CLOCKWORK SOLUTIONS

PRODUCT APPLICATION

Process Industry-
Plant Wide "Availability Throughput" Optimization

In a modern refinery or chemical plant, process engineers are often faced with the following question, "Where should I spend my next capital or maintenance dollar to increase long-term plant production capability?" In today's business environment, that question has become more important than ever.

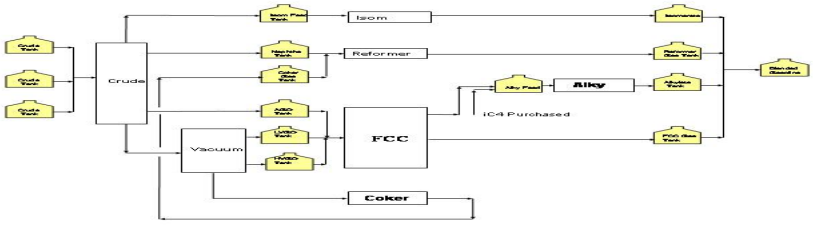
Optimal Use of Capital Funding

In a complex process plant, such as a refinery, even an experienced engineer is often not able to predict long-term plant throughput given different unit availabilities, highly integrated process unit configurations, and intermediate storage capacities. Fortunately, Clockwork Solutions offers simulation, modeling, and optimization tools for asset management that allow engineers and business managers the ability to increase the long-term throughput based on a sound life-cycle analysis technique instead of simply being relegated to educated guesses.

Standard Process Simulators vs. Life Cycle Analysis Techniques

When considering major capital expenditures, engineers often must weigh the cost/benefit of different alternatives. Process engineers have long used process simulation techniques to debottleneck plants. While obviously important, standard industry simulators tend to be steady-state time or have a time horizon measured in hours.
On the other hand, life cycle simulation, the basis of the Clockwork technology, has time horizons measured in years. Life cycle technology is able to make such long-term production predictions because they include the probability of equipment failure and the impact of tankage into their overall throughput calculations.
Consider a 100 KBPD refinery:

For this plant, engineers might be considering the cost/benefit of upgrading the vacuum unit and how that will affect the long-term production capability of the plant. Or they might be considering if it is economically feasible to remove one of the crude feed tanks. A Plant-Wide "Availability Throughput" analysis can answer those questions.



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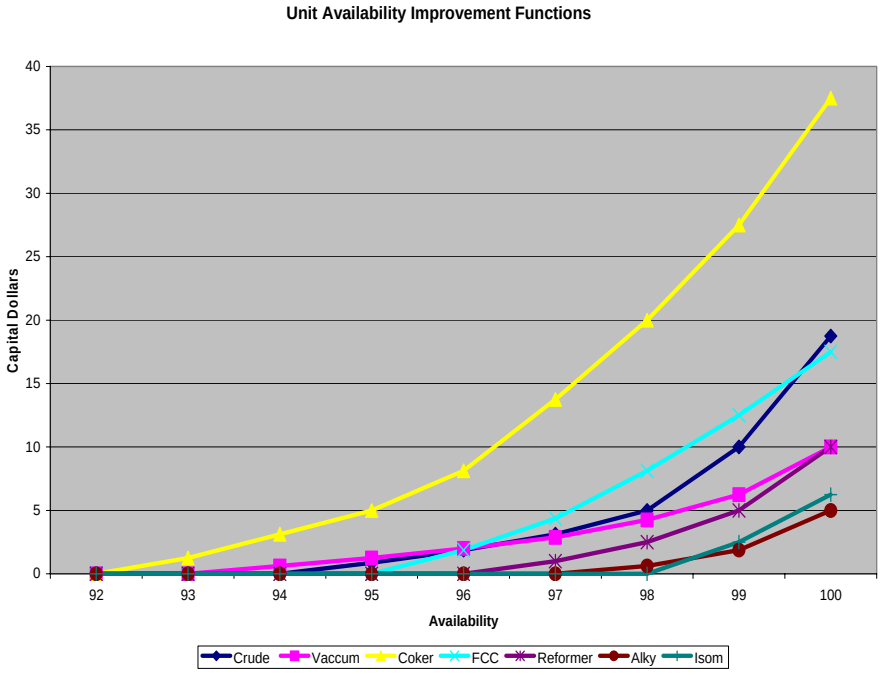
Clockwork's Approach to "Availability Throughput" Analysis

Clockwork's approach in determining the long-term production plant capability considers the following variables:

- Reliability/availability characteristics of each process unit
- Intermediate storage capacities
- Capital costs for each process unit to achieve a given availability level as shown in the figure
- Interconnection of the process units



Optimizing Capital Costs

To determine long-term throughput and capital investments, the model would typically be run with a given set of unit availabilities. For example, the Base Case and 98% Case shown in the picture to the right. Next, a general purpose optimization can be run to determine optimal unit availabilities; hence optimal unit capital costs. The optimization selects unit availabilities and calculates the corresponding system availability, the NPV of increased production, and the capital costs to achieve those availabilities. The objective function maximizes the difference between the production increase and the capital investment necessary to achieve that production increase.

	Base Case	**98% Case**	**Optimization**
Crude	94%	98%	97%
Vacuum	93%	98%	99%
Coker	92%	98%	95%
FCC	95%	98%	96%
Isom	98%	98%	99%
Reformer	96%	98%	98%
Alkylation	97%	98%	97%
System Availability	81.3%	92.7%	90.3%
Gasoline Production	42,983 BPD	49,031 BPD	47,773 BPD
Actual Crude Throughput	81,829 BPD	93,210 BPD	90,878 BPD
Delta Gasoline Production above base	N/A	6,048 BPD	4,790 BPD
Capital Investment	N/A	$40.5 MM	$21.3 MM
NPV based on 3 year production		$18.8 MM	$24.8 MM

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