



Energy Management
-
Pipeline Power Optimization

Galen Stanley
Simulation Chief Scientist, Telvent



What is Pipeline Power Optimization?

It is the capability to determine the energy (kW, MMBTU, GPH) and cost (\$) of a pipeline's operation at a specific moment in time and to then use this information to determine the optimum pipeline pump configuration and DRA injection in order to minimize operating cost.



What Pipeline Power Optimization is Not

- Not a SCADA application, but instead a business application
- Not focused solely on the reduction of KW but total operating cost
 - time of day and contracts can impact cost
 - KW usage can be higher but actually cost less
- Not a transient solution, but is instead based on the steady-state version of SSP
- Not optimizing batch schedules



Energy Management Pipeline Power Optimization (“EM-PPO”)

- Joint Venture between Chevron, NuStar and Telvent
- Implemented in Multiple Phases
 - Phase 1: Detail Design via Co-Engineering (Complete)
 - Phase 2: Initial Infrastructure Development (Complete)
 - Phase 3: Optimization Algorithms
- Online, provides current and transition costs as well as What If analysis
- Offline, based on real-time snapshot, but extends What If to support pipeline and tariff rate configuration changes

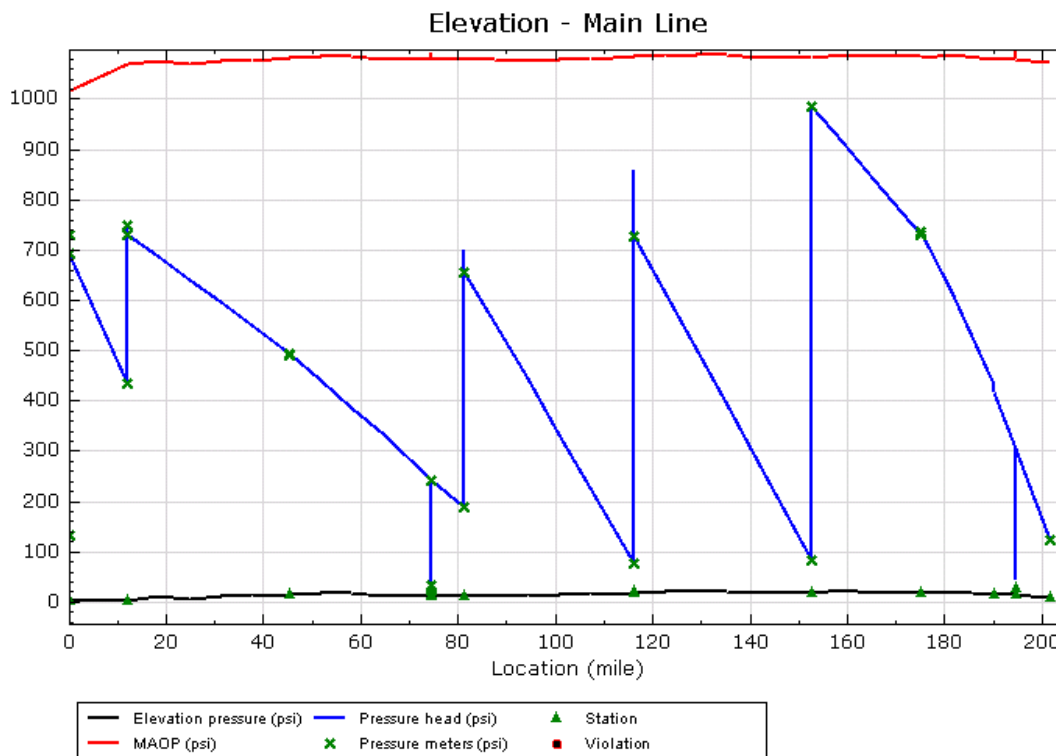


Case Study NuStar - Houston 12''



Houston 12"

This pipeline is an approximate 200-mile mainline 12" products pipeline. It has 7 pumping stations, (2 with VFD), multiple DRA injections, multiple deliveries, two tank farms and several different rate contacts. The products include several grades of gasoline, jet fuel, and distillates. Normal, average flow rate is around 4000 Bbls/hr.



Batches





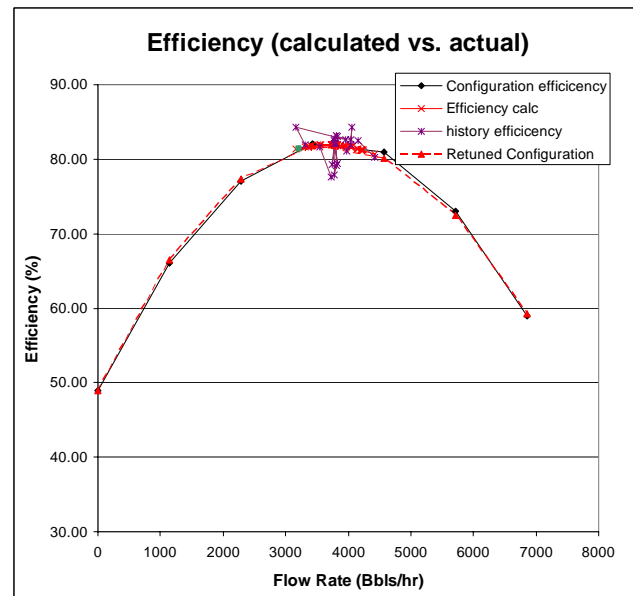
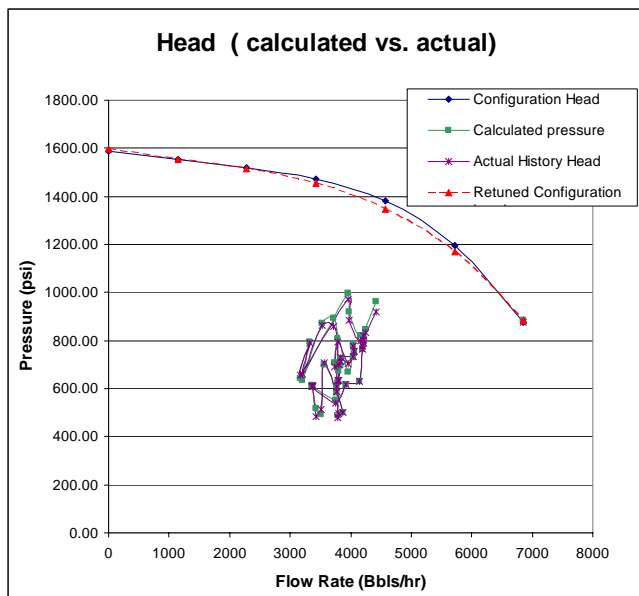
Tuning and Validation

- System verified using archived SCADA data for
 - Flows, Pressures, Temperatures, API, kW (if available)
 - Data captured on 15 minute and 1 hour intervals
- If available, kW data from Power Utility may be included for a higher level of accuracy in tuning model
- EM-PPO model tunes several variables to ensure fidelity to real world.
 - Tuning is perpetual within the online system
 - Offline tuning enables pre-tuning to help improve initial pump curves and to assist in base station kW load determination



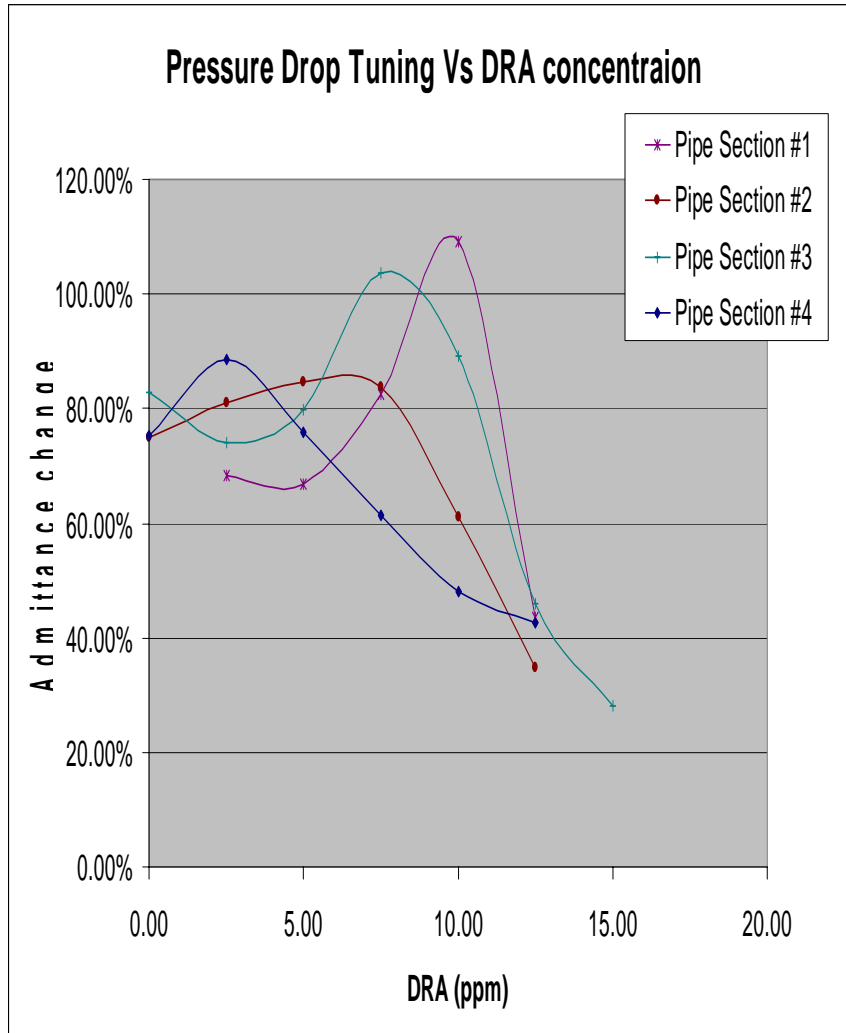
Pump Head and Pump Efficiency

- Flow rate varied from 3172 to 4418 bbls/hr
- Pump speed from 62% to 87%
- Pressure difference from 478 to 970 PSI
- Average absolute error on pressure was 2.2% and efficiency was 1.4%





DRA Coefficients – A Challenge

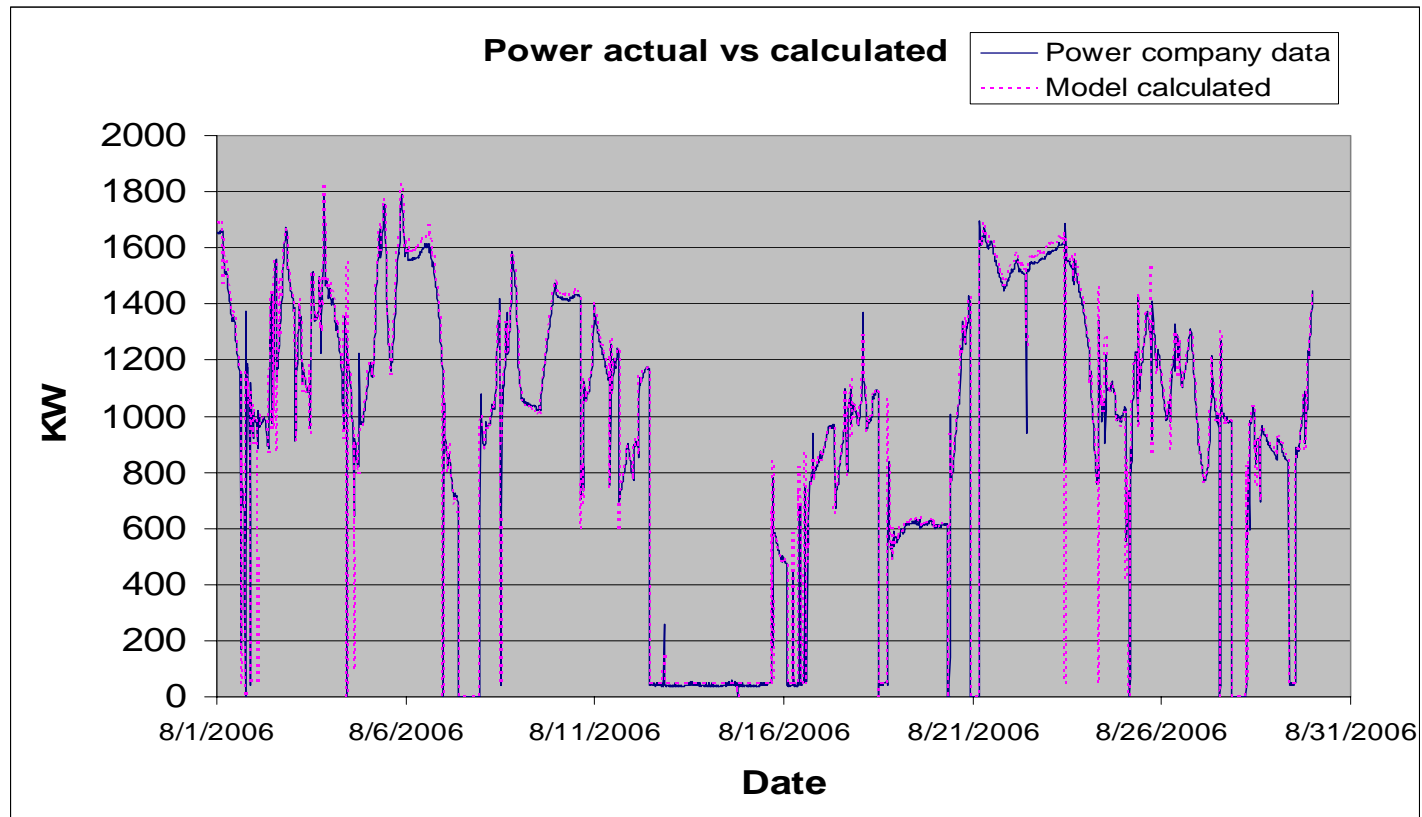


- DRA is a difficult factor to account for in EM-PPO for several reasons:
 - The time it takes to move down the pipeline
 - Its effects vary dependent on injection concentration
 - Difficult to obtain good equations and coefficients
 - Its effects can vary by product being treated
- Telvent technology and customer input can mitigate this challenge



End Result – Power Calculations

- SCADA data sampled at 15 minute intervals
- Steady flow, 1% absolute average error





Costing



Power Contracts

- Power utility contracts range from:
 - Simple kwh based rate
 - Demand, energy, fuel rates
 - Demand, tiered energy brackets, and fuel rates
 - Demand, tiered energy brackets, fuel with demand ratchets
- Can be regulated or deregulated style contracts per regulatory status



Power Contracts – Demand, Energy and Fuel

- Demand charges are expressed in \$/kW
 - demand (kW) is typically the average instantaneous power consumed during any 15 minute interval (other time intervals as well) within a billing period.
 - Utilities bill on maximum Demand during a billing period
- Energy charges can be tiered by following examples:
 - 1st 1,000,000 kwh at some \$/kwh
 - All additional kwh at some lower \$/kwh
 - Or
 - 1st 250 kwh / billed demand at some \$/kwh
 - Next 250 kwh / billed demand at some lower \$/kwh
 - All additional kwh at some lower \$/kwh
- Fuel charges are in \$/kwh for all kwhs in billing period
 - Fuel charges passed on by Utilities and can be NG, coal, wind, nuclear, purchased power, or mixture of all



Power Contracts –with Demand Ratchets

- Demand Ratchets are charges passed by Utilities to penalize the consumer for erratic usage of power
- May be a % of the highest peak demand over the previous number of months
 - % amount varies per utility
 - Number of months
 - can be for fixed period; i.e. Summer period: June – Sept
 - Rolling number of months, such as 11, 8, or other number
- So, Billed Demand for a billing period can be:
 - Maximum of (peak demand of current billing period, 80% of previous 11 months peak demand)



Demand Recorder

- Software module that mimics the power utility's own hardware demand recorder
- Shares Data Acquisition with SSP Costing Models
- Stores data interval samples in an RDB on a per Pump basis.
 - Average kW and Total kW for the contract-specified interval
- No Billing period is accounted for in the DR



Costing Module

- System component that assigns kW to \$ based on power contract
- Users enter rate schedules that specify the rules for cost calculations and then assign pumps, meters to the appropriate rates
- SSP Model interfaces with station kW per pump and receives energy, fuel and demand costs in \$'s
- Uses the Interval History to calculate Demand and Energy Brackets



Conclusions



Some Lessons Learned

- Prior to implementation of a real time power optimization software, behaviors noted:
 - Little use of DRA for energy optimization; mainly “throughput increaser only”
 - Inappropriate DRA technology used
 - Various starting/stopping pumps while lacking knowledge of which is more economical
 - Running inactive pump stations for benefit of operating CPG pigs at faster rate in effort to save OT costs



Value Added

- EM-PPO allows end user:
 - study pipeline optimization options with DRA usage, technology, location
 - Study operational delivery schedules for possible improvements
 - Study efficiency improvements with new pumps, impellar changes, fixed vs. variable applications
 - New electrical tariff negotiations
 - See in real-time, early warning of transition to higher energy rates in TOU



Thank You!

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Deployments



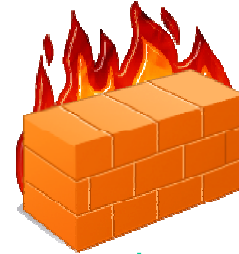
Possible Deployment

Power Opt Server



Power Opt WebServer

SCADA Firewall



Corporate Browser Clients



Power Opt WebServer



SCADA WorkStation



SCADA DSS



Energy Manager(s)

Redundant SCADA Servers



Power Opt Engineering Station