Fig. 1 – Export oil pipeline pump (BB5)

Centrifugal Pumps for an Offshore Platform

Termomeccanica supplied 14 pumps for the Greater Stella offshore FPF1 platform facing many design and management challenges related to the specificity of the project

Cesare Nardini
Termomeccanica Pompe - TMP

Within the development program of the Greater Stella oil & gas field, Ithaca Energy awarded Petrofac the refurbishment of the FPF1 platform which will be carried out at Remontowa Shipyard, Gdanz, in Poland.

The refurbished platform will be assigned to the offshore processing and export of hydrocarbons extracted from the Greater Stella field, located in the UK's Central North Sea continental shelf; the end user is a joint venture between Ithaca Energy, Dyas and Petrofac itself.

Termomeccanica Pompe scope of works is the design and supply of the 14 centrifugal pumps to be installed on the PFP1 platform, comprising 2 export oils pumps with their booster pumps, 3 circulation pumps and 7 utility pumps.

The installation of the pumps was completed last March and the start of operations with the pumping of oil for within the end of 2014.

Main oil export pumps & booster pumps

The export of oil is carried out by two BB5-type pumps (**figure 1**) (Termomeccanica MESB 150.11 model), each coupled with a 1.5 MW electric motor working under inverter. The use of the inverter is necessary so as to guarantee the pump working range under the various conditions expected during the development of the oil field, for a flow rate of 170 m^3/h with the head ranging from 1350 m to 2073 m, obtained by increasing speed from 2720 rpm up to 3280 rpm.

The use of the inverter has also proven necessary to increase the pumping pressure so as to remove the wax obstructions that may be generated during pumping stop at the typical North Sea temperatures, with the possibility to reach up to 2584 m at 3564 rpm with a flow rate reduced to 120 m^3/h.

The 2 export oil pumps are coupled with two OH2-type pumps (**figure 2**) (Termomeccanica 100AP50 model) working as booster. Both the main and booster pumps are provided with double pressurized mechanical seals with API Plan 53/b.

On top of the typical design issues that usually mark offshore projects, additional requirements from Petrofac Engineering, such as the installation on three-point baseplates and the blast load resistance design for both the main and booster pumps, have increased the contract design complexity (**figure 3** and **figure 4**).

Fig. 2 - Export pipeline booster pump (OH2)

It is also important to remember that this project stems from the refurbishment of an existing platform, with already defined spaces and a pre-existing hull, which will moreover operate in rough sea conditions. The combination of these additional project-specific factors entailed a further increase of the supply's

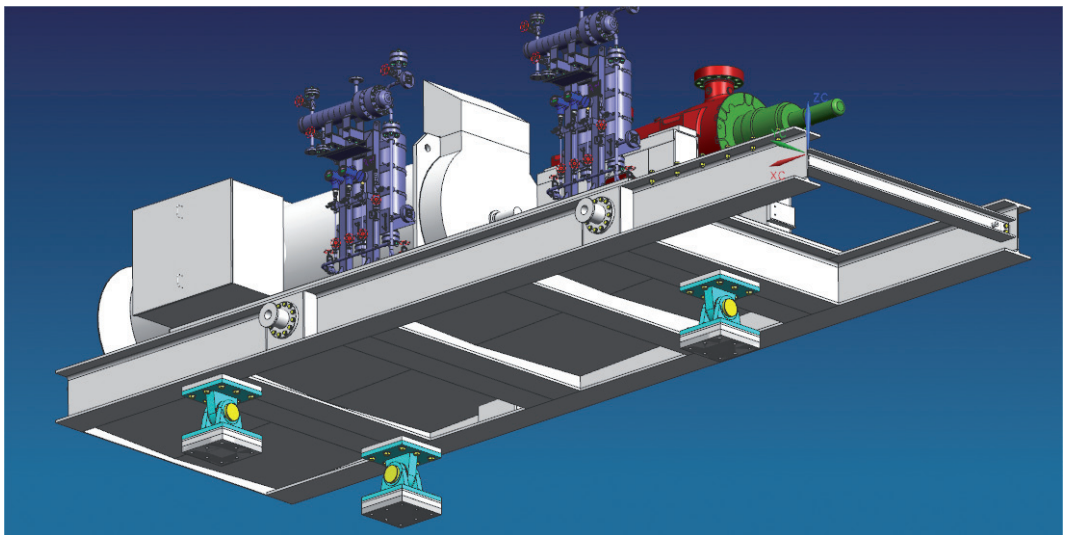
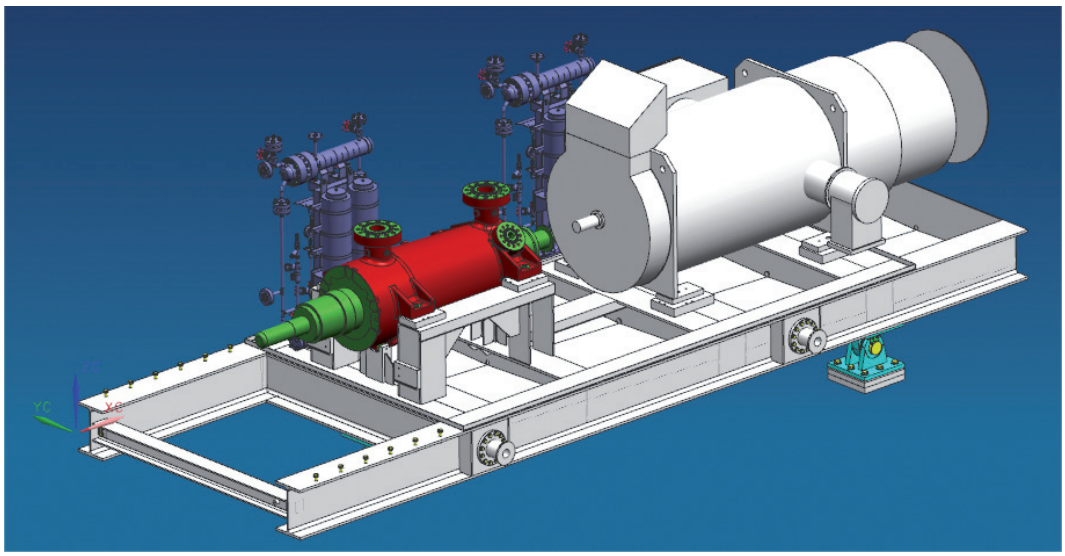


Fig. 3 – Base plate, general arrangement: bottom

Fig. 4 - Base plate, general arrangement: top view



design complexity. In fact, design not only had to be adapted to the particularly limited spaces available but it also had to take into account the tight constraints of vessel motion specification on structural elements and accessories; design further had to take into consideration interface loads higher than usual for this type of application.

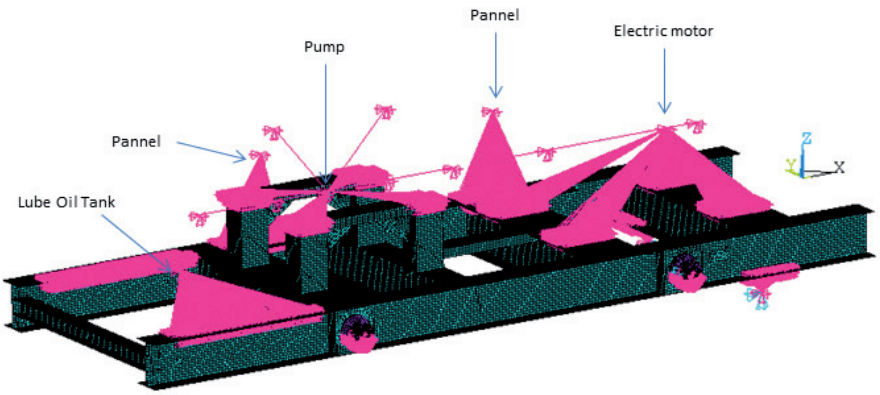
All the above requirements have entailed the necessity to dedicate considerable resources to engineering activities, substantially higher than for other comparable projects, whether related to the *ad hoc* design of the baseplate and other skid structural elements or to the methodical use of FEM (Finite Element Method) analysis (**figure 5**) for both design and verification of various components of the supply.

The engineering of auxiliary and electrical components, such as inverters, electric motors and lube oil system was also subject to the limitations imposed by the afore-mentioned requirements.

A Hazop (HAZard and OPerability analysis) review was conducted at design completion in order to verify that all measures necessary to guarantee the safe operation of the plant had been taken into account during the design phase.

The complete test of the pumping unit under all its operating conditions was carried out at Termomeccanica La Spezia's in-house test center facilities.

Fig. 5 – Baseplate FEM model



Cooling circulation pumps

For the cooling medium circulation service, the contract also included the supply of 3 vertical "in-line" API OH3-type pumps (**figure 6**), with a flow rate of 1050 m^3/h at a 52.5 m head and driven by a 230 kW electric motor.

In this case too, the specific requirements of this project, particularly the need to reduce overall dimensions without affecting technical requirements, have led to a tailor-made solution with the supply of Termomeccanica DDBV-type pumps. This is actually a typical solution for Termomeccanica which consists of "in-line" vertical pumps that are however axially-split instead of radially-split as for the API 610 OH3 standard.

Utility pumps

The remaining utility services of the platform are covered by 5 more OH2-type pumps: 2 "off-gas compressor suction drain pumps", Termomeccanica 25AP32 model, and 3 "heating medium circulation pumps", Termomeccanica 80AP20 model.

Vertically suspended pumps

Termomeccanica supply finally included 2 vertically suspended pumps: one VS2-type pump, working as glycol transfer pump (Termomeccanica CPP50.1 model) and one VS4-type pump, working as drain sump pump (Termomeccanica 25CPPL16 model).

Once again, the peculiarities of the project have prevailed over design standardization.

The lack of space on the platform deck did not allow the development of design according to API610

standard as originally planned. In fact, the entire upper part of the pumps surmounting the baseplate had to be completely re-designed so as to reduce its height and allow installation as well as maintenance of the pumps in the small space available on the deck.

Quality & certification

As it is usual for offshore projects, certification has represented an essential component of the scope of work of the supply. In addition to CE marking and Atex certification, project specifications have required the involvement of the Lloyd's Register as Inspection & Verification body for marine classification and Bureau Veritas as third party inspector. Moreover, TÜV has been involved to carry out Ped related activities.

Project management

In addition to the technical constrains described above, this project has also been subject to a major management challenge due to special customer requests.

For example, as part of the de-risking project of the Greater Stella Area Development, both the client and the end user have requested Termomeccanica Pompe's involvement in a series of activities aimed at reducing the delivery lead-time by one or two months according to pump type.

Termomeccanica succeeded in moving up delivery as requested and it managed to do so by involving not only many departments across the company but also its main sub-suppliers as well as the client itself (Petrofac).

Flexibility is the key

The design and supply of the 14 centrifugal pumps to be installed on the PFP1 platform of the Greater Stella oil & gas field has been characterized by uncommon design and management challenges that have not only tested Termomeccanica's experience and know how in the oil &gas off-shore sector, but also its flexibility to adapt and customize to the most diverse requests from both its client and end user. From this point of view, the positive feedbacks received by Petrofac and Ithaca Energy have confirmed the successful completion of the project by Termomeccanica.

Fig. 6 – Cooling medium circulating pump (OH3)

Cesare Nardini

After attending the University of Wollongong in Australia and Universitat Politecnica de Catalunya of Barcellona (Spain), Cesare Nardini completed his studies in 2000 at Politecnico di Milano obtaining a graduate degree in Management Engineering.

He started his work experience the same year at Alstom T&D in Montpellier (France), where he worked for two years on the development and installation of digital control system for electrical networks and substation, starting with product engineering development and then moving on to site- and project-management.

In 2002, he changed to the automotive industry and went to work as a project manager for Saira SpA, a company of Gruppo Industriale Tosoni, which focuses on the railway market. He was first in charge of all projects related to foreign markets but later moved on to the domestic market, being also the project manager for the engineering and supply of the components for the ETR 600 / New Pendolino project, developed in co-design with Alstom Transport and Giugiaro Design.

He finally joined Termomeccanica Pompe's Project Manager team in 2008, with whom he has followed to date more than 30 projects in the power generation market (including the nuclear sector) and oil & gas market (including both the onshore and offshore sectors).

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