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Experimental investigation of hydrodynamic slug mitigation potential of an intermittent absorber

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ABSTRACT

The need to handle hydrodynamic slugs in a more efficient way becomes important as oil and gas activities shift deep offshore. This study describes the use of a vessel coupled to the pipeline-riser system upstream of the first stage separator for hydrodynamic slug attenuation. The experiments were carried out in a 2″ pipeline-riser system which comprises of a 40 m long horizontal pipe connected to a 11 m high vertical riser followed by a 3 m horizontal topside section. Air and water were used as experimental fluids. Bifurcation maps and slug attenuation index (SAI) have been used to quantify increase in oil production and the slug attenuation potential of this concept. The device was observed to reduce the pressure fluctuations characterising hydrodynamic slug flow up to 22%. The device also provides additional benefits of stabilising the flow at higher valve opening (choke setting) and lower pressure compared to traditional choking. This in practice translates to increase in oil production. Special case of hydrodynamic slugs which exhibit overchoking induced slugging (OIS) was also observed to be relatively attenuated by the introduction of the absorber.

1. Introduction

Slugging is one of the flow assurance challenges usually encountered in multiphase transportation of oil and gas. It is an intermittent flow of liquid and gas which manifests in pressure and flow fluctuations capable of causing upset in topside process facilities. This intermittent behaviour can induce structural defects in pipeline-riser system, and impact oil production negatively. The threat of slugging to oil and gas facilities has been known since the early 1970s. Three types of slugging are widely known: Terrain/severe, hydrodynamic and operation induced slugging.

During the life of a field, there are usually operational changes such as system depressurization and restart, flow ramp up, and pigging operations. These operations usually give rise to huge volume of liquid body in form of slugs. This type of slugging is referred to as operational induced slugging.

Terrain/Severe slugging is known to occur due to undulating pipeline geometry and has been extensively researched by many authors (Barbuto and Caetano, 1991; Ehinmowo, 2015; Malekzadeh et al., 2012; Sarica et al., 2014; Schmidt et al., 1985; Yocum, 1973). This type of slugging is known to exhibit large fluctuation in flow rates and pressure resulting in poor separator performance, pipeline fatigue, and sometimes eventual plant shutdown. On the other hand, hydrodynamic slug is usually encountered in horizontal or near horizontal pipelines. This slug is usually believed to be short, high frequency slugs. Many researcher including Danielson (2011), Issa and Woodburn (1998); Issa and Kempf (2003) have investigated this phenomenon and proposed model for its prediction.

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