Technology Focus

This section was edited by Executive Editor Harry Hutchinson.

FLUID HANDLING & FLUID POWER

SUPPLY IT YOURSELF

WHAT CAN A COMPANY DO WHEN MOST OF ITS SUPPLIERS NO LONGER DELIVER WHAT IT NEEDS? For one manufacturer, the answer is to start making a key component itself.

Weldmac Manufacturing Co. in El Cajon, Calif., makes assemblies and components for customers in aerospace and process industries, including operators of pipelines and power stations.

A 52-inch-long assembly of a piping segment by Weldmac contains two bellows. Each has a 12-inch interior diameter and is made of two plies of Inconel 625, each 0.03-inch thick. It is designed for slurries at temperatures to 1,650 °F at 30 psi. It can handle compression up to 6.5 inches and lateral movement of 2.5 inches.

According to Weldmac's president, Marshall Rugg, one component that the company had sourced from suppliers was the bellows that it needed for some assemblies. The bellows is an accordion-pleated segment built into pipelines, for instance, to accommodate expansion and vibration. Structures such as pipelines in the desert or the exhaust systems of large turbines, which undergo great changes in temperature, are subject to significant expansion and contraction as they heat and cool. The bellows absorbs the deformation. Its pleats also allow for lateral movement to absorb vibration.

Rugg said Weldmac's experience in buying bellows over the years was marked by inconsistent quality. Workmanship could vary from piece to piece from the same manufacturer, he said. There were also problems with shipping damage.

"We've had many suppliers over the years," Rugg said. Most of the good ones, though, have shut down or been sold off.

When the company recently needed a bellows to fill a customer's order, Kim Healy, a Weldmac engineer in charge of outside sales, said the company decided to design digitally controlled equipment to produce the bellows it needs in-house.

The nature of the Weldmac's business is that each piece is made to order. And because the company is used to working to tight aerospace specifications, Weldmac promises that the dimensions of the product are repeatable within 0.005 inch.

The company is set up to manufacture bellows in a range of materials and in as many as four plies. Weldmac can make bellows of 100 inches or more in diameter.

The product has application in "wherever you have vibration, temperature change, and fluids," Healy said.

A CENTRIFUGAL COMPRESSOR TO PUSH HYDROGEN

A contractor working for the U.S. Department of Energy to develop a large-scale centrifugal compressor for hydrogen pipeline transmission says it expects to finish Phase 1—the computational analysis and engineering design—by the end of this year. The contractor, Concepts NREC in White River Junction, Vt., is working on a three-year project to design an approximately 8,000-hp compressor that will be considerably smaller and more efficient than compressors currently in use on hydrogen pipelines.

Fred Becker, director of engineering sales for Concepts NREC, said the aim of the project is to design a compressor that can move 240,000 kg of hydrogen a day at pressures up to 1,200 psi. Current hydrogen pipelines carry process gas, not fuel, and typical hydrogen compressors capable of moving this volume are large reciprocating units occupying 500 to 600 square feet.

There is concern that lubricants needed by reciprocating compressors can seep into cylinders and contaminate the hydrogen. Lubricant contamination would present problems in a future hydrogen supply line for fuel cells.

Two advantages of using a centrifugal compressor, Becker said, are that the machine's footprint would be about 150 square feet, and lubrication cannot come in contact with process fluid. A centrifugal compressor also allows higher compression efficiency than reciprocating machinery for an equivalent duty.

As Becker explained, there are several challenges in designing a compressor for the job. Compression using a centrifugal compressor increases with the speed of the impeller tips and with the number of stages. Compressing hydrogen, with its low molecular weight, to the desired discharged pressures demands high-strength impellers that can hold up at very high speeds if the compressor is to have a reasonable number of stages.

In selecting materials, engineers had to rule out titanium. Although it is strong and light-weight, and is used in many high-performance turbomachines, titanium is subject to hydrogen embrittlement. Steels that resist embrittlement are heavy.

"That has pushed us in the direction of aluminum," Becker said.

The physical properties of hydrogen also present a problem. Hydrogen, H_2, has molecular weight of 2; air is mostly nitrogen, with an approximate molecular weight of 28—a factor of 14 greater. To compress hydrogen to the same degree as air by increasing tip speed alone would require an increase by a factor of about 3.7 (the square root of 14). That would be impractical.

Right now Concepts NREC is aiming to run aluminum impellers at a tip speed of about 2,250 feet per second through five or six stages to reach target compression. The compressor will start with hydrogen at about 300 psi and will push the average hydrogen compression ratio per stage by approximately 1.3:1 to arrive at a discharge pressure of 1,200 psi.

By way of comparison, were one to use this pump to compress air instead of hydrogen, Becker said, a tip speed of 2,250 feet per second would increase the compression by a factor of about 15 per stage. A typical compressor increases air pressure only 2.5 times per stage.

The project began on June 1, 2008, and Phase 3 is schedule for completion in June 2011.

Phase 2 will end with delivery of more detailed engineering analysis, designed as if for production, Becker said. Concepts NREC is using advanced engineering design software called Agile Suite that it has developed specifically for turbomachinery and which the company also sells.

The deliverable for Phase 3 will be validation testing. Becker said the company may build perhaps two stages of a six-stage compressor for testing at full scale. The project has a total value of $4 million.

GEOTHERMAL AND A GREEN HUMMER

GEOTHERMAL POWER PLANTS AND ELECTRIC VEHICLES MAY SEEM TO BE VERY DIFFERENT TECHNOLOGIES. But they have this in common: a Utah-based company is developing both. Since we first wrote about Raser Technologies Inc. last year, the company has made some headway. Raser has begun to supply electricity to the city of Anaheim, Calif., from a geothermal site in southwest Utah. And the company has introduced a modified Hummer H3 that it claims can average more than 100 miles per gallon of gasoline.

The company began in April to deliver electricity from the Hatch Geothermal Power Plant, in Beaver County, Utah. Raser said the Hatch Plant is named after Utah's long-serving U.S. Senator, Orrin Hatch.

A plug-in hybrid Hummer uses a drive system developed by Raser Technologies with a partner, FEV Inc. It has a range of 40 miles before the combustion engine starts to drive the electric generator.

The company has a 20-year purchase agreement with Anaheim. According to Issa Arnita, director of investor relations at Raser, the company is in the process of getting its well field up to speed and expects to be operating at full capacity of 10 to 11 MW of electricity before the year ends.

The company's goal is to add about 100 MW of capacity a year, Arnita said. The slowdown in the economy has affected the availability of funding, he said, but Raser is in talks with other potential buyers of its electricity. One possible plan to raise capital is to offer customers long-term purchase agreements at low rates in return for up-front seed money for development.

The Raser geothermal system uses a power generation technology called PureCycle from United Technologies' Pratt & Whitney Power Systems to generate electricity from groundwater heated naturally to temperatures up to 300 °F. This is a lower temperature than most geothermal resources that are being tapped at present.

On the automotive front, Raser introduced a plug-in hybrid Hummer at the SAE International World Congress in Detroit in April. The SUV, which the company calls an E-REV, or extended-range electric vehicle, uses a drive system developed by Raser in cooperation with FEV Inc. of Aachen, Germany.

According to Raser, the plug-in hybrid Hummer, which has a range of about 400 miles, can drive as far as 40 miles exclusively on batteries before the combustion engine kicks in to start the generator. The company claims that most vehicles drive fewer than 40 miles a day, so average drivers could use the vehicle for days without burning any gasoline, so long as they recharge the batteries at night.

The claim that the E-REV can get the equivalent of more than 100 miles per gallon is based on an average over time, the company said. In addition, the company has said that by using electricity from its geothermal fields to charge an electric vehicle it could demonstrate a "well to wheels" strategy.

HOLISTIC HVAC RETROFIT
By Don Talend

THE LAKESHORE CAMPUS OF CHICAGO'S LOYOLA UNIVERSITY HAD BEEN PLAGUED FOR YEARS BY AN OUTMODED COOLING AND HEATING SYSTEM. Some buildings were cooled less efficiently than others, and the campus lacked central HVAC control.

One proposed fix would have required a costly new underground pipe network. Instead, the university opted for a retrofit of the system that not only needed no new pipes, but has saved about $30,000 a month in energy costs.

The upgraded chilled water plant at Loyola University in Chicago.

The old chiller plant had three centrifugal chillers—a roughly 30-year-old unit rated at 1,250 tons and two newer 750-ton units—in a traditional constant-flow chilled water distribution network. The retrofit replaced the older unit with two more 750-ton chillers.

Other additions were a 3,000-ton, three-cell cooling tower with 30-hp fans with variable frequency drives; three 100-hp chilled water pumps shared by the four 750-ton chillers in a variable-prime piping arrangement to the campus buildings and air handler cooling coils; and three 75-hp condenser water pumps with VFD motors and shared by the four 750-ton chillers in a variable-prime piping arrangement to the cooling towers.

The system relies on centralized control of chilled water throughout the distribution network via a BACnet software program. University staff can adjust the chiller plant equipment from a networked computer or a handheld wireless device.

Don McLauchlan of Elara Engineering, which worked on the retrofit project, said that the new system improved chiller efficiency, and can now use 42 °F water, two degrees cooler than the previous system.

Using flow optimization enabled the team to keep upfront costs down, because existing piping could be used. In buildings with dual-temperature hydronic systems, the pumps that are kept off during cooling are turned on during heating to circulate the water in a closed loop through existing steam to hot water heat exchangers.

The retrofit team consisted of Nancy Hamill Governale of Facilities Research, North Barrington, Ill.; Elara Engineering of Hillside, Ill.; Delta Controls Chicago; and Wayne Sliwa, senior project manager with Loyola.

Don Talend of Write Results Inc., West Dundee, Ill., is a writer who specializes in technology and innovation.

PUMPED LEVEL

A market research firm predicts that, despite the recession, sales of pumps in 2009 will remain at the 2008 level of $32 billion worldwide. Substantial reductions in revenues in some markets will be matched by gains in others, according to the forecast reached by the McIlvaine Co. in its latest edition of Pumps World Markets.

According to the forecast, centrifugal pumps will be the biggest product group, at almost $24 billion in revenues. Rotary pumps, at nearly $3.8 billion, will be the second largest group. Sales of diaphragm pumps will total almost $2.8 billion, and reciprocating pump sales will be $2.3 billion.

Some sectors that buy pumps, such as municipal water and municipal wastewater services, will show increases. Combined, these two markets will generate $12 billion in revenues, the McIlvaine Co. said. Infrastructure investment spurred by economic stimulus funding in the U.S. and China are the main drivers for the projected market increase.

Conversely, the power market will remain flat, and there will be decreases in chemicals, mining, metals, refinery, stone, and pulp and paper.

Regionally, Asia will show modest increases whereas the European market will shrink.

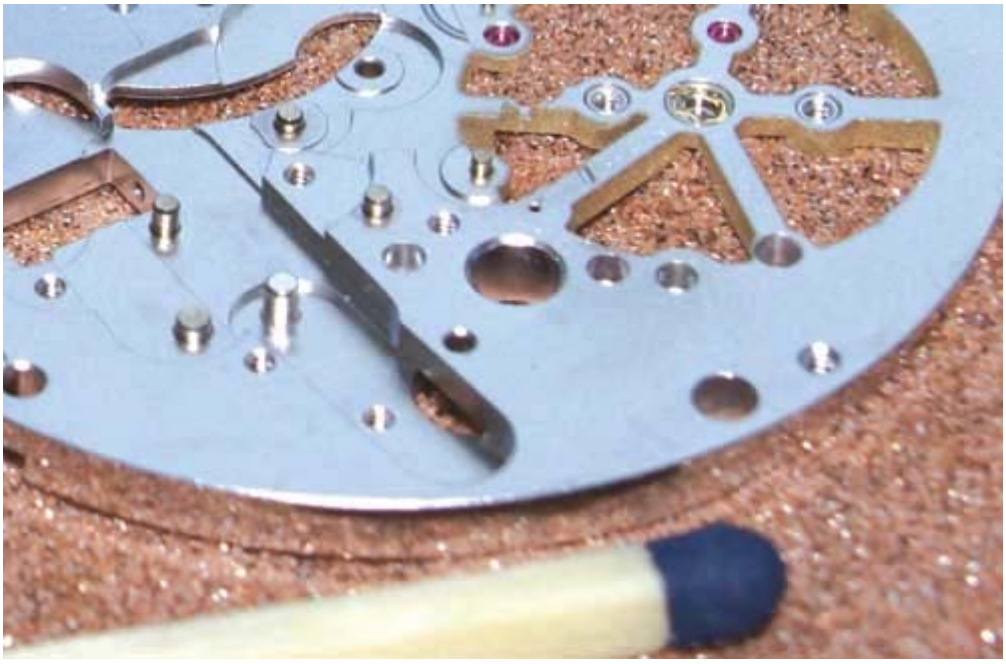
The research firm says the report, which is available for a fee online, looks at more than 500 pump companies and analyzes markets in 80 countries. Details on Pumps World Markets and other McIlvaine Co. products are available at http://www.mcilvainecompany.com.

PRECISION WATERJET CUTTING

A COMPANY FORMED IN NORTH CAROLINA IS BRINGING TO THE UNITED STATES A MICROMACHINING SERVICE THAT APPLIES ABRASIVE WATERJET MACHINING WITH WHAT THE COMPANY CLAIMS IS “LASER-LIKE ACCURACY.” The company uses machines developed by a Swiss company, Waterjet AG in Aarwangen.

The new company, Micro Waterjet LLC, is a joint venture of Waterjet AG and Daetwyler Corp., the machine builder in Huntersville, N.C.

According to Micro Waterjet, its abrasive waterjet micromachining capabilities can handle workpieces as large as 600 by 1,000 mm and hold tolerances to 0.01 mm.



Cuts were made in this watch base plate after the rubies went in.

Steve Parette, who is in charge of sales for the new company and for Daetwyler custom fabrication and machining, said Micro Waterjet will be offering machining services. The precision waterjet cutting machinery is not offered for sale, at least for the present time.

According to Parette, the connection between Daet-wyler and Waterjet goes back some time. As a machine builder, Daetwyler was a customer of Waterjet, which provided machining services.

Later, when Waterjet developed its high-precision machines, it hired Daetwyler to build them.

Micro Waterjet is circulating photos of some of its work. One photo shows a watch base plate next to a match head. Along with intricate cutouts the plate contains a number of rubies. According to Parette, the cutouts in the plate had to be made after the rubies where pressed into place. The rubies needed to be pressed into the solid blank. Had the operation taken place after the cuts were made, the workpiece would have been more susceptible to

deformation.

According to Micro Waterjet, its machinery is an advance over conventional abrasive waterjet cutting, in which abrasive particles are added to an accelerated water stream that can be used to cut metals. Among the advantages of waterjet cutting is that there are no heat-affected zones or residual stresses on the cut surface.

The company says its process is a refinement of the conventional waterjet process by a factor of 10. The waterjet diameter, or kerf, is reduced by a by factor 5, to 0.2 mm. The company claims a positioning accuracy of +/-3 µm.