ABSTRACT

MCE Deepwater Development 2019

Boost Deepwater Recovery with World's most Autonomous Boosting System

Company:	FSubsea AS
Author:	Alexander Fuglesang (CEO)
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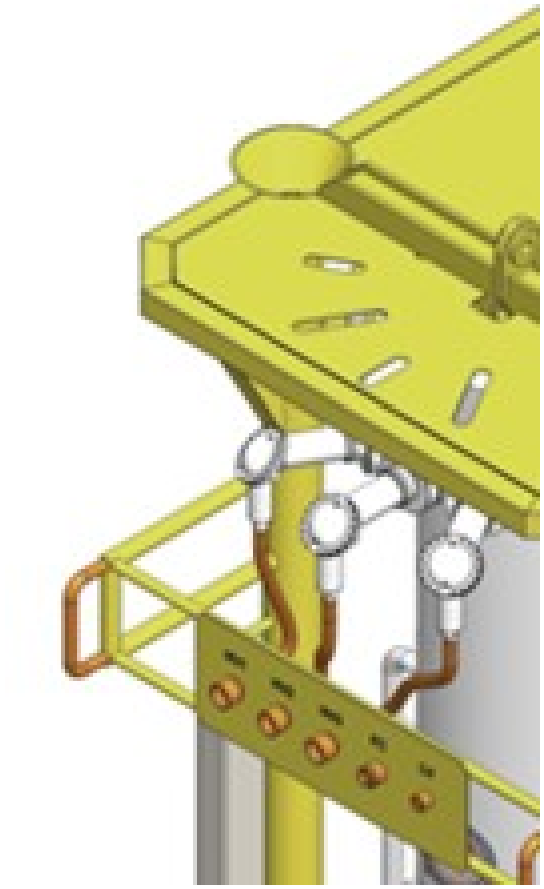

Barrierfluid-less and Topside-less Subsea Pump Module: Omnirise™

Background

Offshore oil & gas operators are demanding lower cost from vendors, more flexibility, higher equipment reliability and lower environmental impact – all at the same time, which is a major challenge. The best way to achieve this is to put more functionality on the seabed or on unmanned platforms, while reducing complexity and costly engineered-to-order projects. However, in the deepwater space, standardized and cost effective technology is not yet on the market for this purpose.

At the same time, it is generally accepted by most industry players that seabed pumping systems are some of the most efficient tools available in an operators IOR 'tool-box', provided that the capex and opex costs are within reason. Applications include such as subsea boosting of oil and gas (multi-phase) mixtures, transport of condensate or separated crude oil, or injection of produced water or seawater. The first seabed pump for multi-phase boosting was successfully installed more than 20 years ago and several systems are in the process of being qualified. More than 15% increased recovery from installing subsea pumps have been demonstrated several times.

But…of the 1500 or so existing subsea fields, containing more than 5000 individual wells, with several being added each year, only about 20 subsea fields or so are presently actively using this type of technology. How is that possible?

The boosting industry has so far seen only a few projects per year of which many are large and complex fields. As a result, the main vendors have developed costly, bespoke and intricate systems. At the same time, reliability of boosting systems are not where it should be, according to several large operators .

As an example of the latter; In September 2018, Bernard Quoix, the global head of rotating systems at Total, one of the worlds biggest users of subsea pumping technology, stated at a Multiphase Pump User Roundtable (MPUR) in Paris that; "the single largest concern and limiting factor to increased use of subsea multiphase boosting systems is the mechanical seal and barrier fluid."

The Solution

Norway-based FSubsea wishes to change all this. In 2016 it was confirmed that the company had successfully qualified its Omnirise miniBooster which was the worlds first seal-less and barrier fluid-less subsea pump with embedded subsea VSD, qualified in partnership with NOV, Shell, Statoil, Total and Chevron. The pump is intended for permanent subsea applications, using permanent magnetc coupling system and a pressure compensated subsea motor technology.

This core platform is now being developed further and the company's next goal is to qualify a 1.5 MW Omnirise Single-phase Booster and later an Omnirise Multiphase Booster. The fully modular Omnirise Boosting system aims to be world's first "All Electric" subsea pump (i.e. no barrier fluid). As the solution also has built-in variable speed functionality, it shall be the most flexible, low cost and reliable solution of its kind. In other words, - a real opportunity to get more (recovery) for less (capex).

The most important features are that it shall be the worlds first system of its kind to be fully *barrier-fluid-less* and have *integrated variable speed* functionality. This functionality is enabled by the patented Hydromag Drive Unit (HDU), a unique, pressure-compensated combination of a ultra-high performance Permanent Magnetic coupling, a hydrodynamic Torque Converter, a (fixed) low-speed induction motor and an embedded control and cooling system. The HDU is pressure-compensated and hermetically sealed from the process and the environment and can be used to drive both single-phase, multiphase and eventually compressor systems, with speeds over time reaching up to 7200 rpm.

A more detailed presentation of the technical elements shall be presented at the conference.

Both Hydromag and Omnirise technology is currently being developed for a full scale test at 1.5 MW, initially with speeds up to 6000 rpm, supported by Innovation Norway, Demo2000 (Research Council of Norway) and large industrial client partners such as Equinor, AkerBP, Lundin, ConocoPhillips, OMV and National Oilwell Varco.

If selected, we expect to be able to share early test data with the audience at MCE Deepwater in April 2019.

Key functional components of Hydromag™ Drive Unit

Advantages

As opposed to all existing seabed pumping systems; the Omnirise boosting system does *not* depend on: (i) expensive and fragile high pressure mechanical shaft seals, (ii) complex barrier fluid systems with sensitive and quick acting regulating valves, (iii) long hydraulic umbilicals, (iv) large topside Hydraulic Pressure Units (HPU) and (v) electric Variable Frequency Drives (VFD). Furthermore, the Omnirise pumping system enables use of low pressure motor casings and electrical penetrators, which are already standardized or qualified, substantially reducing costs.

The use of an integrated Torque Converter allows a soft start of the system and the use of a low speed motor (low viscous losses, low vibrations) driving a high speed pump. Furthermore, the Torque Converter opens up for more easy regulating of multi-phase pumping systems, and use of smaller and simpler fluid conditioning devices (slug catchers etc) due to its inherent constant power control functionality.

The Omnirise Boosting System enables the following key advantages to end-users, compared to a traditional injection and boosting systems:

1) Minimized topside footprint: Lower CAPEX and OPEX cost and increased reliability
2) No need for scheduled maintenance in case of topside (unmanned platform) installation
3) Removal of barrier-fluid system: Lower CAPEX and OPEX and increased reliability
4) Simplified & Lean field architecture: Autonomous and “All-electric” system
5) Reduced environmental impact from

a. Eliminated risk of *un-controlled* hydraulic fluid release to the sea
b. Eliminated hydraulic fluid consumption
c. Reduced carbon foot-print due to reduced topside and manning

The modular and simple Omnirise system should have particular interest in one-pump-per-tree architectures employed by Petrobras, not least as it is estimated to save up to 70% of costs, and remove 90% of topside space required, compared with similar systems. This can be substantial, not least knowing that topside equipment relating to subsea pumps have been known to approach more than 500 tonnes in a single project. In 2017, Rystad Energy estimated that more than 15 USD million of CAPEX costs could be saved based on a single-pump project.

The system can be used on unmanned platforms or on the seabed; as an independent IOR tool or it could be a key enabling part of emerging OEM equipment in applications such as subsea storage, water treatment, or innovative separation units. Irrespective of the exact application, brown-field and tie-back applications where topside space is limited is the "sweet spot" for the technology.

FSubsea – Who we are

FSubsea is headquartered in Oslo, Norway and has supplied more than 40 pumps that are currently operating in the deep seas worldwide for a variety of applications. We set up the company in 2013 as a subsea technology spin-off from Fuglesangs Group of companies, with proud origins back to 1855.

Our vision is to disrupt the offshore petroleum and energy sector. We will do this by providing the most autonomous, modular and robust boosting systems for the global subsea process, unmanned offshore, subsea drilling and deep sea excavation markets.

Over the past few years we have created a very strong team of experienced and driven individuals, and we have invested in a major workshop and pump test facility in Oslo. This facility includes a well-equipped pump workshop, subsea test pit, in-house 11kV power supply, advanced DAQ systems and 25 ton gantry cranes.

Key members of the Omnirise™ Project and Technical teams, include:

Tommy Westberg. VP R&D
Tommy holds a MSc. in Physics from Karlstad University in Sweden. His background includes both in-depth studies of fluid and heat transfer, practical experience from being an industrial electrician and significant experience from working more than 6 years at a senior level on subsea multiphase booster pump development projects for Aker Subsea and FMC Technologies. Tommy also strenghtens the team with his academic record, which includes hydraulic pump design, stationary and transient fluid simulations, as well as hot-spot prediction in subsea electric motors.

Christian Abelsson, VP Projects
Christian holds a M.Sc. in Mechanical Engineering from University of Linköping in Sweden. After graduation, he joined Volvo Aero's trainee program where he started his technical career through building his competence across diverse and complex engineering projects. The continuation in Volvo Aero's Aerothermodynamic department provided him with a deep understanding of the complexity of rotating machinery. Christian joined Aker Solutions Subsea Pump System department in 2010. He has worked with development and engineering of subsea processing and boosting equipment, as an analysis engineer, concept architect, and Technology Qualification Program manager of a new, gas tolerant, subsea pump technology. His experience as TQP manager gave him the opportunity to follow, and learn from, the complete process of subsea pump technology development, from idea to TRL 4.

Terje Hollingsæter, VP Products
Terje holds a master's degree in mechanical engineering within Thermal Energy and Hydro Power from NTNU in Trondheim, Norway.Terje is an experienced subsea pump expert with wide experience from development, design manufacturing and testing of subsea boosting systems. His background is from mechanical engineering but he has a multi-disciplinary knowledge about subsea boosting systems. Terje is skilled in pumps, system engineering, system testing, product development and process control. Terje has for several years has senior roles or led the development and integration of subsea boosting systems in companies such as Framo, OneSubsea and TechnipFMC.

Tommy Østerhus, Test Manager
Tommy holds a B.Sc. in mechanical engineering from Oslo University College specializing in construction. His background includes 10 years of versatile experience within Subsea oil and gas industry within project execution, testing and offshore operation of subsea process, boosting, production and well intervention systems at Aker Solutions and TechnipFMC. During his time in FMC Technologies he mainly worked as test manager and technical lead within subsea process systems and subsea boosting qualification projects.

Appendix

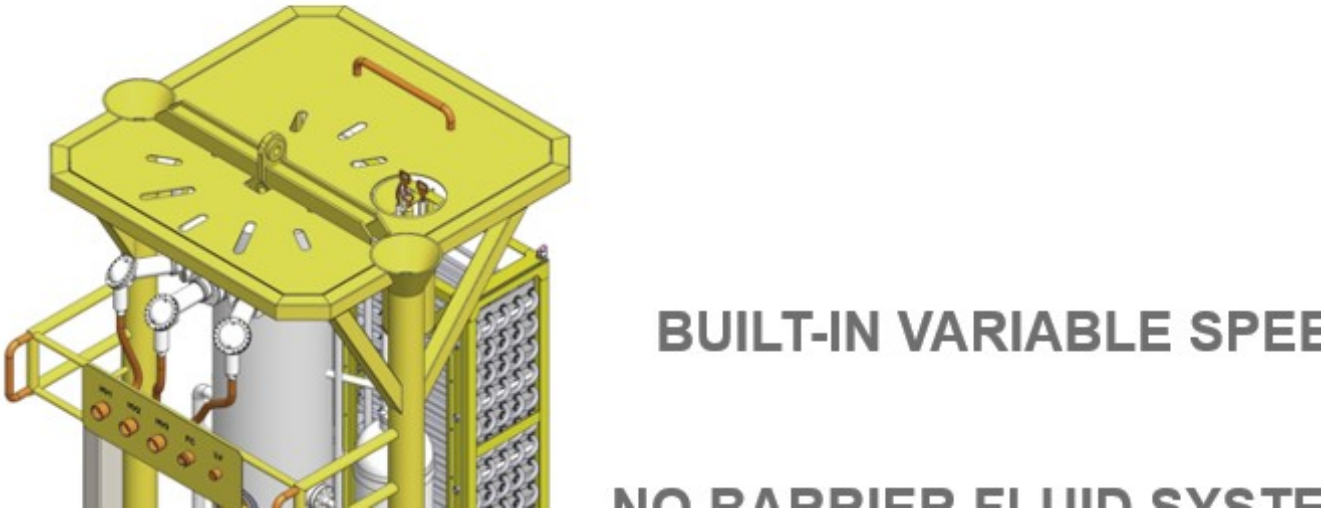

Figure 1: Overview of typical Omnirise™ Pump Module & key features

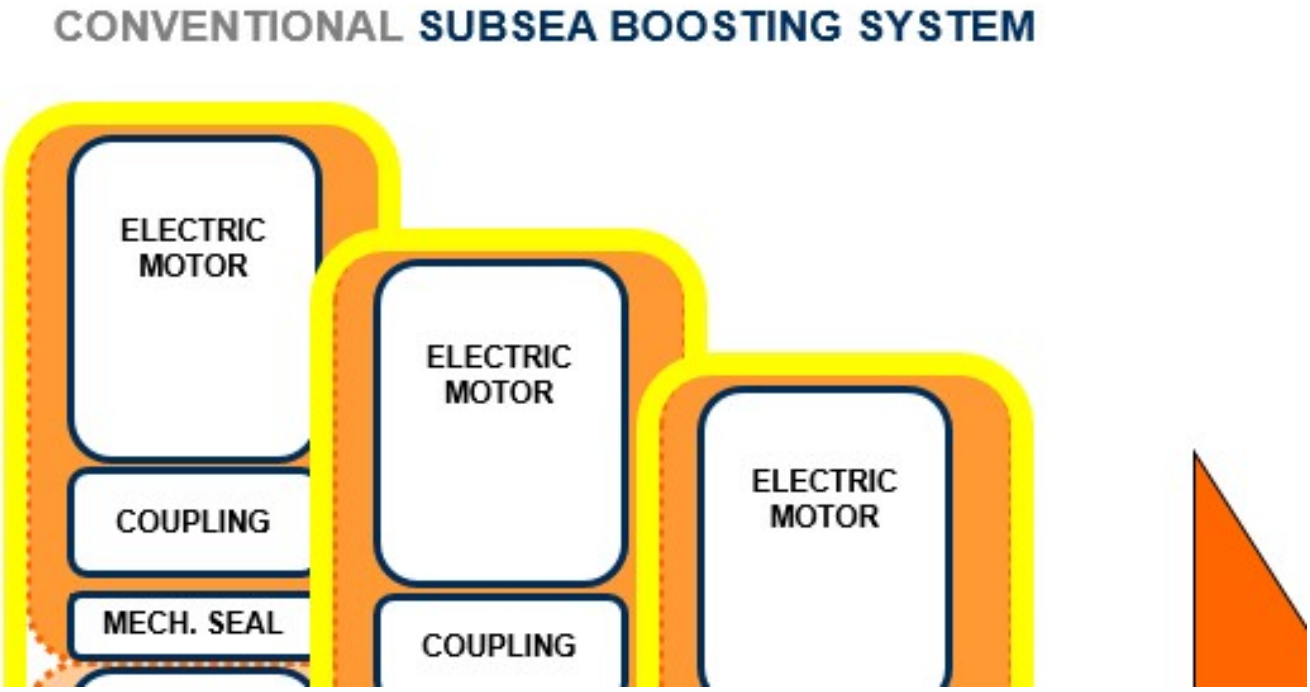

Figure 2: Modularity of Hydromag™ Technology when embedded in Omnirise™ Boosting System