FLOW ASSURANCE STUDY FOR A GATHERING PIPES SYSTEM OF AN EGYPTIAN GAS-CONDNESATE FIELD

By

Emad El-Din Mahmoud Rabeea

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
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MASTER OF SCIENCE
in
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Under the Supervision of

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Key Words:
Flow assurance; Pipes; Condensate; Gas; Multiphase flow

Summary:

Flow assurance refers to ensuring successful and economical flow of hydrocarbon from reservoir to the point of sale. In this study, a gas-condensate field gathering system is considered for a flow assurance study to determine its integrity and reliability towards current, future conditions and at maximum capacity. A transient flow study is performed assuming two scenarios; the time needed to reach the maximum allowable working pressure and performing pigging to the trunk lines. The study showed the importance of flow assurance for management decision and engineering design.

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Dedication

To my Advisor, Prof. Dr. Abdel Waly, without your advice, support and encouragement, this work wouldn’t be possible. Thank you.

To my parents, this day wouldn’t be possible without your full support and help. This day is the crown jewel of your journey. Thank you.

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To my son, this is my legacy to you. Be proud of it, learn from it and improve it.

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Nomenclature

AGA	:American Gas Association
API	:American Petroleum Institute
CGR	:Condensate/gas ratio
CPF	:Central Processing Facility
Dab-x	: Dabayaa well number x
ESD	: Emergency Shut down
EVR	: Erosion Velocity Ratio
EWE-2	: El-Wastani East-2 well
EW-x	: El-Wastani number x well
Far-3	: Faraskur-3 well
FL	: Flow Line
FLP	: Flow Line Pressure
FLT	: Flow Line Temperature
GPS	: Global Positioning System
ID	: Internal diameter
MAWP	: Maximum Allowable Working Pressure
MFD	: Manifold
Mscfd	: Thousand standard cubic feet per day
MMscfd	: Million standard cubic feet per day
NA	: Not available
NCE	: Node connecting element
psia	: Absolute pound per square inch
psig	: Gauge pound per square inch
Qc	: Condensate flow rate
Qg	: Gas flow rate
Qw	: Water flow rate
S-Far-x	: South Faraskur well number x
SAEN	: South Abu EL-Naga Field
SAEN-x	: South Abu El-Naga well number x
SIWHP	: Shut-In Well Head Pressure
STB/D	: Stock tank barrel per day
TL	: Trunk Line
VR	: Valve Room
WASCO	: El-Wastani Petroleum Company
WC	: Water Cut

Abstract

Flow assurance is a newly concept introduced to industry in the 90th decade. Flow assurance refers to ensuring successful and economical flow of hydrocarbon stream from reservoir to the point of sale. Flow assurance is extremely diverse, encompassing many discrete and specialized subjects and bridging across the full series of engineering disciplines.

There are several obstacles to the flow from the reservoir till the end user. The most common obstacles are pressure drop, liquid holdup, erosion and hydrate formation. There are several correlations were developed in literatures to predict those obstacles. Those correlations can be time-dependent, thus called transient flow correlations. There are several commercial simulation software equipped with these correlations and save time and energy for solving this equations by hand.

In this study, WASCO gas-condensate field gathering system is considered for a flow assurance study to determine its integrity and reliability towards current and future conditions. The commercial, multiphase, transient flow software OLGA is used in this study. Data from the fields are collected, sorted and filtered to match the required input format of the software. After building the mathematical model, data matching is done to verify the model.

The current condition of the network is studied for steady-state flow assurance aspects as pressure drop, liquid holdup, flow regime, erosion and hydrate formation. It was found that the network is suitable for the current production rates. The maximum capacity of the network is then calculated and the flow assurance study for the new flow rates is repeated.

A transient flow study is performed assuming two scenarios. The first scenario is to calculate the time needed for the network to reach the maximum allowable working pressure, if an emergency shutdown occurred in the downstream processing facility. The second scenario is performing pigging operation to the main trunk lines and studying its effect on the pressure drop.

The study clearly showed the importance of flow assurance study for management decision and engineering design. The effect of liquid holdup on pressure drop is clarified and regular pigging operation is recommended to overcome the high pressure drop. The effect of gas velocity on liquid holdup is stated. The erosion velocity ratio also limited the maximum capacity of the network and the study recommended looping the main trunk line to increase its capacity.

Chapter 1

Introduction

The increasing demand of energy sources, along with fluctuation of oil and gas prices make it inevitable to review the current technologies of production, transportation and storage of oil and gas. New technologies have been introduced in exploration and development of oil or gas well to be able to produce economically. These technologies show great success in drilling and producing oil and gas wells economically and efficiently. However, one major obstacle aroused recently especially as we dig deeper under water and underground. This obstacle is how to deliver the valuable hydrocarbon from the reservoir economically to the end user. This concern made the manufacturer and scientists to come up with a new term in oil and gas industry; flow assurance .

Flow assurance refers to ensuring successful and economical flow of hydrocarbon stream from reservoir to the point of sale. By definition, Flow assurance focuses on the whole engineering and production life cycle from the reservoir through refining, to ensure with high confidence that the reservoir fluids can be moved from the reservoir to the refinery smoothly and without interruption.

Flow assurance is extremely diverse, encompassing many discrete and specialized subjects and bridging across the full series of engineering disciplines. The financial loss from production interruption or asset damage due to flow assurance mishap can be astronomical .

According to API [(1)], Flow assurance is a term commonly used to cover a wide range of flow-related issues. These issues typically include:

1. Hydrate formation،
2. Wax formation،
3. Asphaltene formation،
4. Emulsions،
5. Foaming،
6. Scale formation،
7. Sand production،
8. Slugging،
9. Materials-related issues .

The flow assurance study should cover the entire system, from the perforations through to and including the processing facilities on the host/drilling rig, as well as considering the complete life-cycle of the development, including:

1. Installation activities،
2. Commissioning activities،

3. Routine operation،
4. Intervention and maintenance activities،
5. Abandonment activities.

In this thesis, the main focus will be on the flow assurance regarding the hydrocarbon transport from gas-condensate wells to the processing facility through a pipeline gathering system.