

Process Output Improved through Online Monitoring of Hydrogen Reciprocating Compressor

Alberto Schirmer

Dresser-Rand - Senior Maintenance & Reliability Engineer

Nelmo Furtado Fernandes

PETROBRAS - REGAP - Engenheiro de Processamento Pleno

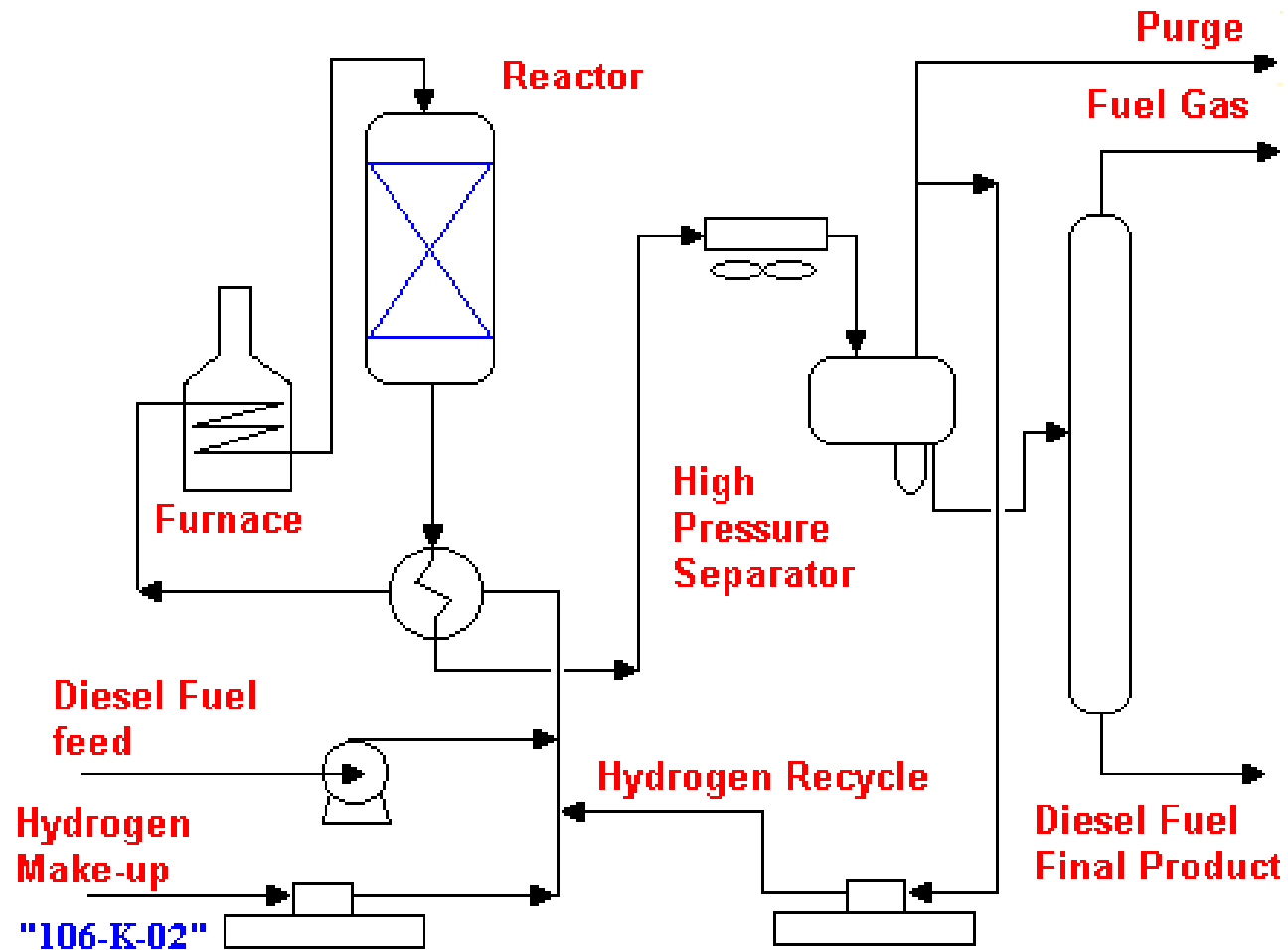
José Eduardo de Caux

PETROBRAS - REGAP - Consultor Técnico

Problem

- ◆ Refinery Diesel Fuel Production limited by Hydrogen make-up compressor (106-K-2A) discharge pressure.
- ◆ Maintain eventual improvements, i.e. keep new discharge pressure levels at the allowable reactor pressure reliably
- ◆ Maximize run time of motor driven compressor due to lower operational costs as compared to the steam turbine driven compressor

Typical HDT Flowchart



106-K-02A Specs



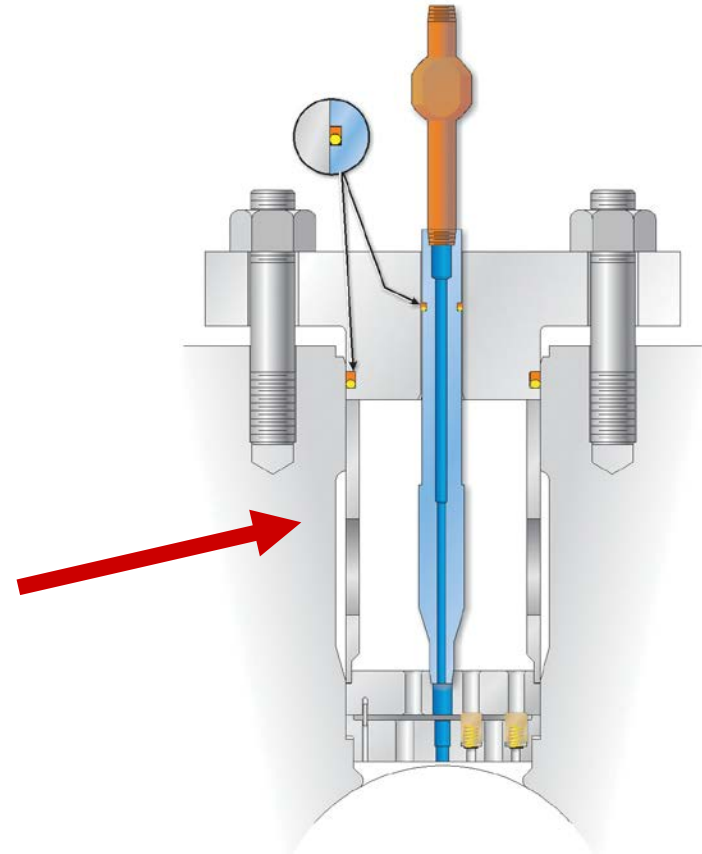
	Compressor	1st Stage	2nd Stage
Model	Worthington BDC		
HP	805	-	-
RPM	595		
Service	Hydrogen	-	-
Flow 216.000 Nm ³ / dia	9.000 Nm ³ / h		
Suction Pressure (psig)	-	198	465
Discharge Pressure (psig)	-	482	796
Suction Temperature (°F)	-	95.4	110
Discharge Temperature (°F)	-	247.3	202
Cylinder Diameter (inches)	-	11 1/2	7 1/2
Suction Valves		4	2
Discharge Valves		4	2
Unloaders		4	2

Solution

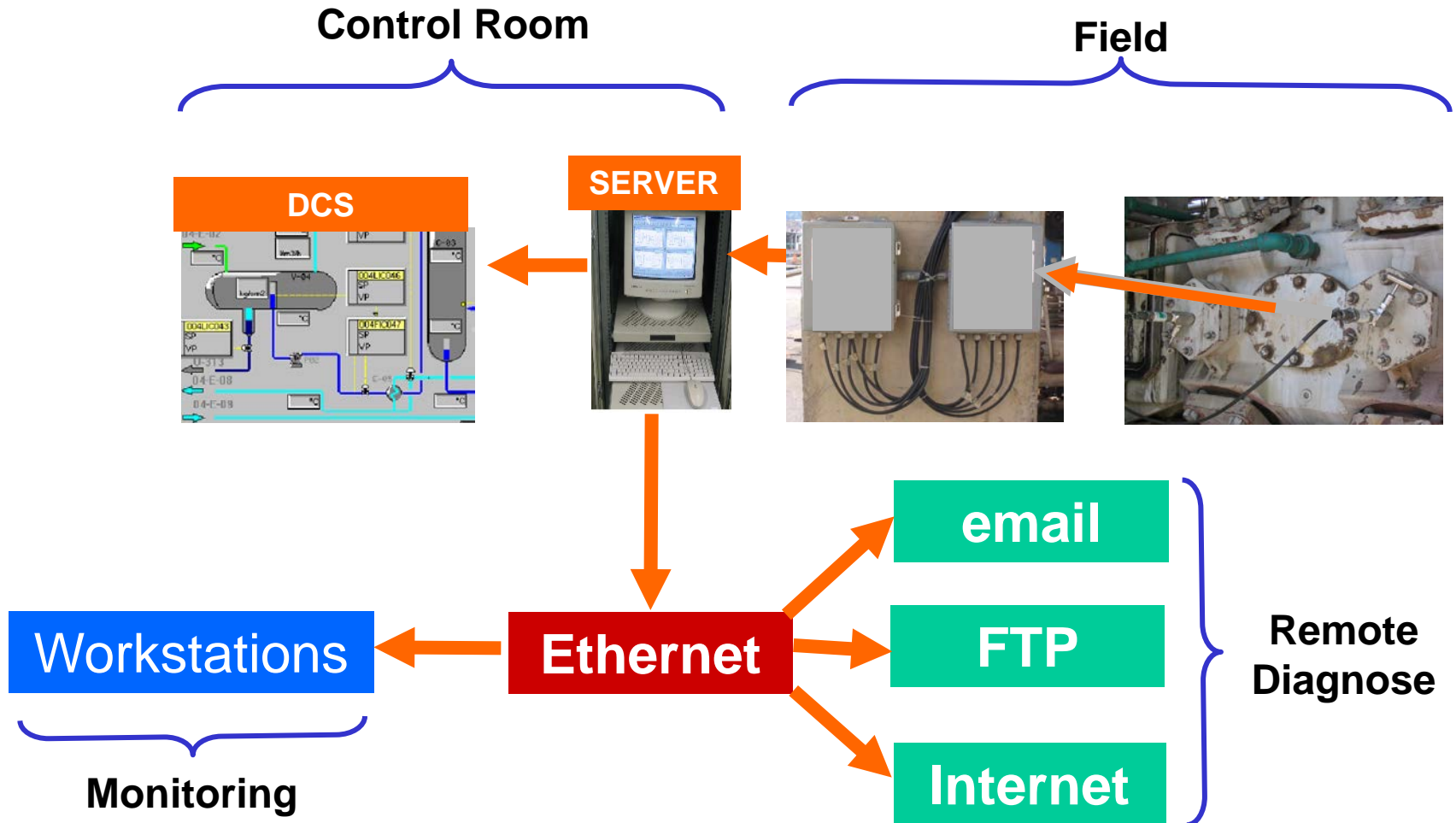
- ◆ Reciprocating Compressor Dynamic Analysis to diagnose causes of discharge pressure limitation.
- ◆ Online monitoring including analysis capabilities to maintain compressor at new discharge pressure levels.
- ◆ Online diagnose to minimize downtime of motor driven compressor

Pressure Ports

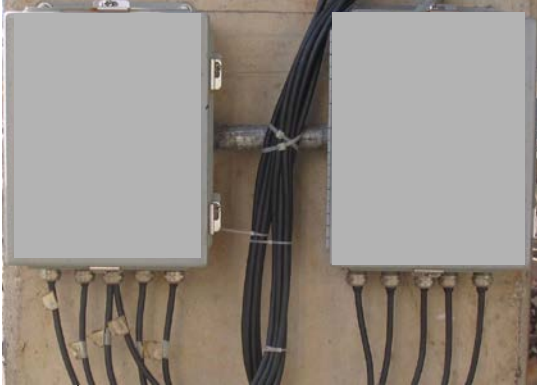
- ◆ Compressor is not equipped with cylinder internal pressure ports necessary for Dynamic Analysis
- ◆ Modified discharge valves and covers were installed to provide cylinder internal pressure ports



Monitoring Scheme



Monitoring Scheme Details



2 Smart Transmitters

**4 Temperature Transmitters
1st and 2nd Stage
Suction and Discharge**



**4 Pressure Transducers
1st and 2nd Stage**



2 Frame Accelerometers

1 Phase sensor

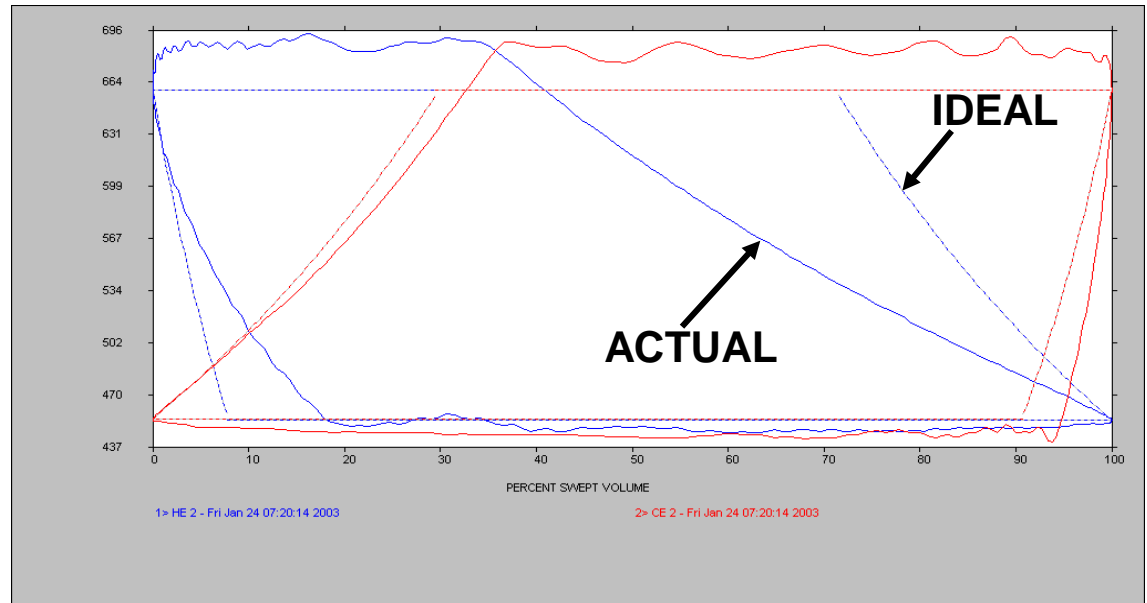
2 Rod Drop Sensors



UN-REGAP - 106-K-2A - Before

Remote diagnose:

- ◆ Severe 2nd Stage Suction Valves' Leak
- ◆ Quantitative evaluation of leak indicated unloader fingers' partially opening the valves



Recommendations:

- ◆ Replace 2nd Stage Suction Valves
- ◆ Check and correct unloader fingers

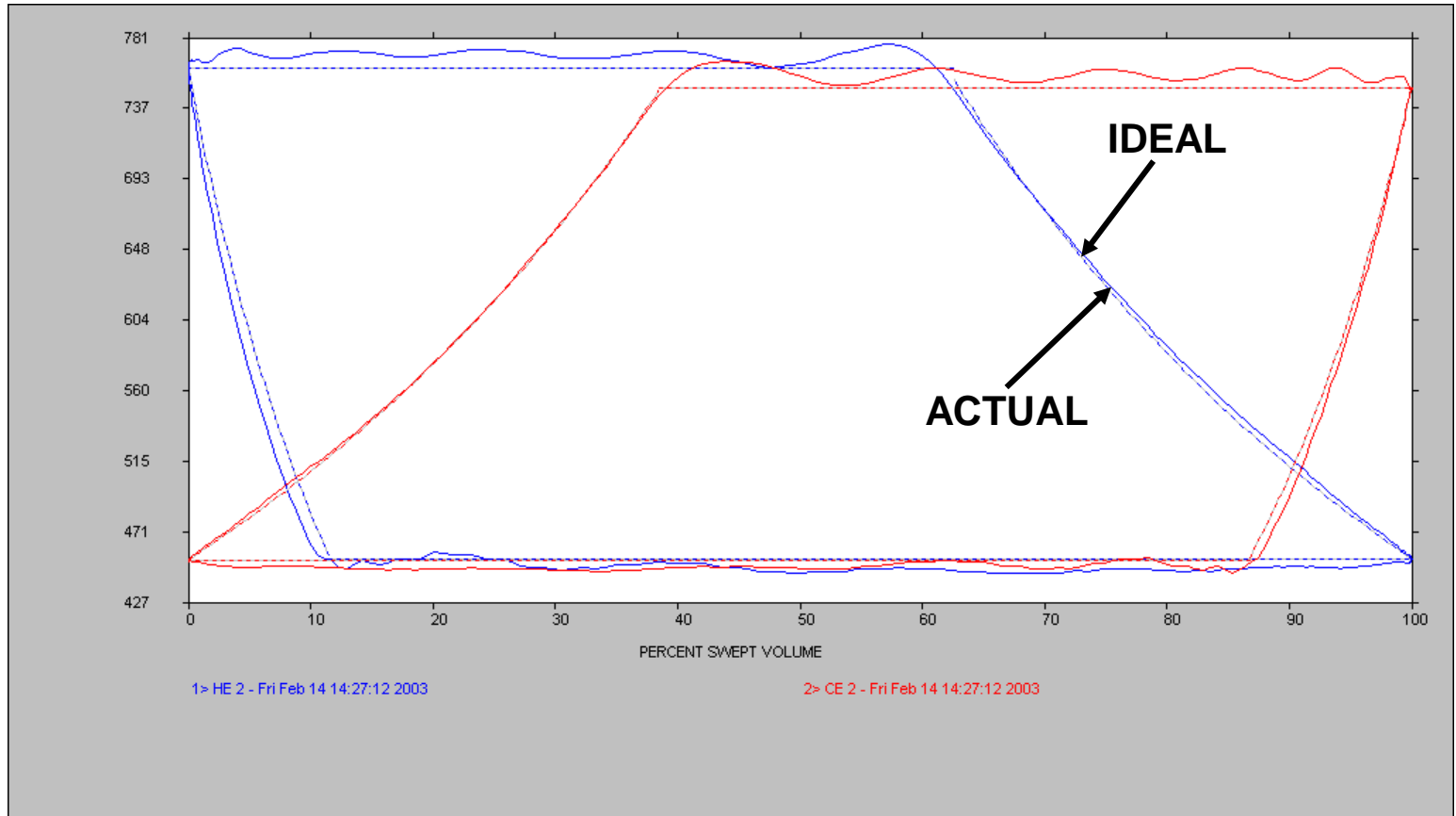
UN-REGAP - 106-K-2A

Valve Inspection

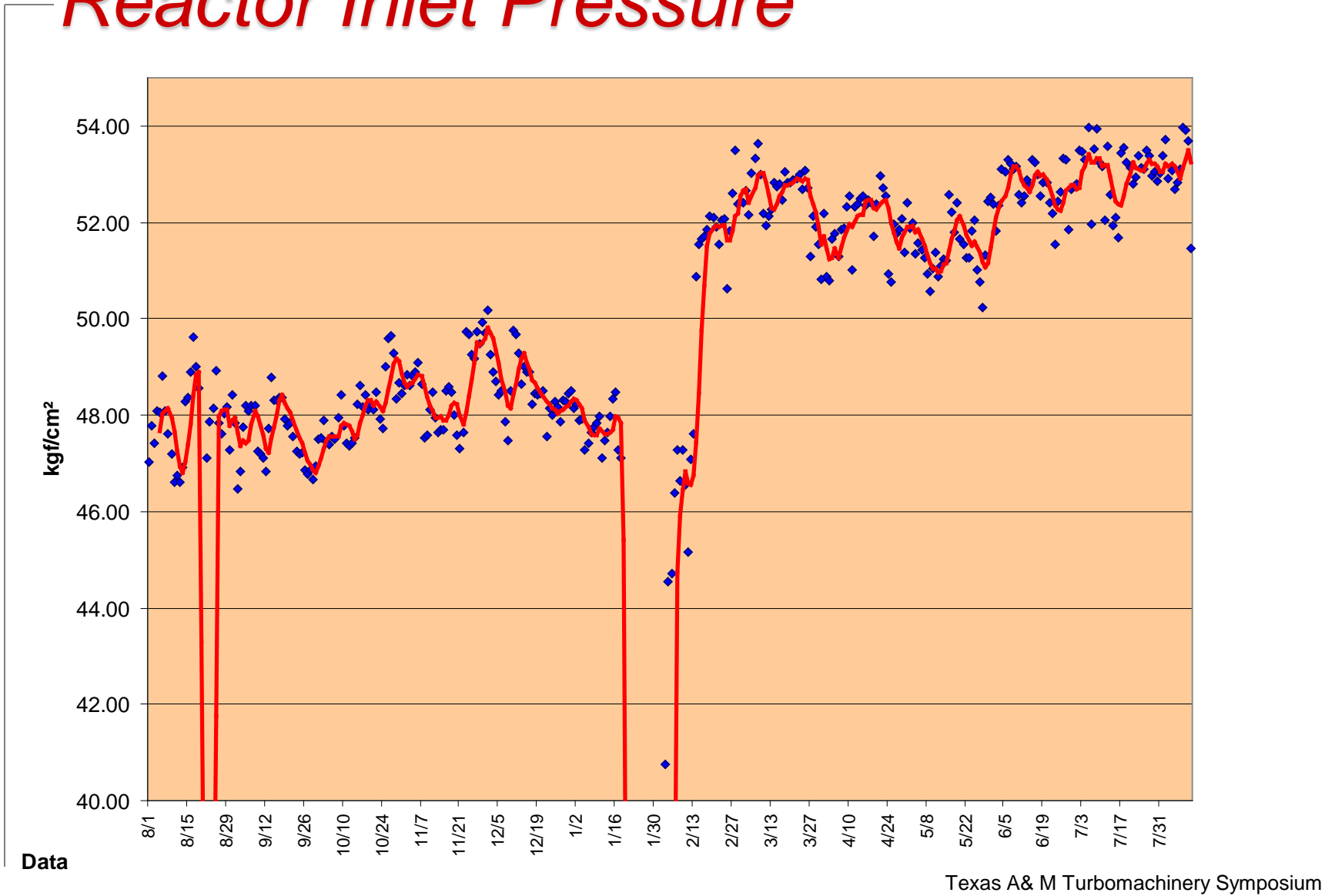


Unloader Finger
Marks and gas
passage path

UN-REGAP - 106-K-2A - After



Reactor Inlet Pressure



Data

Added Value

- ◆ Incorporation of lower value streams to produce Diesel fuel.
- ◆ Additional margin of \$10.00 for each m³ of lower value streams incorporated to Diesel fuel for Reactor Inlet Pressure increment of 57 psi.
- ◆ Average daily production increase, 100 m³/day.
- ◆ Added value \$1,000.00/day
- ◆ Pay-off < 3 months



Lessons Learned

- ◆ Monitoring justification is easier when process gains are involved.
- ◆ Remote diagnosis is possible and greatly reduces monitoring costs
- ◆ Maintaining the gains is key for justification