

Trendminer® dashboard for fouling analysis

Nathan Guy

October 8, 2026

About me



Nathan Guy
Principal Process Engineer, Polymers

Agenda

Polyolefin gas phase process overview; *Trendminer*® fouling dashboard

Fouling model 1 – Area of heat exchanger free

Fouling model 2 – Hydraulic limitations from compressor curve data

What we do



Olefins & Polyolefins (O&P) – Americas ¹

Our O&P – Americas segment produces and markets olefins & co-products, polyethylene (PE) and polypropylene (PP).

Selected products

- Olefins & co-products
- Polyethylene
- Polypropylene
- *Catalloy* and polybutene-1

Major markets

Packaging, automotive, films, pipes, textiles, roofing, appliances



O&P – Europe, Asia, International (EAI) ¹

Our O&P – EAI segment produces and markets olefins & co-products, polyethylene and polypropylene.

Selected products

- Olefins & co-products
- Polyethylene
- Polypropylene
- *Catalloy* and polybutene-1

Major markets

Packaging, automotive, films, pipes, textiles, roofing, appliances



Intermediates & Derivatives (I&D)

Our I&D segment produces and markets propylene oxide and its derivatives, oxyfuels and related products and intermediate chemicals such as styrene monomer and acetyls.

Selected products

- Propylene oxide & derivatives
- Intermediate chemicals
- Oxyfuels & related products

Major markets

Insulation, home furnishings, coatings, adhesives, automotive, fuel additives



Advanced Polymer Solutions (APS)

Our APS segment produces and markets compounding & solutions, such as PP compounds, engineered plastics, masterbatches, engineered composites and colors.

Selected products

- Compounding & solutions

Major markets

Automotive, packaging, films



Technology

Our Technology segment develops and licenses chemical and polyolefin process technologies and manufactures and sells polyolefin catalysts.

Selected products

- Licensing
- Catalysts

Major markets

Polyolefin and chemical manufacturing



Note: Chart represents the five operating segments through which we manage our business.

¹ Our CLCS business is part of our O&P-Americas and O&P-EAI segments.

Catalloy is a trademark owned and/or used by the LyondellBasell family of companies and are registered in the U.S. Patent and Trademark Office.

Where we are located

Our global footprint allows us to support customers where they operate. With manufacturing capabilities and commercial reach spanning regions around the world, we combine global strength with local insight to help customers compete and grow.



North America

Leveraging scale and access to low-cost feedstocks



Europe

Focusing on high demand for sustainability by building cost-advantaged waste feedstock networks across the Circular and Low Carbon Solutions business



Asia Pacific

Using LYB technologies within joint ventures to capture market growth with minimal capital investment



South America

Providing tailored local solutions for global brand owners



Middle East

Becoming partner of choice for low-cost feedstock owners to add value with our technologies and market access

100+

Countries where our products are sold

20

Countries with manufacturing sites and joint ventures

18,970

Employees

#1

Largest producer of oxyfuels worldwide

#2

Largest producer of PO worldwide



Statistics are as of December 31, 2025

1 Typical polyolefin gas phase process overview

Typical polyolefins gas phase reactor loop

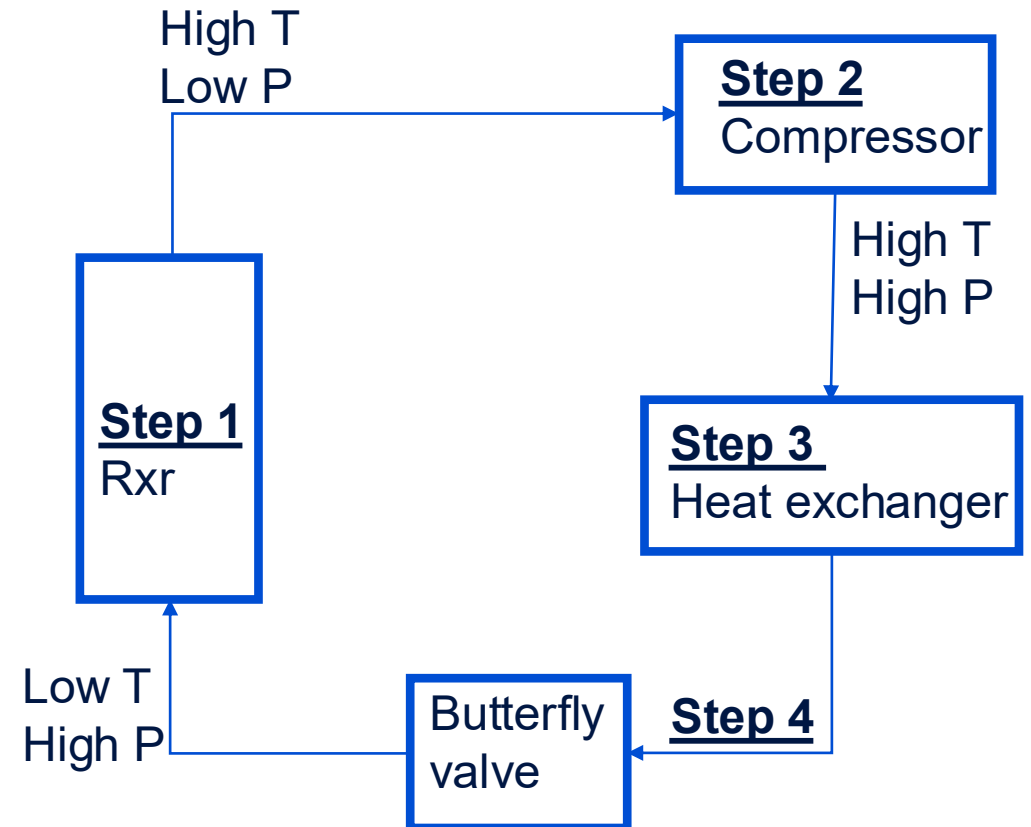
Step 1: Monomer reacts in a fluidized bed reactor to produce polymer

Step 2: Unreacted olefins exit top of reactor and is compressed to make-up reactor loop pressure loss

Step 3: Unreacted olefins pass through a heat exchange to remove heat of reaction

Step 4: Unreacted olefins return to inlet of reactor; gas flow is controlled by a butterfly valve.

Steps 1-4 Repeat

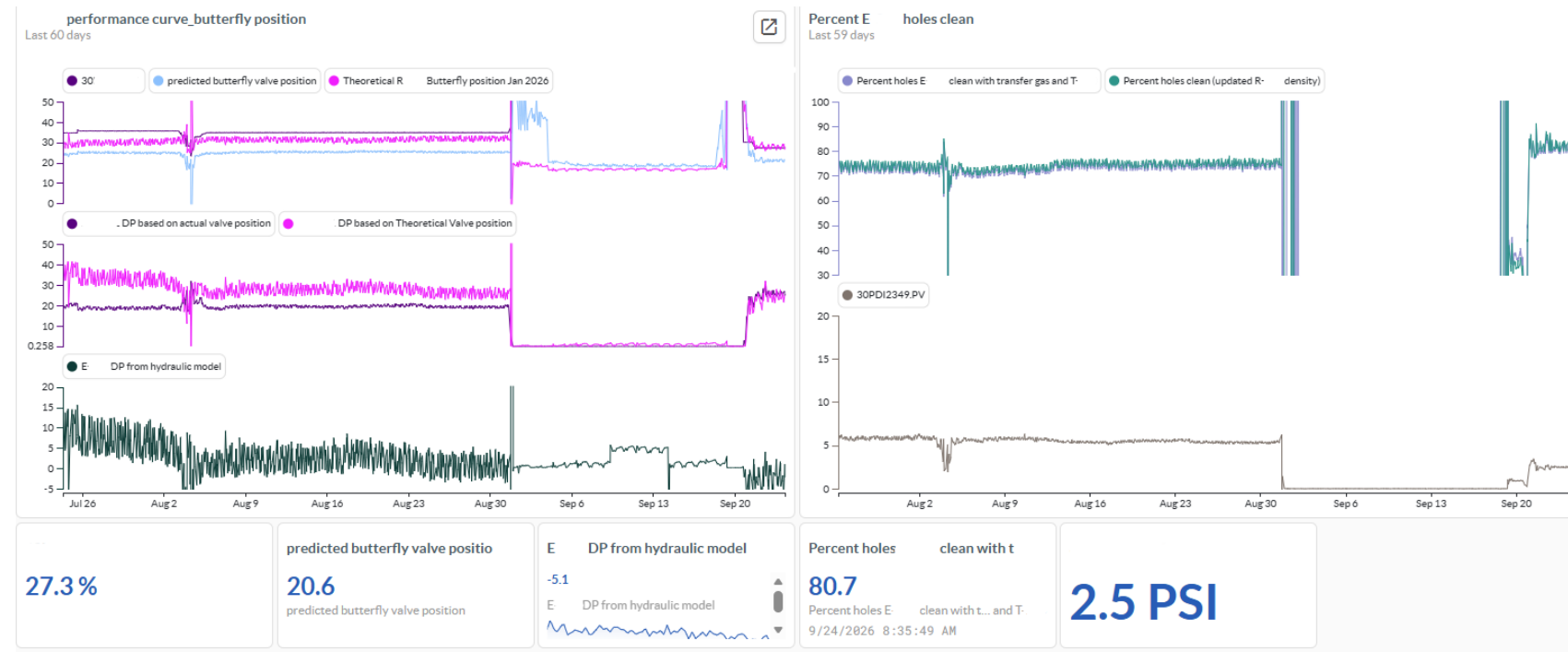


Process fouling in cycle gas cooler is very typical in polyolefins service. Good fouling indicators can greatly assist with process optimization. *Trendminer®* can help!

Trendminer[®] dashboard

Trendminer[®] dashboard contains several indicators of exchanger fouling and compressor performance:

- Heat exchanger percent area clean
- Heat exchanger fouling from hydraulic model
- Predicted DP of compressor from hydraulic model
- Heat exchanger fouling from heat transfer model



Dashboard allows for easy access for several metrics related to cycle gas loop fouling and cycle gas compressor performance. Very easy to reach a wide audience. Easily sharable, easy to set alerts, easy to modify.

2

Fouling model 1 “percent area free”

Fouling model – Converting DP to “% area clean”

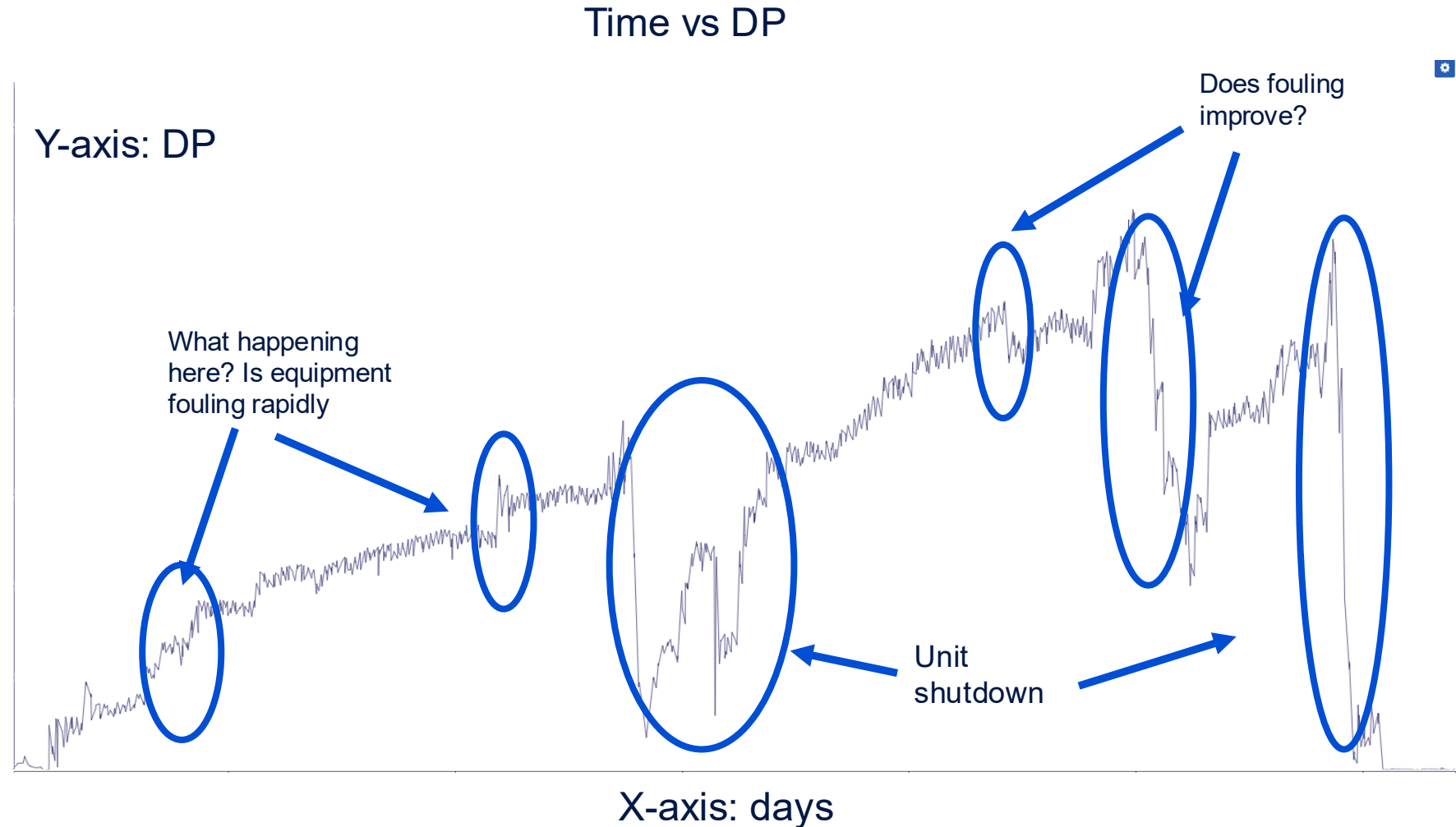
- No obvious way to monitor polymer buildup on inlet of heat exchanger.
- Using equipment DP is helpful but has limitations. Changes in gas density and gas flow complicates situation.
- Not easy to evaluate rate of polymer buildup based on DP measurement alone.

Example of polymer buildup at HE head



Fouling model – Converting DP to a “% area clean”

- Hard to analyze fouling with DP alone.
- Do the rises and falls in DP correspond to increases and decreases in polymer build up?



Fouling model – Converting DP to a “% area clean”

$$DP = k\rho v^2$$

Most useful equation in chemical engineering

Foundational fluid dynamic principles are extremely useful when analyzing fouling

Fouling model – Converting DP to a “% area clean”

Step 1: After a heat exchanger cleaning, solve for k. This represents the resistance factor on the tubes including any inlet and exit losses. v_c is “clean velocity”

- $DP = k\rho v_c^2 \rightarrow DP, \rho, \text{ and } v_c \text{ are known. } k \text{ is unknown}$

Step 2: k is now known, when running, solve for “dirty velocity” (v_d)

- $DP = k\rho v_d^2 \rightarrow DP, \rho, \text{ and } k \text{ are known}$

Step 3: compare v_d to v_p (v_p is measured velocity)

- $\% \text{ area clean} = \frac{v_p}{v_d} \rightarrow \text{Example: if dirty velocity is 2x process velocity, half tubes are plugged}$

Very intuitive way to analyze heat exchanger polymer buildup; factors in changes in density and velocity

Fouling model – Converting DP to a “% area clean”



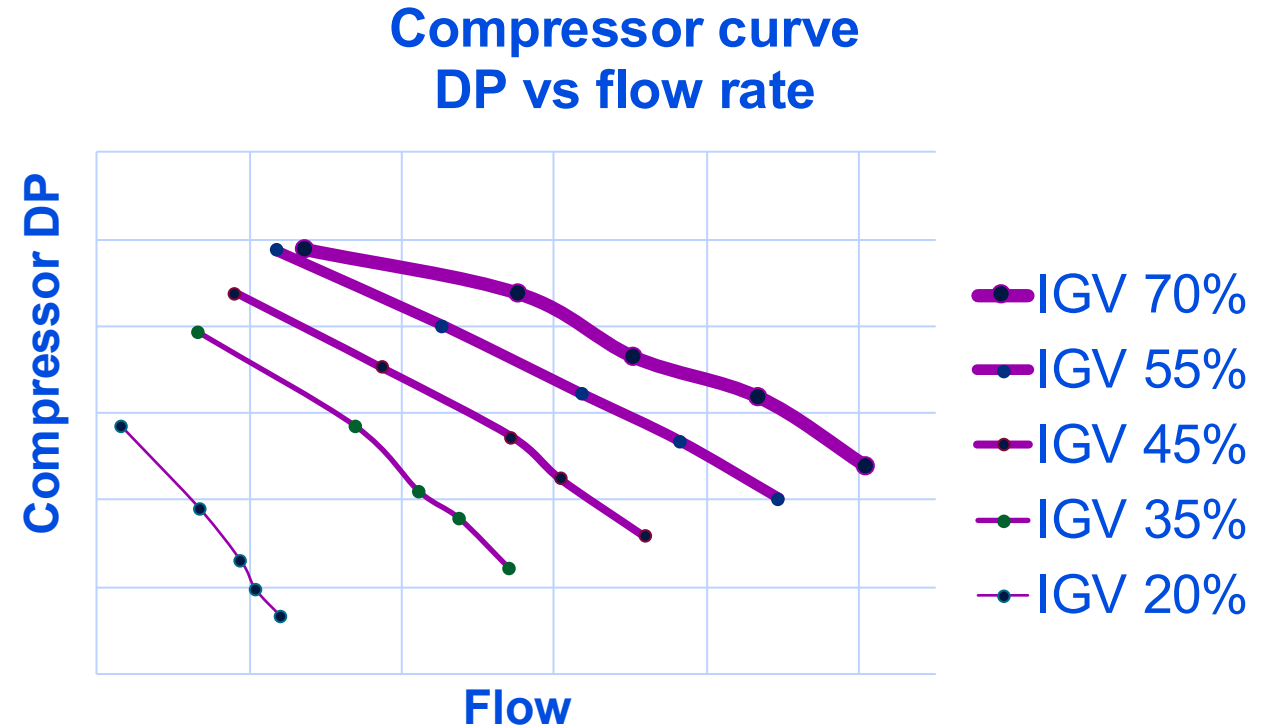
Trendminer® allows for easy implementation.

3

Fouling model 2 using compressor curves

Fouling model – Hydraulic limitations from compressor curves

- Compressor curve relates:
 - Capacity (mass flow in this example)
 - IGV position (could be RPM)
 - Discharge pressure/shaft power
- Each curve is valid at only a single set of process conditions
 - Gas density
 - Viscosity



Using the data from compressor curves, a model can be generated that can indicate increases in system resistance (i.e. fouling)

Fouling model – Hydraulic limitations from compressor curves

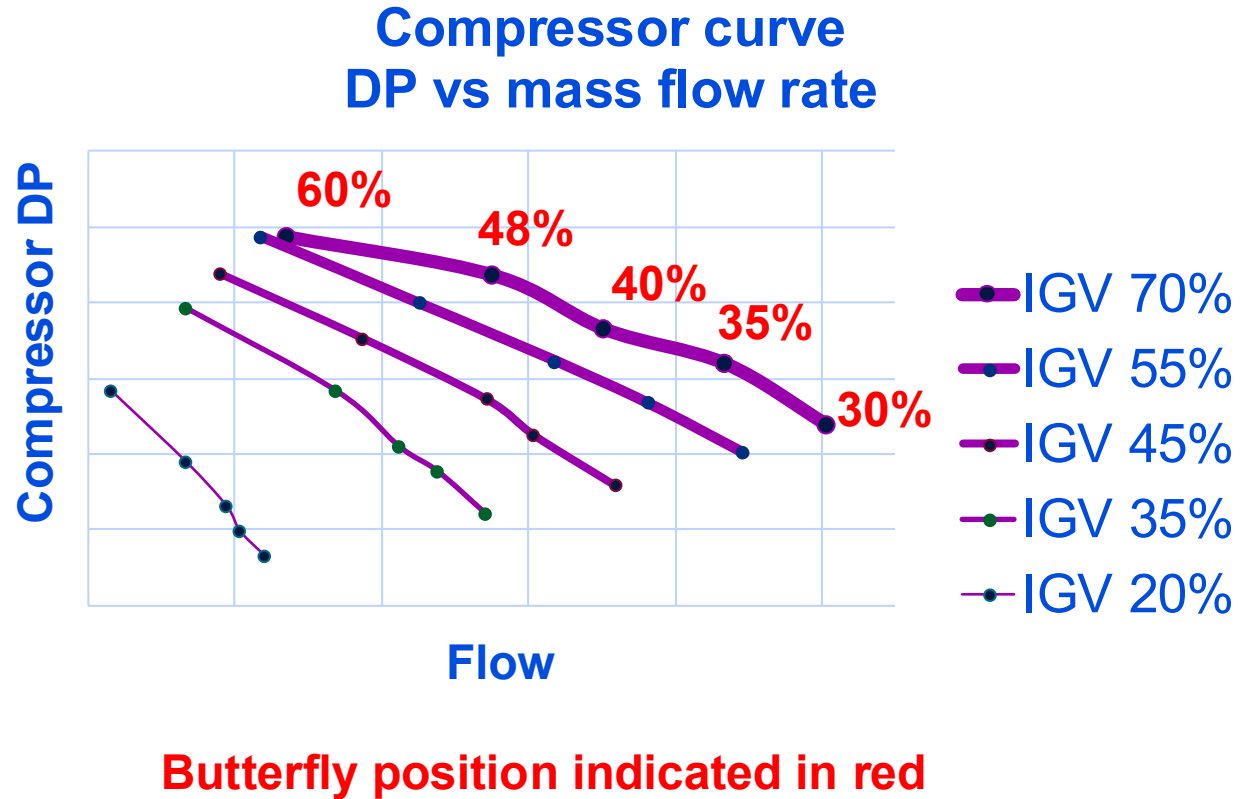
Data from compressor curves used to generate models:

$$DP = f(\text{IGV, flowrate, gas density})$$

Very useful confirming compressor is operating at intended operating point

$$\text{Theoretical butterfly valve position} = f(\text{IGV, flowrate, gas density, compressor DP})$$

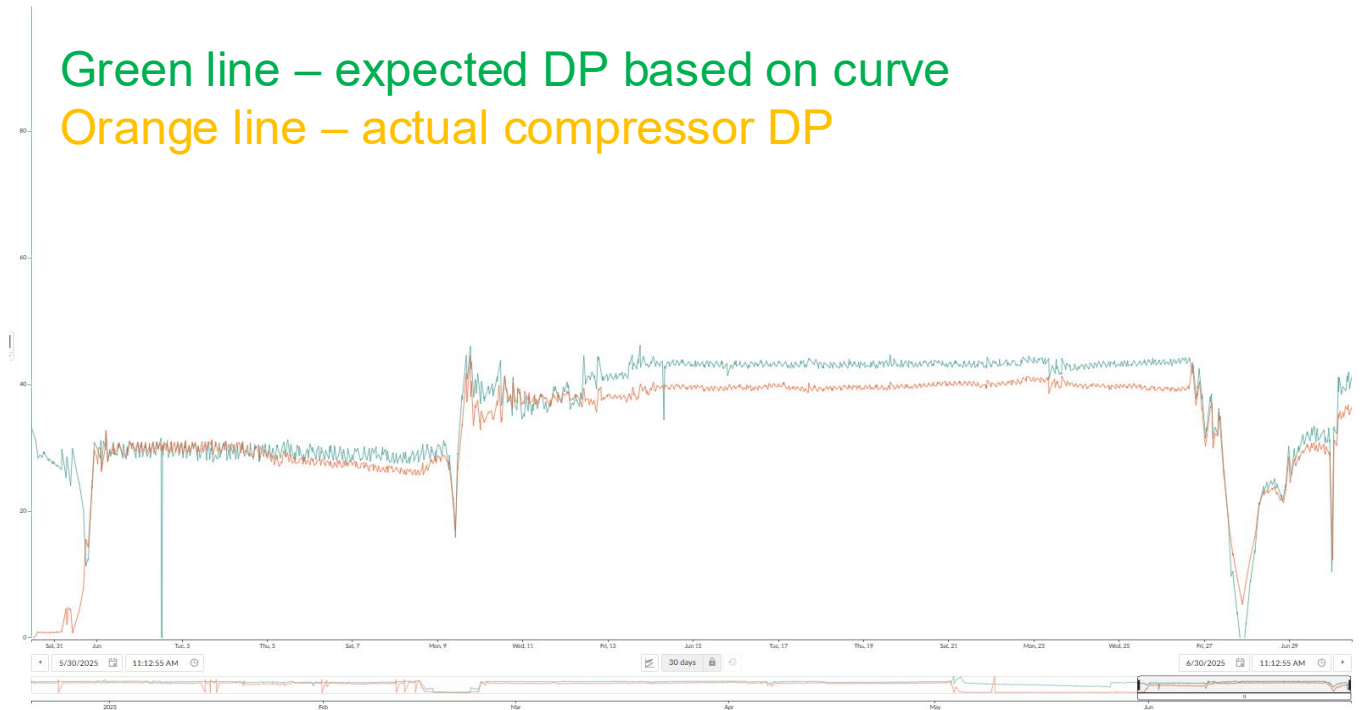
Very useful. If actual butterfly position is open more than the theoretical position, that is an indicator of increased system resistance (i.e. fouling)



Using the data from compressor curves, models can be built that provide useful fouling and compressor performance indicators

Fouling model – Hydraulic limitations from compressor curves

- *Trendminer*® trend which is part of daily monitoring
- <3-5 psi difference shows compressor is likely operating as expected



***Trendminer*® has allowed data from compressor curves to be turned into trends that are easy to share and interpret!**

Summary

Trendminer® has enabled us to combine data with foundational fluid dynamic concepts to create easy-to-monitor trends that has assisted with improved operations

Disclaimer

Before using a LyondellBasell product, customers and other users should make their own independent determination that the product is suitable for the intended use. They should also ensure that they can use the LyondellBasell product safely and legally. This document does not constitute a warranty, express or implied, including a warranty of merchantability or fitness for a particular purpose. In addition, no immunity under LyondellBasell's or third parties' intellectual property rights shall be implied from this document. No one is authorized to make any warranties, issue any immunities or assume any liabilities on behalf of LyondellBasell except in a writing signed by an authorized LyondellBasell employee. Unless otherwise agreed in writing, the exclusive remedy for all claims is replacement of the product or refund of the purchase price at LyondellBasell's option, and in no event shall LyondellBasell be liable for special, consequential, incidental, punitive or exemplary damages.

Catalloy is a trademark owned or used by LyondellBasell group companies and they are registered in the U.S. Patent and Trademark Office.

Trendminer is a trademark owned by Trendminer NV and is registered in the U.S. Patent and Trademark Office.

