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Please fill in your manuscript title.	Assessment of Flow Instability and Its Mitigation in a Deep Water Flowline Network

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Abstract

The objective of this paper is to study the flow instability and its mitigation in the subsea flowline system from the wellbore to topside facility for a deep water oil field located in the east coast of India. The system studied in this paper has an oil field in 400 - 550 meters water depth located at a distance of 40 kms from the shore and with an ambient sea water temperature of 8 - 10^{o}C. The field development plan employs a floating production storage and offloading vessel (FPSO) stationed at about 400m water depth (Figure-1). The peak production from the field is 3550 bopd from 5nos. subsea oil wells with profile life of 15 years. The wells are connected to a 10inch dia dual flowline system in a daisy chain manner and tied back to the FPSO with flexible risers.

For all the wells, reservoir pressures are high in early field life and hence there is no artificial lift requirement for well production during this period. However, there is requirement of artificial lift in 3 wells, viz. KG-1, KG-2 & KG-3 after 5th, 10th and 12th year of the profile respectively with depletion of reservoir pressure and increase in water cut. Gas lift is chosen as the artificial lift mode for the field to attain the profile production rates and all the wells will be equipped with gas lift from day one to meet any well kick off and slug mitigation requirement.

Due to low GLR, terrain induced slug flow is expected in Flowline -01 even during normal steady state production, while flow through other line is stable. Assessment of the hydraulic flow instability for the oil production flowlines and risers has been performed using OLGA transient simulation. A key observation from the flowline profiles (Figure-2) is the undulating nature of the seafloor where the difference in elevation from ‘peak-to-trough’ of the flowline route is of the order of 70m and the elevation difference between the riser base and the turret is about 455m. These features have the potential of promoting ‘terrain-induced slugging’ in the flowline and riser systems and these slugs can propagate downstream and generate riser-induced slugging flow into the FPSO separators and cause severe problems. Study indicates that the magnitude of slugging is prominent at the riser base with pressure fluctuation of about 15 ksc. By considering gas lift injection during early life of oil production, the GLR in the production flowlines increases and thereby helps to reduce the magnitude of slugging and also reduce the back pressures at the manifolds and wells. Options of downhole gas lift to the wells, choking at the riser top (FPSO) along with subsea choking and single line operation with the aim of stabilizing flowline pressures were investigated and the optimum measures have been suggested. Due to reduction in flow rates after year-8, single flowline operation through is envisaged by diverting production from all the wells through the Flowline -01.

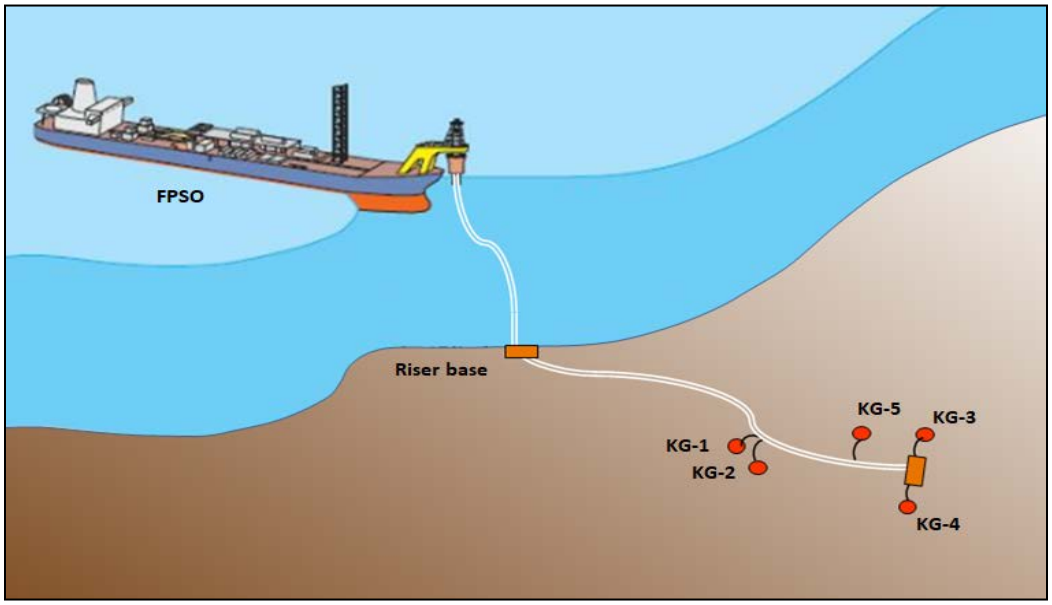

Fig. 1 Development schematic of the deepwater field

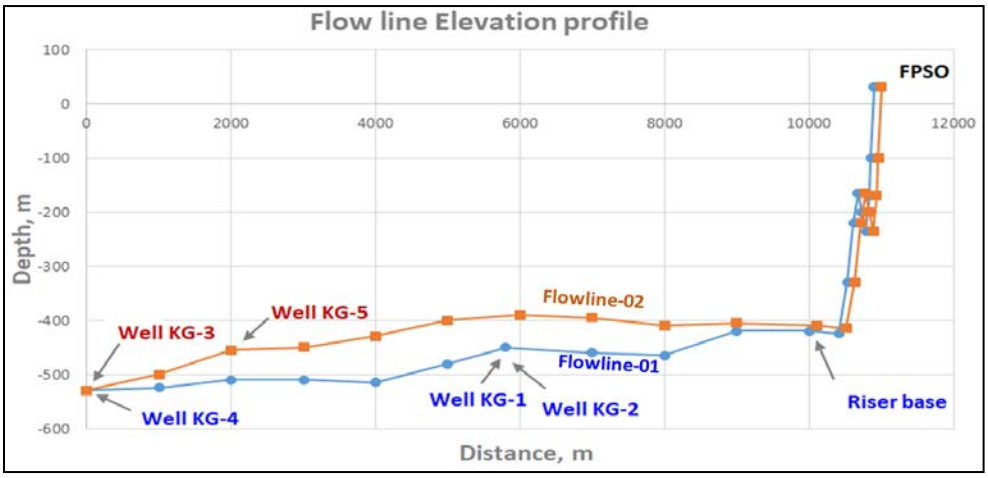

Fig. 2 Elevation profile of the subsea flowlines