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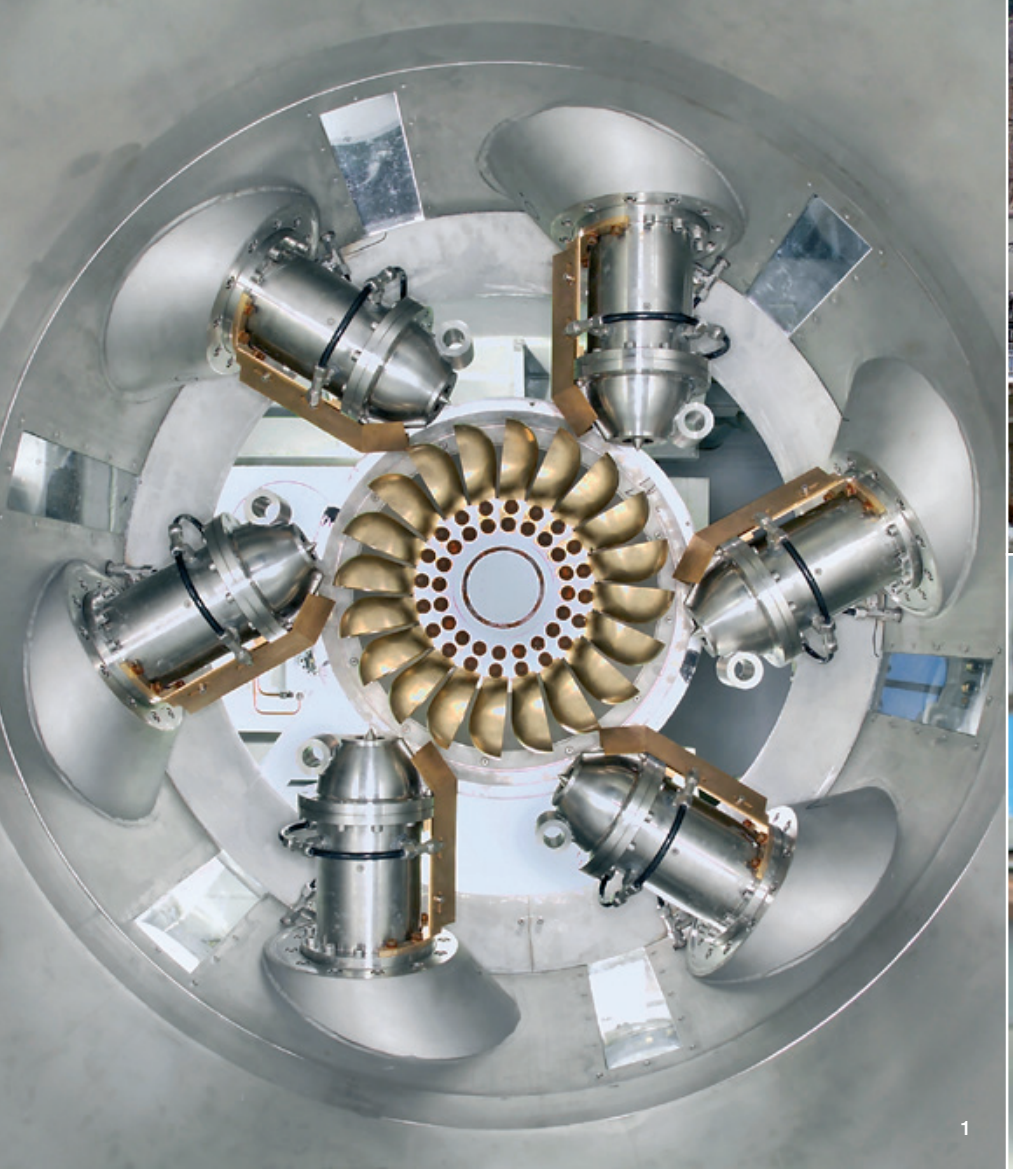
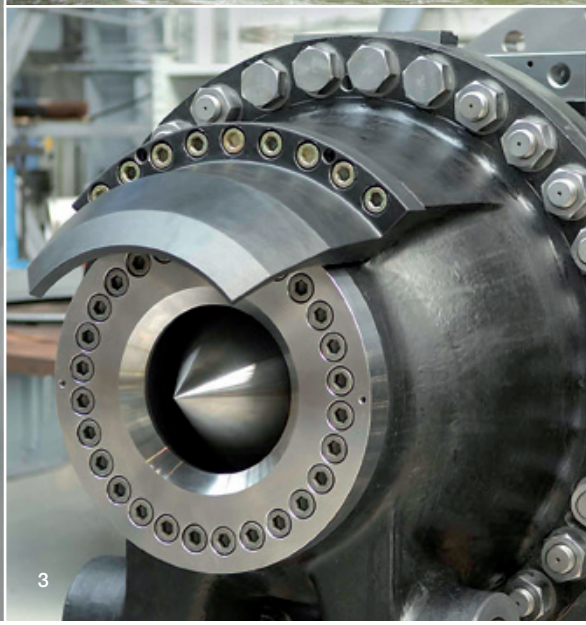
VOITH

Pelton turbines





Harnessing the power of water

Generating electricity from the power of water represents large amounts of clean, renewable energy. Seventy-one percent of the earth's surface is covered by water. The world's hydropower potential amounts to 20 million Gwh/a and only 25 percent of this has been developed so far.

1 Model test set up for dynamic measurements

2 Akköy, Turkey

3 Pelton nozzle

Hydropower is a clean, renewable and environmentally friendly energy source – with low carbon dioxide emissions. Hydropower plants have the highest operating efficiency of all renewable energy 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 recreational areas.

Voith is a leading full-line supplier as well as trusted partner for equipping hydropower plants. Voith develops customized, long-term solutions and services for large and small hydro plants all over the world. Our portfolio of products and services covers the entire life cycle and all major components for large and small hydropower plants, from generators, turbines, pumps and automation systems, right through to spare parts, maintenance and training services, and digital solutions for intelligent hydropower.

As part of our international network, each Voith facility operates under the same cutting-edge platform and 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.

Using state-of-the-art technologies, innovative digital solutions, and more than 150 years of experience, we are committed to developing customized long-term solutions for both large and small hydropower plants.

Technical reliability

This 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, Propeller, Deriaz, Bulb/Pit/S-turbines, pump turbines, standard and customized products, small to large size, rehab and new
- 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
- Digital solutions for intelligent hydropower

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 has 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.

The 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.

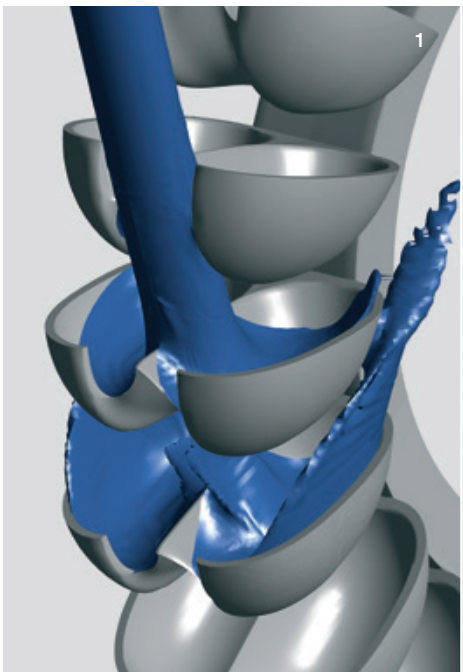
Today, designers have new insights into complex jet, bucket and casing flow phenomena providing a solid basis for the development of new bucket profiles that result in improved performance.

1 Simulated flow through Pelton runner

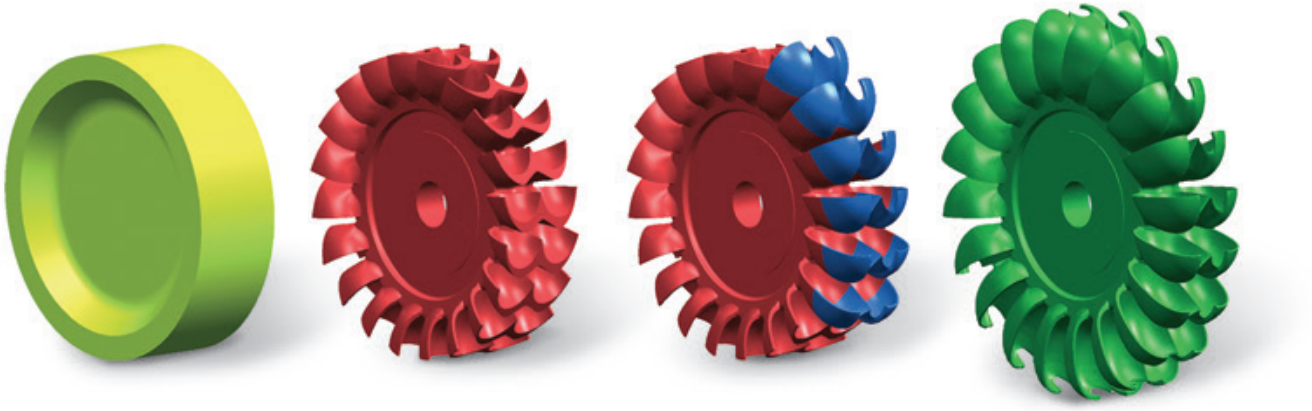
2 Actual flow through model

3 Disc for welded manufacturing strategy, Workshop, São Paulo, Brazil

4 Disc for fully milled manufacturing strategy, Workshop, St. Poelten, Austria



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



Step 1:
forged disc machined

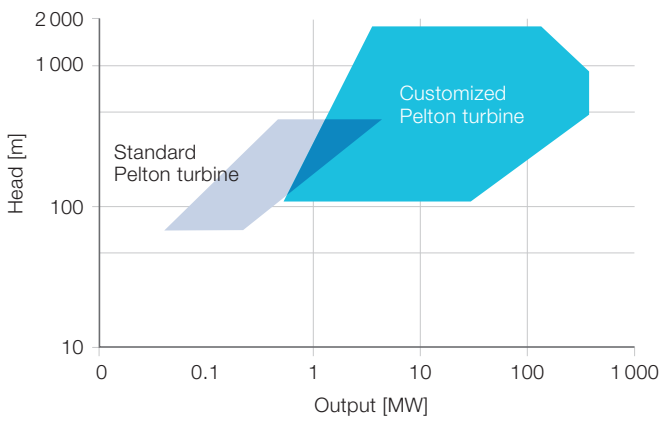
Step 2:
milled root area

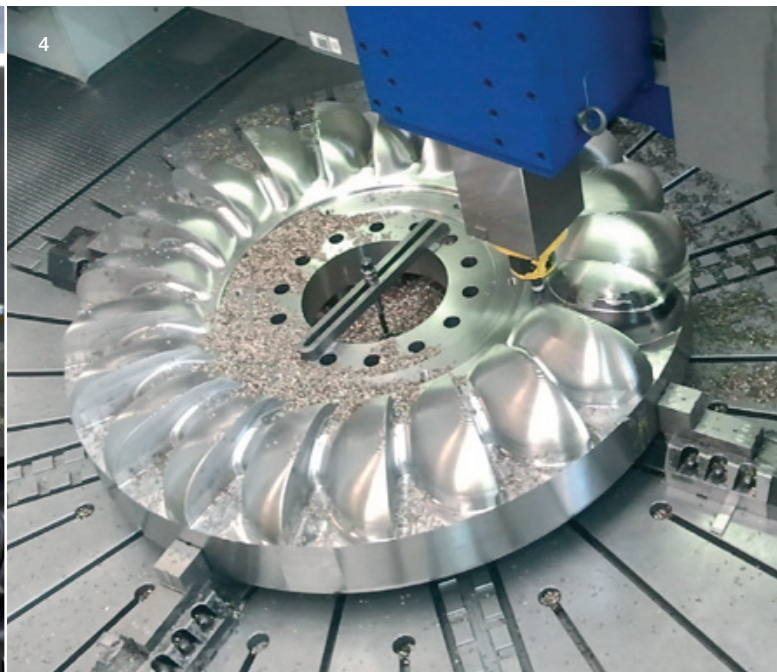
Step 3:
bucket head welded

Step 4:
finished mashined runner

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.

Application range





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1870 **Beginning of the hydropower turbine manufacturing.**

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.

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 turbines at that time with an output of 28 MW, a runner diameter of 4.4 m, a jet diameter of 315 mm and a bucket width of 1.1 m.

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 a head of 1220 m.

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

1 Gilgel Gibe Powerhouse, Ethiopia

2 Sedrun, Switzerland

3 Modernized Pelton model test rig, Germany

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.

2015 Los Condores, Chile:
Two six-jet units with a rated output of 89.6 MW operated at a head of 699 m.

2017 Nikachu, Bhutan:
Two four-jet units with a rated output of 66.2 MW operated at a head of 520 m.

2019 Ritom, Switzerland:
Two new units, one running at 500 rpm (16,7 Hz) and 750 rpm (50 Hz) each with a rated output of 62.66 MW operated at a head of 809 m.

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