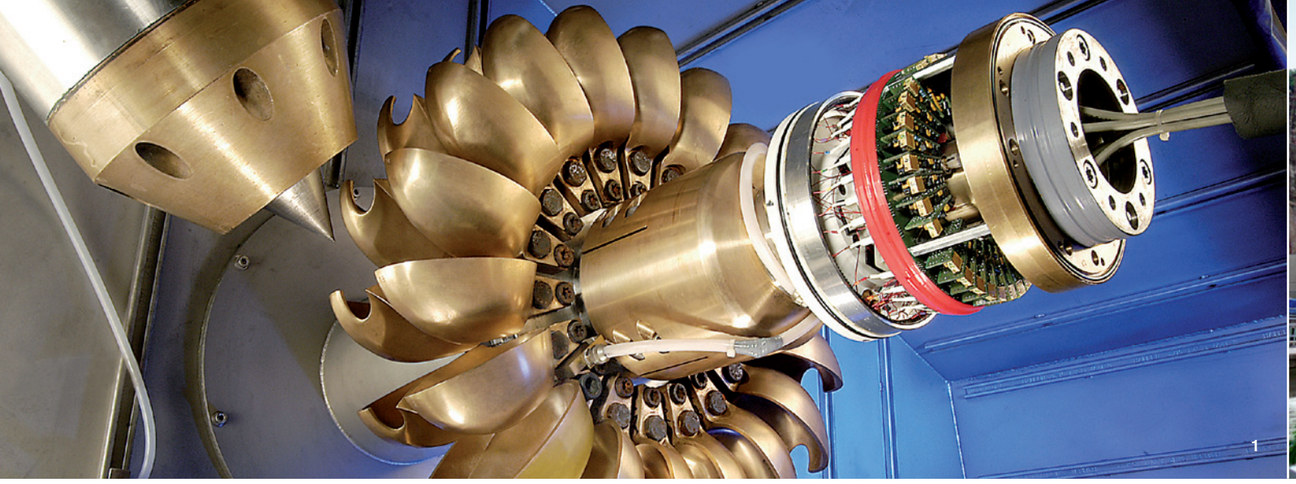
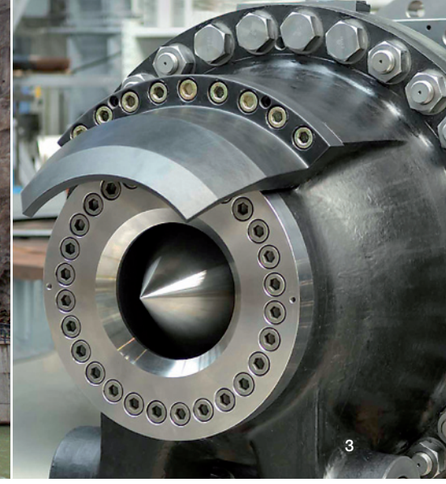
VOITH

Pelton turbines





Cover picture Machined bucket backside, Workshop, St. Pölten, Austria

1 Model test set up for dynamic measurements

2 Akköy, Turkey

3 Pelton nozzle

Harnessing the power of water
with engineered reliability

Generating electricity from the power of water represents large amounts of clean, renewable energy. 71 percent of the earth's surface is covered by water. The world's hydropower potential amounts to 20 billion Megawatt hours per year and only 25 percent of this has been developed so far.

Hydropower is not only environmentally friendly, but also cost-effective. Hydropower plants have the highest operating efficiency of all renewable generation systems. They are largely automated, and their operating costs are relatively low. Hydroelectric power plants also play an important role in water resource management, flood control, navigation, irrigation and in creating recreation areas.

Voith is an industry leader in the production of generators, turbines and the associated control systems to put the power of water to work. A range of services, from engineering through manufacturing and project management to commissioning, completes our portfolio as one of the world's leading hydropower product and service provider.

As part of our international network each Voith facility is equipped with consistent best-in-class processes and tools. This network also ensures that we can meet special customized requirements: from individual components to project planning, through project management and plant maintenance. With branches and production facilities for electrical and hydraulic machines and components in Europe, Asia, North and South America we are close to our customers and active in all major hydropower markets worldwide.

With more than 140 years experience in the field of hydropower and major achievements in research and development, Voith is well equipped to continue delivering excellence in hydropower in the years to come.

Engineered reliability
Is our promise to our customers. Our products and services are designed specifically for our customers' needs. Always efficient and economical and, above all, following our values and visions for sustainable hydropower solutions.

Competence and capabilities
- Consulting, engineering, erection and commissioning
- System/plant assessments
- HyService – global, fast and effective for modernization and rehabilitation of existing hydroelectric power plants
- Complete equipment, installation and services for hydroelectric power plants
- Francis, Pelton, Kaplan, Bulb/Pit/S-turbines, pump-turbines, standard and customized products
- Storage pumps, radial, semi-axial and axial-flow pumps
- Generators and motor-generators for constant and adjustable speed, excitation systems
- Frequency converters, protection systems, switchyards for all voltages, transformers
- Power plant automation, control centers for hydropower plants and cascades, including plant management and diagnostic systems
- Shut-off valves
- Integrated Management System to safeguard excellence and quality

Characteristics and latest technology

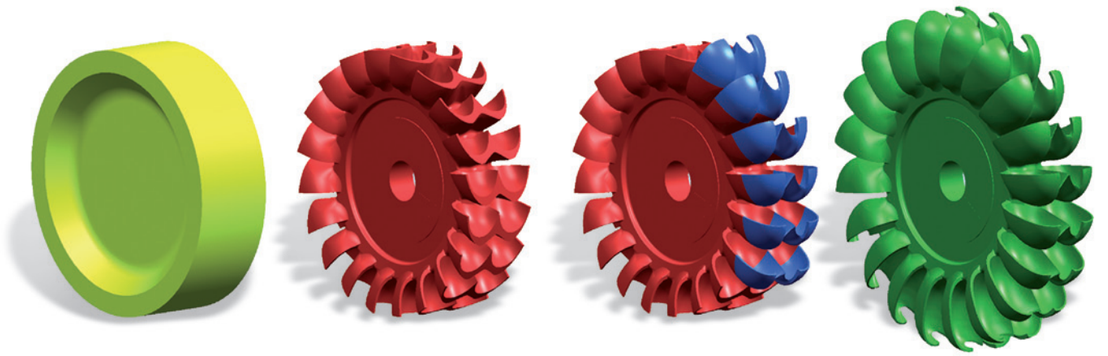
From the beginning, the development of Pelton turbine technology has been synonymous with Voith. Since the turn of the 19th century, Voith have supplied thousands of Pelton turbines, including large and powerful machines. These turbines are in service around the globe in many hydropower plants.

The flow simulation of Pelton turbines is by far the most complex and difficult of all hydraulic turbo-machinery simulations.

Pelton turbines involve a number of special flow characteristics which are extremely difficult to simulate. The jet-to-bucket interaction is fully transient and depends on the geometry of the moving buckets. Even more challenging is the multiphase system of air and water that governs the formation of the free jet and the flow through the buckets. In the past, developing a flow simulation that would allow a realistic analysis of these phenomena seemed to be an impossible task.

A broad manufacturing program offers an economical solution for any requirement. Large, custom-built Pelton turbines for high output ranges are our speciality, but we also offer a full line of cost-effective standard machines for small hydropower plants.

Pelton runner made of forged disc/welded-on bucket heads, manufacturing steps



Step 1: forged disc machined

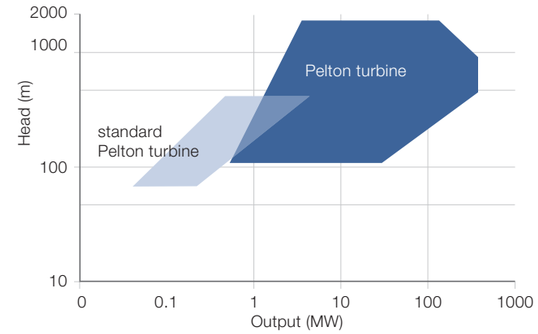
Step 2: milled root area

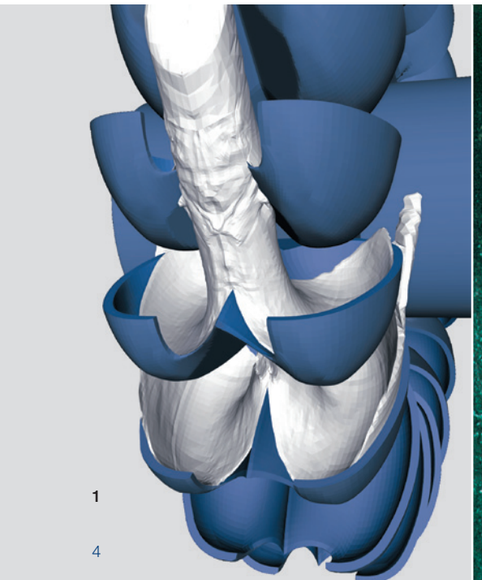
Step 3: bucket head welded

Step 4: finished mashined runner

Voith numerical development group has overcome the major problems of simulating typical free water jet and bucket flow for Pelton turbines. Simulation results and experimental data have shown a remarkable congruence. Today, designers have new insights into complex jet, bucket and casing flow phenomena providing a solid basis for the development of new bucket profiles that result in improved performance.

Application range





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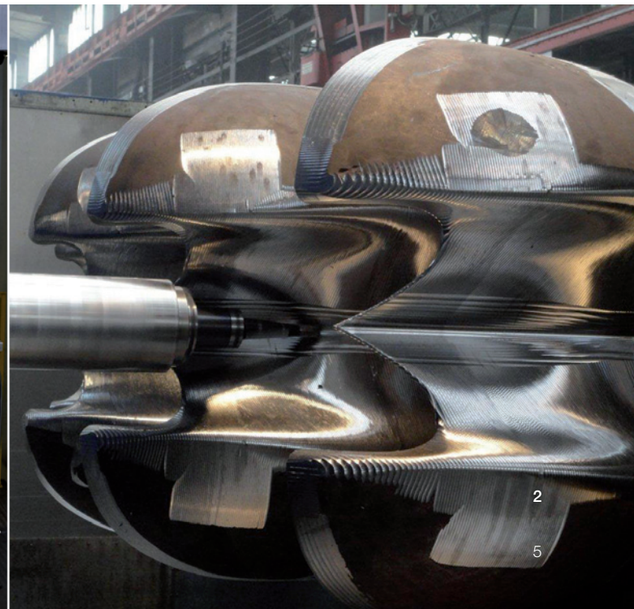
1 Simulated flow through Pelton runner

2 Actual flow through model

1 Manufacturing step 2, Workshop, St. Pölten, Austria

2 Manufacturing step 4, Workshop, St. Pölten, Austria

1



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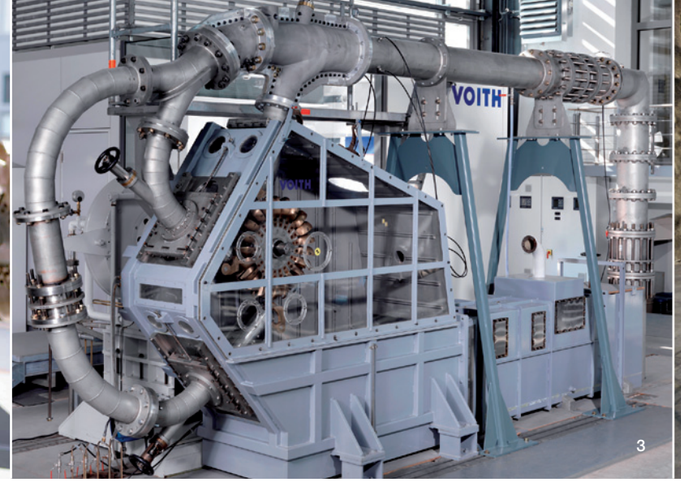

1 San Giacomo sul Vomano, Italy

2 Sedrun, Switzerland

3 Modernized Pelton model test rig, Germany

4 Gilgel Gibe Powerhouse, Ethiopia

1870 Hydro turbine manufacture began.

1903 First Pelton turbine.

1924 Walchensee power plant, Germany:
First high-head power plant in the country with 18 MW Francis double-spiral turbines and twin 15 MW Pelton turbines.

1960 Naturns, Italy:
Pelton turbine at a head of 1129 m.

1964 New Colgate, USA:
Largest Pelton turbines at that time with 5.44 m outside runner and 1.1 m bucket width.

1972-1977 Chivor, Colombia:
Largest Pelton power plant in the country at that time with eight 151 MW units.

1985 Carona, Italy:
Three horizontal Pelton turbines were replaced by one 48 MW vertical machine while preserving historical structures.

1998 San Giacomo sul Vomano, Italy:
One of the most powerful Pelton turbine at that time with an output of 282 MW, a runner diameter of 4.4 m, a jet diameter of 315 mm and a bucket width of 1.1 m.

2001-2002 Breakthrough in 3D-simulations for Pelton turbines.

2003 Gilgel Gibe II, Ethiopia:
Four vertical, six-jet Pelton turbines, each with a rated output of 105 MW at a net head of 487 m.

2007 Sedrun, Switzerland:
Large rehabilitation project with seven runners and 12 nozzles.

2008 Extensive modernization of Pelton test facility at Corporate Technology Center in Heidenheim, Germany.

2008 Akköy II, Turkey:
One of the highest head Pelton applications worldwide with two 117 MW Pelton turbines at 1220 m head.

2008 Zaramag 1, Russia:
Two 176.5 MW Pelton turbines with runner diameters of 4.2 m at a head of 635 m.

2012 Kops I, Austria:
Modernization and uprating of three horizontal twin Pelton turbines to 96 MW at a head of 776 m.

2012 Alfalfal II, Chile:
Two 135.6 MW Pelton turbines at a head of 1122.6 m.

2012 Las Lajas, Chile:
Two 135.2 MW Pelton turbines at a head of 465 m.

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