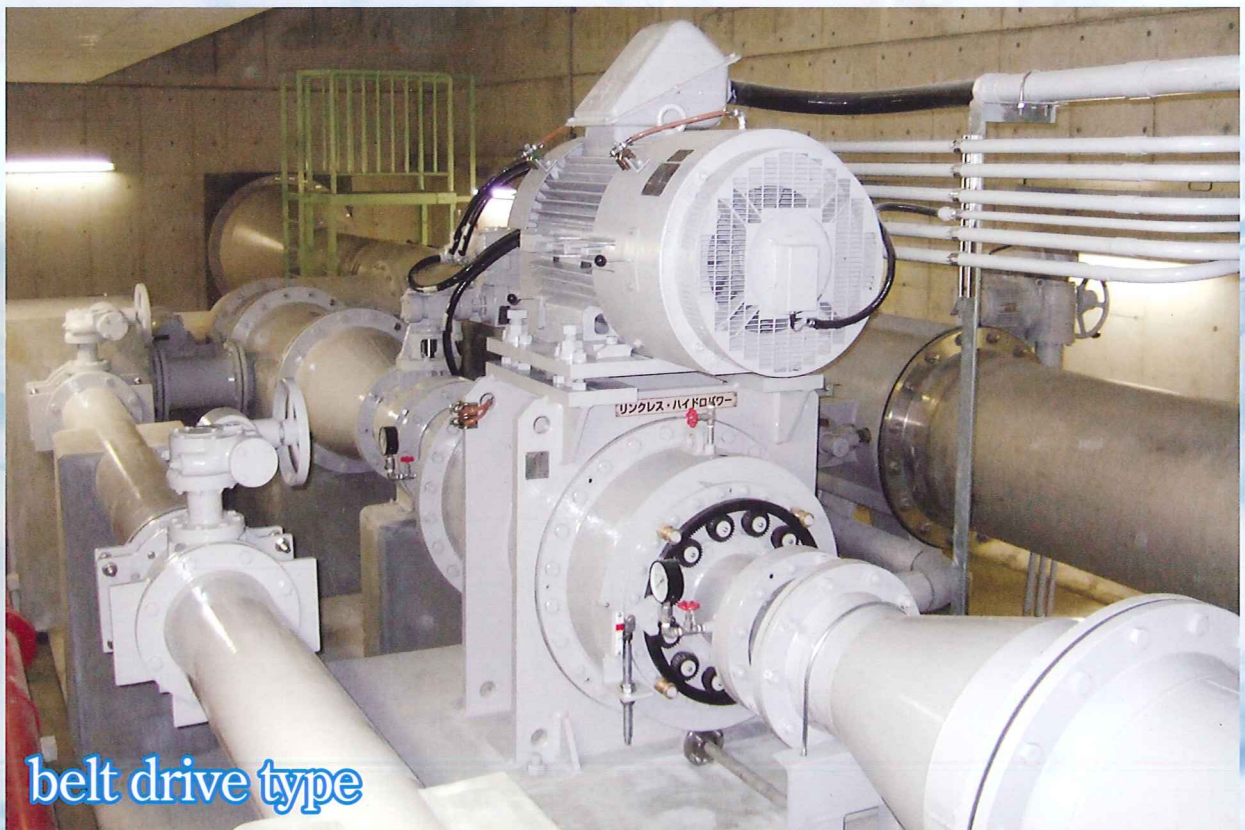


Inline Linkless Hydropower

(inline type linkless Francis turbine)



belt drive type



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The Francis turbine is a type of reaction turbine, which is the mostly widely used turbine in the world. Specifically within small and medium scale hydropower installations, over 70% of the turbines fall within the Francis category due to its many advantageous properties. Among these advantages include the following:

- Applicable head and flow range is wide (specific speed N_s : about 70~300m-kW)
- Maximum efficiency is high
- Maintains high efficiency when flow rate or head fluctuates
- Draft tube allows for maximum use of head
- Allows for relatively high RPM (over 600 revolutions per minute)

While the Francis turbine does possess clear advantages, there are some disadvantages as well. For example, the overall design is complex, the spiral casing increases cost, and it requires a large amount of installation space. The Inline Linkless Hydropower, designed jointly by Tokyo Electric Power Co. Inc., Tokyo Electric Generation Co., and Tanaka Suiryoku Co. Ltd., was designed to counter these disadvantages while utilizing the many strengths of the Francis turbine.

Inline Linkless Hydropower Characteristics

1 Cylindrical casing and inline design

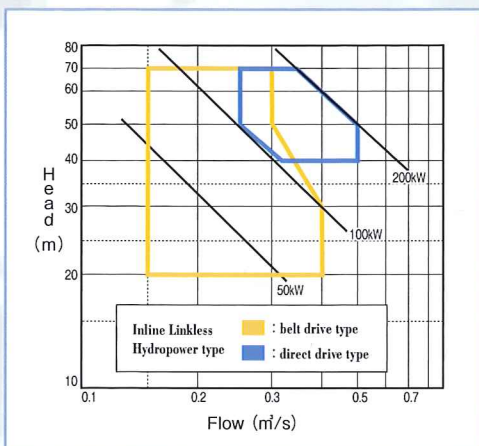
The use of a cylindrical casing allows for a more compact design. This compactness along with the inline nature allows for easy “drop-in” installation within existing infrastructure.

2 Recommended applicable range

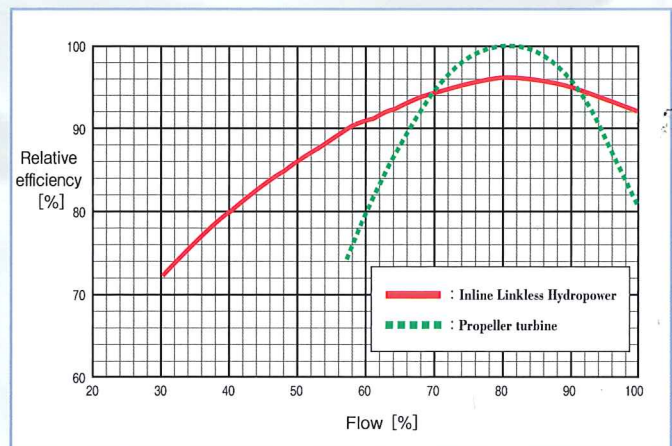
The graph below (graph 1) depicts the recommended applicable range of both the belt drive type and direct drive type Inline Linkless Hydropower. (applicable head=20~70m, applicable flow=0.15~0.50m³/s)

3 Relatively flat efficiency

As shown in Graph 2, the propeller turbine has a slightly higher maximum efficiency rate; however, the Inline Linkless Hydropower has a relatively flat efficiency curve and in most all use case scenarios, has a higher overall efficiency rate.



graph 1



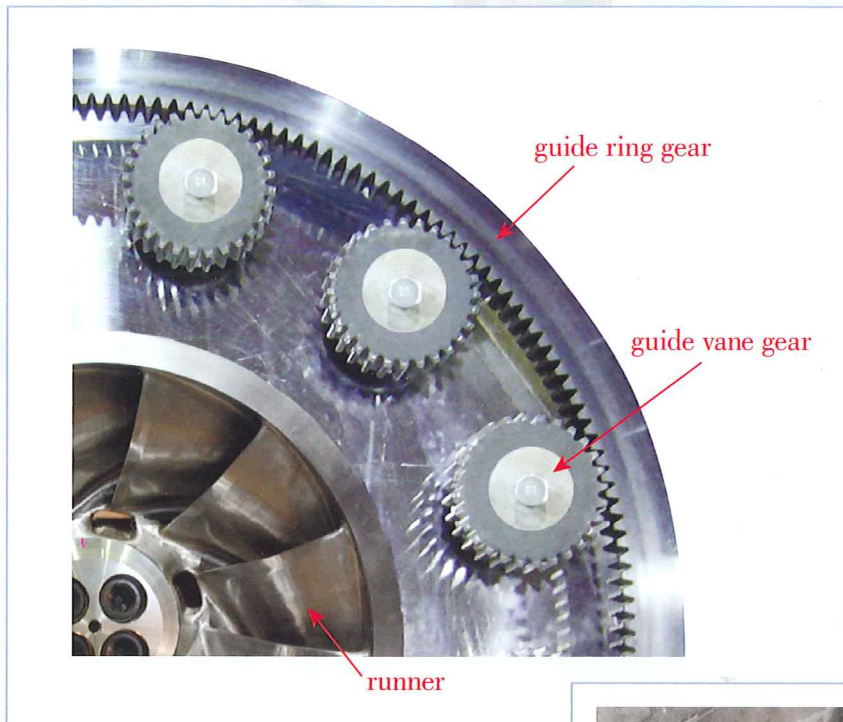
graph 2

4 Simplified structure and reduced cost

The simplified design and cost reduction of the Inline Linkless Hydropower was achieved by the following factors.

- ①The guide vane link and pin structure was eliminated and replaced with a gear structure as shown in pictures 3A and 3B below.
- ②With the cylindrical design as well as the use of a timing belt to transfer power to the generator (diagram 4A) the required installation space was reduced.

Note: the Inline Linkless Hydropower can also be installed via the direct drive method (picture 3B and diagram 4B), in which the turbine and generator share the same shaft.



picture 3A



picture 3B

5 Maintenance reduction

The simplified design equates to less moving parts and in turn, easier and less costly maintenance.

6 Flow adjustment system

An electric servomotor can be implemented to automatically control the guide vane when the head or flow rate changes, which in effect, will further increase efficiency.

Standard Structural Design

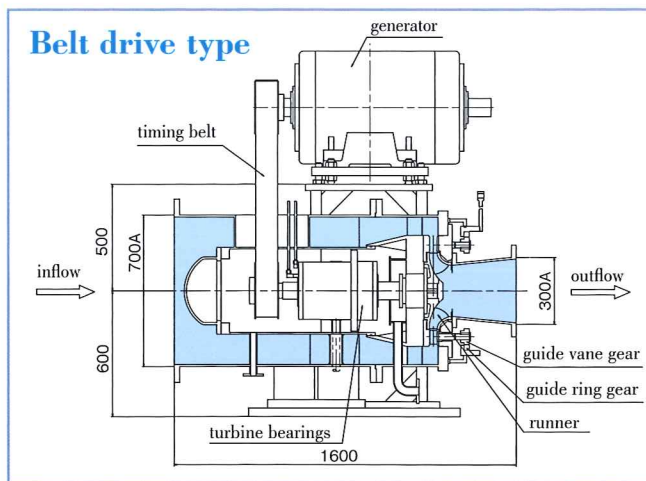


diagram 4A

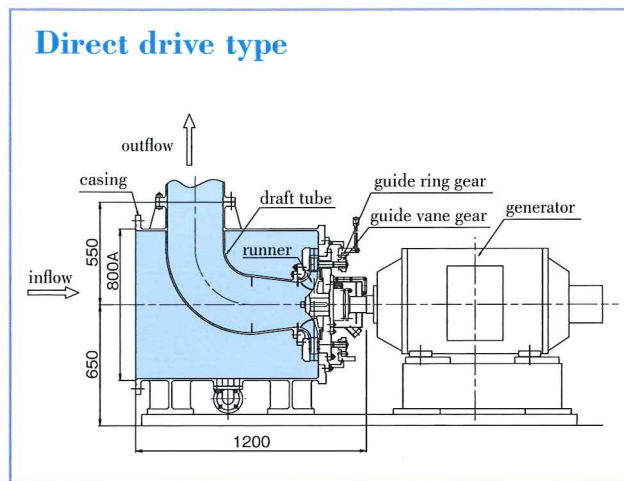


diagram 4B

Standard Material Type and Replacement Parts

- Material type of main turbine parts
 - Casing : steel plate (JIS SS400)
 - Runner: stainless steel (JIS SCS19)
 - Guide vane: stainless steel (JIS SCS1)
- Replacement parts (recommended)
 - Timing belt: ~1 year (for belt type Inline Linkless Hydropower)
 - Turbine bearings: ~5 years
 - Generator bearings: ~5 years

Typical Inline Linkless Hydropower Installation Sites

Besides the standard run of the river sites, the Inline Linkless Hydropower is ideal for the following:

1 Water and sewage infrastructure

Ideal to make use of excess pressure and can be used to replace pressure reduction valves

2 Waste water infrastructure within factories

Allows for installation even within very space limited factories

3 Reservoir dams

Can be implemented to utilize the maintenance discharge from reservoir dams



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