

## CASE STUDY

# Dunbar Field Life Extension Using Sulzer Multiphase Pumps

The advent of high power multiphase pumps is changing the world of oil production, in particular by allowing the exploitation of fields nearing the end of their useful lives. This revolutionary technique has been operated since autumn 1999 on the Dunbar platform, in the UK sector of the North Sea.

### Sulzer multiphase pumps

- The Sulzer MPP range of pumps are of the helico-axial design originally developed in the 90's by Institut Français du Pétrole (IFP)
- Such pumps are particularly well suited to high capacities. Current installations include pumps with a total capacity of over 500,000 bpd

### The role of multiphase pumping

Multiphase pumping is essentially a means of adding energy to the unprocessed effluent which enables gas/liquid mixtures to be transported over longer distances without the need for prior phase separation. This also enables the wells to produce at a lower WHFP (Wellhead Flowing Pressure) and consequently:

- The production from existing fields and weak wells is increased
- Ultimate recovery is increased
- The life of a field can be extended
- Development costs are reduced

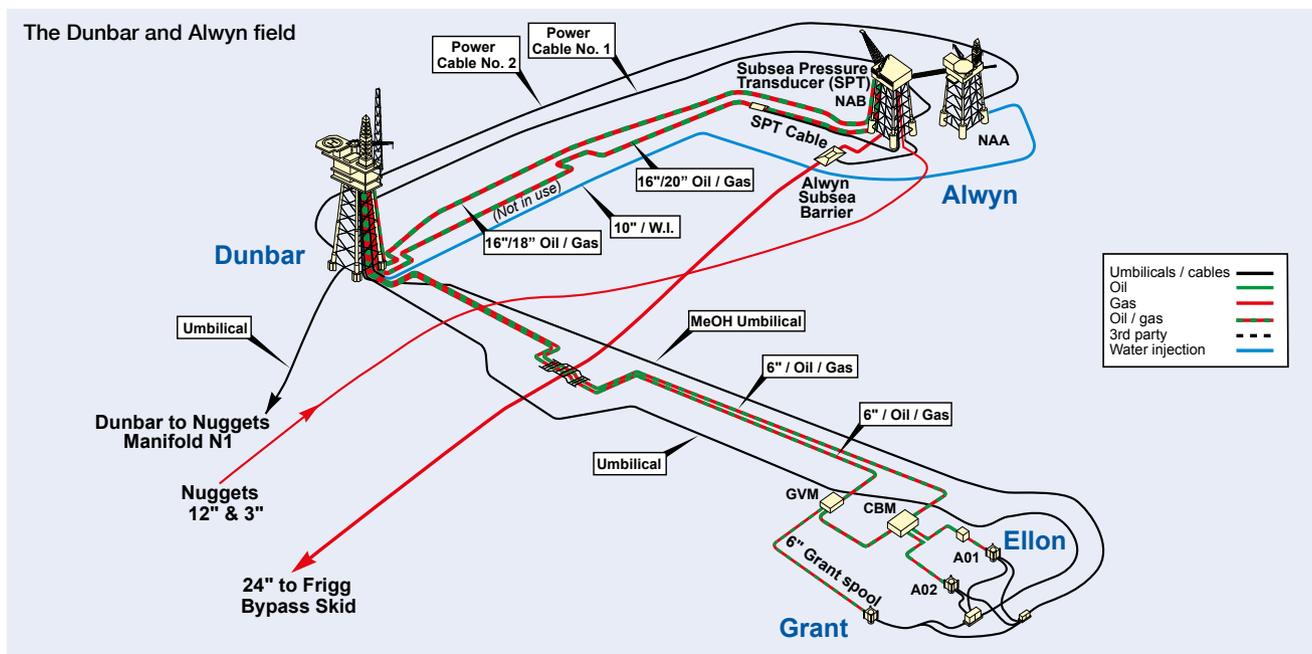
The Dunbar development is an example which demonstrates how these benefits have been realized in the field.

### The Dunbar field

The Dunbar field is located 120 km North East of the Shetland Islands and 440 km from Aberdeen. Dunbar is a wellhead platform which is operated as a satellite of the Alwyn North Platform located 22 km to the North East.

In the first phase of production, the wellhead pressure was sufficient for the effluent to flow naturally from Dunbar fields along a 16" multiphase pipeline to the Alwyn platform.

The introduction of multiphase pumps on Dunbar for the second phase has enabled production to continue in the face of declining wellhead pressure.



## Why multiphase pumps

The two main alternatives considered for the second production phase were:

- Firstly a conventional system (fig. 1) comprising a separator operated at low pressure with the liquids pumped and the gas compressed upstream of the multiphase pipeline.
- Secondly an innovative system (fig. 2) using multiphase pumps to boost the low pressure wells directly into the multiphase pipeline.

Multiphase pumps were selected in preference to a separator based solution because:

- There were no major modifications required to the existing process facilities other than tie-ing in the MPPs
- They provided a more cost effective solution being 50% lower CAPEX
- Weight and space restrictions on the Dunbar platform favored the design of the MPP cantilevered module extension. This module was over 30% lighter than a conventional system and installing the pumps vertically minimized the space requirements
- Operational flexibility was provided by implementing a well segregation scheme

## Well segregation scheme

This scheme of three independent production headers (High Pressure HP, Low Pressure LP and Low Low Pressure LLP) makes maximum use of the natural energy of the wells which means that electrical power requirements are minimized:

- High pressure wells bypass the pumps
- Lower pressure wells are routed to one of the two MPPs in order to maximize production. In the early years of MPP operation this routing was based upon the wellhead pressures (see LP and LLP wells on fig.2). In recent years other factors such as gas-to-liquid ratio and water production have also influenced the routing

About 20 wells are routed to the MPPs at present with others planned in the future in order to accelerate their production.

## Pump package

The pumpset packages were supplied by a consortium between Sulzer, ABB and Total Fina Elf. Each pumpset comprises the following main items:

- Process cooler
- Buffer tank at pump suction
- Multiphase pump
- Epicyclic gearbox
- Lube oil and seal oil systems
- Electric motor
- Frequency converter
- Transformer
- Anti-harmonic filters



Dunbar multiphase pump package during Factory Acceptance Test (FAT)

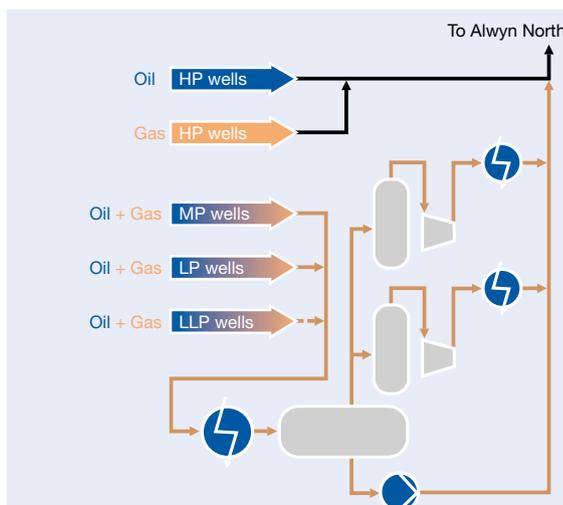


Fig. 1: Conventional concept

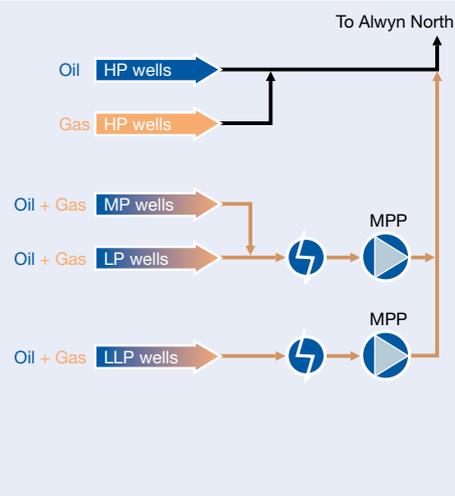


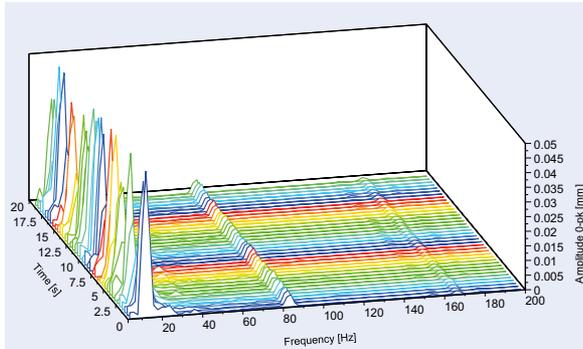
Fig. 2: Innovative concept using MPP



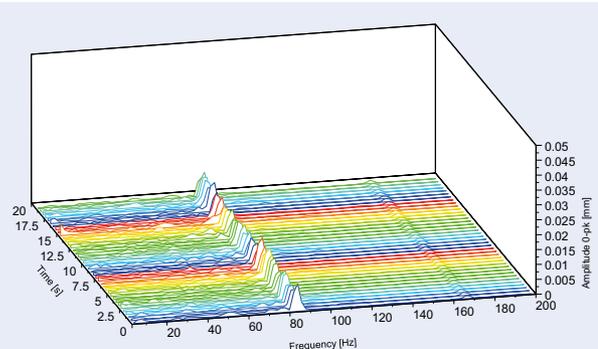
## Multiphase pump design upgrades

The reducing Dunbar wellhead pressures over time increased the ratio of gas-to-liquid flowrates. This produced liquid slugs that caused MPP instability, particularly increased sub-synchronous vibration, sometimes causing MPP trips and lengthy platform downtime.

Sulzer R&D center located in Winterthur, Switzerland dedicates a lot of efforts on developing new solutions for multiphase pumps. The charts below show the reduction in sub-synchronous vibration resulting from a revised balance drum design (design 2 is with revised balance drum).



Balance drum liner design 1



Balance drum liner design 2

## The Sulzer partnership

Good collaboration between Sulzer and Total has allowed this work to be successfully applied to the Dunbar MPPs in 2013 to overcome instabilities resulting from reduced wellhead pressures. The modifications to the pump include:

- Re-design of the balance drum providing additional damping

- Significant changes to the hollow shaft manufacturing process providing additional stiffness and better pump rotordynamic behavior
- Installation of a Sulzer patented damping device on the shaft to provide additional damping

These modifications together with good management of well routing has allowed further reduction of wellhead pressures and increased MPP availability to over 90%.



Dunbar multiphase pump rotor on the balancing machine

## Evolution of process conditions from 1999 until 2015

The depletion of Dunbar wells has led to a significant decrease of the wellhead pressure. These pressures have reduced from about 70 barg in 1999 to less than 30 barg in 2015.

The required discharge pressure has also reduced, from about 125 barg to about 70 barg, due to less pressure drop in the export pipeline to Alwyn platform at lower production rates. Consequently, the pump pressure rise has remained constant at between 40 and 50 bar.

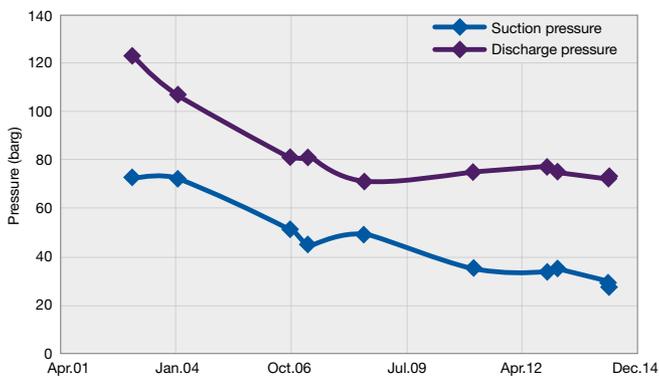
However, the inlet Gas Volume Fraction (GVF) has increased from 77% in the early days to 90-92%.

Thanks to the wide range of operation of the helico-axial hydraulics, the pump is still in operation with the same hydraulic design as in 1999.

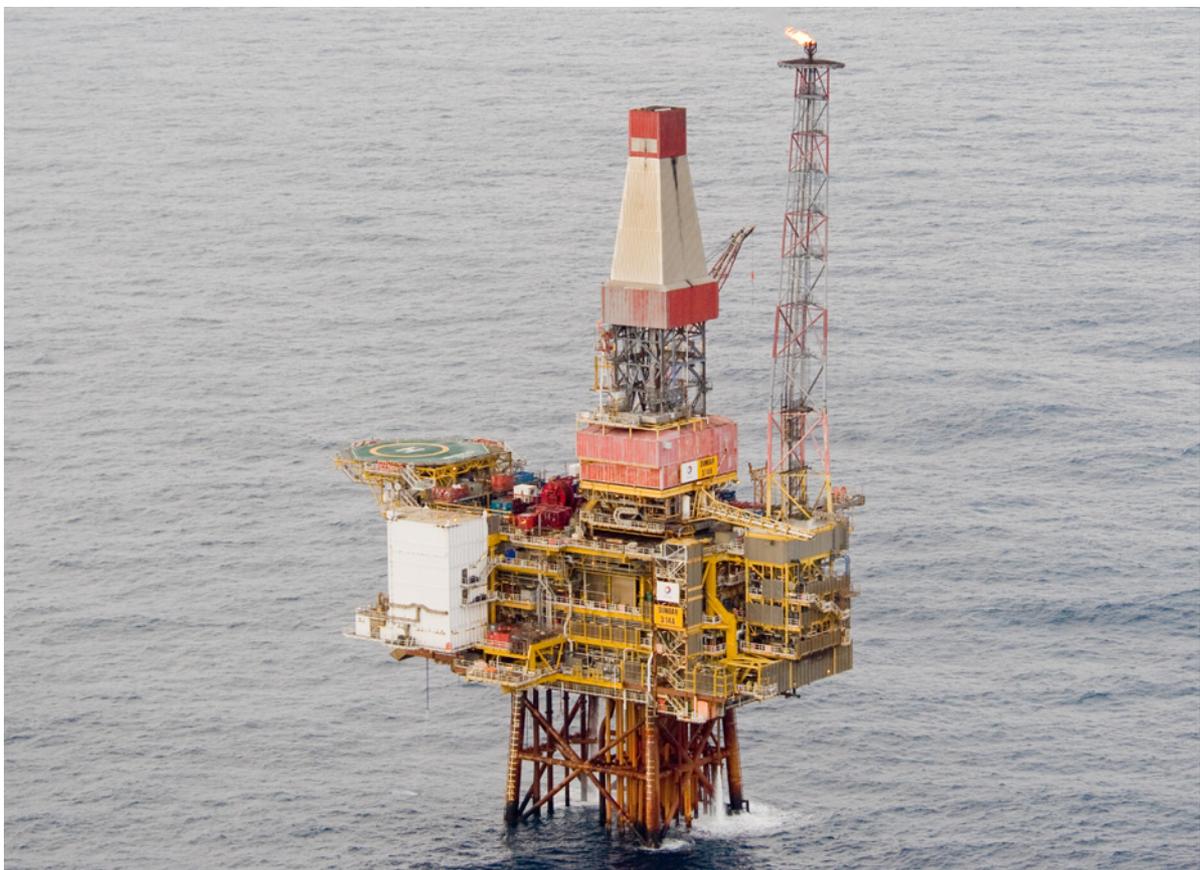
## Future Dunbar MPP operation

Total E&P UK and Sulzer are confident that the flexibility of the MPPs will help optimize late-life production from the Dunbar reservoir. Wellhead pressures of 20 barg and below are possible without the need for significant investment.

The present focus is on maximizing MPP speed as the pressure rise achieved for a given inlet pressure and inlet gas-to-liquid ratio increases rapidly with speed.



Dunbar MPP G2100B



The Dunbar platform in the North Sea

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### **Applicable markets**

Oil and Gas

### **Applicable products**

MPP multiphase pumps