CC-Link In Action

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Torqueing Undersea Cables

Fraser Hydraulic Power, a family owned company based in Newcastle Upon Tyne, have developed an interesting solution to overcome some of the problems associated with the laying of the latest generation of subsea Telecommunication cables.

For many years the machines for laying the cables on the seabed have been hydraulically driven. The old cables were heavy and rugged and hydraulic systems proved to be the most reliable, suiting the arduous conditions on the exposed decks of vessels at sea.

Now Fraser's (like many other companies) are faced with new challenges as the introduction of Fibre-optic cables begins to replace old armoured copper based cables

During laying operations a large plough is towed behind a ship at a approximately 6 knots, typically at depths of 1000m and up to 2000m behind the ship. The plough opens up a furrow and the cable is fed into the trench. The same plough then back fills the trench to cover the cable. All of this happens as a continuous operation. It is essential that the tension in the telecommunications cable being layed, is maintained within predetermined limits to suit the laying conditions and the type of cable being used. Failure to maintain tension can cause the cable to foul up on the plough or on the towing vessel and if there is too much tension the cable can break. With typical repair costs for cable damage being around £100k, it is imperative that the cable is not damaged

As Fibre-optic cables are not as robust as copper cables, i.e. more easily damaged, it has became more important to be able to achieve improved control over the new criteria of lower tensions.

The Linear Cable Engines manufactured by Fraser's are based on a series of tyred wheels that are set along the axis of the ship with the cable being fed through the tyres. The wheels are squeezed together and hydraulic motors on each of the wheels generate the power to drive or apply a braking affect on the cable as it leaves the vessel for the seabed. The number of wheels indicates the driving power of the machine; the more wheels the higher the drive or hold back tension. This machine must compensate for changes in the motion of the vessel and also the variations in seabed conditions.

The new generation of Fraser machines have been designed to meet the changing needs of the market and are designed as "Plug and Play" units. They are compact, self-contained and modular to enable them to be installed with minimum

re-engineering on smaller vessels or vessels of opportunity. They are skid mounted and can easily be transported from vessel to vessel. For many lay operations the small flexible mount design removes the need for expensive dedicated cable laying vessels.

The laying machine is based on a series of load cells which monitor the tension in the cable. The measurement values of the load cells then cause the driving wheels to speed up or slow down to maintain the pre-set tension

The need for finer control over tension has resulted in Fraser's move to a new generation of machines that use a Mitsubishi Electric A2S series PLC system as the electronic brains behind the controls and Mitsubishi's AC inverter drives on the motors to control the wheels.

The PLC calculates and compensates for change in cable tension then feeds information to the processor that adjusts the drive wheel speeds, to meet the prevailing conditions.

Each dispensing wheel on the machine is connected to a Variable speed drive (VSD), with all the drives connected onto the system torque-sharing the load and working together to control torque, which is measured in the drive controllers.

Each of the Drives on the platform are connected to the PLC system via a CC-Link Fieldbus system. The Drives send constant information of their torque status via CC-Link to a PID loop control in the PLC, which then outputs speed commands to the Drives, to ensure that all drives are matched and constant torque maintained. The PLC also monitors via an absolute encoder input, exactly how much cable has been laid, allowing the calculation of dispensing rates and other important data.

All information regarding the entire control and monitoring of the Cable laying machine is done with an E300 HMI. This allows the user to see at any time, any torque on any of the drives and check cable dispensed and monitor any equipment alarms.

Torque matching is extremely critical in preventing cable breaks. Each cable break costs around £100k to repair, making the emphasis on zero breakages very high on the agenda. The monitoring of torque on all dispensing wheels is also very important, if a tyre punctures or bursts, torque is seriously affected. This could cause catastrophic effects if not reacted to quickly enough.

A major problem Fraser overcame was when the cable dispenser was rendering (free spooling) cable onto a seabed; when this occurs the motor becomes a generator. Fraser's overcame this by using FR-A540 VSDs and its regenerative breaking function on each dispensing wheel set.

This approach removed the need to have huge break resistors ensuring the machine remained compact. The "regen" element of the VSDs simply connects to a heating element. This then cooled using sea water which is readily available, allowing them to use the VSD as a simple four quadrant controller.

Another major problem the new machine faced was the ambient moisture and temperature it was expected to work in. This is due to different conditions the machine would meet worldwide, i.e. one week it could be in the Arctic, the next week in the Tropics. The entire installation had to tolerate this wide change in environmental conditions as well as being able to resist the corrosive effect of continued coverage by salt water. The low power dissipation and high environmental tolerances of the Mitsubishi equipment made the housing of the controllers much easier as there was no need for expensive heated and cooled cabinets.

The cost of these machines is the same as conventional systems. However, the operator can make large savings on usage costs. This is because they can utilise smaller boats and have far fewer cable breakages due to the increased sensitivity of the new electronically controlled system.

Additional benefits in moving over from hydraulic control to electronic cable laying are the environmental benefits. Companies are now more aware of their corporate responsibilities to the environment and fines for accidents such as Hydraulic fluid leaks are now getting extremely severe, making an alternative electrical solution to cable laying very attractive, especially in coastal areas around countries like Japan, and the Caribbean.

Apart from being extremely tolerant to electrical noise, which can be quite a problem on electrical systems on boats, the A2S PLC PID loop control was extremely fast in reacting with a high resolution and accuracy and the VSDs very flexible to the new application demands put on them.

Fraser's approach differs to other cable laying machine manufacturers, with machines that are now much smaller, more flexible and meet the new adaptation requirements of the undersea cable laying industry.

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