

## **The high-grade complex technologies of large capacity, high lift pump system, which transfer river water for long distance**

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### The background of developing these technologies

These technologies were developed for China Shan-xi Yellow River Diversion Project, which is one of the largest water supply project in the world that once started in 1956 getting approval of the Chairman of the day Mao ze dong and re-started from 1993 after long intermission related with the Cultural revolution in China. EBARA Corporation has supplied the pump systems that shoulder the keystone of the scheme, which is remarkable on the world pump history and as well required the advanced complex technologies. The contract was made January 1999 to supply equipments for the first stage construction was made and commercial operation has started from September 2003 after overcoming various difficulties.

### The outline of these technologies

These technologies concern with the large capacity, high lift pump system of supplying the Yellow River water for long distance, which contains a large amount of sand. EBARA Corporation has practically succeeded to supply the pump system by integrating the advanced technologies such as pump performances, anti-abrasion measures, pump hardware, flow control technology, water transient phenomena analysis, unit control and etc. Fig.1 shows the pump structure.

The water is drawn from Wanjiashai dam, which is located in the midstream of Yellow River and is lifted as high as 632m through five pump stations located in series, which has three pump-motor units each, total 15 sets. The water is supplied to Taiyuan, the Shan-xi province capital, through water passages including total 270km length tunnel, surge tank and others.

The most serious problem in dealing with the water of Yellow River is the wear of equipment caused by the large amounts of

Yellow River sand, which is very fine as the average diameter is  $25\mu\text{m}$  so that it does not easily sediment. It will cause holes to develop in the pump impellers and turbine runners within a few years at best or a few months for the worst case. EBARA Corporation had developed one of the highest-grade surfaces hardening technology for attaining anti-wear property against the Yellow River sand and demonstrated its effectiveness.

Further, for the maintenance of anti-abrasion coating, the stay-ring and the spiral case of the pump are separated and the spiral case is completely exposed. These concepts for the class of large capacity and high head hydraulic unit are likely not to be adopted and unprecedented one since they cause extreme difficulties to solve various problems on designing the pump supporting structure against huge hydraulic forces generated by the water for this class of large machine.

New type shaft seal for this pump was also developed which will bear against the large amount of yellow sands.

In addition, several advanced technology such as flow control, transient phenomenon

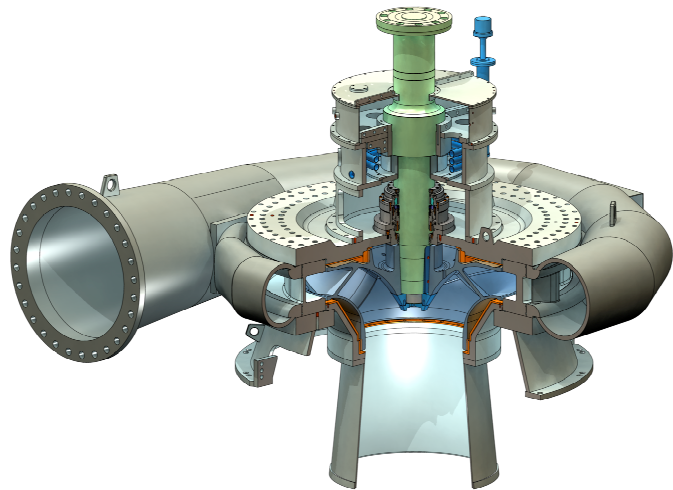


Fig.1 Pump structure

analysis and multiple units control techniques were also necessary to be developed for this complex flow system.

#### The diligent points for accomplishing these technologies

Since the water of the Yellow River contains a large amount of sand, that is far ahead among the world big river, most of all hydraulic machines that handle Yellow River water are abraded in a few months and they may result the heavy difficulties of continuing operation of the unit since the decrease of the pump performance and increase of unit vibration and noise may be caused by the heavy abrasion. Fig.2 shows a example of abraded pump impeller of some pump station dealing the Yellow River water.

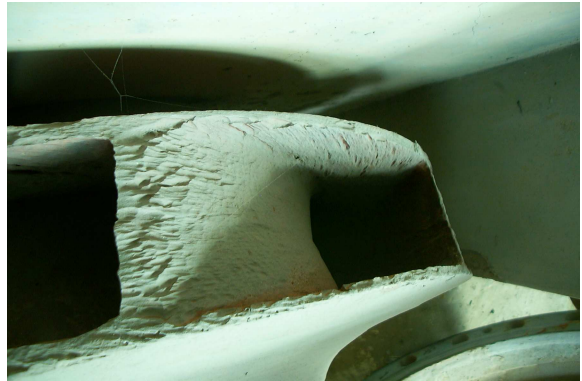


Fig.2. Example of abraded pump impeller

In order to measure this problem, EBARA Corporation has developed the advanced anti-abrasion hard coatings in addition to adopting said pump structure that the spiral case is fully exposed and divided.

One of the highest class of pump efficiency as well as the other characteristics such as anti-cavitation performances were also required since the electricity to operate these units is large as about 110MW for first stage and it is estimated to be 300MW after completion of second stage construction.



Fig.3 Water running in the dry river

#### Postscript

Thus not only establish each advanced technologies such as hydraulic performances, anti-abrasion technologies and unprecedented structure for hard coating maintenance, water filling procedure, multiple units operation control, transient phenomenon analysis but also integrate and develop all these technologies, EBARA accomplished the high-grade complex technologies of large capacity, high lift pump system, which transfer Yellow River water for long distance and contributed to the friendship between Japan and China. Fig.3 shows the running water in Bin-guan River, which is a subsidiary of Yellow River and usually a dry and no flow.