ACE

Aquatic Control Engineering



Keadby Terminal Assisted Outfall

Client: Environment Agency
Location: Isle of Axholme

Situation

Keadby Pumping Station is the Environment Agency's (EA) terminal outfall at the end of a complex network of rivers and pumping stations within the low-lying Isle of Axholme. An area covering around 500 km2 across South Yorkshire, Lincolnshire and Nottinghamshire. Within the area are over 28,000 houses and 30,000 hectares (Ha) of high-grade agricultural land as well as significant infrastructure.

Keadby Pumping Station was built around 1939 and has undergone a number of modifications over the years. The pumps amongst other items had reached the end of their serviceable life. The previous pumps were nearly 80 years old, inefficient, polluting due to their diesel motors, unreliable and becoming increasingly costly to maintain.

The existing horizontal axial pump's impellors were inside the building and above the intake water level requiring an unreliable vacuum pump to prime the system. The Dutch call this pump arrangement a "cats back" as the pipework rises from the water level to the impellor and then drops again to the outfall resembling a cats back. The EA were keen to change the pumps orientation, from a vacuum priming system to a self-priming system which requires the impellors to be submerged.

The EA had concluded that new pumps were required at Keadby TAO, the new pumps were to be fish friendly, have dry mounted electric motors and remove any requirement for priming the system before starting.



The Project

ACE were engaged to assist the team with optioneering at Keadby. The first challenge was to remove the vacuum pump, to do this we had to present a design with the pump impellor below the intake water level. As Keadby pumping station was not designed for a pump to be situated in this new location a smart solution would need to be considered to ensure suitable impellor submergence and optimal flow presentation for the new pumps. Using Computational Fluid Dynamics (CFD) modeling a special composite Formed Suction Intake (FSI) was designed which could be assembled underneath the existing building. A vinyl ester-based composite was selected for the FSI to enable not only aid the assembly of the FSI underneath the building, but also ensuring incredibly smooth rounded curves to ensure perfect presentation of the flow to the pumps. ACE also designed, supplied and installed aluminum stoplogs across the pumping station intake with divers to set the sumps dry and enable the FSI to be installed.

After the CFD model was completed, it was confirmed that the pumps could operate in a fish friendly manor in the new location with an FSI. The next challenge was to change the motors from diesel to electric. The lifting plant within the building was designed to lift the existing motors and gearbox's for which 5tons was sufficient. The new electric motors however needed to be 330kW which when using conventional induction motors meant the weight would be circa 12tons! ACE solved the problem whilst also improving the pumps efficiency by using permanent magnet motors. As the magnets are permanent and the magnetic field does not need to be induced the motors can weigh less, in this case we could supply a motor that only weighs 3.5tons and therefore allowing the existing lifting plat to be retained.

The IE4 permanent magnet motor technology also provided advantages in other areas, reducing the size of the invertor drives, new transformer that was required and generator set.

The pumps were FAT tested against ISO 9906 and therefore proven to operate at or above the efficiencies shown in the curves.

Summary

Through innovative, intelligent design, cutting edge motor technology and variable speed drive's the new pumps will deliver vastly improved efficiency and therefore carbon savings not only when compared to the existing pumps but also any fish friendly alternatives.

The pumps are driven by permanent magnet motors with an IE4 efficiency rating, each capable of delivering over 10,000 Nm of torque at 330 kW. ACE delivered six pumps, each capable of pumping over four thousand liters of water per second.

The fish friendly pump design ensures fish can enter and exit the pump system without damage – This has been tested and confirmed by the EA at Keadby on site using live eel. The patented impeller which ensures fish are not struck on entering the pump has been rigorously tested and monitored on a wide variety of land drainage pumping stations across Europe, no other fish friendly pump design has been monitored so robustly. The pump also incorporates elongated guide vanes to guide fish unharmed through the system. Independent testing has demonstrated that over 97% of fish and 100% of eels sampled, passed through the pump with no harm. This market leading fish friendliness does not compromise on flood prevention, nor does it excessively increase the costs.

500km^2

Protecting an area covering approx. 500km^2 across South Yorkshire, Lincolnshire and Nottinghamshire.

28,000

Over 28,000 houses and 30,000 hectares (Ha) of high-grade agricultural land as well as significant infrastructure protected.

4,000l/s

ACE delivered six pumps, each capable of pumping over four thousand liters of water per second.

10,000Nm

The pumps are driven by permanent magnet motors with an IE4 efficiency rating, each capable of delivering over 10,000 Nm of torque at 330 kW.



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