.

- This material in the Mcilvaine Power Plant Air Quality Decisions is outdatged. Dichtung ceramic pumps and several offerings from Chinese companies need to be evaulated and this maerials section changed
-

Veolia COLD™ Process for ZLD

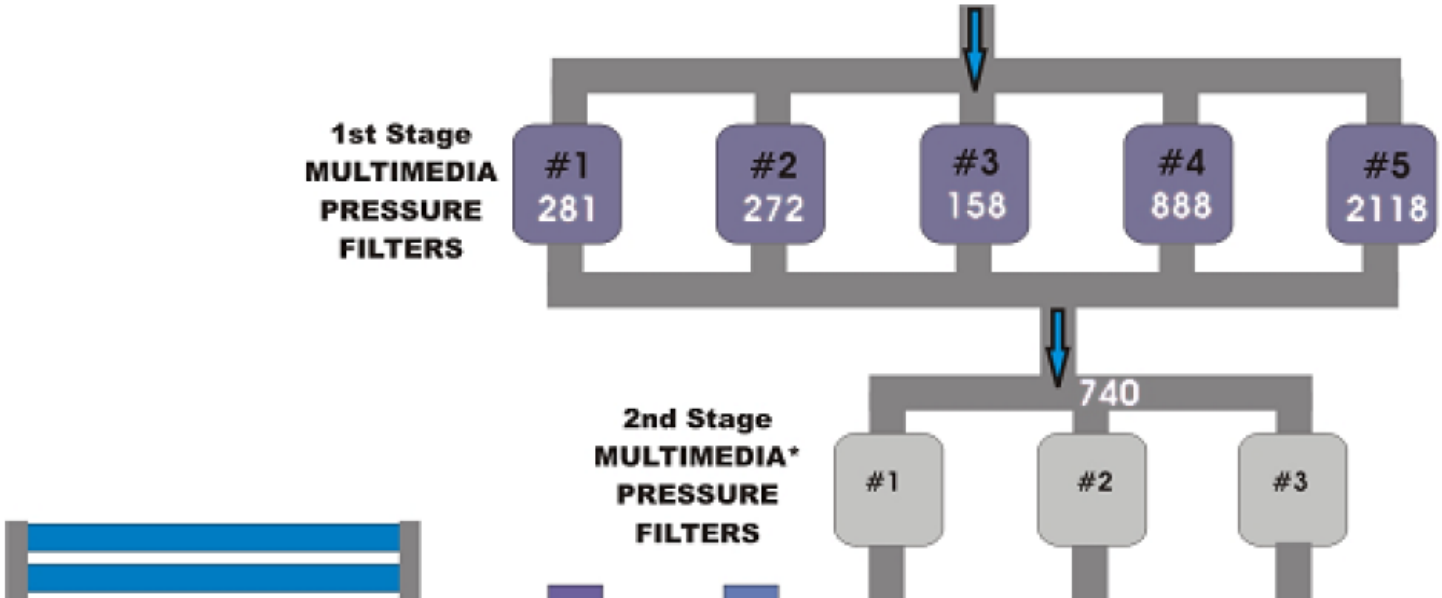


Pre-treatment (chemtrac)

Applications

Pre-Treatment

- Monitor filter performance



Pump Suppliers

Pump suppliers to the Power industry

SPX offers pumps and many other components for CCGT plants

This brochure covers the complete range of SPX products for the power industry. Good diagrams on GTCC show the boiler feed pumps and other offerings. Since SPX also offers complete cooling tower systems they can offer pumps as part of packages or separately. ***Revision Date:*** 8/18/2014 ***Tags:*** 221112 - Fossil Fuel 化石燃料, 221114 - Solar Power , 221112 - Fossil Fuel 化石燃料, SPX, Cooling System, Pump, Boiler Feedwater Pump, Cooling Tower, Air Cooled Condenser, Schematic, Flow Control

Grundfos has Pumps for Steam Boilers and District Heating

Grundfos supplies the high pressure multi stage pumps for steam boilers. It is a leader in pumps for district heating. Gas turbine combined cycle plants are often replacing coal plants in district heating systems. At the same time the distribution systems are being upgraded with new pumps.***Revision Date:*** 8/8/2014

Tags: 221112 - Fossil Fuel 化石燃料, McIlvaine, Grundfos A/S, Pump, Boiler Feedwater Pump, Combined Heat & Power

Buffalo Pump Explains Lubrication Evolution to 7F Users

A 2007 design upgrade switched the thrust-bearing lubricant from grease to oil, supplied via a connection on the pump discharge, thereby extending the bearing replacement time to 30,000 hours. ***Revision Date:*** 8/7/2014 ***Tags:*** 221112 - Fossil Fuel 化石燃料, Buffalo Pumps, Pump, Maintenance, Combined Cycle Journal

Ebara boiler feed pumps

Super High Pressure Boiler Feed Pump For Ultra-Super Critical Thermal Power Plant

- Flow:1,200m^3/hDischarge Pressure:38.05MPaSteam Turbine Power:17,500kW

Pumps for Thermal Power Plants -MHI

Boiler Feed Water Pumps

Boiler Feed Water Booster Pumps

Condensate Extraction Pumps

Variable Pitch Vane
Circulating Water Pumps

Fixed Vane
Circulating Water Pumps

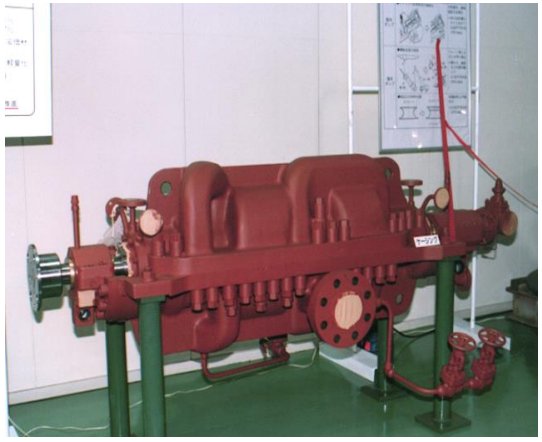
Variable Pitch Vane Slurry Pumps
for Flue Gas Desulfurization Plants

Boiler Feed Water Pump-MHI

Double-casing
(Horizontally-split internal element) type

Double-casing
(Sectional internal element) type

Single-casing horizontally-split type



Single-casing sectional type

ITT Pumps for power

Raw Water Intake

For raw water intake from lakes, rivers, or even from the sea, ITT manufactures vertical turbine, submersible, mixed and axial flow pumps that can meet your requirements. Whether you need low head, high flow or the reverse, ITT has a pump to meet your needs. Vertical Turbine Pumps
Vertical Column Pumps

Burner (Boiler)

Our pumps and valves are designed to withstand a myriad of conditions, including corrosion, abrasion and extreme pressures and temperatures. ITT can meet your pump services needs, including boiler feed (LAC), discharge service (LCM), glycol circulating, descaling operations, and water treatment.
High Pressure, Multistage Ring Section Pumps
Axially Split Multistage Process Pumps
Multistage Ring Section Pumps
Vertical Turbine Pumps
Circular Volute Sump Pumps
Process Pumps
Vertical Can Pumps
Single Stage, Double Suction Pumps
ISO Chemical Process Pumps

Demineralization

The demineralizer process purifies water by the ion exchange method, reducing the amount of ions in the salt solution. Within this process, ITT demineralized water pumps (GHC, GHD) and weir diaphragm valves are utilized. ITT's Dia-Flo weir diaphragm valves are used extensively on demineralizers to provide water to the boiler front because of its clean, versatile design and ease of operation.

Multistage Pumps
Diaphragm Valves

Cooling, Circulating

ITT has a long list of references for pumps in main cooling water (PAC), secondary cooling water circulation (PC), intermediate cooling water circulation (PG), and blow down service (PS). Depending on performance requirements, NPSHR, and available pump space, ITT will supply the right pump for your service. ITT also provides valves (PAB, PCB, PGA, PGB) for processing cooling water systems.

Vertical Column Pumps
Vertical Turbine Pumps
Vertical Sump and Process Pumps
Heavy-Duty Process Pump
Process Pumps
Extra Large Capacity, Single Stage, Double Suction Pumps
Single Stage, Double Suction Pumps
Self-Priming Pump

Service Water

For handling service water intake (GAF) including recycled pond water, emergency drainage, and FGD waste treatment, ITT provides vertical turbine, submersible and multistage pumps. Depending on the NPSHR, performance, and space constraints, ITT offers the following pump types for this service.

Multistage Pumps
Vertical Turbine Pumps
Vertical Sump and Process Pumps

Circulating Water Pump

MHI Pump (Type MN, MKV, KPV) is Vertical, Mixed Flow pump, applicable to large capacity with having various varieties.

Fixed vane (Type : MN)

Variable pitch vane (Type : KPV)

Capacity	Approx. 100 to 160,000m³/h
Total Head	up to 50m
Speed	100 to 1,800rpm
Discharge Bore Diameter	300 to 4,100mm
Liquid Temperature	Normal

*) The above range is our supply record basis.
The specification over this range is also applicable.

[Features]

- Stable performance over whole capacity range
- Shop test using actual unit is available
- Well stocked research data for Performance, Vibration, Anti-corrosion Technique
- Hydraulic model test on water intake channel is conducted, pertinent advice for vortex-free, compact & safe pit design is available
- Various varieties are available

Flowserve feedwater pumps capable of optimization

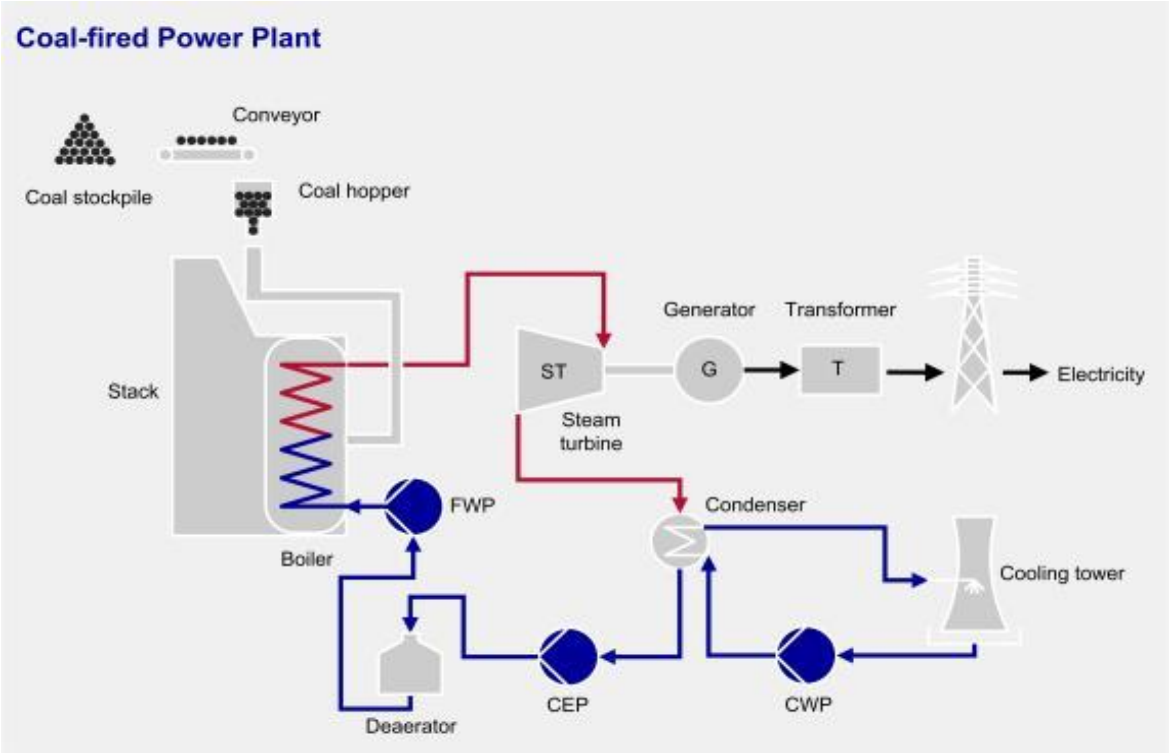
The Rewards of Pump System Optimization

Typically, when talk turns to power plant pumps, boiler feed and cooling water pumps immediately dominate the discussion. And that's as it should be: these pumps are critical to a plant's thermal efficiency and availability. They are also the most costly to produce, operate and maintain, so optimizing their efficiency is imperative. However, in terms of reliability and profitability for the entire plant, it is also prudent (and economically rewarding) to optimize pump system performance throughout the entire station. ***Revision Date:*** 9/8/2014 ***Tags:*** Flowserve, Boiler Feedwater Pump, Pump, Cost, Efficiency, Optimization, Power Engineering

Flowserve Boiler Feedwater pumps have beneficial features

This brochure describes pumps offered by Flowserve for combined cycle applications. Flowserve models DMX and WXH are commonly used for boiler feedwater to handle high pressures and fairly high flow rates. Flowserve models APKD and VPC are commonly used for condensate services. ***Revision Date:*** 8/19/2014 ***Tags:*** 221112 - Fossil Fuel 化石燃料, Flowserve, Pump, Boiler Feedwater Pump, Schematic, Flow Control, Boiler Feedwater Treatment

Sulzer feedwater, condensate extraction and cooling water pumps



FWP: Feed Water Pump. CEP: Condensate Extraction Pump CWP: Cooling Water Pump

Using Anti Vortex Vanes: Pump Symposia next week

- **CSP01: Eliminating Damage by Using Anti-Vortex Vanes**
- Author: Joseph Silvaggio, Jr. (Siemens)

- **Session Description**
- Damage to the end head was observed on the discharge end of boiler feed pumps. The damage was in the seal housing locating diameter area to the end head. This damage was determined to be “water wash” type damage due to the flow exiting from the balance drum area and swirling in the wedge area between the seal housing and end head bore. This swirling, vortex type flow was eliminated by using anti-vortex vanes mounted on the seal housing. After the anti-vortex vanes were implemented, the damage was eliminated

Components

Vibraton Problems with boiler feed pump- Pump Symposia next week

- **SP04: Piping Load effect on shaft vibration in a multi-stage barrel type boiler feed pump**
- Authors: Maki M. Onari (Mechanical Solutions, Inc.), Gary Krafft (HydroTex Dynamics, Inc.), Keith Munn (AEP Welsh Plant)

- **Session Description**
- Since 2009, a steam turbine driven boiler feed pump (TDBFP), installed in 1974 at a coal-fired power plant located near Pittsburg, TX, had been reported to have high shaft vibration (6+ mils pk-pk) at the pump inboard bearing (IBB), but mostly in the X direction (this pump has tilting-pad bearings with 7 to 9 mils diametral clearance). The vibration appeared to be p1opo1li011al lo l11e load of the plant and sensitive to the alignment. However, no apparent damage had been detected on the bearing or shaft journal. It was noticed that the wear rings of the 1A and 1B impellers had had over 3 mils or wear near 12 O'clock position.
- Thorough investigation revealed that the high vibration of the IBB-X probe of the pump was due to elevated preload on the shaft caused by excessive pipe strain in the vertical direction (suction and discharge piping). Severe pipe loading was observed during the warm-up of the pump and also while the load was increasing to 525 MW. In this particular case, the pump casing was acting as a pipe anchor/support. It was also determined that the vibration was not caused by resonance from a structural or lateral natural frequency nor an acoustic natural frequency. The change in vibration amplitude due to increase in speed appeared to be directly proportional, but the pump vibration did not reduce as the same rate as the speed. After reducing the piping loads, by correcting the suction pipe hangers, the overall vibration at the IBB X was reduced from 6.0 to 2.1 mils pk - pk at full load operation

Increasing cooling water capacity without problems or maintenance- Pump Symposia next week

- Authors: Georgi Ushev, Henry Huynh, Patrick Guy (Amec Foster Wheeler) and David Werth (Clemson Engineering Hydraulics)
-

- This presentation will walk the audience through a case study involving the increased flow rate through an existing, open circuit, cooling water pump intake system associated with the upgrade of a large cooling tower. Challenges include utilizing an existing cooling tower sump structure with increased cooling water pump capacity without an extended outage period or any major structural changes. The discussion will cover the use of physical modelling to better understand existing hydraulic issues and how it was used as a tool to develop remedial measures to avoid vortex activity.

VFD for pumps

- **Power Plant Pumps Webinar - Hot Topic Hour September 11, 2014**
- For power plant pumps, discussion was the ability of variable speed drives to potentially save power companies billions of dollars. There is evidence that power plants can use this technology and avoid installing cooling towers to meet the 316(b) water intake rules***Revision Date:*** 9/11/2014
- ***Tags:*** 221112 - Fossil Fuel 化石燃料, 221112 - Fossil Fuel 化石燃料, WEG, McIlvaine, Ekwestrel, Water Intakes, Variable Frequency Drive, Pump, 316(b), Energy Efficiency

Variable Speed Pumping in GTCC Power Plants by William Livoti, WEG - Hot Topic Hour September 11, 2014

- William Livoti of WEB recommended that power plants assess their pump requirements and consider variable speed drives to reduce energy consumption. He cited the advantages when handling off peak loads. A specific example was given for the VFD saving with cooling water makeup pumps. The number of pumps and potential savings is substantial***Revision Date:*** 9/11/2014
- ***Tags:*** 221112 - Fossil Fuel 化石燃料, 221112 - Fossil Fuel 化石燃料, WEG, Pump, Variable Frequency Drive, Energy Efficiency, Water Treatment

Siemens VFD pumps for 316B compliance

VFDs: An Attractive Investment for Circulating Water Pumps and a Possible Compliance Method

SIEMENS

Power Gen Industry Needs

Rule Compliance

- Proven impingement mortality reduction up to 85% and entrainment reductions up to 89%

Minimize Costs

- Only option with an ROI!
- Reduce energy consumption and improve electrical system performance

Up Time

- Eliminate start up system stress
- Low maintenance costs and high system reliability

VFDs offer many benefits, including:

- 316(b) Compliance
- Process System Performance
- Energy Efficiency
- Mechanical System Performance
- Return on Investment

Siemens Drive Technologies

VFD for pumps to improve process performance

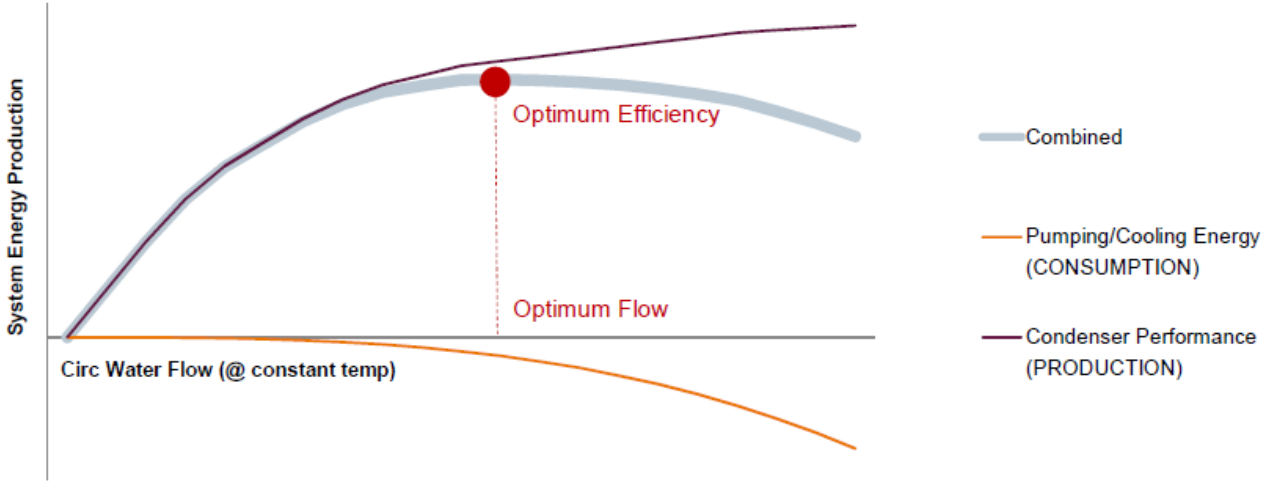
VFD Benefit #2
Process System Performance

SIEMENS

Process Performance

Example: Improved condenser performance

- Condenser efficiency is directly related to temperature and flow rate of the Condenser Circulating Water.
- Any deviations from the ideal flow will yield less-than-optimal efficiency
- Flow control can also minimize condenser subcooling by allowing the condenser to only cool to just below saturation temperature and avoid excess energy consumption for steam production



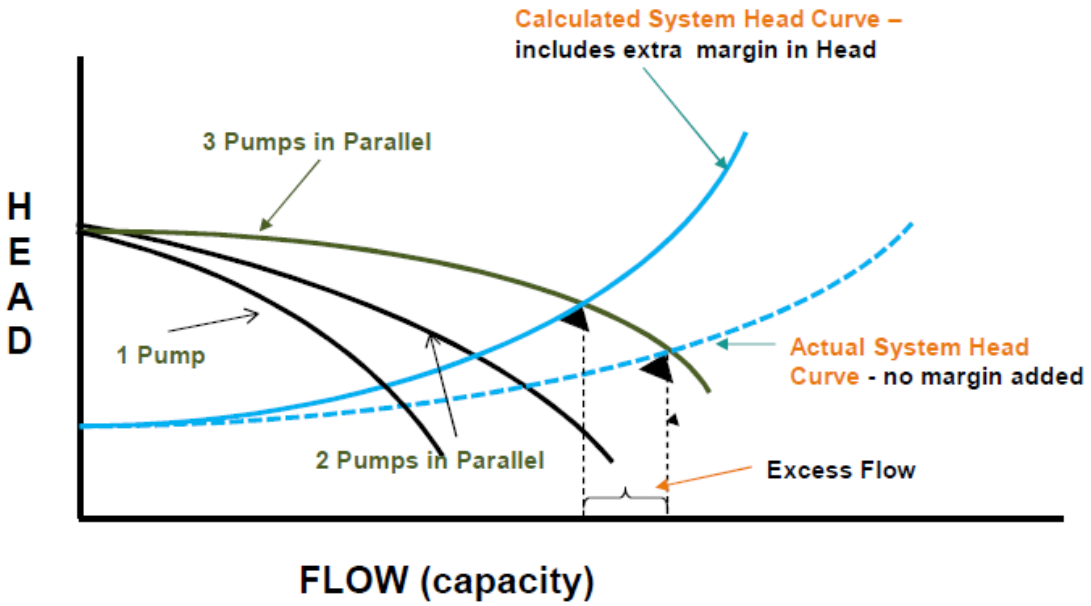
VFD for Energy Efficiency

VFD Benefit #3
Energy Efficiency and Savings

SIEMENS

Energy Efficiency and Savings

Excess flow means wasted energy…and money!



Pump Driver documents in Knowledge System

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.

Pump monitoring-ITT

- **Overview**
- Leveraging our 160+ years in process machinery design, manufacture, and operation, ITT PRO Services® has one goal - improving the profitability of your plant. Our products and services target your biggest issues of **process uptime**, **maintenance**, and **energy costs**.
- Our monitoring portfolio helps you to make the crucial decisions about your equipment before there is a problem.
- ***i-ALERT®*** was the first continuous monitoring device offered as a standard by a pump OEM. *i-ALERT* acts like a check engine light for your equipment.
- ***i-ALERT®2*** combines the latest in Bluetooth low energy and sensor technology into a rugged, safe, industrial certified package. *i-ALERT2* puts monitoring and diagnostics in the hands of everyday users, empowering anyone to safely monitor equipment from a distance.
- **ProSmart** provides continuous monitoring of your rotating equipment, that will proactively send you warning or alarm conditions 24/7.
- **PumpSmart** pump control systems provide real-time control and protection of your pumps while also providing valuable process insight. By protecting against unplanned pump failure due to process upsets, we can keep your process running longer and eliminate unplanned repair activities. By Right-Sizing your pumps to your system, we can reduce not only your energy consumption, but the wear and tear on your process system.

GE Intelligent platforms anticipate pump problems

- A problem identified by the SmartSignal solution occurred on a boiler feed pump at Dickerson Station . Mirant was notified of a step change in both x and y vibrations on a coupling. The Mirant Predictive Maintenance group confirmed the readings and recommended work on the coupling. The turbine/pump was tagged and isolated, and the coupling was replaced.
- the Proficy SmartSignal solution detected a potential problem on the recirculation valve on a feed pump at a Combined Cycle Power Plant. Given the current operating conditions, the Proficy SmartSignal solution was expecting the difference between the actual recirculation valve position and the demanded recirculation valve position to operate around 5%. However, actual values were seen to be operating as high as 8.5. and eventually reaching values as high as 20%. What was the underlying cause? The client found a failed converter on this valve and replaced it. What was the value to the client? Because of the early warning of this valve failure, the client had an opportunity to plan their maintenance action.

Power Plant Maintenance

Maintenance (Henkel)

Wear Factors

Wear factors to be taken care of during their equipment maintenance

Henkel coating applications

Ash Handling

Equipment	**Ash Slurry Pumps & Lines**	
Purpose	Removal of ash slurry (10:1 with water)	
Working conditions	Temp.	160-175^{o}F (70-80^{o}C)
	Wear Factors	1.Wet abrasion 2.Cavitation
	Other Maint. Issue	Thick slurry handling

Equipment function

- Centrifugal pumps are generally used for pumping ash slurry
- Ash clinkers are grinded by clinker grinder and mixed with water and pumped using these pumps
- Slurry lines are generally cast basalt lined
- Other important areas & equipment: Slurry pool with agitator

Henkel coating applications

Circulating Water Pump

Equipment	**Circulating Water Pump-Impeller & Casing**	
Purpose	Pumps cooling water through condensers	
Working conditions	Temp.	Ambient
	Wear Factors	1. Cavitations 2. Wet Erosion
	Other Maint. Issue	Efficiency of pumps

Equipment function

- **Stored water** from the pond is taken by **CW pumps to condenser**
- **Efficiency of these pumps** is critical which drops due to wear on internal parts
- Typically, power plant has **multiple CW pumps**
- Other important equipment: Circulating water make-up pump

Requlations, Associations, Conferences

ELG to be released by September 30

- On April 19, 2013, EPA proposed new effluent limitation guidelines (ELGs) under the Clean Water Act for fossil-fuel and nuclear power plants. The proposed ELGs set limits on the amount of pollutants that can be discharged into surface waters. EPA intends to coordinate the ELG rule with the CCR rule (below). A consent decree requires EPA to issue a final ELG rule by September 30, 2015. IMPACTS EPA estimates the proposal would cost $185 million to $954 million per year but would not cause any coal retirements.7 However, NERA's analysis for ACCCE indicates the proposed rule could cost approximately twice EPA's estimate and cause up to 10,000 MW of additional coal retirements.

5 options in new ELG will affect pump decisions

TABLE VIII–1—STEAM ELECTRIC MAIN REGULATORY OPTIONS

Wastestreams	Technology basis for the main BAT/NSPS/PSES/PSNS regulatory options							
	1	3a	2	3b	3	4a	4	5
FGD Wastewater	Chemical Precipitation.	BPJ Determination.	Chemical Precipitation + Biological Treatment.	Chemical Precipitation + Biological Treatment for units at a facility with a total wet-scrubbed capacity of 2,000 MW and more; BPJ determination for <2,000 MW.	Chemical Precipitation + Biological Treatment.	Chemical Precipitation + Biological Treatment.	Chemical Precipitation + Biological Treatment.	Chemical Precipitation + Evaporation
Fly Ash Transport Water.	Impoundment (Equal to BPT).	Dry handling ...	Impoundment (Equal to BPT).	Dry handling ...	Dry handling ...	Dry handling ...	Dry handling ...	Dry handling
Bottom Ash Transport Water.	Impoundment (Equal to BPT).	Impoundment (Equal to BPT).	Impoundment (Equal to BPT).	Impoundment (Equal to BPT).	Impoundment (Equal to BPT).	Dry handling/ Closed loop (for units >400 MW); Impoundment (Equal to BPT)(for units ≤400 MW).	Dry handling/ Closed loop.	Dry handling/ Closed loop
Combustion Residual Leachate.	Impoundment (Equal to BPT).	Impoundment (Equal to BPT).	Impoundment (Equal to BPT).	Impoundment (Equal to BPT).	Impoundment (Equal to BPT).	Impoundment (Equal to BPT).	Chemical Precipitation.	Chemical Precipitation
FGMC Wastewater	Impoundment (Equal to BPT).	Dry handling ...	Impoundment (Equal to BPT).	Dry handling ...	Dry handling ...	Dry handling ...	Dry handling ...	Dry handling
Gasification Wastewater.	Evaporation	Evaporation	Evaporation	Evaporation	Evaporation	Evaporation	Evaporation	Evaporation
Nonchemical Metal Cleaning Wastes[19].	Chemical Precipitation.	Chemical Precipitation.	Chemical Precipitation.	Chemical Precipitation.	Chemical Precipitation.	Chemical Precipitation.	Chemical Precipitation.	Chemical Precipitation

Ash Handling

Reclamation of worn out end cover saved replacement cost

Equipment	Ash slurry pump
Product	Loctite Wear Resistant Putty, Loctite Pneu Wear
Application	Rebuilding and protective coating

Saved replacement cost

Situation

- **Pump casing was worn out** due flow of ash slurry
- Reduced efficiency and leakages

Solution

- Use **Loctite Wear Resistant Putty** rebuild and to original geometry, and top coat of **Loctite Pneu Wear** for abrasion resistance

Benefits

- Saved replacement cost of casing
- Improved efficiency of output

Associations and conferences

Pump Users Group	Focused on pumps for nuclear plants with yearly EPRI conference
Pump Summit	Houston, 2016, (Mcilvaine is on steering committee)
Pump Users	Houston September 2015
Power –Gen Exhibitors • Buffalo pump • Cat Pump • Denmar Pump Services • Hempel • Mitsubishi	Las Vegas , December 2015 • Progress Pump and Turbine Services • Pumps & Systems Magazine • Schneider Electric • Siemens • SPX • Sulzer • Victaulic

Gas Turbine Associations with pump data

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.)

Presentation at Pump Users, Sept 15-17 in Houston

Increase Cooling Water System Capacity Without Introducing Problems and Maintenance

- this presentation will walk the audience through a case study involving the increased flow rate through an existing, open circuit, cooling water pump intake system associated with the upgrade of a large cooling tower. Challenges include utilizing an existing cooling tower sump structure with increased cooling water pump capacity without an extended outage period or any major structural changes. The discussion will cover the use of physical modelling to better understand existing hydraulic issues and how it was used as a tool to develop remedial measures to avoid vortex activity.

Authors: Georgi Ushev, Henry Huynh, Patrick Guy (Amec Foster Wheeler) and David Werth (Clemson Engineering Hydraulics)

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- Author: Joseph Silvaggio, Jr. (Siemens)
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