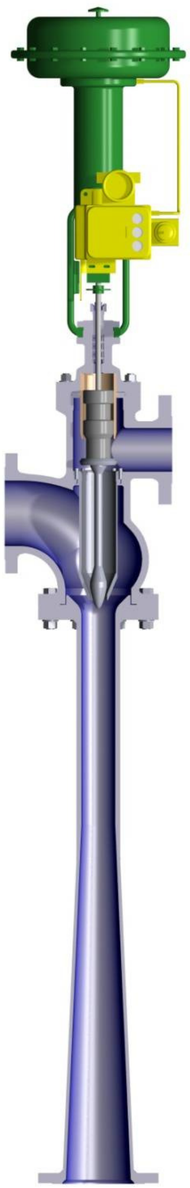

Optimizing Thermocompressor Design & Operation For Paper Drying Applications

By:

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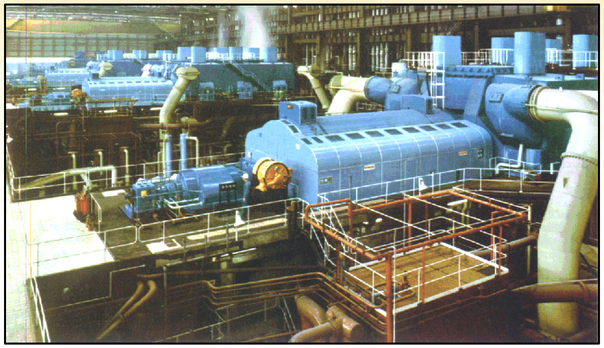
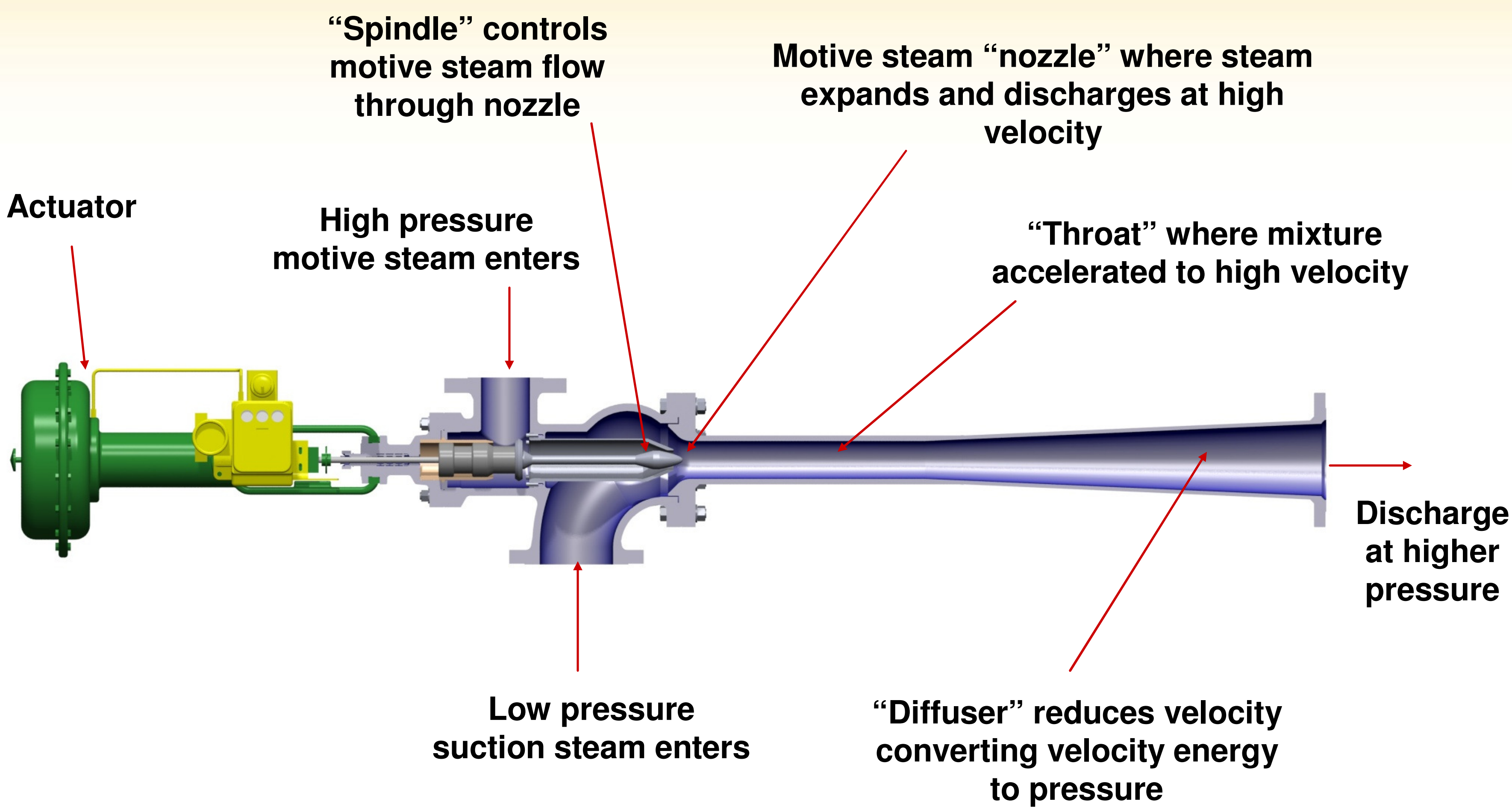
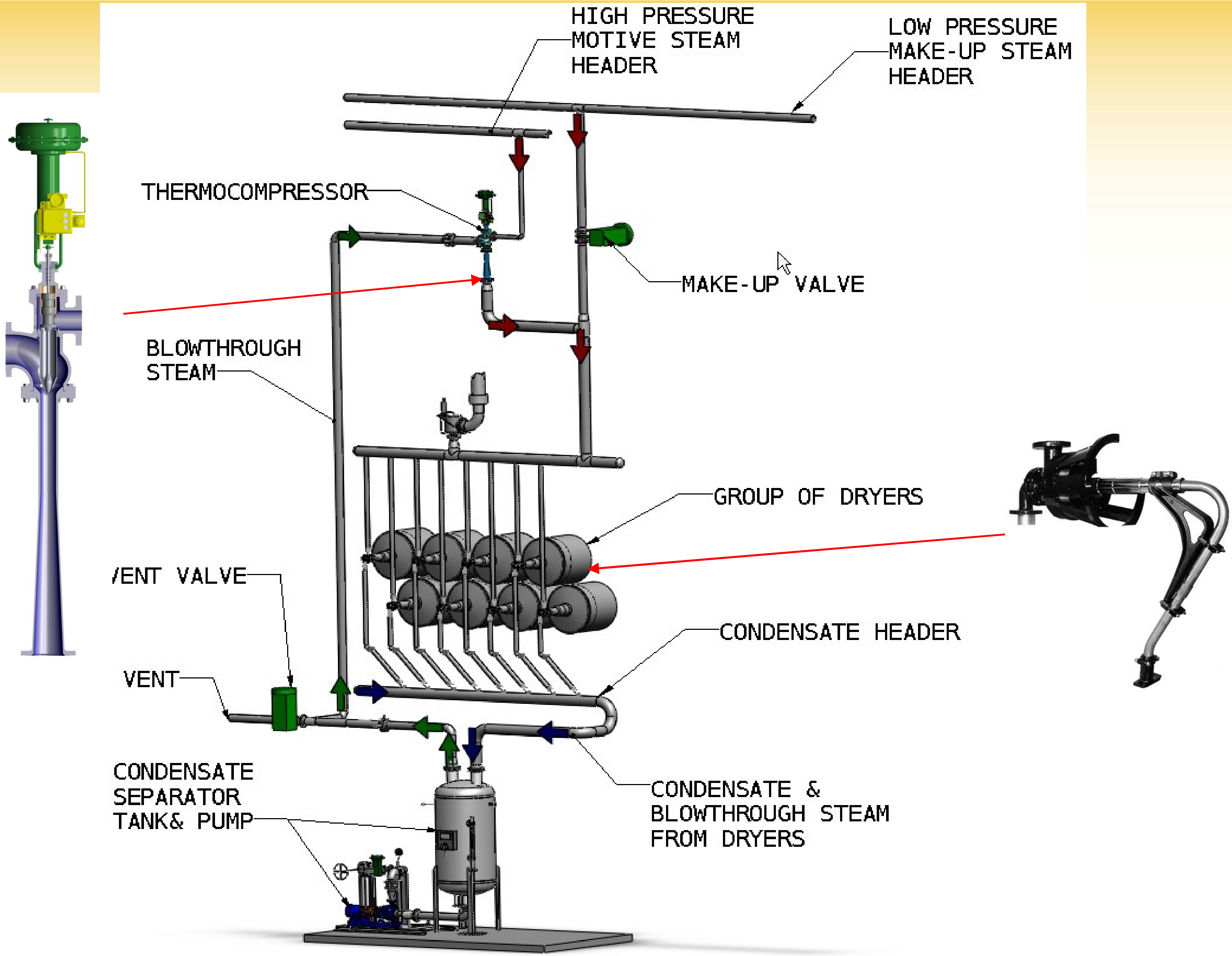
Benefits Of Thermocompressor Optimization



- Reduced motive steam consumption.
  - Increased electrical generation in a cogeneration facility.
- Reduced steam losses from system.
- Improved control for system.
- Reduces blowthrough steam flow.
  - Reduced pressure losses.
  - Reduced piping erosion.
  - Reduced condensate carry-over.

Thermocompressor Components



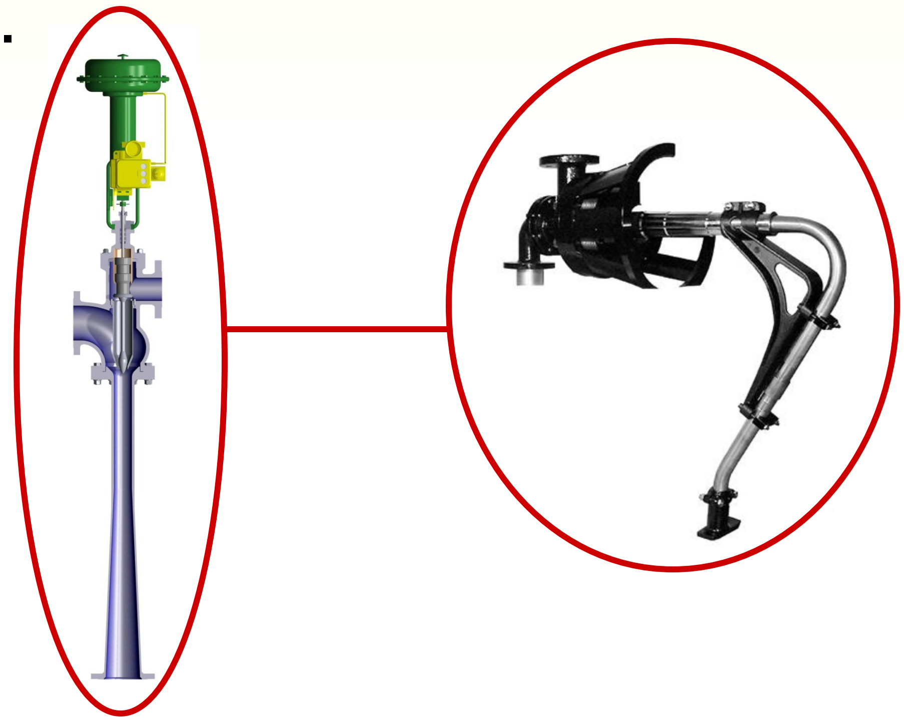

HIGH PRESSURE MOTIVE STEAM HEADER
LOW PRESSURE MAKE-UP STEAM HEADER
THERMOCOMPRESSOR
MAKE-UP VALVE
BLOWTHROUGH STEAM
GROUP OF DRYERS
ENT VALVE
CONDENSATE HEADER
VENT
CONDENSATE SEPARATOR TANK& PUMP
CONDENSATE & BLOWTHROUGH STEAM FROM DRYERS

Five Step Approach To Optimization

1. Minimize blowthrough flow from dryers with proper syphon selection.
2. Operate the syphons at the correct differential pressure.
3. Properly size the thermocompressor to match the syphons.
4. Utilize high efficiency thermocompressor designs.
5. Avoid “over the top” operation.

Step 1 – Minimize Blowthrough Steam

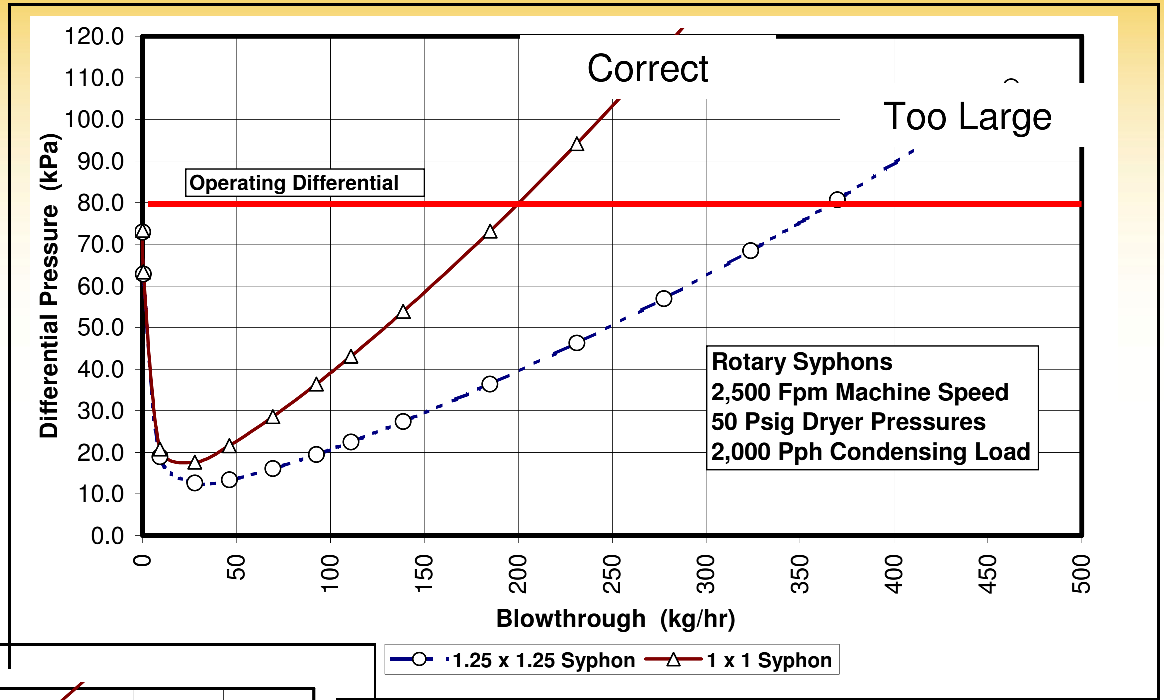
- The thermocompressor design & the syphon design are married.

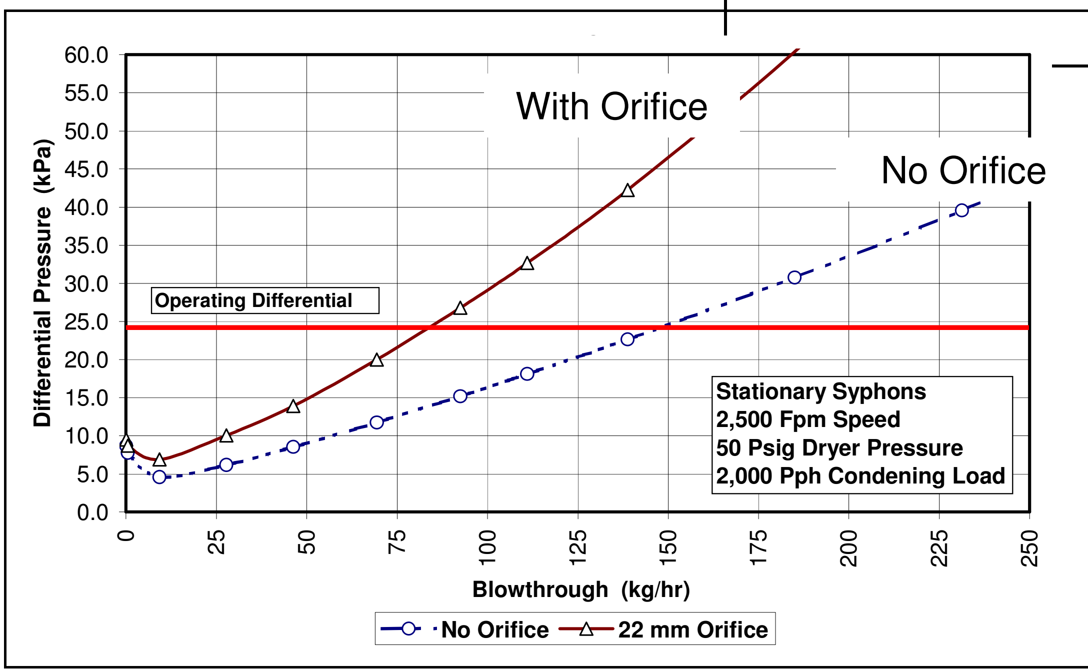


- Objective is to reduce blowthrough steam to the lowest possible level while still satisfying the syphon requirements.

Syphon Curves

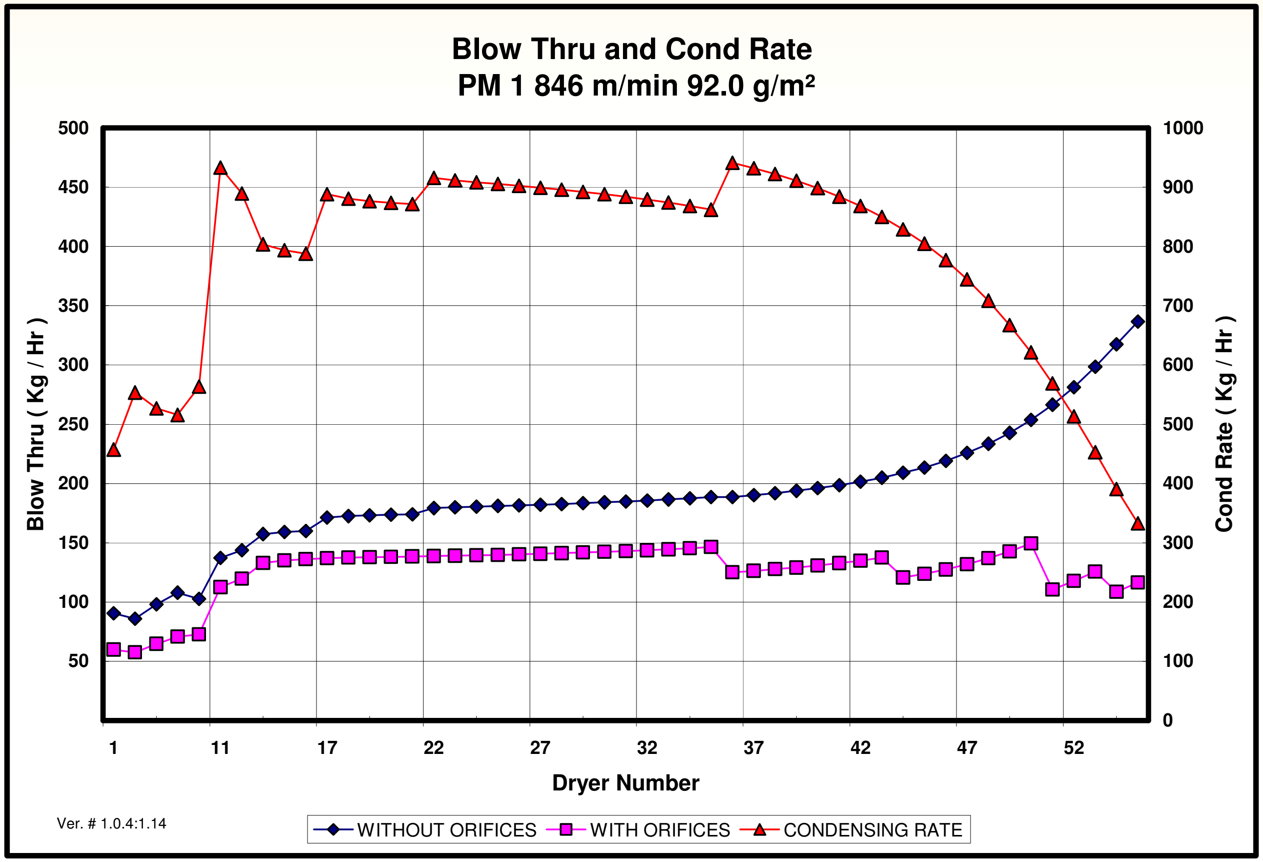
Rotary Syphon Properly & Improperly Sized

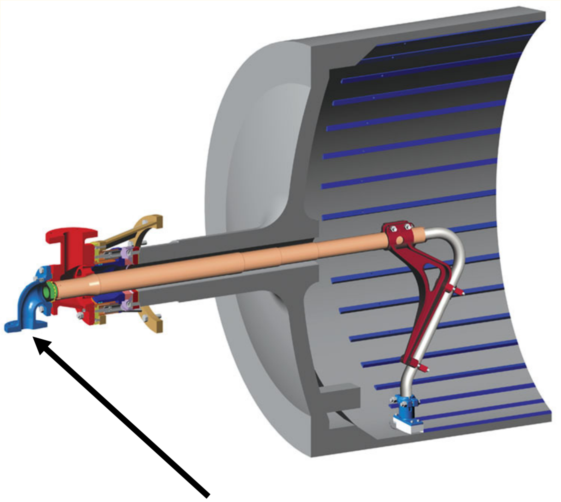




Stationary Syphon With & Without Restricting Orifice

Match Blowthrough Curve To Drying Curve





Condensate line orifices can be used with stationary syphons to match blowthrough curve to drying curve.

Step 2 – Correct Differential Pressure

- Syphon systems are often operated at excessive differential pressure or blowthrough flow.
  - Poor understanding of syphon curves.
  - “Safe operating point”.
  - “That’s where we have always run”.
  - Poor differential or blowthrough flow transmitters.
  - Syphons were changed but operation didn’t.
  - Improperly sized thermocompressors.

- Thermocompressors can not be optimized if system is not operated to the correct differential pressure.

Control Methods

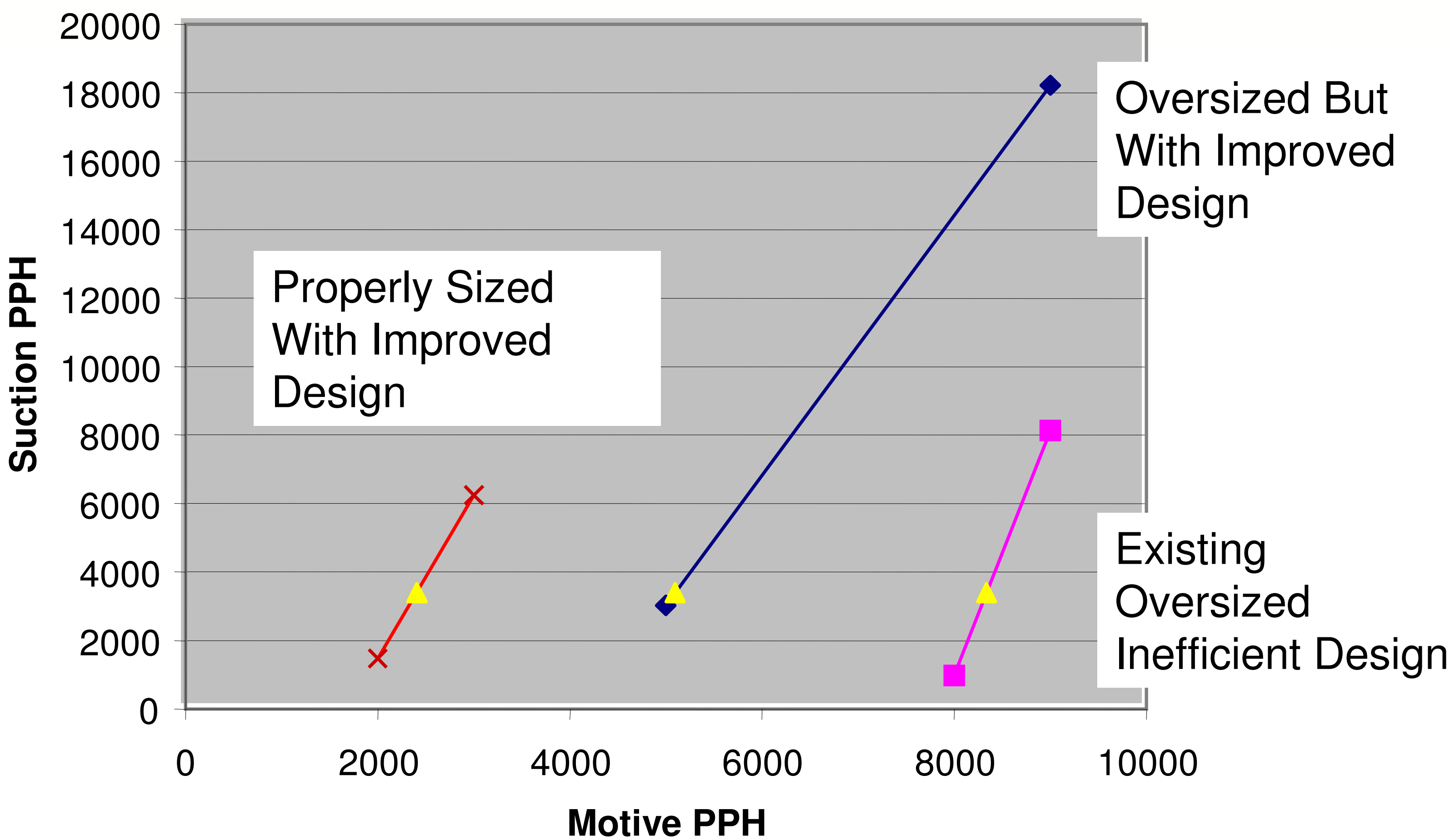
- Differential pressure control.
  - Typically only one differential pressure used for all operating conditions.
    - “Safe” differential = high value = excessive motive use.

- Blowthrough flow control.
  - Improvement over differential pressure control.
  - Can be a poor match to syphon requirements.
  - Operators establish “safe” setpoints.

- Managed Differential Pressure Control.
  - Control algorithms in DCS use inputs of speed, pressure, and sheet break status.
  - Differential automatically set to match syphon requirements.
  - Operators not required to set differential pressures.

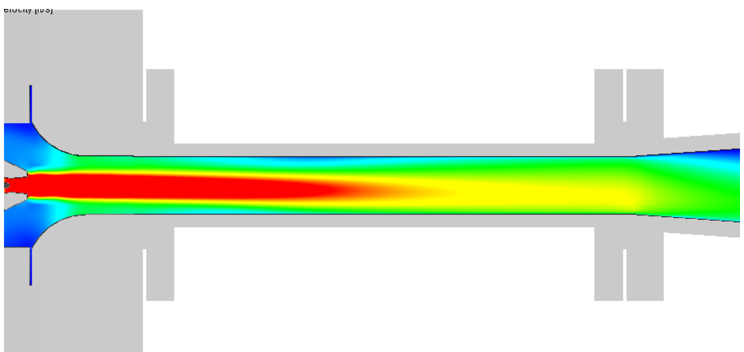
Step 3 - Properly Size Thermocompressor

- Oversized thermocompressors are very inefficient.

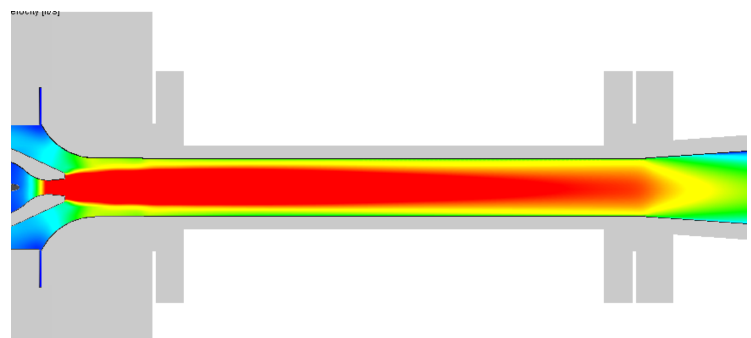


Step 4 – Utilize High Efficiency TC Design

- Geometry of thermocompressor has a large impact on motive steam use.
- CFD (**C**omputational **F**luid **D**ynamic) modeling is an essential tool.
  - Modern technology brought to an old “art”.
- 15% to 20% motive reductions are typical.



Not Optimized

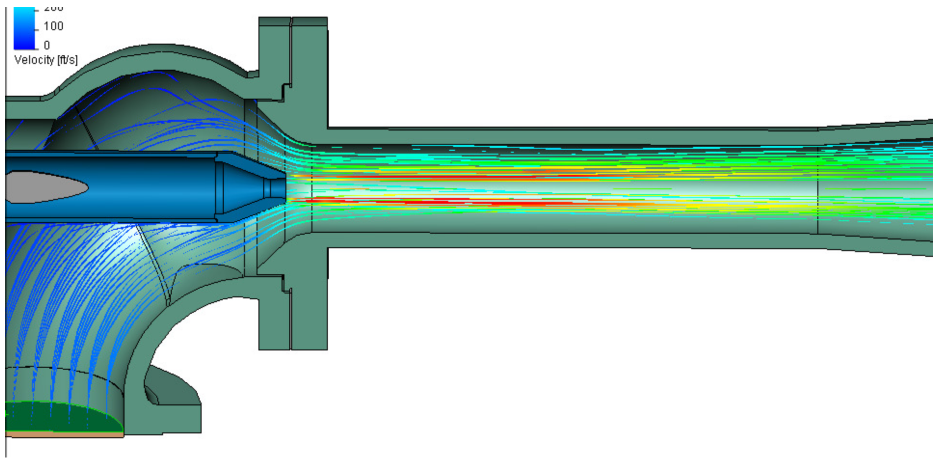


Optimized
20% less motive

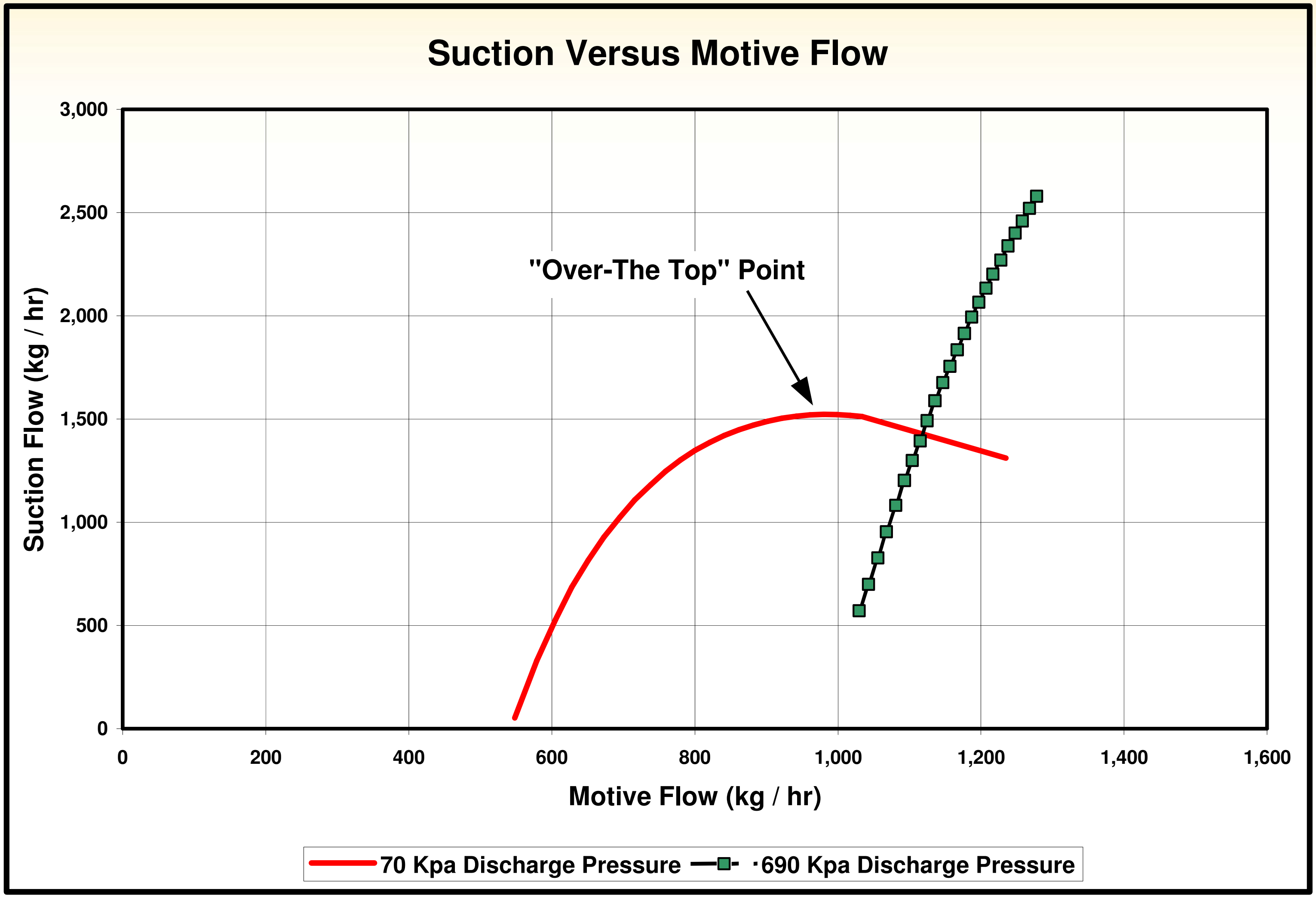
Step 5 – Prevent "Over The Top" Operation

- Thermocompressors are not normally designed for one operating point in paper drying applications.
  - Throat size is determined by low pressure operating point.
    - Means throat is "oversized" for high pressure operation.
  - Nozzle size is determined by high pressure operating point.
    - Means nozzle is "oversized" for low pressure operation.

- Thermocompressor can open up "too much" at low operating pressure.
  - Excess motive steam causes loss of efficiency.
  - Called "choked flow".

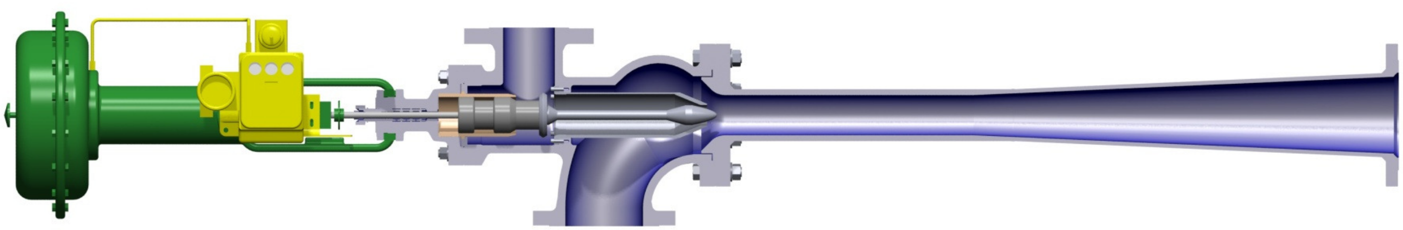


"Over The Top" Operation



Method To Prevent "Over The Top"

- DCS logic used to limit thermocompressor opening.
  - Managed Differential Pressure Control to prevent excessive differential pressures.
  - Thermocompressor "anti-choke" logic to limit % open below choke point.
    - Inputs of discharge pressure and differential pressure.
    - Algorithm calculates "choke" point from thermocompressor curves.
    - % open limited.



Case History

- Fine paper machine
- 2,900 fpm - 500 tpd
- 7 steam sections – 6 thermocompressors
- 400 psig motive steam
- 125 psig make-up steam
- Stationary syphons
  - Installed 8 years previously
- Thermocompressors not optimized when stationary syphons installed.
  - Oversized – Designed for rotary syphons.
- 8 to 9 psi differential pressures used.
  - No good reason
  - Mill experienced excessive condensate line erosion
- Wet end dryers discharge excessive blowthrough to condenser.

Rebuild Scope Of Work

- New high efficiency thermocompressors matched to syphons.
- Replaced condensate line orifices to match blowthrough curve to drying curve.
- New transmitters.
  - Differential pressure & blowthrough.
- Differential pressure valves for some of the wet end dryers.
- Eliminated one of two condensers.
  - Vented system to atmosphere instead of condenser.

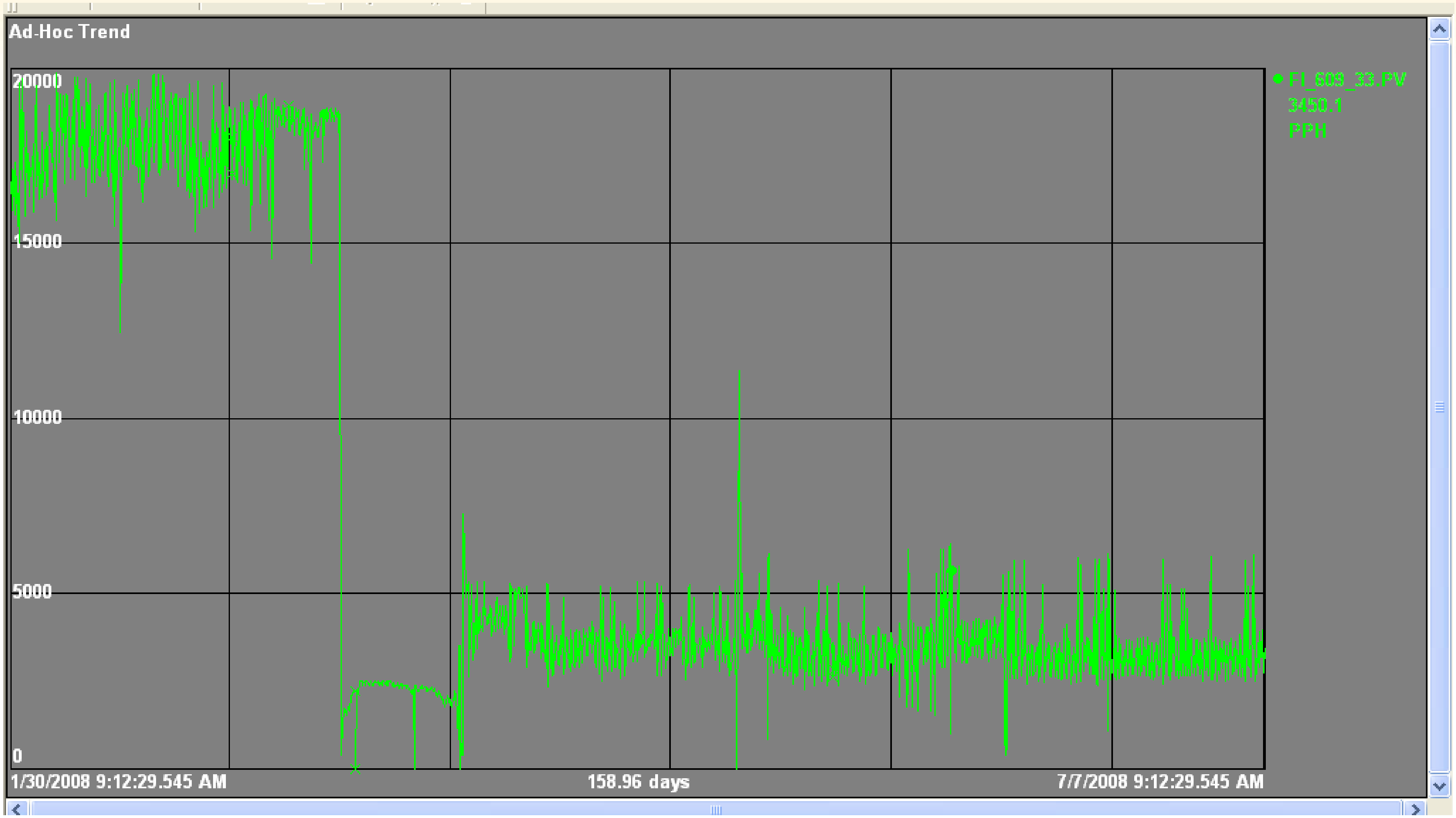
Results

		Before	After	% Change
Differential Pressure	Psi	8 to 9	3 to 5	- 45%
Blowthrough Flow	Pph	30,000	11,000	- 63%
TC Motive Steam	Pph	18,000	3,800	- 79%
Loss To Condenser (Wet End Dryers)	Pph	2,100	1,000	- 52%
Venting On Sheet Breaks	Pph	16,000	None	

Benefits ($US / year)

Power Generation From Reduced Motive	$183,000
Reduced Loss From Wet End Dryers	$40,000
Reduced Venting On Sheet Breaks	$27,000
Total	**$250,000**

Motive Steam Reduction



Summary

- Optimizing thermocompressor operation can produce significant cost savings and operating benefits.
- Minimizing blowthrough steam with proper syphon design is the starting point.
- Match the thermocompressors to the syphons.
- Modern design tools help to optimize geometry producing efficiencies.
- Managed Differential Pressure Control and Anti-Choke logic produces the best result.