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SOURCES FOR FUTURE ENERGY CARRIERS: WATER ENERGY – TRIBOLOGICAL ASPECTS

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Abstract: The targets for the future are concentrated on the following considerations: saving of resources, because they are limited; and protection of the environment, because the humanity (mankind) has to survive. We have to take into account the depletion of conventional raw materials, e.g. crude oil, coal, metals and non-metals, because they will run out during the next some hundred years. But sun, wind and water energy are available for ever. Today we have to rely to the following energy carriers: conventional carriers like crude oil and natural gas; biomass; hydrogen; and electricity. But electricity has to be produced by sun, water and wind energy. As long as mechanical devices for the production of electricity are needed we have to take into account tribological systems with friction, wear and lubrication aspects.

Keywords: depletion of raw materials, future energy carriers, using water energy content: flowing rivers, tidal water flowing, wave moving.

1. INTRODUCTION

The targets for the future are concentrated on the following considerations:

- Saving of resources, because they are limited;
- Protection of the environment, because the humanity (mankind) has to survive.

We have to take into account the depletion

of conventional raw materials, e.g. crude oil, coal, metals and non-metals, because they will run out during the next some hundred years (Fig. 1).

2. FUTURE ENERGY CARRIERS

But sun, wind and water energy are available for ever. Today we have to rely to the

Depletion of raw materials

- **Crude oil:** Depending on scenario of consumption and technical possibilities of extraction:
Depletion within a few hundred years (150-300 yrs)
- **Coal:** Depending on consumption and extraction cost:
300-600 yrs
- **Metals:** Depending on consumption (the known resources shall not increase) e.g. mercury, lead, tin, tungsten, copper, nickel ≤ 50 years
- **Non-metals:** e.g. sulphur, potash > 100 years

Figure 1. Example for the depletion of raw materials

following energy carriers:

- Conventional carriers like crude oil and natural gas;
- Biomass;
- Hydrogen;
- Electricity.

But electricity has to be produced by sun, water and wind energy. As long as mechanical devices for the production of electricity are needed we have to take into account tribological systems with friction, wear and lubrication aspects.

3. WATER ENERGY CONTENT

There exist three possibilities to use the energy content of the movement of water to the turbines:

- Flowing river or flowing from high levels to low levels and driving turbines;
- The movements of waves can be used to drive turbines (Fig. 2);

The flowing water caused by the tide can be used to drive turbines (Fig. 3).

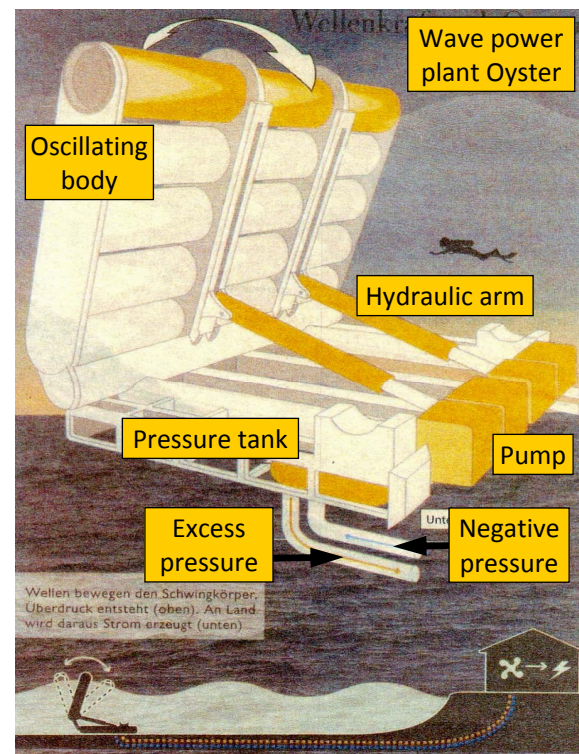
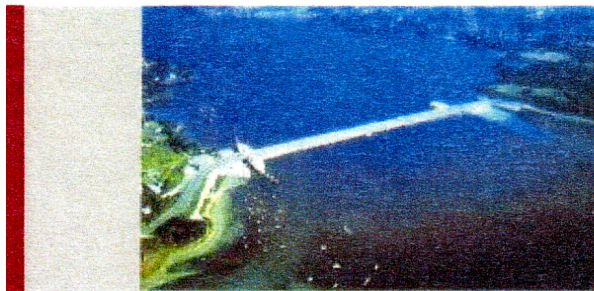


Figure 2. Example for wave power plants (waves move the oscillating body forward and backward producing pressure differences resulting in an operation of a hydraulic cylinder by pressure differences)

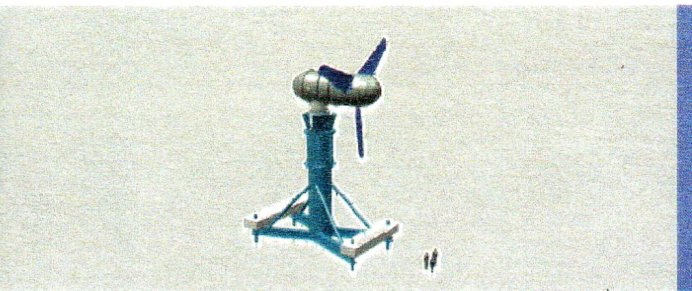
Two possibilities to use tidal energy



Tidal dam

- Sea water flows, initiated by tide, into a natural basin
- The dam directs sea water into and out of a turbine
- Continuation of conventional hydro-technology

Tidal dam



Tidal flow

- Using the flowing energy of the periodical tides
- Tidal Flow Plant without dam: Underwater Flow Park

Developing state

Tidal flowing energy

Figure 3. Example for tidal plants

As frictional systems bearings, gears and hydraulics have to be operated.

Examples bearing systems:

- Concept of an energy producing line (Fig. 4);
- Large bearing system (Fig. 5).

Lubricating greases, bearing lubricating oils

and hydraulic oils will be used.

4. CONCLUSION

As summary the view of an existing hydro power plant working in Guigang, China, is shown (Fig. 6).

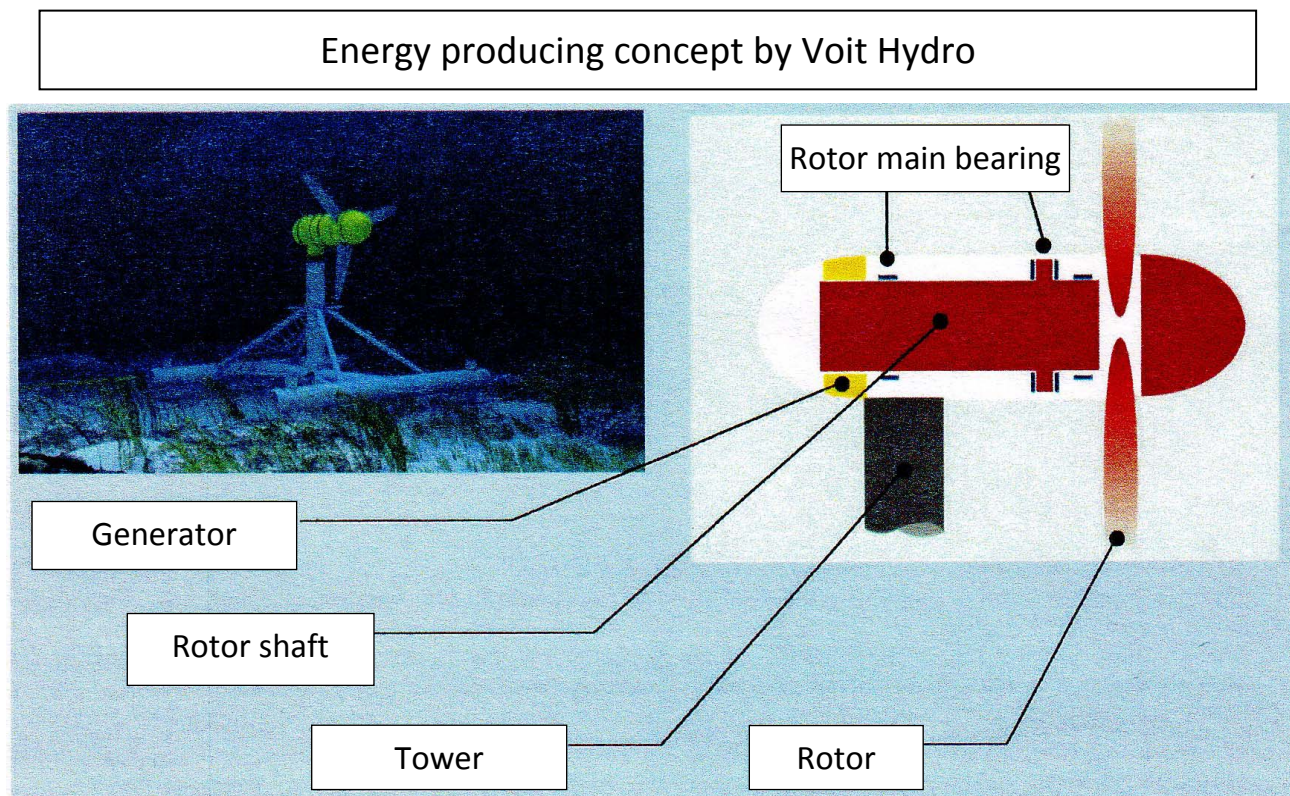


Figure 4. Concept of an energy producing line

Typical design of a **hydrogenerator** with vertically rotating shaft

Bearings

Above: Guide bearing (radial bearing)

Below: Thrust axial bearing and guide radial bearing

The turbine is located under the generator

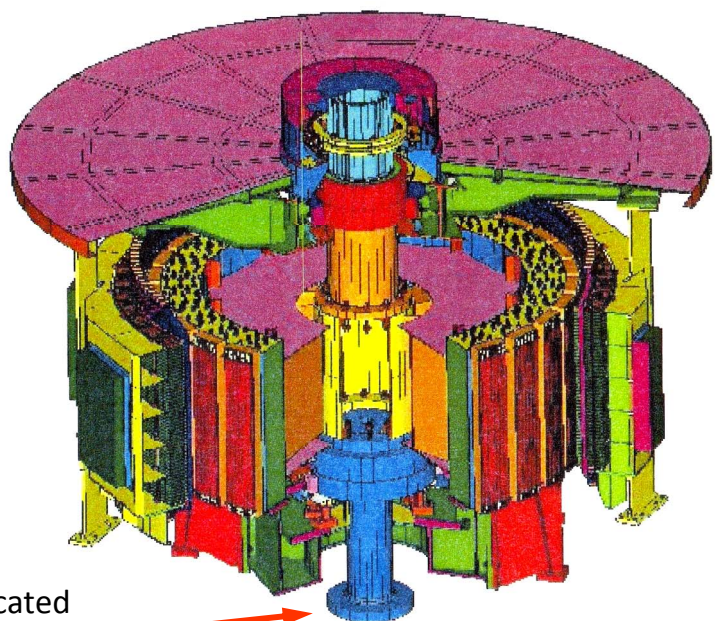
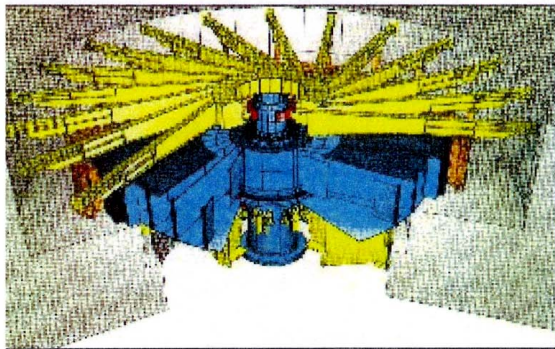
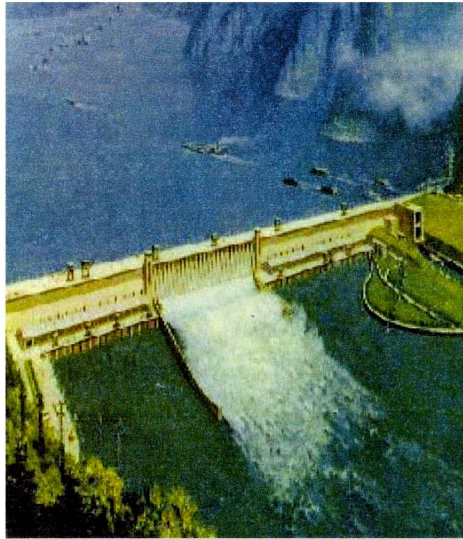


Figure 5. Example of large bearing system



Three Gorges / China

Planned total power: 18200 MW

26 Generators

- Low speed generator
- Driven by Francis-turbine
- 8 Generators, left side
778 kVA, 700 MW, 75 rpm
- Plant with worldwide highest power
- Bearing data (Tilting pads)

NDE-side:

Guide: $d = 2200 \text{ mm}$

DE-side:

Thrust: $d = 5200 \text{ mm}$

$f = 5520 \text{ t}$

Guide: $d = 5200 \text{ mm}$

Turbine side:

1 guide bearing

Figure 6. An existing hydro power plant working in Guigang, China