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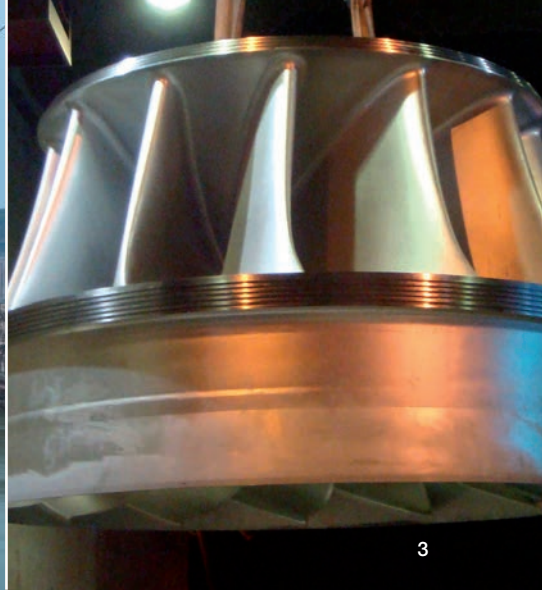
VOITH

Francis Turbines

Cover picture Francis Runner, Workshop, Brazil

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.



1 Xi Luo Duo, China
2 Omkareshwar, India
3 San Esteban II, Spain

Engineered reliability

Is our promise to our customers. Voith's products and services are designed specifically for our customers' needs. We always work efficiently and economically 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

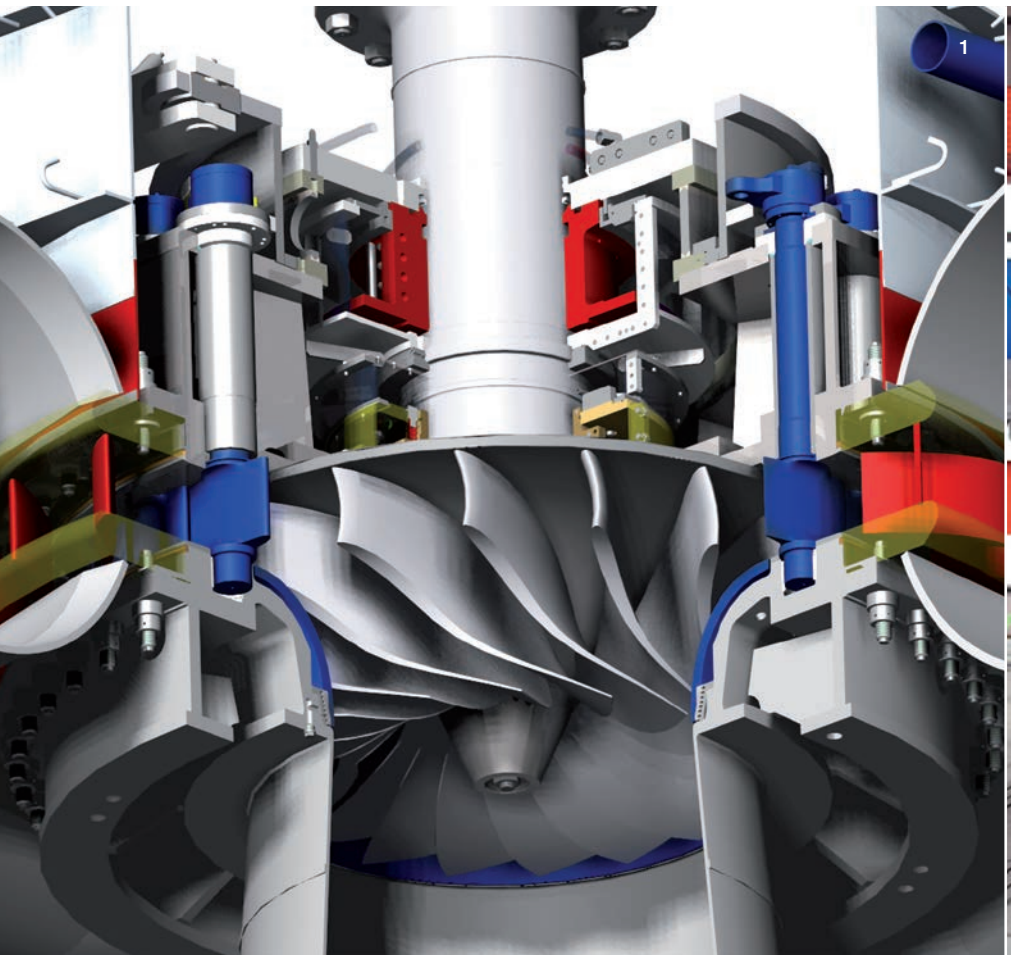
From the beginning, Francis turbine development has always been synonymous with Voith.

With decades of continuous optimization based on the latest hydro-dynamic research, well over half the turbines manufactured by Voith are of the Francis type.

Our Francis turbines, including the world's largest and most powerful, are in service around the globe. What better testimony to our more than 140 years of hydro turbine experience?

1 Francis turbine 3D model

2 Xi Luo Du, China

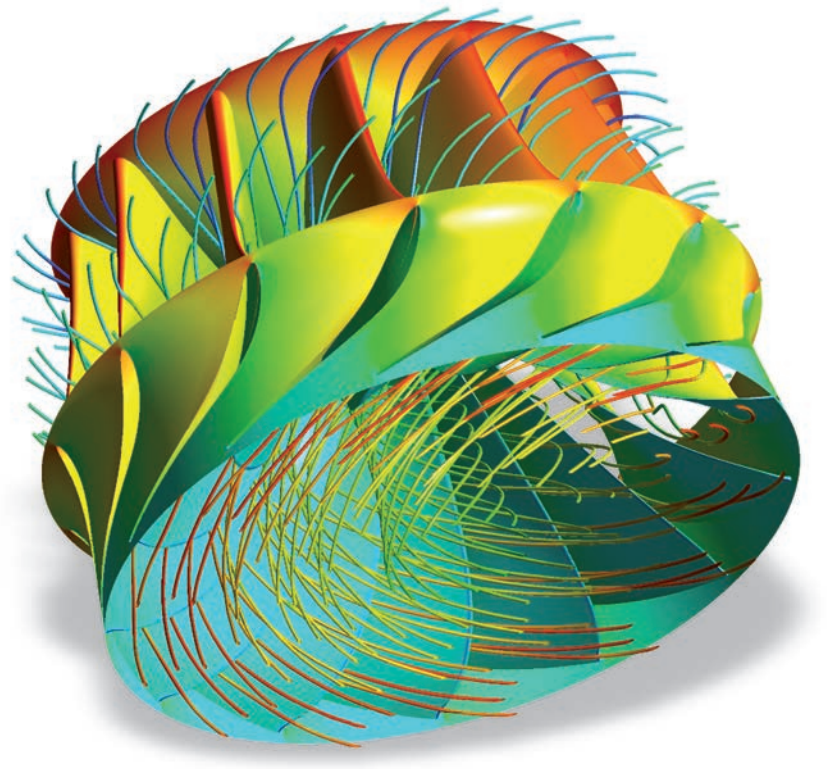


Numerical development methods linked to computer-aided manufacturing processes guarantee optimum hydraulic performance and reliability.

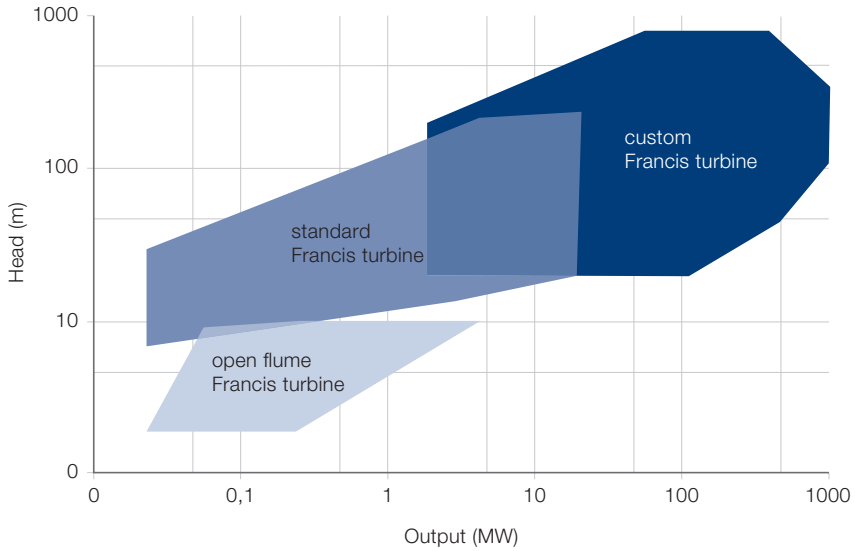
Francis turbines are used primarily for medium heads and large flows applications. Their special hydraulic characteristics result in relatively high-speed compact units, right up to the largest capacities.

Voith also supplies cost-effective Francis units in standardized designs and packages for small hydro plants.

Francis turbine 3D model



Application range



1870 Hydro turbine production began.

1873 First Francis turbine with a modern distributor.

1903 Niagara Falls, Canada:
Double spiral turbines with P = 5.2 MW and H = 79.5 m.
Most powerful turbines of their time.

1912 Niagara Falls, Canada:
Double spiral turbines with P = 12 MW and H = 54.9 m.
Most powerful turbines of their time.

1974 Grand Coulee III, USA:
P = 820 MW and H = 87 m.
Most powerful and largest Francis turbines in the world with 9.7 m runner diameter.

1974 Rovina-Piastra, Italy:
P = 133 MW at the high head of H = 554 m.

1978 Itaipu, Brazil/Paraguay:
P = 800 MW and H = 118.4 m.
Overall design and joint supply of turbines and generators for the world's most powerful hydro plant to date at 13,300 MW.

1982 Xingo, Brazil:
6 x 535 MW; Francis turbines with an operating head of 111.7 m and a runner diameter of 7.2 m.

1991 Norris Dam, USA:
First aerating Francis turbine runner increases dissolved oxygen content for enhanced aquatic life.

1997 Three Gorges, China:
Participation in the supply of turbines, generators and electrical equipment for the world's largest hydroelectric power plant with a total capacity of more than 18,000 MW.

1997 Ghazi Barotha, Pakistan:
5 x 295 MW; vertical Francis turbines with an operating head of 69 m and a runner diameter of 6.4 m.

1 **Xingo, Brazil**

2 **Xi Luo Du, China**

3 **Eastmain, Canada**

4 **Revelstoke, Canada**

2003 Omkareshwar, India:
8 x 66.3 MW; large low head Francis turbines with operating head in the range of about 30 m.

2005 Xiaowan, China:
6 x 714 MW; Francis turbines including 8.7 m outside diameter ring gates.

2006 Revelstoke, Canada:
1 x 512 MW; Francis turbine with an operating head of 127.1 m and a runner diameter of 7.1 m.

2007 Jin Ping II, China:
8 x 610 MW; high head Francis turbines equipped with ring gates; first application of the splitter blade design for a large runner (runner diameter about 6.5 m).

2007 Eastmain 1 A, Canada:
3 x 260 MW; Francis turbines with an operating head of 63 m and a runner diameter of 6.6 m.

2007 Nuo Zha Du, China:
3 x 650 MW; Francis turbines with an operating head of 187 m and a runner diameter of 7.3 m.

2008 Xi Luo Du, China:
3 x 784 MW; Francis turbines with an operating head of 197 m and a runner diameter of 7.7 m.

2008 Li Yuan, China:
4 x 612 MW, Francis turbines with an operating head of 106 m and a runner diameter of 8.2 m.

2009 San Esteban II, Spain:
1 x 177.3 MW, Francis turbine with an operating head of 95 m and a runner diameter of 4.6 m.

2010 Waneta, Canada:
2 x 167 MW Francis turbines with an operating head of 61 m and a runner diameter of 5.5 m.

2011 Bratskaya, Russia:
Refurbishment and runner replacement for 6 x 255 MW Francis turbines, operating head of 100 m, runner diameter of 5.6 m.

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for Generations