

# Design, Operation, and Troubleshooting of Dual Gas-lift Wells

**Upstream Segment**

API RECOMMENDED PRACTICE 19G9  
FIRST EDITION, FEBRUARY 2010



AMERICAN PETROLEUM INSTITUTE

## Special Notes

API publications necessarily address problems of a general nature. With respect to particular circumstances, local, state, and federal laws and regulations should be reviewed.

Neither API nor any of API's employees, subcontractors, consultants, committees, or other assignees make any warranty or representation, either express or implied, with respect to the accuracy, completeness, or usefulness of the information contained herein, or assume any liability or responsibility for any use, or the results of such use, of any information or process disclosed in this publication. Neither API nor any of API's employees, subcontractors, consultants, or other assignees represent that use of this publication would not infringe upon privately owned rights.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any authorities having jurisdiction with which this publication may conflict.

API publications are published to facilitate the broad availability of proven, sound engineering and operating practices. These publications are not intended to obviate the need for applying sound engineering judgment regarding when and where these publications should be utilized. The formulation and publication of API publications is not intended in any way to inhibit anyone from using any other practices.

Any manufacturer marking equipment or materials in conformance with the marking requirements of an API standard is solely responsible for complying with all the applicable requirements of that standard. API does not represent, warrant, or guarantee that such products do in fact conform to the applicable API standard.

Users of this RP should not rely exclusively on the information contained in this document. Sound business, scientific, engineering, and safety judgment should be used in employing the information contained herein.

All rights reserved. No part of this work may be reproduced, translated, stored in a retrieval system, or transmitted by any means, electronic, mechanical, photocopying, recording, or otherwise, without prior written permission from the publisher. Contact the Publisher, API Publishing Services, 1220 L Street, NW, Washington, DC 20005.

*Copyright © 2010 American Petroleum Institute*

## Foreword

Nothing contained in any API publication is to be construed as granting any right, by implication or otherwise, for the manufacture, sale, or use of any method, apparatus, or product covered by letters patent. Neither should anything contained in the publication be construed as insuring anyone against liability for infringement of letters patent.

This document was produced under API standardization procedures that ensure appropriate notification and participation in the developmental process and is designated as an API standard. Questions concerning the interpretation of the content of this publication or comments and questions concerning the procedures under which this publication was developed should be directed in writing to the Director of Standards, American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005. Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the director.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years. A one-time extension of up to two years may be added to this review cycle. Status of the publication can be ascertained from the API Standards Department, telephone (202) 682-8000. A catalog of API publications and materials is published annually by API, 1220 L Street, NW, Washington, DC 20005.

Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, [standards@api.org](mailto:standards@api.org).



# Contents

Page

1	Scope .....	1
2	Why Dual Wells Exist .....	1
2.1	General .....	1
2.2	Lower Drilling Cost .....	1
2.3	Possible Mitigating Factors .....	3
2.4	Insufficient Surface Space .....	3
2.5	Multi-lateral Completions .....	3
2.6	Completion/Operation Concerns.....	4
3	Dual Gas-lift Overview .....	4
3.1	General .....	4
3.2	Goals of Dual Gas Lift.....	4
3.3	Problems Associated with Dual Gas Lift .....	5
4	Dual Gas-lift Recommended Practices .....	14
4.1	General .....	14
4.2	Practices That are Recommended .....	14
4.3	Practices That are Not Recommended .....	22
5	Candidates and Screening Criteria for Dual Gas Lift .....	24
5.1	General .....	24
5.2	Acceptable Candidates for Dual Gas Lift .....	24
5.3	Wells That are Not Good Candidates for Dual Gas Lift.....	26
5.4	Considering Artificial Lift Alternatives to Dual Gas Lift .....	27
6	Staffing Commitment Required for Successful Dual Gas Lift .....	28
6.1	General .....	28
6.2	Commitment Required by Management .....	28
6.3	Engineering Commitment.....	30
6.4	Commitment Required by Members of Dual Gas-lift Team .....	33
6.5	Commitment Required by Trainers and Others.....	34
7	Designing Dual Gas-lift Wells.....	36
7.1	General .....	36
7.2	Mandrel Spacing .....	36
7.3	When One Zone is much Deeper Than the Other Side .....	42
7.4	The PPO vs IPO Gas-lift Valve Debate .....	44
7.5	Unloading Gas-lift Valves .....	48
7.6	Operating Gas-lift Valve or Orifice.....	48
7.7	Designing for Dual Gas Lift if Mandrels Spaced Too Far Apart .....	50
7.8	Review of Various Dual Gas-lift Design Options .....	50
8	Operation of Dual Gas-lift Wells.....	52
8.1	General .....	52
8.2	Installing Dual Gas-lift Equipment.....	52
8.3	Wireline Operations in Dual Gas-lift Wells .....	54
8.4	Additional Recommended Wireline Procedures .....	56
8.5	Unloading Dual Gas-lift Wells .....	60
8.6	Kicking Off Dual Gas-lift Wells.....	62
8.7	Operating Dual Gas-lift Wells .....	63
8.8	Optimizing Dual Gas-lift Wells .....	66

<b>9</b>	<b>Surveillance of Dual Gas-lift Wells</b>	<b>68</b>
9.1	General	68
9.2	Wireline Operations in Gas-lift Completions	68
9.3	Pressure/Temperature Surveys	69
9.4	Using Pressure/Temperature Surveys to Evaluate and Diagnose Dual Gas Lift	71
9.5	Fluid Levels	72
9.6	Well Tests	73
9.7	CO <sub>2</sub> Tracer	74
9.8	Continuous Monitoring and Control	75
<b>10</b>	<b>Diagnosis and Troubleshooting</b>	<b>78</b>
10.1	General	78
10.2	Diagnostic Techniques	78
10.3	Locating Communications Problems	84
10.4	Typical Dual Gas-lift Problems	85
<b>11</b>	<b>Automation of Dual Gas-lift Wells</b>	<b>88</b>
11.1	General	88
11.2	Gas-lift Automation Logic	88
11.3	Key Measurement Parameters	89
11.4	Dual Gas-lift Controls	90
11.5	Responding to Gas-lift System Problems	92
<b>12</b>	<b>Special Issues</b>	<b>93</b>
12.1	General	93
12.2	Gas Lift and a Flowing Well in the Same Wellbore	93
12.3	Gas Lift and a Pumping Well in the Same Wellbore	94
12.4	Intermitting One or Both Zones	95
12.5	Completing With or Without Mandrels	96
12.6	Transitioning from Flowing to Dual Gas-lift Operation	97
<b>Annex A (informative) Dual Gas-lift Unloading Valve Design for PPO Valves</b>		<b>99</b>
<b>Annex B (informative) Dual Gas-lift Mandrel Spacing Design</b>		<b>103</b>
<b>Bibliography</b>		<b>108</b>
<b>Figures</b>		
<b>1</b>	<b>Mandrel with Injection String Beneath the Upper Packer</b>	<b>42</b>
<b>2</b>	<b>Gas-lift Response</b>	<b>67</b>
<b>3</b>	<b>Flowing Pressure Survey</b>	<b>80</b>
<b>4</b>	<b>Inflow Performance Relationship</b>	<b>81</b>
<b>5</b>	<b>Gas-lift Response Curve</b>	<b>81</b>
<b>6</b>	<b>Gas-lift Response Curve Comparison</b>	<b>82</b>
<b>7</b>	<b>Production Rate vs Mandrel Depth</b>	<b>83</b>
A.1	Graphical Method for Design	101
B.1	Gas-lift Mandrel Spacing	
<b>Tables</b>		
<b>1</b>	<b>Gas-lift Installation Problems</b>	<b>59</b>
A.1	PPO Valve Calculations	102
B.1	Example Well Parameters	104
B.2	Example Gas-lift Characteristics	104
B.3	Calculated Long String Mandrel Depths	106
B.4	Calculated Short String Mandrel Depths	106

## Introduction

This document is one of a series of recommended practices (RP's) produced by the American Petroleum Institute (API) for use by oil-field engineers, operators, and others around the world. This RP focuses on dual gas-lift.

This API recommended practice provides guidelines and tools to facilitate the effective and efficient design, operation, optimization, and troubleshooting of dual gas-lift completions. As used in this document, a dual completion is one in which there are two producing zones, each with its own tubing string, in a single production casing. So, there are two separate producing wells, with one common annulus.

It is sometimes concluded in the development of fields with multiple reservoirs that the economic benefits of dual completions outweigh the operational problems that frequently result from trying to effectively produce a dual completion and the higher operating and workover costs that may occur over the producing life. Thus, dual completions (and occasionally even triples) are sometimes attempted to reduce upfront drilling costs and accelerate production from the multiple reservoirs.

This document focuses on the issues that can be faced when it becomes necessary to artificially lift both sides of a dual completion with gas-lift. Management of the problems facing operators of dual gas-lift wells may be easier and more successful if the recommended practices in this document are followed.



# Design, Operation, and Troubleshooting of Dual Gas-lift Wells

## 1 Scope

This document provides recommended practices for the design, operation, optimization, and troubleshooting of dual gas-lift wells.

Compared to single completions, dual completions have a higher initial cost, have more operating problems, are more difficult and expensive to work over, and often produce less efficiently. Based on experience, most technical gas-lift specialists and operations staff prefer single completions to duals.

It is not the purpose of this document to recommend the practice of dual gas lift. In many cases, dual gas lift is problematic and often it is ineffective. Often it is difficult or even impossible to effectively produce both completions in a dual well using gas lift, over the long term. If there are other feasible alternatives to produce dual wells, they should be considered.

However, many dually completed oil wells should be artificially lifted—initially or after reservoir pressures have declined and/or water cuts have increased. And in many cases, the only practical or feasible method of artificial lift for these wells is gas lift. So, if dual wells must be artificially lifted, and if the only practical or feasible means to do this is with gas lift, every effort should be made to perform this dual gas-lift function as effectively as possible.

Therefore, the purpose of this document is to offer recommended practices, guidelines, and tools to make the best of what may otherwise be a difficult situation. This document also contains suggestions on practices that should be avoided to minimize problems, inefficiencies, and poor economics that may be associated with ineffective dual gas-lift operations.

## 2 Why Dual Wells Exist

### 2.1 General

Dual wells exist for a number of reasons. The primary ones are summarized in this section.

### 2.2 Lower Drilling Cost

The primary reason why duals exist is economics. It is often less expensive to drill one wellbore to serve two (or more) vertically oriented production zones, than to drill two or more separate wells to reach these same zones.

In some fields, there are multiple reservoirs “stacked” on top of each other. In some fields, there may be as many as 5, 10, or even more separate reservoirs located vertically above one another. The development plans for such fields are often complex and require an economic study that should consider the initial drilling and completion costs plus the producing costs, workover costs, and the potential production rates over the life of the field.

The objective is normally to produce the reserves as quickly as feasible, and realize the highest profits, while protecting the environment and being good world citizens. Multiple completions that result in significant loss or deferment of reserves, prolonged producing lives, and much higher producing and workover costs are not recommended. It is very tempting, economically, to drill one well to intersect several reservoirs, and to produce more than one of the reservoirs at the same time with the same well, to minimize overall costs and to accelerate overall production. But this should be done correctly, or the economic benefits may not be achieved.