EDITION **No. 4 | 2013**

TECHNEWS

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Project report LLNL-Supercomputer

This project report has been prepared by our American partners and informs about the tender and installation of a pipe-system for the data processing system of the most powerful super computer in the world.
An extremely critical application relies on aquatherm PP-R-pipes for cooling.

Project	Products Used	Location / Date
Lawrence Livermore National Laboratory, HVAC	climatherm®	Livermore, California - 2012

The Challenge

Specifying and installing a piping system into the data center housing the world's most powerful supercomputer.

Aquatherm Advantages

- Provided $2 million dollar project savings
- Leak-proof heat fusion joints are fast, simple, and reliable
- Chemical inertness ensures complete campatibility with sensitive equipment

The Solution

Aquatherm's PP-R pipe offered all of the benefits of plastic (cost savings, easier installation, improved flow) without any fumes, glues or chemicals used during installation.

Lawrence Livermore National Laboratory (LLNL) is an enduring symbol of America's scientific and military proficiency. Located in Livermore, California, LLNL's stated mission is strengthening U.S. security through development and application of world-class science and technology to:

- Enhance the nation's defense;
- Reduce the global threat from terrorism and weapons of mass destruction;
- And respond with vision, quality, integrity and technical excellence to scientific issues of national importance

In an effort to achieve this mission, LLNL has continually sought to lead the world in terms of computing power. It recently realized that goal. According to Top 500® Supercomputers (http://www.top500.org/):

"For the first time since November 2009, a U.S. supercomputer sits atop the TOP500 list of the world's top supercomputers.
Named Sequoia, the IBM BlueGene/Q system installed at the Department of Energy's Lawrence Livermore National Laboratory achieved an impressive 16.32 petaflop/s on the Linpack benchmark using 1,572,864 cores. Sequoia is also one of the most energy efficient systems on the list..."
Sequoia is not only the biggest supercomputer in the world, but also the most efficient, and is number 1 on the Green Top500. In designing Sequoia and its supporting infrastructure, LLNL's engineers sought a more compact physical footprint
than other supercomputers while also using LEED Gold certification as a guideline.

A No-Weld Spec

When designing the piping for the cooling system, LLNL engineers were primarily concerned with addressing potential cost savings in the piping system. While the computer manufacturer initially required that the piping be either stainless steel or copper, LLNL engineers developed a plan in conjunction with the computer manufacturer to research the use of plastic piping materials.

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An additional goal was mitigating fumes and particles that are introduced into a space during the process of welding of metal pipe. While this specification ruled out metal pipe systems and limited the options to plastic, a side benefit was that using plastic would provide better flow rates. LLNL officials were aware of a number of highly engineered plastic pressure pipe systems, but were only vaguely familiar with a proven, yet new-to-North-America pipe system: Aquatherm.

EMCOR Services Mesa Energy Systems (Irvine, California) was one of the bidding mechanical contractors and had recently been introduced to the German-manufactured Aquatherm systems. With nearly 30 years of experience in HVAC maintenance, service, building automation systems services, and commercial HVAC and retrofit contracting, EMCOR/Mesa has earned a reputation for innovation and providing value to customers. EMCOR, working in conjunction with LLNL engineers, decided to use the Aquatherm. After much research, this resulted in a $2
million dollar project savings.

All about Fusion

Heat fusion is essential to Aquatherm's success: it bonds both sides of a joint into a single, homogenous material without the use of chemicals or mechanical connections – eliminating systematic weaknesses and fail points in the pipe.

Serving as the prime contractor on the job, EMCOR/Mesa and their subcontractors participated in a factory training provided by Sustainable Building Products and Aquatherm at EMCOR/Mesa's Hayward, California shop.

Stringent H2O Requirements

The computer manufacturer had established strict water treatment requirements for the cooling system and Aquatherm's chemical inertness played a key role in meeting that requirement. Due to the cleanliness of the piping, the system was not exposed to any foreign oil or material from the pipe. If steel had been used the oil residue would not have met the specification. Also had PVC been used there was a risk that the glue overflow would have possibly clogged the computer coil.

The mechanical team did experience a learning curve in working with the fusion connections, but overall the installation went quite smoothly.

Installing Aquatherm allowed the designers and installers to comply with the specifications of plastic type piping and deliver a good product to the lab in addition to helping LLNL achieve Environmental Management Systems (EMS) goals and standards. Use of the pipe is also expected to assist in the facility's 2015 LEED™ point re-certification.

The German-manufactured pipe has been one of the world's most durable and greenest piping systems for nearly four decades and proven successful in 70-plus countries. Aquatherm piping systems offer many performance and environmental
benefits, such as:

- Eliminating toxic materials, glues and resins, and open flames from the piping installation equation
- An R-value of 1 or greater depending on pipe size and SDR
- The fusion welding process, which creates seamless connections that last a lifetime without leaking or failing
- An optional faser-composite layer in the pipe reduces linear expansion of the pipe by up to 75% compared to plastic piping

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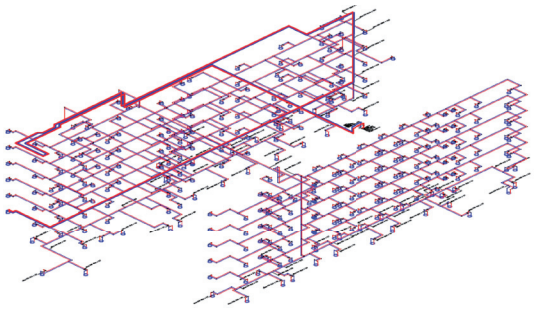
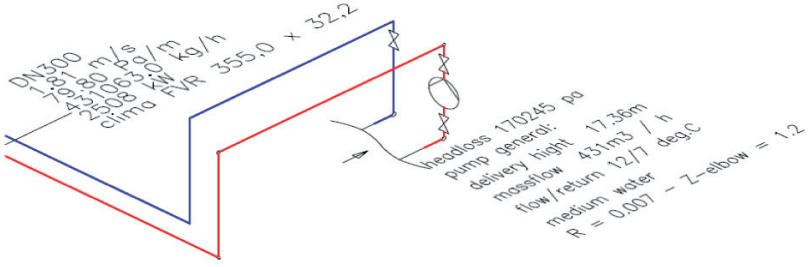
Pressure drop and pump power: Comparison of Climatherm pipe SDR 11 and steel pipe DIN 2456 by means of a specific project

Even in the planning phase, due to the almost constant low pipe roughness of aquatherm pipe systems, pump capacities and dimensions can be selected smaller than for steel pipe systems with expected incrustation. Even with lower energy costs – e.g. outside Germany – the savings potential is clearly evident. Furthermore the life period of aquatherm pipe systems can be expected much longer.

Based on this finding a sample project has been selected, which was already calculated and installed with climatherm pipes in 2009/10.





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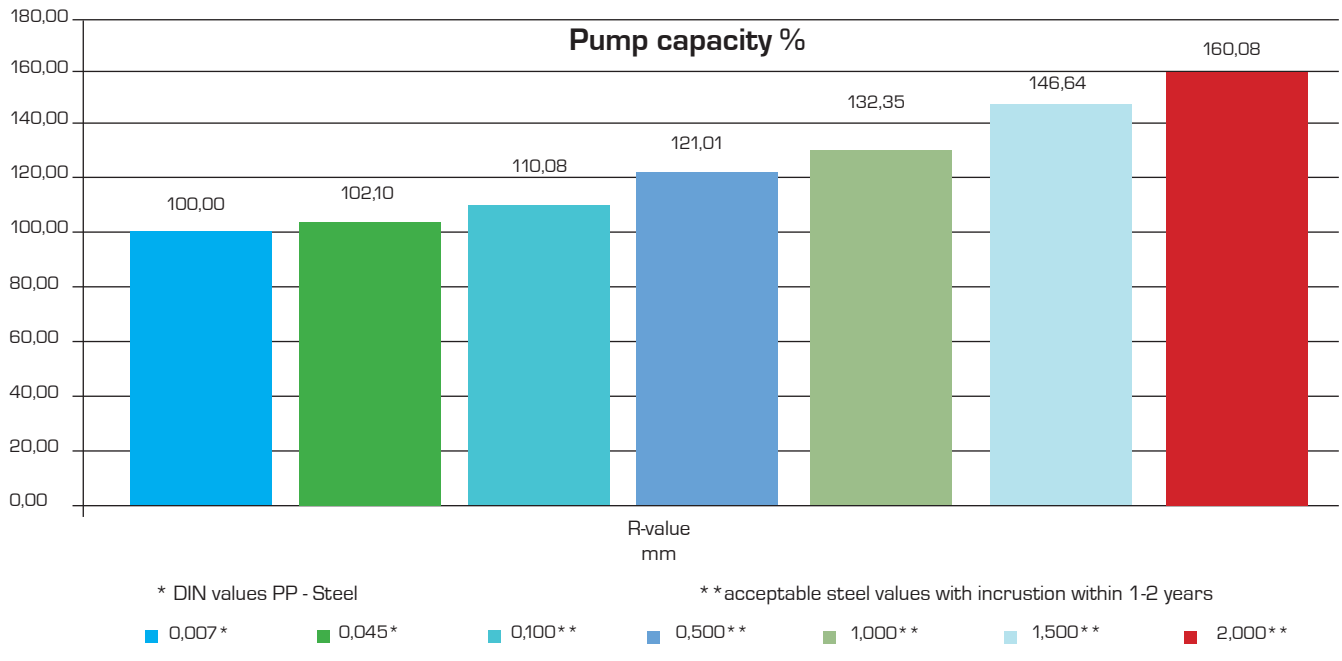
This is a chilled water network with an output of 2508 kW and a mass flow of 431 m^3/h at temperatures of 7/12 °C F/R and up to 2 m/s velocity.
The calculation data (headloss / pump delivery hight) for climatherm pipes so were available. Now for comparison the same system was calculated with steel pipe in various stages of incrustation. R-value 0.045 (DIN) up to 2.00 mm and Zeta-values for the bows from 1.2 up to 4.2.

Chilled water network 2508 KW, 431m²/h at 7/12°C flow/return
Medium water with max. velocity 2 m/s

Pipe type	Dimension DN	Inner Diameter mm	R-value mm	Z-value elbows	Total headloss PA	Headloss difference %	Pump delivery hight m	Pump type example	Pump capacity KW	Pump capacity %
climatherm SDR11	25 - 300	26,2 - 290,6	0,007*	1,20	170245	100,00	17,36	SCP200/310	23,8	100,00
steel DIN 2456	20 - 300	22,9 - 312,7	0,045*	1,20	172771	101,48	17,62	SCP200/310	24,3	102,10
steel DIN 2456	20 - 300	22,9 - 312,7	0,100**	1,80	183036	107,51	18,67	SCP200/310	26,2	110,08
steel DIN 2456	20 - 300	22,9 - 312,7	0,500**	2,40	205296	120,59	20,93	SCP200/310	28,8	121,01
steel DIN 2456	20 - 300	22,9 - 312,7	1,000**	3,00	227528	133,65	23,20	SCP200/310	31,5	132,35
steel DIN 2456	20 - 300	22,9 - 312,7	1,500**	3,60	253134	148,69	25,81	SCP200/310	34,9	146,64
steel DIN 2456	20 - 300	22,9 - 312,7	2,000**	4,20	280505	162,36	28,60	SCP200/310	38,9	160,08

*DIN values / ** acceptable values with incrustion within 1-2years (reduced ID not considered)



According to the latest industry standards a reduction of the pipe internal diameter by incrustation of 3 % per year is accepted. This is significantly more than the underlying roughness in the calculation in table 1 of not more than 2 mm.

So from the calculation resultant increased pressure drop, associated with the corresponding increase in pump head, leads to a higher energy demand by about 60 %. This relates to the selected Wilo pump SCP200/31/HA and on the assumption that the 2 mm incrustation is reached after about 2 years. The reduced internal pipe diameter was not considered yet.

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SCP 200/310HA-30/4-T4-R1-ROHS/E1
Anlage: Split case pump

WILO

Kunde	Projekt
Kunden Nr.	Projekt Nr.
Ansprechpartner	Positions-Nr.
Bearbeiter	Einbauort
	Datum 12.12.2012

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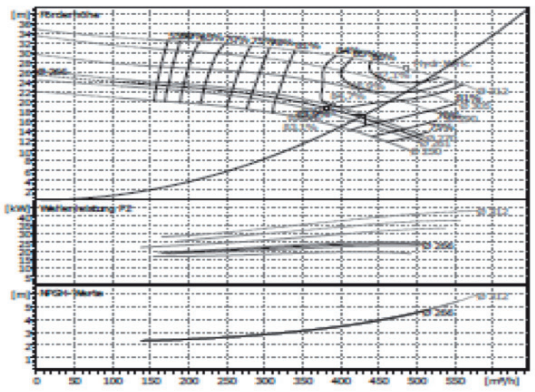

Betriebsdatenvorgabe

Förderstrom	431	m³/h
Förderhöhe	17,36	m
Fördergut	Wasser	
Fluidtemperatur	10	°C
Dichte	0,9996	kg/dm³
Kinematische Viskosität	1,367	mm²/s
Dampfdruck	0	bar

Pumpendaten

Fabrikat	WILO
Typ	**SCP 200/310HA-30/4-T4-R1-ROH**
Konstruktionsart	Split case Pumpe
Anlagenart	Einzelpumpe
Nenndruckstufe	16 bar
Min. Fluidtemperatur	-8 °C
Max. Fluidtemperatur	120 °C

Hydraulische Daten (Betriebspunkt)

Förderstrom	425	m³/h
Förderhöhe	16,9	m
Wellenleistung P2	23,8	kW
Drehzahl	1460	1/min
NPSH	3,69	m
Laufraddurchmesser	266	mm

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SCP 200/310HA-55/4-T4-R1-ROHS/E1
Anlage: Split case pump

WILO

Kunde	Projekt
Kunden Nr.	Projekt Nr.
Ansprechpartner	Positions-Nr.
Bearbeiter	Einbauort
	Datum 04.01.2013

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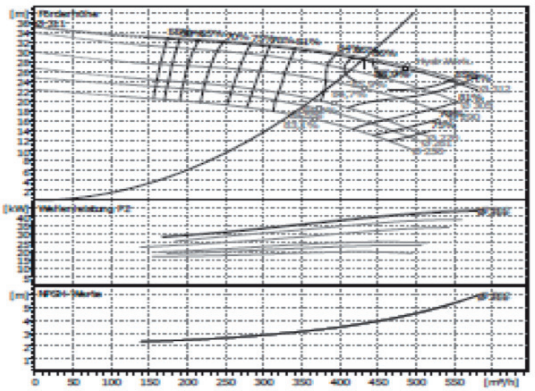


Betriebsdatenvorgabe

Förderstrom	431	m³/h
Förderhöhe	28,6	m
Fördergut	Wasser	
Fluidtemperatur	10	°C
Dichte	999,6	kg/m³
Kinematische Viskosität	1,367	mm²/s
Dampfdruck	0	bar

Pumpendaten

Fabrikat	WILO
Typ	**SCP 200/310HA-55/4-T4-R1-R**
Konstruktionsart	Split case Pumpe
Anlagenart	Einzelpumpe
Nenndruckstufe	16 bar
Min. Fluidtemperatur	-8 °C
Max. Fluidtemperatur	120 °C

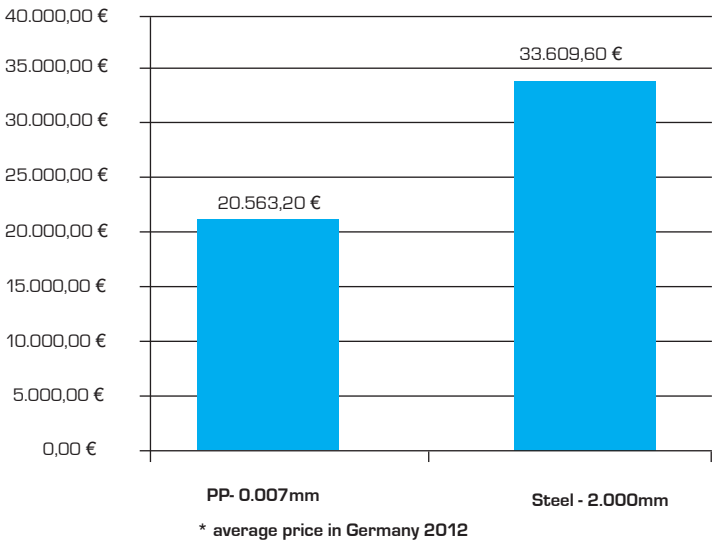
Hydraulische Daten (Betriebspunkt)

Förderstrom	430	m³/h
Förderhöhe	28,5	m
Wellenleistung P2	38,9	kW
Drehzahl	1470	1/min
NPSH	3,75	m
Laufraddurchmesser	311	mm

This now results in potential energy savings of about € 12,600 per pump/year, basing on German average electricity prices for the corresponding decrease/size of building.

Theoretical power cost saving potential
Expected pump operating time 4320 h/y

Total power consumption KWh	Expected price* per KW/h €	Power cost per year €	Power cost saving per year €
102816	0,20 €	20.563,20 €	0,00 €
104976	0,20 €	20.995,20 €	432,00 €
113184	0,20 €	22.636,80 €	2.073,60 €
124416	0,20 €	24.883,20 €	4.320,00 €
136080	0,20 €	27.216,00 €	6.652,80 €
150768	0,20 €	30.153,60 €	9.590,40 €
168048	0,20 €	33.609,60 €	12.614,40 €



* average price in Germany 2012