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Let's Solve Water

Case study
2019, March

Upgrading the Nagoya Seaberth System with Accurate Current Flow & Directional Monitoring in Real-Time

AANDERAA DOPPLER CURRENT SENSOR & AQUA DATA SERVICE

This project was implemented in a port in the middle of Nagoya harbor approx. 5km from land (see Figure 1). The Port of Nagoya is the largest and busiest trading port in Japan, located in Ise Bay. Despite its shallow waters at 15 meters deep, it accounts for about 10% of the total trade value of Japan. Notably, this port is the largest exporter of Toyota cars in Japan to other parts of the world.

The Seaberth is used for offloading oil from tankers to a large pipeline that moves the oil to the refinery on land. These offshore berths are created for the handling and storage of hazardous cargo from oil and gas vessels. The Seaberth contain stand-alone structures called dolphins, which have fenders, is used for offloading oil from tankers to a large pipeline that moves the oil to the refinery on land. These offshore berths are created for handling and store hazardous cargo from oil and gas vessels.

Because of their huge mass, tankers have a large inertia, making them very difficult to steer. A loaded supertanker could take as much as 4 to 8 kilometres and 15 minutes to come to a full stop with a turning diameter of about 2 kilometres. This means real-time accurate current speed and direction are essential to aid large vessels in smooth and safe maneuvering and provide confidence to authorities to manage sea traffic for navigation and safe berthing.

"‥ real-time accurate current speed and direction are essential to aid large vessels in smooth and safe maneuvering‥"

Project Scope

The scope of this project was to upgrade existing systems and continue to provide real time current speed and direction information to the port authorities and vessels. The Xylem Japan team examined the existing system, which utilized an electromagnetic (EM) sensor for current monitoring. The sensor is lowered through a 15m pipe to allow the sensor to sit at the appropriate depth (see Figure 3). The depth is related to the draft of the oil tankers themselves and this is dependent on the size and load on the tankers, varying between 15-30m.

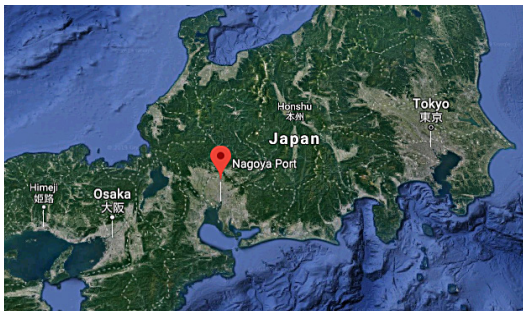

Fig1: Location of Nagoya Harbor (Source: Google Earth)

Fig 2: Seaberth transportation, 1 boat per day

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In this instance the sensor can then be lowered to 15m at the bottom of the installed pipe where it sits in place, collecting both current speed and direction data. Using this pipe, when needed the sensor can be retrieved to perform cleaning and repair maintenance.

EM sensors are measuring currents close to the sensor head and are sensitive to fouling and objects, e.g. algae/plastic bag, caught on the sensor. In addition the zero current measurement point must be determined by calibration and it drifts over time. In the field, calibration of EM sensors proves to be a challenge, thus without regular calibration, the accuracy of EM sensors is compromised.

To improve on existing current flow and direction monitoring, Xylem Japan proposed to replace the existing system with Acoustic Doppler Technology and the Aqua Data Service (ADS) over Electromagnetic Technology for current flow monitoring.

In this project, the Aanderaa (a Xylem brand) Doppler Current Sensor 4420 (DCS) is introduced. The Aanderaa DCS 4420 sensor is rugged and insensitive to biofouling, which allows it to operate at long periods without having the need to carry out cleaning maintenance work. Unlike EM sensors, neither zero calibration nor field calibration is required, thus reducing the risk of data inaccuracies.

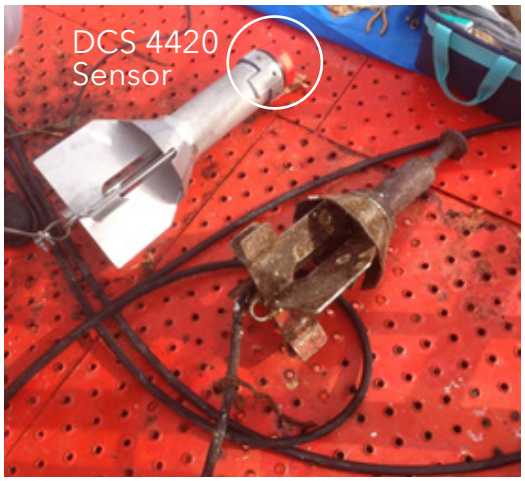

Fig3: Aanderaa DCS system from Xylem (LEFT) lying next to the previously installed EM sensor (RIGHT)

> "The DCS 4420 sensor is rugged and insensitive to biofouling, which allows it to operate at long periods without having the need to carry out cleaning maintenance work."

At a low current speed, DCS does not compromise accuracy in current direction. The DCS works on a backscatter acoustic Doppler principle,. It simultaneously sends out an acoustic pulse on four horizontally facing transducers and measures the current remotely 0.4-1 m away from the sensor. In its recommended operation it uses the two upstream facing transducers, forward pinging, to assure a non-disturbed current detection. The Doppler principle works on short ultrasonic pulses being sent off from each transducer, and the same transducer receives backscattered signals from particles in water. In coastal water conditions, high suspended sediment concentrations would pinpoint Acoustic Doppler Technology to be the right application over EM. With ZPulse technology introduced by Aanderaa, it uses multi frequency acoustic technology to improve data quality, sampling period and power consumption.

Fig4: Aanderaa DCS 4420 sensor

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The sensor has a built-in compass and a tilt sensor that can compensate for tilt up to 50 degrees and can also provide sea temperature. The speed range is 0 to 300 cm/s with low current drain and flexible sampling schemes. The low current drain and durability of this sensor makes it ideal for this application as it allows the port authority to limit repeated site visits for maintenance. The speed range and accuracy of specifications are also much higher than the previously supplied EM sensor.

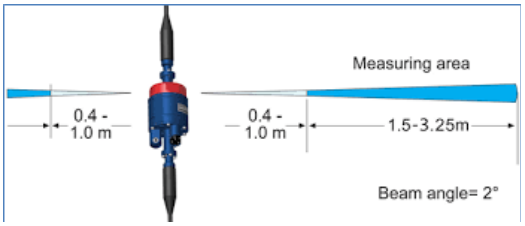

Fig 5: Aanderaa in-line DCS 5800 which deploy similar acoustic Doppler principle in measurement. Field of measurement (shaded in blue) starts from 0.4m – 1m from the sensor, covering an area of 1m – 2.25m .

Result

The integration of the Aanderaa DCS was easily carried out with the port's existing infrastructure. The port operator only needed to change the sensor, the sensor cable and power communication systems.

At the same time, Xylem Japan also provided the Nagoya port authority with a customized version of the Aqua Data Service (ADS) - a real time data software system to replace the original system (Figure 6). This was easily integrated in the network server.
For those customers who do not possess their own network server, the data on this system can be stored in Xylem Japan's server and accessed remotely and securely by the customer.

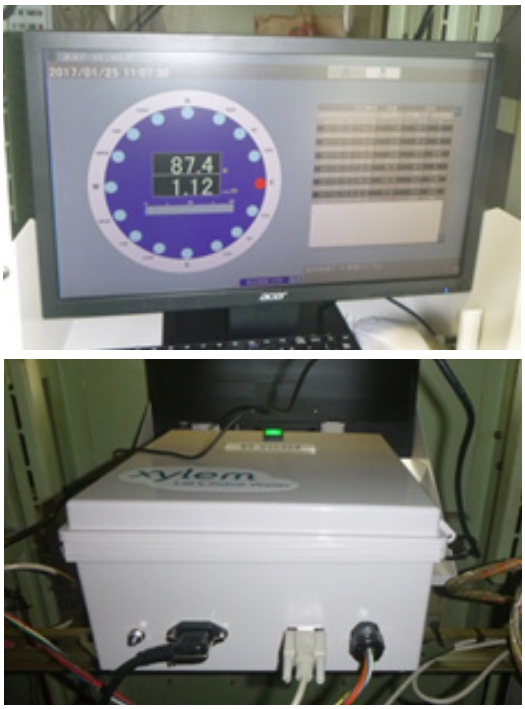

Fig 6: Real time data pertaining to current direction and speed acquired by Aqua Data Service is shown clearly on Desktop (TOP) linked to a data logger (BOTTOM).

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