by Thomas Tschanz

Pumping Power

As Energy Needs Rise, So Too Do Pump Applications

In the current (or ending) economic recession – depending on your take of things – there have been a few market sectors, including pharmaceutical, municipal wastewater, desalination, and power generation, that have fared better than most. According to McIlvaine Company's Pump World Markets report, the global power generation sector remains a hot spot for pump applications for the foreseeable future, with demand in China and India being particularly high. Drivers of pump growth in the power segment include:

- Population growth and standard of living improvements;
- Increased industrialization;
- Growth in energy-intensive processes, such as desalination of seawater
- Replacement of aging power plant equipment; and
- Growth in sales of liquid-slurry scrubbing systems to remove NOx, SO2, CO2, mercury, and other airborne pollutants from utility flue gas.

The opportunities for pumps in power generation are most evident in a year-over-year analysis of projected megawatt growth by country. Another indicator of pump sales can be found in projections for new and retrofit flue-gas scrubbing systems. These systems are heavy users of slurry, dewatering, and metering pumps. The growth in scrubbing systems is being driven by a worldwide focus on improved air quality and reduction of greenhouse gas emissions. This growth bodes well for pump suppliers because the power sector is among the largest consumers of pumps among all industries. A breakout of pump markets is shown in Figure 1. This article will focus on pump opportunities within the power sector.

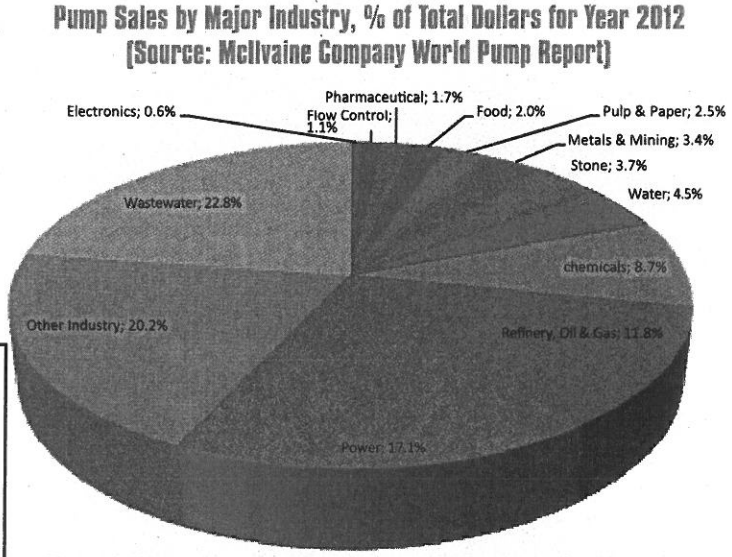


Figure 1. *Worldwide pump sales (percent of total pump dollars) by industry for the year 2012.*

Power Plant Pumping Systems

For the purpose of this article, pumps in power plants will be segmented into two basic systems:

- Primary pumps for application in the water/steam cycle; and
- Secondary pumps for water treatment, equipment lubrication, and other ancillary systems

An inventory of major pump systems for a 400 MW coal-fired power plant is shown in the table below. This is an approximate representation, and will vary by plant.

Primary System Pumps: These pumps include large centrifugal pumps used for boiler feed, condensate extraction and condenser cooling.

In a typical utility power plant, each cooling water circulation pump is rated 100,000 GPM or more. These pumps provide condenser-cooling water that is drawn from a nearby lake, river or even the ocean in seawater-cooled systems.

The boiler feed pump operates in the range of 6,000 GPM for

Plant System	Pump Application	Liquids Handled	Generic Pump Technology	Approx. Pump Capacity for 400 MW Reference Plant (GPM)	Approx. Number Per 400 MW Reference Plant
Primary System Pumps	Boiler Feed	Water	Centrifugal	6,000	1or 2
	Condensate Extraction	Water	Centrifugal	3,000	2
	Cooling Water Circulation	Water	Centrifugal	110,000	2
	Cooling Water Makeup	Water	Centrifugal	5,000	1
Secondary System Pumps	Water Treatment (feedwater, cooling water, wastewater)	Chemicals	Metering	<1	25 to 30
	Chemical Transfer (storage tanks to day tanks)	Chemicals	Centrifugal	50	10 to 15
	Ash sluice handling	Slurry	Centrifugal, AODD	1,500	1
	Flue Gas Desulfurization (FGD), circulation	Slurry	Centrifugal, AODD	48,000	4
	Flue Gas Desulfurization (FGD), bleed	Slurry	Centrifugal, AODD	750	2
	Equipment Lubrication	Lubricants	Gear	20	15 to 20
	Fuel unloading & transfer	Fuel Oil	Gear, Vane, Screw	800	2 or 3
	Service water	Water	Centrifugal	7,000	2 or 3
	Fire service	Water	Centrifugal	1,000	2 or more

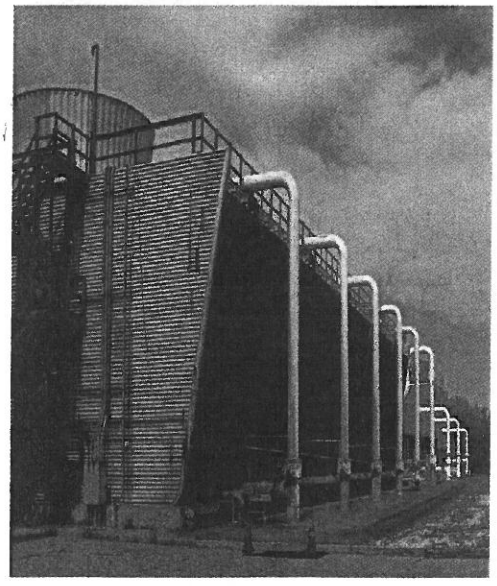
Table 1. *Coal-fired power plant pumps for primary and secondary systems*

a 400 MW plant, and at an operating pressure of 2,400 PSI for a conventional boiler. The current trend in power generation, however, is toward the use of higher efficiency boilers known as super-critical or ultra-super-critical boilers. These boilers operate at substantially higher pressures in the range of 3,000 PSI to 6,000 PSI and place additional demands on boiler feed pumps.

Condensate pumps are sized to collectively handle the condensate load based on boiler feed rate. Typically two or more condensate pumps are required per plant. Flow capacities are typically in the thousands of gallons per minute.

Pumps in these primary applications are most commonly of the centrifugal type. Critical requirements include high reliability, long service life, and serviceability.

Suppliers of pumps include Flowserve (*www.flowserve.com*), ITT (*www.itt.com*), KSB (*www.ksb.com*), Sulzer (*www.sulzerpumps.com*), Torishima (*www.torishima.co.jp*), Weir Minerals (*www.weirminerals.com*), and others.



An example of a forced-draft cooling tower installation.

Secondary System Pumps: These pumps are quite prevalent in the power generation segment, and offer a greater representation of pump technologies than that which is represented in the primary system.

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.

The trend is for increasing numbers of secondary pumps in power plants, particularly to support scrubbing systems for flue gas. Flue gas scrubbing requires slurry pumps, chemical metering pumps and a support network of chemical transfer pumps. The greatest regional opportunities for scrubbing systems are in areas with high percentages of "unscrubbed" power plants as shown in Table 2 below.

Country	Percent of Coal-Fired Power Plants Currently "Unscrubbed" (Source: McIlvaine Company FGD Report)
South Africa	100%
Russia, Belarus, Kazakhstan, Ukraine, Uzbekistan	99%
India	96%
Canada	74%
Eastern Europe	56%
United States	41%
Japan	31%
UK	28%
Germany	14%

Table 2. Coal-fired power plants currently without flue gas scrubbing systems

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.iwaki america.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.

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.

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.

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.

Transfer Pumps for Water Treatment Chemicals: 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.

Other Pumps: Other pumps found in power plants include service water pumps, fire-suppression pumps, HVAC system pumps, sump pumps, and many others. These pumps are typically centrifugal pumps with a broad range of flowrates, ranging from thousands of gallons per minute for service water pumps to less than 100 gallons per minute for small HVAC pumps.

From the foregoing discussion, it is apparent that power plants include large numbers of pumps, ranging from the very large centrifugal pumps for cooling water and boiler feed water down to small metering pumps or gear pumps for chemical injections and lube oil circulation.

The large installed base of power plants throughout the world, combined with the "new builds" in power plants and flue-gas scrubbing systems provide significant growth opportunities for pump suppliers over the foreseeable future. The highest regional growth can be expected in Asia (China and India), while expansion of flue-gas scrubbing systems for NOx and SO2 can be expected more uniformly, but with a concentration in the countries listed in Table 2. Flue-gas scrubbing for carbon capture and sequestration (CCS) is another area of potentially significant opportunity for pump sales that is currently in the embryonic stage, and that will continue to be carefully tracked by industry observers over the upcoming months and years.

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