Physical-stochastic (greybox) modeling of slugging

We use state-based stochastic greybox modeling - combining physics and statistics - to model the slugging phenomenon. We extend the model of DiMeglio et al. (2010) to include random components and variable flow coefficients, providing 30 seconds prediction intervals. Altogether six models, each comprising no more than ten equations, are fitted to off-shore riser training data and then cross-validated on new data sets. We use advanced statistical methods to 1) obtain optimal parameters of a given model fitted to measurements, 2) give model predictions with uncertainty intervals, and 3) quantitatively measure the relative goodness of the extended models. These features of our reductive method are general and can be applied to any data sets. For the slugging data, simpler models are preferable over the more complex ones (although the differences are minute for practical purposes in oil and gas industry) and a high statistical significance obtained on the training data does not imply improved long term prediction on independent data. Better physical (mechanistic) models to capture slugging oscillations are needed, ultimately to develop effective control strategies.

General information
Publication status: Published
Organisations: Department of Applied Mathematics and Computer Science, Dynamical Systems
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Pages: 197-202
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: IFAC Workshop Series
Volume: 51
Issue number: 8
ISSN (Print): 1474-6670
Ratings:
BFI (2018): BFI-level 1
Original language: English
Keywords: Stochastic greybox modeling, Slugging
Electronic versions:
1_s2.0_S2405896318307079_main.pdf
DOIs:
10.1016/j.ifacol.2018.06.377
Source: FindIt
Source ID: 2437931631
Research output: Contribution to journal › Journal article – Annual report year: 2018 › Research › peer-review