Pressure pulsations in twin-screw multiphase pumps conveying oil and air

Florian Hatesuer¹, Mark Reichwage², Jörg Lewerenz², Andrea Luke¹
¹ Institute of Thermodynamics, University of Kassel, Germany
² Joh. Heinr. Bornemann GmbH, Obernkirchen, Germany

ABSTRACT

The two-phase flow of paraffinic oil and dry air conveyed by a twin-screw multiphase pump (MPP) is examined experimentally up to very high gas void fractions. The rotational speed is varied at a constant pressure difference boosted by the MPP. As results, tomography pictures of the multiphase flow are shown and the gradient of the pressure build-up within the MPP is measured. The influence on discharge side pressure surges within the MPP and its propagation in the flowlines is demonstrated.

KEY WORDS: twin-screw pump; multiphase flow; electrical capacitance tomography; ECT; pressure pulsation

NOMENCLATURE

Latin Symbols

\( A \) \quad \text{pipe cross-sectional area, \( \text{m}^2 \)}

\( \text{fps} \) \quad \text{frames per second, [-]}

\( k \) \quad \text{solubility factor, \( \text{bar}^{-1} \)}

\( n \) \quad \text{rotational speed, \( \text{min}^{-1} \)}

\( p \) \quad \text{pressure, \( \text{bar} \)}

\( T \) \quad \text{temperature, \( \text{K} \)}

\( V \) \quad \text{volume, \( \text{m}^3 \)}

\( V \) \quad \text{volume flow, \( \text{m}^3/\text{h} \)}

\( w \) \quad \text{averaged flow velocity, \( \text{m/s} \)}

Greek Symbols

\( \alpha \) \quad \text{gas volume fraction, [-]}

\( \dot{\alpha} \) \quad \text{gas volume flow fraction, [-]}

Subscripts

\text{chamber} \quad \text{chamber of twin-screw MPP}

INTRODUCTION

In conventional crude oil and natural gas production processes local separation units are needed close to the wellbore to prepare the hydrocarbons for single-phase transportation. Associated gas is often burned off. In this way, each year e.g. in Russia 50 billion cubic meters of gas are wasted (Elvidge, Baugh, Tuttle, Howard, Pack, Milesi and Erwin, 2007). Hence, in the future, gas flaring will be banned. Twin-screw multiphase pumps (MPPs) can contribute to avoid flaring when they are used for long distance multiphase conveyance without separation from far-scattered wellbores to central processing facilities (Falcimaigne and Decarre, 2008), see Fig.1. Like this, production costs are lowered and the yield of resource is increased. Even conventionally depleted or difficult to access offshore and distant onshore fields can become worth to be further exploited by MPPs (Quast, Rohlfing and Seeger, 1998).

Due to remoteness, requirements on reliability and safety of MPP units and flowlines gain in importance. As known from related pump types, pressure pulsations may appear and, if so, are considered a detrimental factor not to be neglected (Vetter, 2006). Hence, the mechanical loading of MPP components and the surrounding pipework due to vibrations and shocks, originating from the conveying process, cannot be neglected. In established operating ranges the extent of loading is controllable without any difficulty but extrapolating MPPs to higher engine power, pressure difference and delivered volumes requires a deeper understanding of the origin of vibrations. Thus, the influence of the pressure build-up on pressure gradients within the MPP and the