Transient identification and interpretation of real-time pressure data from modern well surveillance systems

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WEB APP

Introduction

Background

Time-lapse Pressure Transient Analysis (PTA) is One of the most important tools to deal with the data (pressure, flow rate, temperature, etc.) obtained from modern well surveillance system. Unlike traditional PTA which only interpret data in shut-in periods, time-lapse PTA is applied to both flowing & shut-in periods to evaluate time-dependant well-reservoir parameters[1].

Time-lapse PTA contains 7 steps[2]; the third step is the main target of this study: transient identification based on pressure data.

Previous Work

A number of methods (e.g. Spline wavelet[2], Filter convolution [3], etc) were suggested. But they have problems with accuracy, screening out small transients, etc.

Objective

Implement a two-tasks' model with high accuracy, noise tolerance, minimum user interaction, etc.

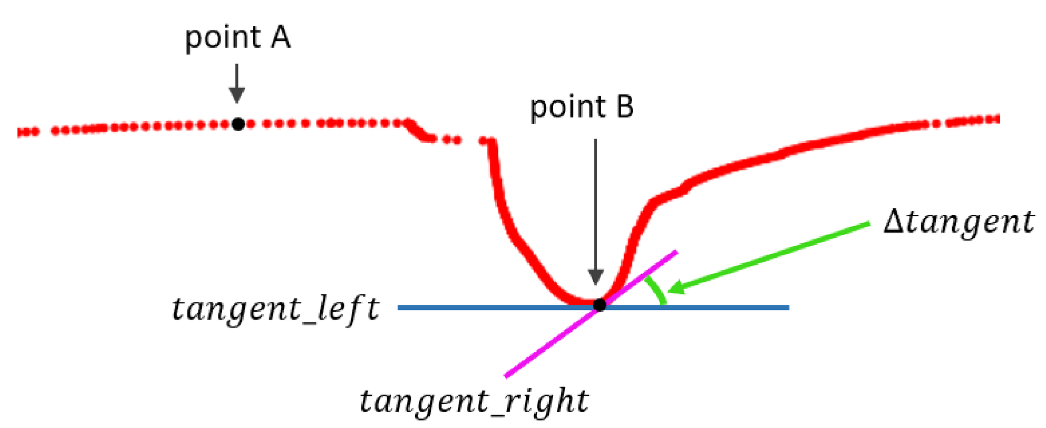
Task 1: separation of flowing from shut-in periods.

Task 2: task 1 + multi-flow periods.

Methods & Workflow

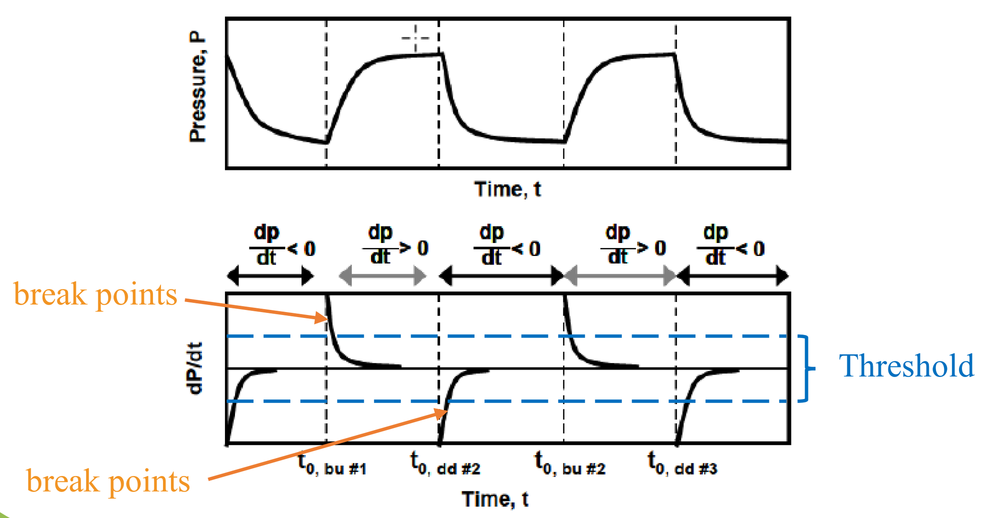
Method 1: Delta Tangent

if abs($\Delta tangent$) of p_i > threshold,
then p_i is a break point (build-up / draw-down).



Method 2: Delta Derivative

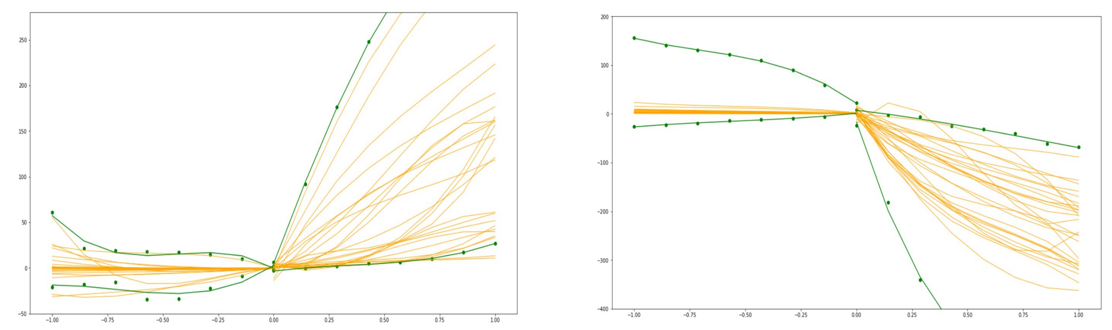
if abs($\Delta average\_Derivative$) of p_i > threshold,
then p_i is a break point (build-up / draw-down).



Method 3: Pattern Recognition

if points in window of p_i **is in** *learned Pattern*,
then p_i is a break point (build-up / draw-down).

Learned Patterns:



build-up pattern **draw-down pattern**

Results

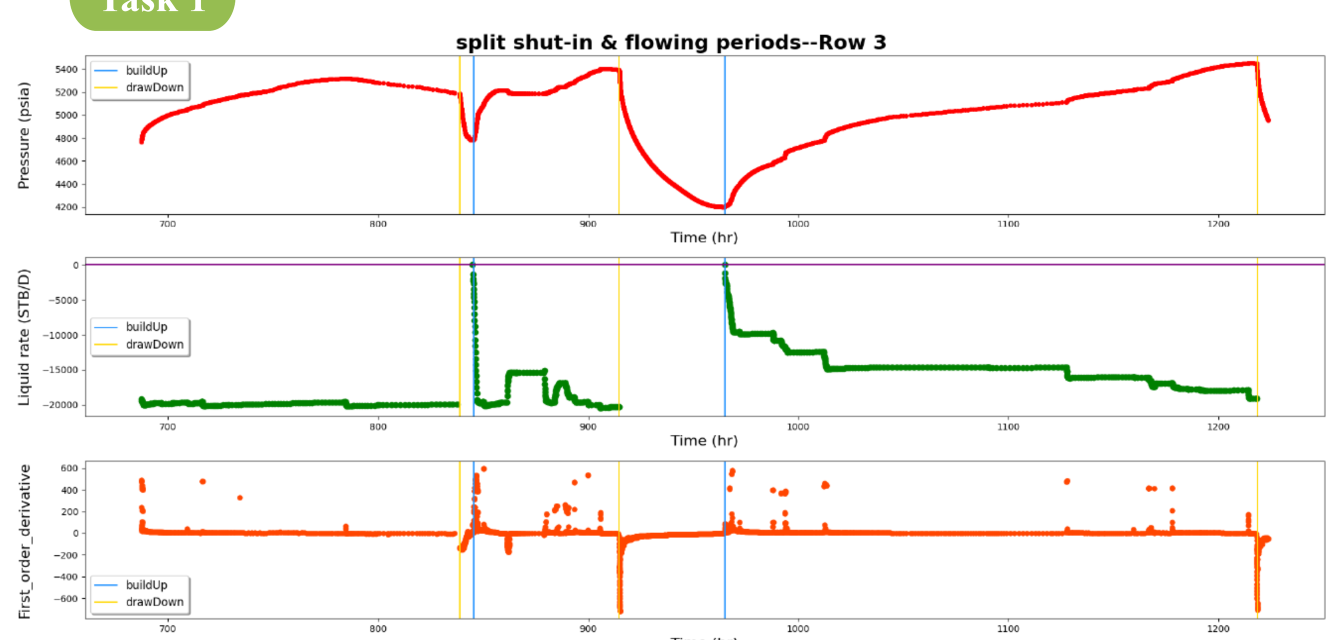
Methods	User Input		Point Window	*Task 1* ShutIn Thresh-old	Filtered ShutIns	*Task 2* Multi-rate Threshold	Multi-rate Points
PR$^\alpha$	Learned Pattern		15	0.02	31	0.03	119
	border$^\gamma$ coefficients						
DeltaDera$^\beta$	Tuning parameter		15	0.02	31$^\delta$	0.03	171
	0.1						
DeltaTan$^\eta$	Polynomial Order	Tangent Threshold	10	0.02	31	0.03	142$^\epsilon$
	1	20					
DeltaDera + DeltaTan$^\theta$	Tuning parameter	Tangent Threshold	15	0.02	31	0.03	117
	0.1	20					

$^\alpha$ PatternRecognition. $^\beta$ DeltaDerivative. $^\eta$ DeltaTangent. $^\gamma$ Obtained from learning procedure. $^\delta$ Best result for *Task 1*, has least position deviation. $^\epsilon$ Best result for *Task 2*, has least position deviation. $^\epsilon$ is not implemented in WEB APP.

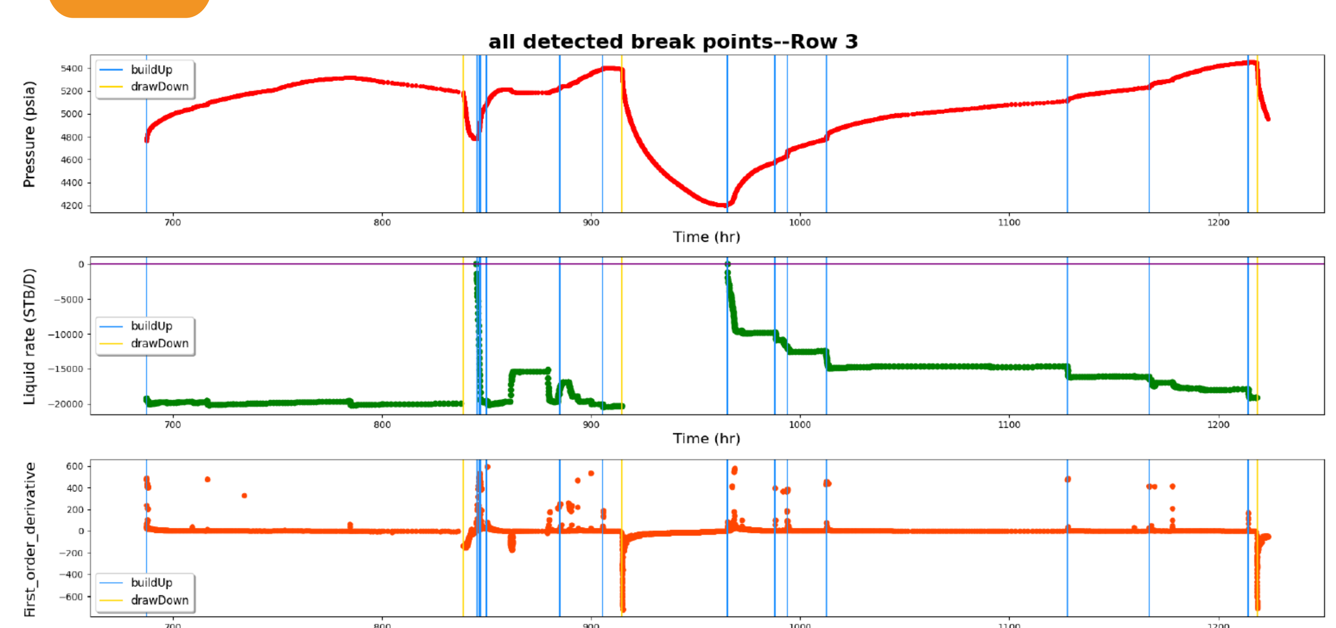
All methods successfully detected all shut-ins.

Note: The number of shut-in periods obtained from manual interpretation is 30.

Task 1



Task 2



Conclusion & Future works

Three methods

- Task 1: all 3 methods works well, *Delta Derivative* is the best.
- Task 2: *Delta Tangent >Pattern Recognition >Delta Derivative*.
- The average algorithm: cause position deviation, the results are still satisfactory.
- The newly designed learning & predicting procedure for *Pattern Recognition* is effective.
- The learned patterns could be improved by learning from more ground truth in future works.

The five-steps workflow

- Fulfill the objective based on the current testing real field data.
- Has a good tolerance to noise and parameters setting.
- Flexible for the system sensitivities of different user cases.
- Need to be adapted to more testing data in future works.

Reference

[1] Shchipanov, A. A., Berenblyum, R. A., and L.. Kollbotn. (2014). Pressure Transient Analysis as an Element of Permanent Reservoir Monitoring. Paper presented at the SPE Annual Technical Conference and Exhibition, Amsterdam, The Netherlands. doi: https://doi.org/10.2118/170740-MS

[2] Athichanagorn, S., Horne, R., and Kikani, J. (2002). Processing and interpretation of long-term data acquired from permanent pressure gauges. SPE Reservoir Evaluation & Engineering, 3(3):384–391. SPE-80287-PA.

[3] Suzuki, Satomi & Chorneyko, David. (2009). Automatic Detection of Pressure-Buildup Intervals From Permanent Downhole Pressure DataUsing Filter Convolution. 10.2118/125240-MS.