WHITE PAPER

Utthunga's Industry 4.0 Application for Asset Management

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Utthunga's Industry 4.0 Application for Asset Management

An IIoT Platform provides a natural extension to Big Data, Analytics and Augmented Reality. Utthunga's IIoT platform provides a unified view and analytics for IIoT applications used in rotating assets, electrical assets and static machinery of the industrial plants. These aggregated measurements can be utilized for obtaining predictive and prescriptive insights about the asset health and thus enable end users to achieve operational and production excellence.

This process raises the question whether the statistical data, its trend and data patterns obtained from the equipment are adequate for forecasting the asset health.

It is a recognized fact that any equipment in the industrial plant is subject to a lot of constraint due to mechanical wear and tear even under the most stringent optimization and economic conditions. This deterioration takes place gradually over a period or sometimes it is so sudden with no time to take corrective actions.

For plants to leverage AI & ML analysis for prediction of failures, it is imperative to get accurate equipment data. However, this again raises the question whether it is adequate or if there is any method in which the AI & ML results can be made more meaningful. One answer could be to model the equipment based on first principles and simulate using design data (from P&ID and PFD). The model is compared with the results of actual process data from the plant. This method should provide more valuable information to the maintenance engineers than a regression model based on historical data.

Such a model developed and simulated using the actual process data would meet the expectations from fundamental process engineering point of view and meet the rigorous principles of thermodynamics, which is material, and heat balance.

The modeling process is easier said than done, as it requires a near dynamic simulator.

Some of the typical list of equipments for critical asset analysis in process industries are:

1. Heat Exchangers
2. Fuel Heaters
3. Drives
4. Pumps
5. Compressors
6. Air Dryers
7. Vessels
8. Fractionators
9. Package Boilers
10. Storage tanks & many others

The following two examples would perhaps help illustrate the asset performance using the technique of simulation based on first principles.

The data analysis comparing the design model with actual simulated data from the process would be highly useful from the process efficiency, operational excellence and maintenance point of view.

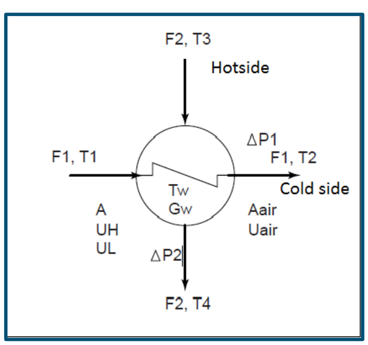
For illustration purposes, two equipment have been considered. They are:

1. Pumps
2. Heat exchangers

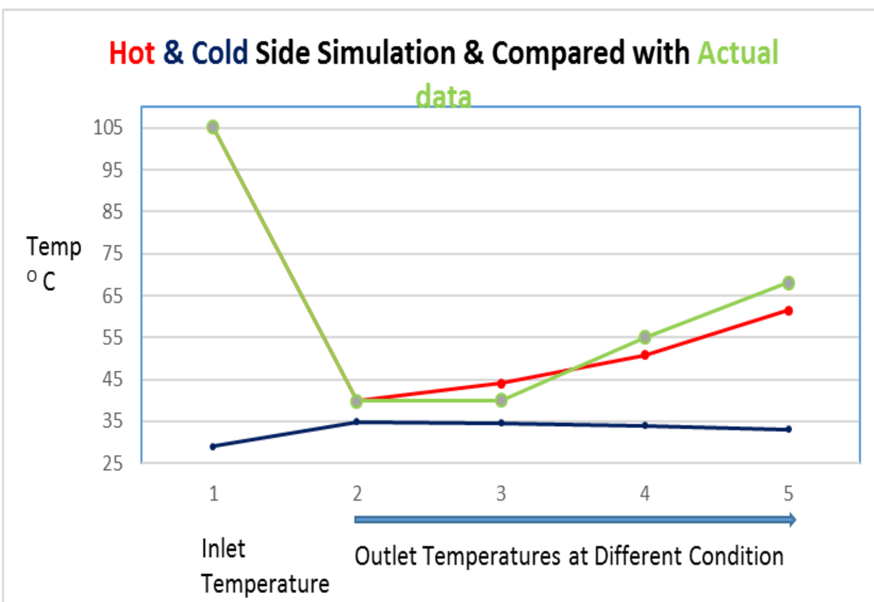
The data below is comparison of the equipment data using the design model v/s the actual process simulated model. Such data is likely to highlight a lot of intrinsic information which otherwise would not be possible.

General-purpose heat exchanger

1. Sensible heat type general-purpose heat exchanger model for both hot and cold side calculations
2. The flow direction can be concurrent or countercurrent
3. The heat transfer area between each fluid and the heat transfer wall is assumed to be the same, but the heat transfer coefficients can be specified independently of each other



	Hot side (process side)	Cold side (Utility side)
Flow	109.6 kmol/h	2789 kmol/h
	Clean condition	
Inlet temp	105.1 C	29 C
Out let temp	39.8 C	34.9 C
	20% Fouling	
Inlet temp	105.1 C	29 C
Out let temp	44.1 C	34.6 C
	40% Fouling	
Inlet temp	105.1 C	29 C
Out let temp	50.8 C	34 C
	60% Fouling	
Inlet temp	105.1 C	29 C
Out let temp	61.5 C	33.1 C



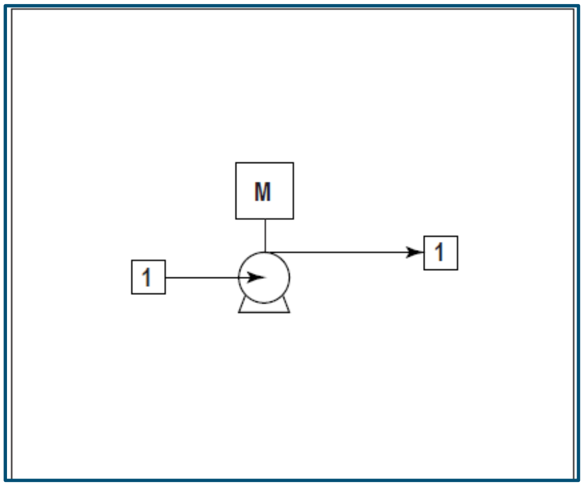
Conclusion:

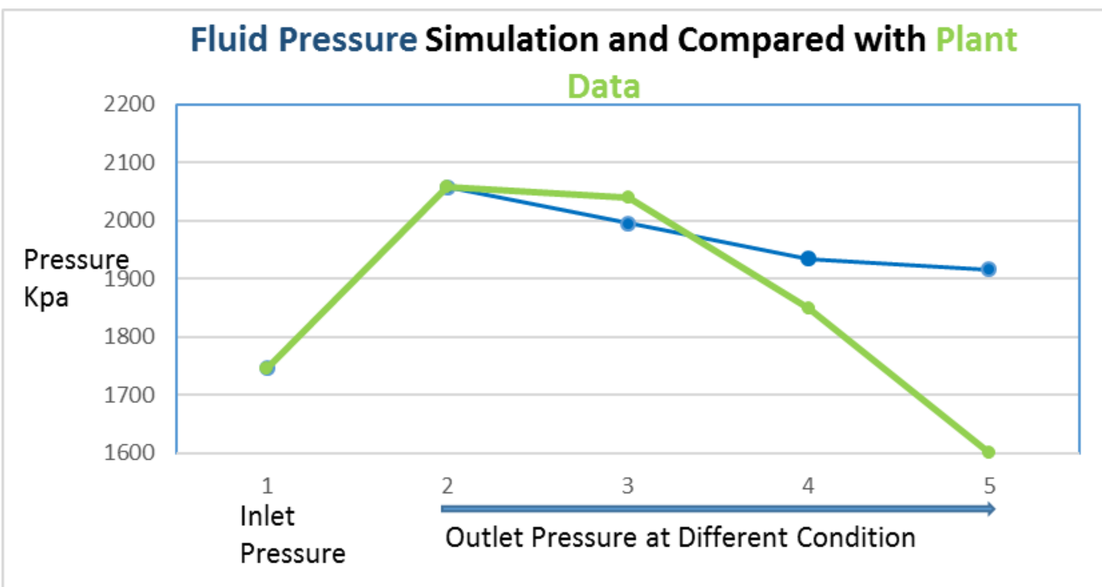
1. Hot side (Process side) outlet temperature is 36^{0}C when the exchanger is clean
2. Point-2 is most clean condition
3. Point-3,4,5 are 20% fouling, 40% fouling, 60% fouling conditions
4. As fouling increases Hot side temperature increases from 36 to 61 ^{0}C

5. As fouling increases Overall heat transfer co-efficient decreases
6. Cold side flow rate is almost 20 times higher, so temperature sensitivity is low
7. When cold side data is compared with actual plant data, it shows initially cooling is good. But over a period, cooling doesn't happen effectively. It predicts severe fouling
8. **So one can call for maintenance work based on hot side actual plant data trajectory**

Centrifugal Pump

1. It is assumed that the pump is motor-driven
2. As performance deteriorates delivery pressure decreases for a given flow rate of pumps





Conclusion:

1. Pump delivers constant flow rate
2. Point-2 is most clean condition
3. Point-3,4,5 are 20%, 40%, 60% deterioration conditions respectively
4. As pump deterioration increases pump discharge pressure decreases
5. When pump discharge pressure is compared with actual plant data, it shows delivery is good but over a period, delivery pressure drops. It possibly indicates severe distortion of pump impeller or other mechanical problems
6. **So one can call for maintenance work based on discharge pressure plant data trajectory**

The above method allows operators and engineers to monitor and optimize the assets and to model the system to perform “What-If?” analyses, and to audit the asset with continually validated data.

By on-line monitoring on a daily or even more frequent basis, operators /engineers can take proactive decisions while maintaining their equipments for the process. The tool also acts as a “watchdog”, allowing management and operations to track the “gap” and in cases such as heat exchangers, optimize energy savings potential.

Benefits of Asset Health monitoring

1. This will help improve the energy system performance
2. It can make the equipment more energy efficient
3. This helps to reduce the operating costs
4. Identify improvement areas and make the system easier to service and maintain at appropriate times

KPI calculations of the equipments

The model shall also allow for online calculation of the Key Performance Indicators of equipments. These KPIs can be used for general trending, viewing, benchmarking of operational, and maintenance efficiencies. Some of online KPIs for equipments are efficiencies, annual cost of operation of the equipments, energy cost per unit and the accumulated savings possible.

Conclusion:

Traditionally supervisors and operators plan for scheduled maintenance activities and regularly repair machines to prevent any downtime.

This activity also consumes resources and causes productivity losses. Studies show that nearly half of all preventive maintenance activities are efforts to mitigate any breakdown and often does not provide the desired results. Sometimes such a maintenance may not be needed at all. Due to such reasons, we are seeing that predictive maintenance is rapidly emerging as a leading Industry 4.0 use case for manufacturers and asset managers. Even as simulation results are also using the first principle basis for prediction, the results will be of greater significance and accuracy.

This article intends to provide business leaders in the process industries including oil and gas, what they can expect from predictive maintenance tools using AI and ML. Process engineers will also appreciate the AI/ML techniques supported by the models, which are fundamental in nature to make informed decisions. This will be the ideal digital twin.

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