Reactor 2
Ratio Assurance
More than just Flow Meters

The Need for Ratio Assurance

Why:

- Peace of mind for the customer and contractor
- Eliminate costly repairs and call backs
- Detect issues quickly and stop off-ratio foam from being applied
- Reduce the risk of new sprayers producing ‘bad foam’
- Provide easy to read data to the customer that the foam was applied correctly: ratio, temps, pressure, etc.
- Educate the industry on key facts they need to know about when measuring ratio

What are Single-Point Variables?

- It is important to understand the types of issues that may cause off-ratio foam to be sprayed. These issues are called ‘Single-point variables’. These variables can be grouped into categories:

- Air in the fluid stream
- Feed pump too small
- Poor material feed to the proportioner
- Proportioner pump issues
- Fluid leaks
- Fluid restriction in heated hose or spray gun

- Since no one detection method can be the best at catching all issues, it is important to have a robust ratio monitoring system that incorporates both pressure and flow meter monitoring.

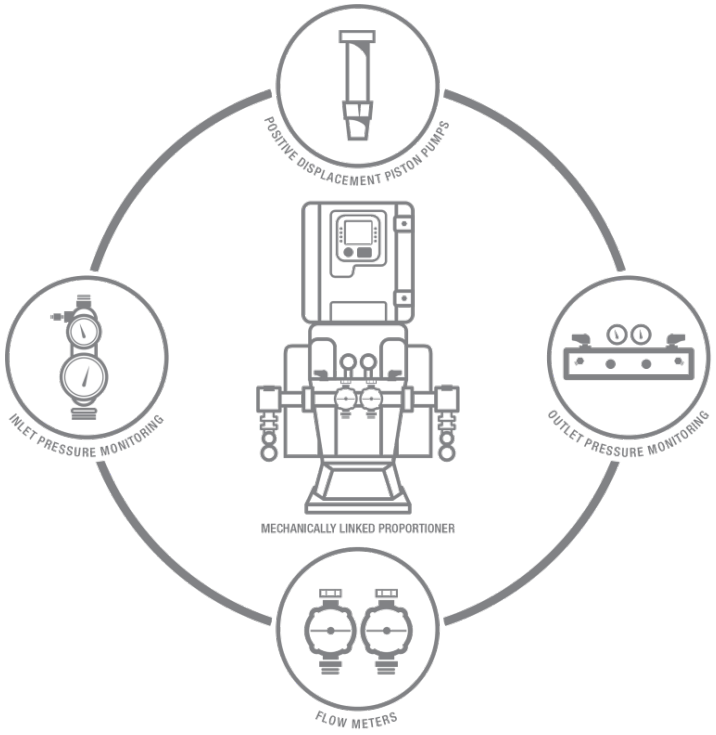
Single-Point Variables

BEST BETTER GOOD

Category Type	Single-Point Variables	Reactor Detection Method		
		Inlet Pressure Sensor *	Outlet Pressure Sensor	Flow Meters
Air in fluid stream	Run away feed pump/ Running out of chemical	NA	Better	Better
	Trapped air in the feed line and/or proportioner	NA	Good	Best
Undersized feed pump	Too large of a mix chamber being used	Best	Good	Better
	Too high of proportioner pressure setting	Best	Good	Better
	Too long of a trigger pull	Best	Good	Better
Poor material feed to proportioner	Cold material(s)	Best	Better	Good
	Feed pump pressure set too low	Best	Good	Better
	Damaged feed pump (seals, check ball, air motor)	Best	Good	Better
	No feed pump pressure	Best	Good	Better
	Plugging inlet filter	Best	Good	Better
Proportioner pump issue	Damaged proportioner pump foot valve ball/seat	Best	Good	Better
	Damaged proportioner pump piston ball/seat	NA	Better	Best
	Damaged proportioner pump seal	NA	Better	Best
Fluid leaks	Leak between proportioner pump and flow meter	NA	Better	Best
	Leak in heated hose	NA	Best	NA
Restriction after flow meter	Blockage in heated hose, build-up on ID of hose(s) **	NA	Best	NA
	Plugged gun filter **	NA	Best	NA
	Gun impingement port plugging **	NA	Best	NA

Graco's Ratio Assurance System

- No single method can easily and accurately detect each of the potential single-point variables
- A multi-tiered ratio assurance system with built in redundancies that will provide the best results in maintaining on-ratio spraying
- A robust Ratio Control System is more than just flow meters.
  - Mechanically linked pumps
  - Positive displacement piston pumps
  - Inlet pressure monitoring
  - Outlet pressure monitoring
  - Flow meters



Mechanically Linked Pumps

- Mechanically Linked Pumps
  - All Reactors use mechanically linked pumps
  - Act like built-in flow meters. The pumps naturally want to pump equal amount of A and B chemical on each stroke

Components of the Ratio Control System

- Positive Displacement Piston Pumps
  - Provide consistent volumetric performance over a large range of temperatures, pressures and viscosities
  - More accurate for use in start and stop applications and for holding stall pressure
- Inlet Pressure Monitoring
  - Best way to detect feed pump and inlet filter issues. They are accurate and the quickest responding method of detection
    - Poor material feed to the proportioner
    - Feed pump too small
    - Damaged proportioner pump foot valve ball/seat

Components of the Ratio Control System

- Outlet Pressure Monitoring
  - Can help detect conditions that may cause poor impingement mixing of the A and B chemicals. Even when chemicals are on ratio
  - Best at detecting running out of chemical, a leak in the heated hoses and restrictions in the gun
- Flow Meters
  - Flow meters tie the complete system together where using pressure alone may not catch certain conditions that could cause off-ratio dispensing
  - Flow meters also provide a way to measure, monitor, and record true volumetric flow
  - Best at detecting running out of chemical, trapped air in the feed hoses, damage to the proportioner pump

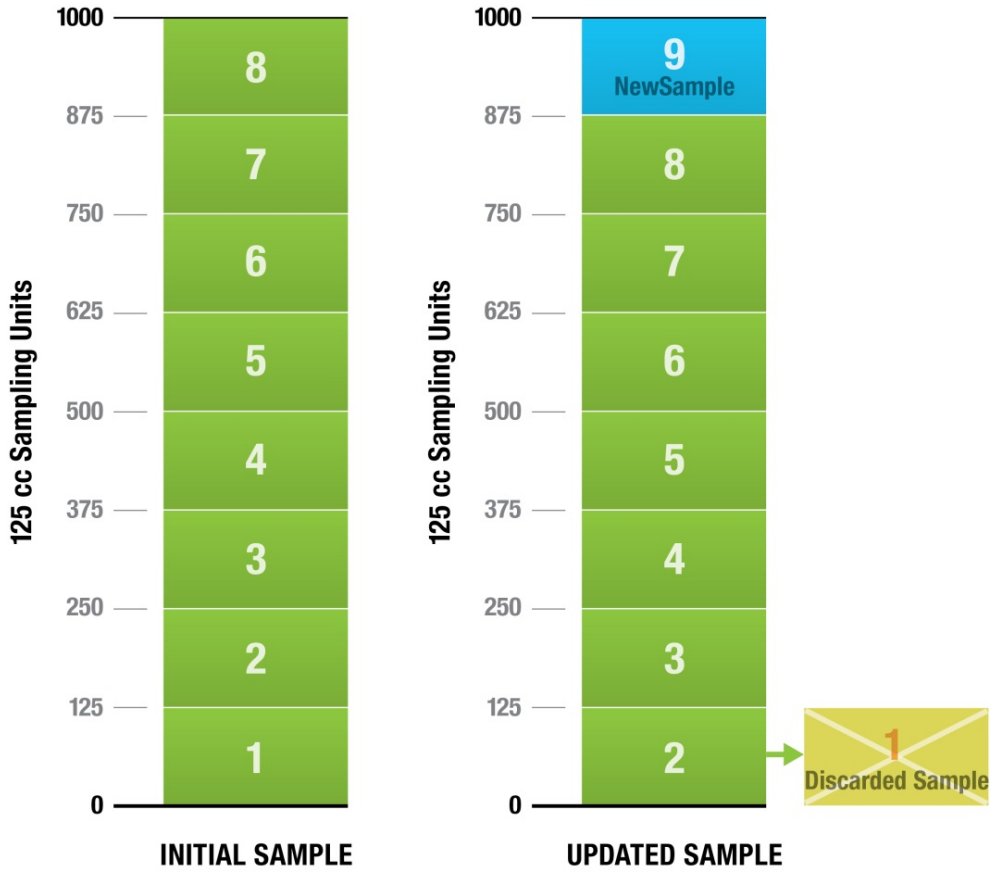
Understanding Flow Meters con't

- Oval gear flow meters are a type of the positive displacement flow meter. By design this type of flow meter is simple and robust.
  - Two interlocking oval shaped gears offset by 90 degrees rotate within a chamber of known volume.
  - As these gears turn, they repeatedly fill and empty a very precise volume of fluid between the outer oval shape of the gears and the inner chamber walls.
  - Each complete 180 degree rotation of the gears is called a pulse. The flow rate is then calculated based on the number of pulses recorded.

Inlet  Outlet

Volume is Important to Ratio

- Graco is calculating ratio using the most recent 1000cc volume (0.26 gal) of material dispensed
  - The goal is to detect an off-ratio condition within 1-3 average size stud cavities
  - The ratio is constantly recalculating based on 125cc samples
  - Every time 125cc's of new material is sprayed that oldest sample of 125 cc's is dropped and the new 1000cc ratio is recalculated using the 8 most recent 125cc samples



Air in Fluid Stream

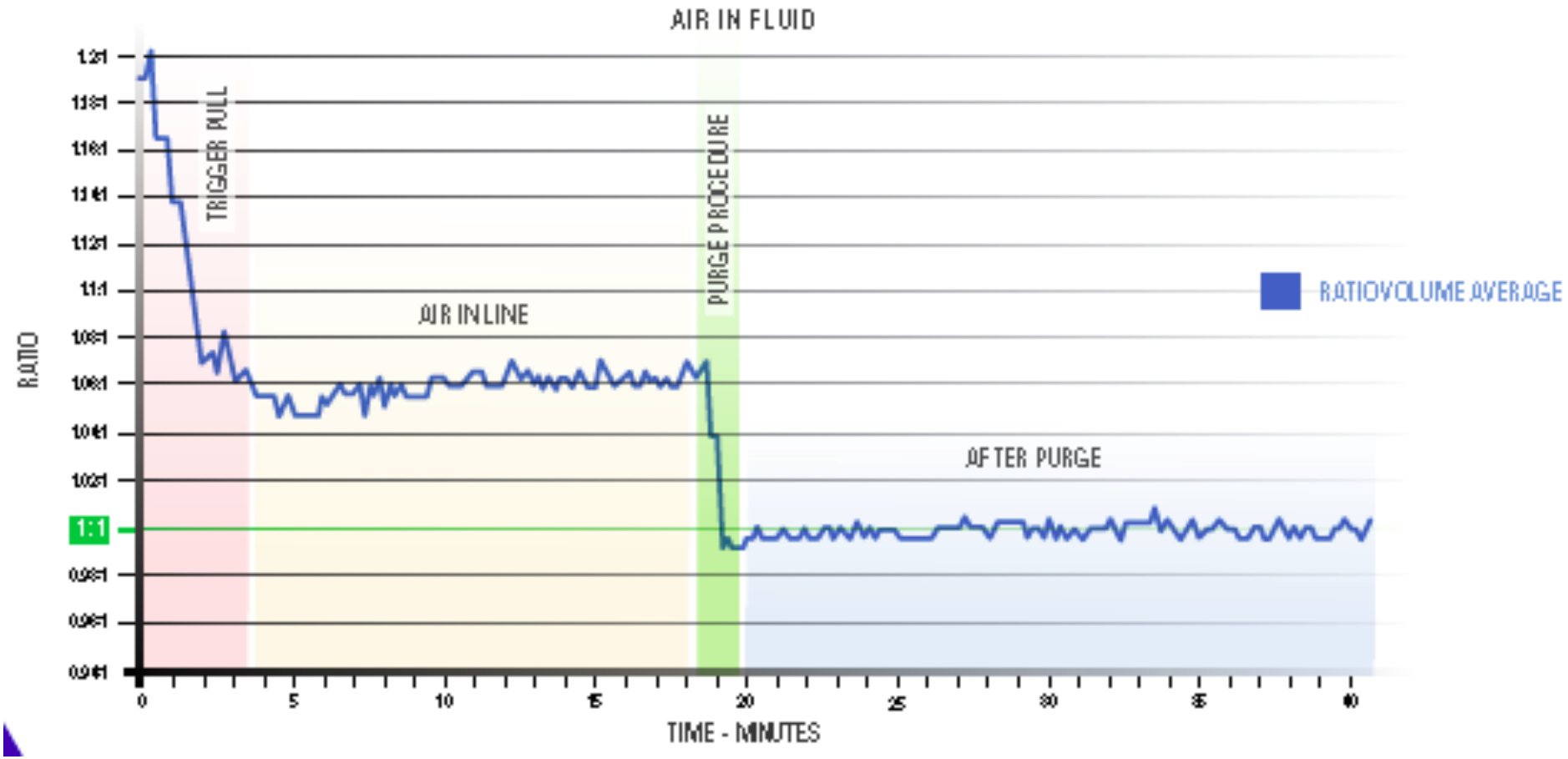


Figure 5: *Graph shows an off-ratio condition caused by having air in the fluid stream. When you pull the trigger ratio quickly falls from 1.20:1 to about 1.06:1. Ratio remains high until a purge procedure is done to remove all air from the fluid stream. After purge procedure ratio is steady between 0.99-1.00: 1averaging window.*

Feed Pump Too Small

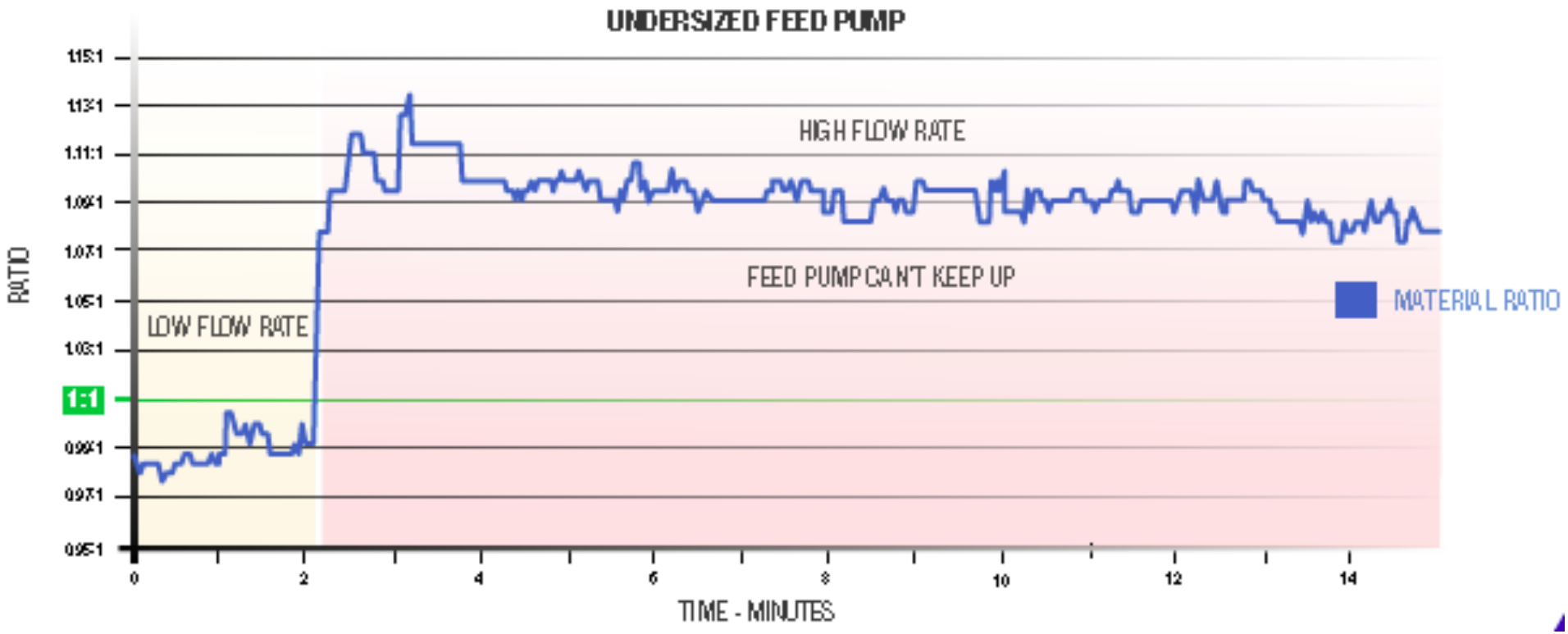


Figure 6: *Graph shows that when spraying at a low flow rate the ratio is close to 1:1, but when spraying at a high flow rate the feed pump cannot keep up causing off-ratio spray between 1.07-1.11: 1*

Reactor Smart Control

- Graco has developed new software for Reactor 2 electric models called Reactor Smart Control
- Smart Control will automatically make adjustments to the Reactor to attempt to prevent off-ratio dispensing.
  - Corrects for some feed pump/material supply issues

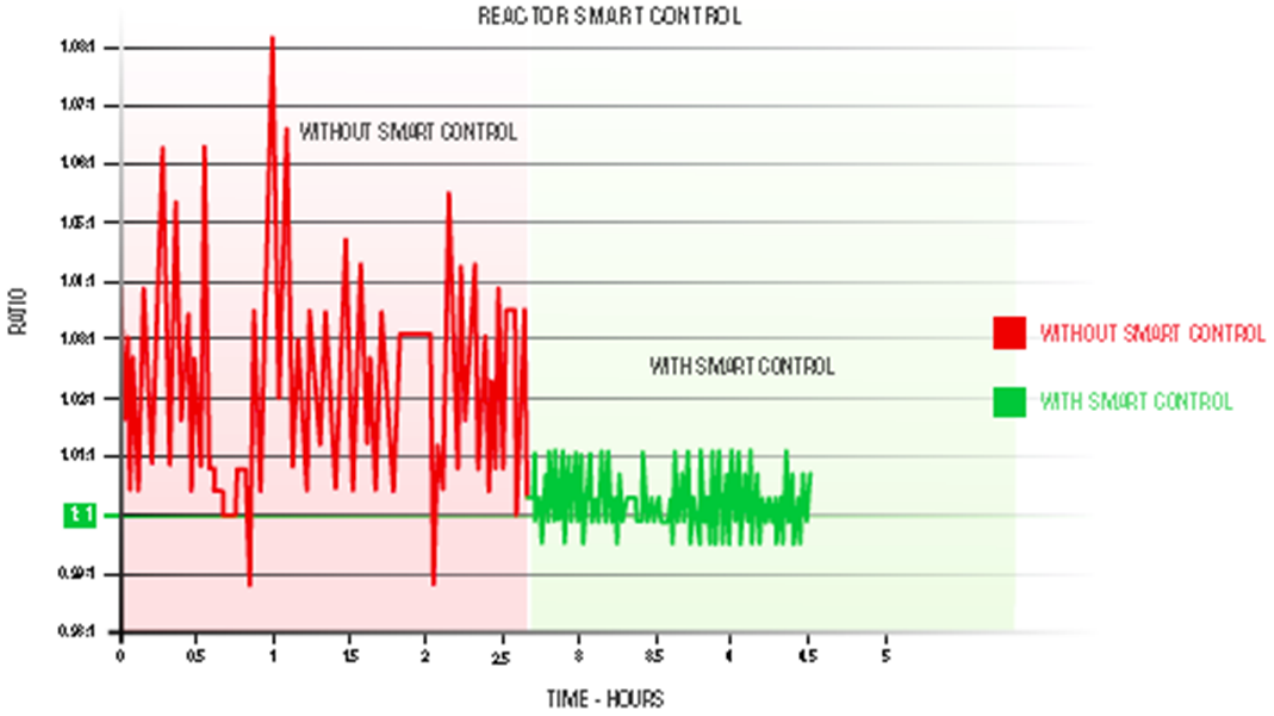


Figure 9: *Graph shows the benefit of using the Reactor Smart Control mode.*

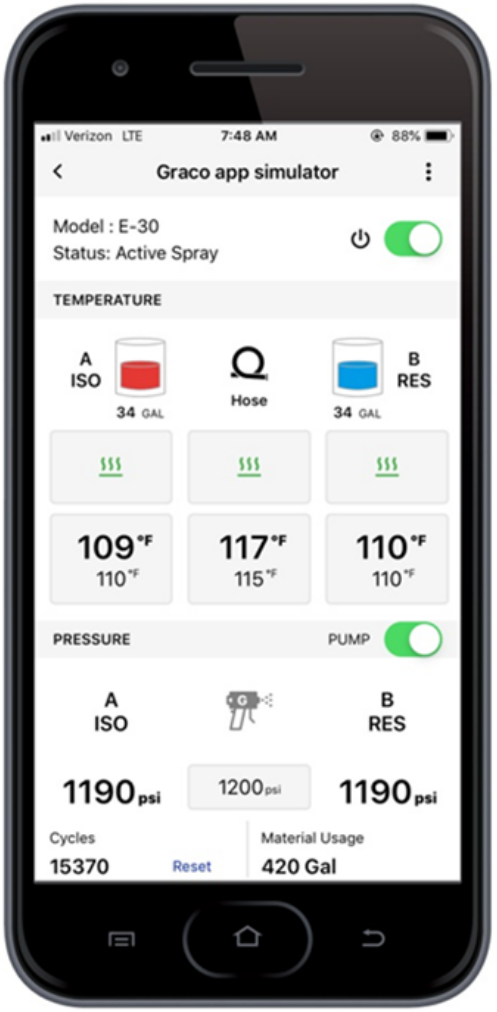
Reactor 2 App

Reactor App Tools

- Sprayers:
  - Control your Reactor 2 with your phone
  - Save time when you are spraying. Adjust the Reactor without having to go back to your rig
- Owners/Managers:
  - Monitor your rigs/crews with the multi-system dashboard
  - Troubleshoot an issue quickly by being able to see real-time machine conditions and parameters
  - Have all your spray data saved to the cloud
  - Use reports to better understand your business, your equipment, your employees
  - Provide documentation to a customer of a job sprayed correctly: on-ratio and at the recommended temperatures and pressures

Reactor App Control Features

- Turn machine on/off
- Turn pumps on/off
- Adjust temperatures for A, B and Hose heat zones
- Adjust Pressure (electric Reactor only)
- Select between spray/park/jog modes
- View material drum levels
- View events and connect directly to help.graco.com
- Reset cycle count and material usage
- Calculate Yield
- Switch control between multiple systems

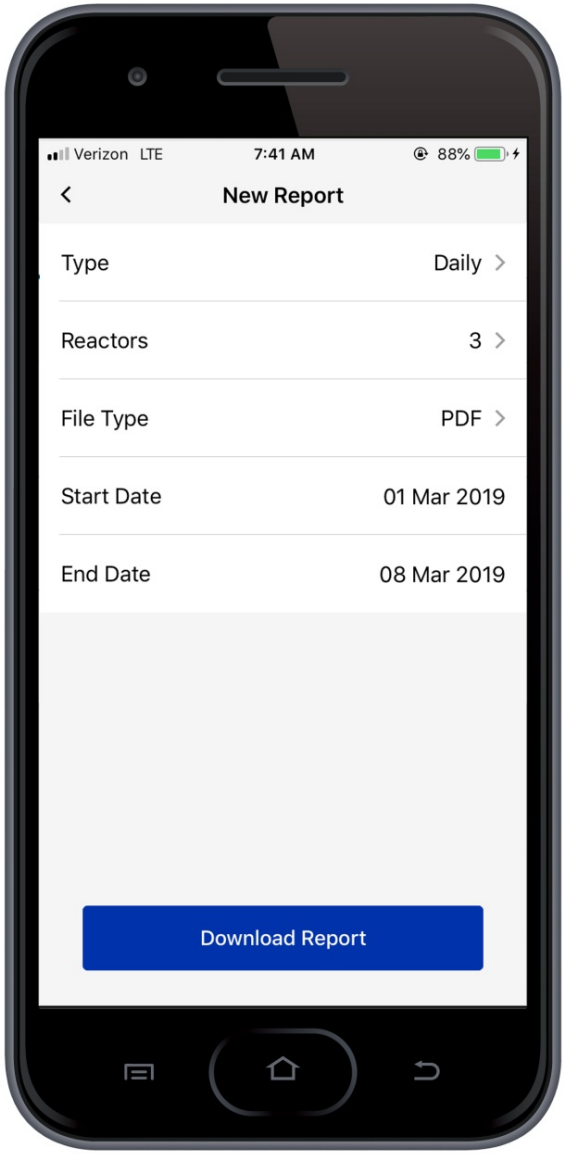


Multi-System Dashboard

- Multi-System Dashboard: See all Reactors on one screen
  - Status
    - Red, Yellow, Green lights
  - Daily Power On Time
  - Actual Spray Time
  - Daily Material Usage
- Click on any machine to bring you to the control view for that machine to see pressure and temperature information

App Reports Available

- Ratio Reports:
  - Ratio Summary Report
  - Ratio Detail Report
  - Ratio Graph
- Job, Material Usage, Productivity, Machine Utilization Reports:
  - Reactor Daily Report
  - Reactor Summary Report
- Reactor Reports
  - Reactor Status Report
  - Reactor Alarms Report
  - Temperature and Pressure Graphs
- Reactor Data Report (Complete data download by the minute)



Ratio Reports

Reactor Ratio Summary Report

January 29, 2019

IMEI	Reactor Name	Start Date	End Date	Material Usage A+B (gallons)	Average Ratio
357520072734862	Graco app simulator	1/28/19	1/28/19	116	1.01:1
357520076059928	SPFA #1	1/28/19	1/28/19	74	1.00:1
357520076060785	SPFA #2	1/28/19	1/28/19	142	0.99:1

Reactor Ratio Detailed Report

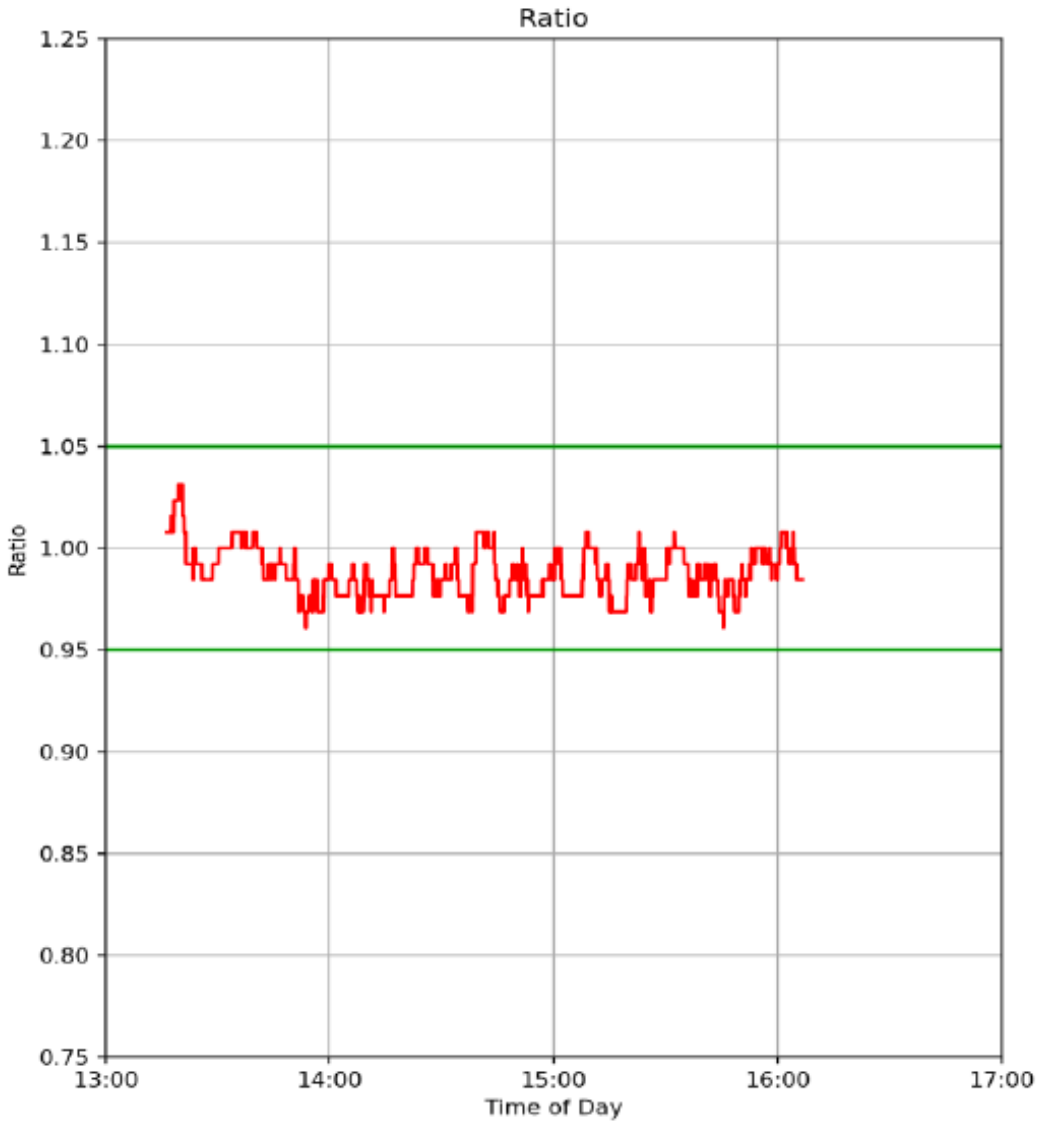
January 29, 2019

IMEI	Reactor Name	Start Date	End Date	Material Usage A+B (gallons)	Avg Ratio	Ratio Range	Ratio Alarm Count	Temp A Setpoint (°F)	Avg Temp A (°F)	Temp B Setpoint (°F)	Avg Temp B (°F)	Temp Hose Setpoint (°F)	Avg Temp Hose (°F)	Pressure Setpoint (psi)	Avg Pressure A and B (psi)
357520072734862	Graco app simulator	1/28/19	1/28/19	116	1.01:1	0.99 - 1.02:1	--	74 - 75	75	74 - 75	74	84 - 85	84	1,280 - 1,280	1,282
357520076059928	SPFA #1	1/28/19	1/28/19	74	1.00:1	0.95 - 1.04:1	--	130	130	130	130	130	130	1,200	1,199
357520076060785	SPFA #2	1/28/19	1/28/19	142	0.99:1	0.96 - 1.06:1	1	125 - 125	125	120 - 125	124	125 - 125	124	1,150	1,149

Ratio Graph

Reactor Ratio Graph Report
January 29, 2019

System Name: SPFA #1
IMEI: 357520076059928
System Type: E-30



Job, Material, Productivity, Utilization Reports

Reactor Daily Report 2019-02-11 to 2019-02-17
February 26, 2019

IMEI	Reactor Name	Date	Start Spray Time	End Spray Time	Number of Alarms	Cycle Count	Material Usage (gallons)	Power On Time (hours)	Actual Spray Time (hours)	Productivity (gallons/hour)	Machine Utilization
111111111111111	Graco #1	02/11/19	8:05 AM	1:05 PM	1	177	11.2	5.0	0.9	2.3	18%
111111111111111	Graco #1	02/12/19	7:24 AM	12:36 PM	1	925	58.6	5.2	3.1	11.3	60%
111111111111111	Graco #1	02/13/19	7:36 AM	1:42 PM	2	358	22.7	6.1	1.6	3.7	25%
111111111111111	Graco #1	02/14/19	7:12 AM	1:24 PM	5	1,119	70.9	6.2	2.8	11.4	45%
111111111111111	Graco #1	02/15/19	6:36 AM	1:13 PM	0	627	39.8	6.5	2.2	6.1	33%
111111111111111	Graco #1	02/16/19	---	---	---	0	0.0	0.0	0.0	---	---
111111111111111	Graco #1	02/17/19	---	---	---	0	0.0	0.0	0.0	---	---
222222222222222	Graco #2	02/11/19	---	---	---	0	0.0	0.0	0.0	---	---
222222222222222	Graco #2	02/12/19	10:15 AM	3:48 PM	2	628	39.8	5.2	2.5	7.7	48%
222222222222222	Graco #2	02/13/19	9:36 AM	4:54 PM	0	582	36.9	6.7	2.3	5.5	34%
222222222222222	Graco #2	02/14/19	9:58 AM	2:45 PM	0	699	44.3	4.8	2.2	9.3	45%
222222222222222	Graco #2	02/15/19	7:55 AM	4:28 PM	3	343	21.7	6.5	1.7	3.3	26%
222222222222222	Graco #2	02/16/19	---	---	---	0	0.0	0.0	0.0	---	---
222222222222222	Graco #2	02/17/19	---	---	---	0	0.0	0.0	0.0	---	---

Reactor Summary Report 2019-02-11 to 2019-02-17
February 26, 2019

IMEI	Reactor Name	Cycle Count	Material Usage (gallons)	Power On Time (hours)	Actual Spray Time (hours)	Productivity (gallons/hour)	Machine Utilization	Days of Use
111111111111111	Graco #1	3206	203.3	29.0	10.5	7.0	36%	5
222222222222222	Graco #2	3664	100.1	11.6	4.6	8.6	40%	3
333333333333333	Graco #3	2252	142.8	23.1	8.6	6.2	37%	4
444444444444444	Graco #4	2395	177.2	31.7	7.8	5.6	25%	5
555555555555555	Graco #5	1248	92.3	5.7	2.8	16.2	49%	2
Total	**---**	**12765**	**715.6**	**101.1**	**34.3**	**7.1**	**34%**	**19**

Reactor Reports

Reactor Status Report

February 27, 2019

IMEI	Reactor Name	System Type	Reactor Part Number	Reactor Serial Number	Lifetime Cycles	Hose Control Mode	Pressure Imbalance Alarm Enabled	Pressure Imbalance Alarm (psi)	Inlet Sensors Enabled	Flow Meters Installed	Ratio Tolerance	Ratio Alarms Enabled	Ratio Smart Control Enabled	Software Versione
111111111111111	Graco #1	E-30	272011	A133XX	361,259	Temperature	Yes	500	Yes	Yes	5%	Yes	Yes	3.02.010
222222222222222	Graco #2	H-30	17H031	A104XX	305,338	Temperature	Yes	500	No	No	---	No	No	3.02.010
333333333333333	Graco #3	E-30	272111	A129XX	574,525	Temperature	Yes	500	Yes	Yes	5%	No	Yes	3.02.010
444444444444444	Graco #4	H-30	17H032	A105XX	780,428	Temperature	Yes	600	Yes	Yes	7%	Yes	No	3.02.010
555555555555555	Graco #5	H-40	17H044	A109XX	379,307	Current	No	500	No	No	---	No	No	3.02.010
666666666666666	Graco #6	H-40	17H044	A115XX	58,858	Temperature	Yes	400	Yes	Yes	5%	Yes	No	3.02.010
777777777777777	Graco #7	E-30i	272089	A152XX	17,952	Temperature	Yes	500	Yes	Yes	5%	Yes	Yes	3.02.010

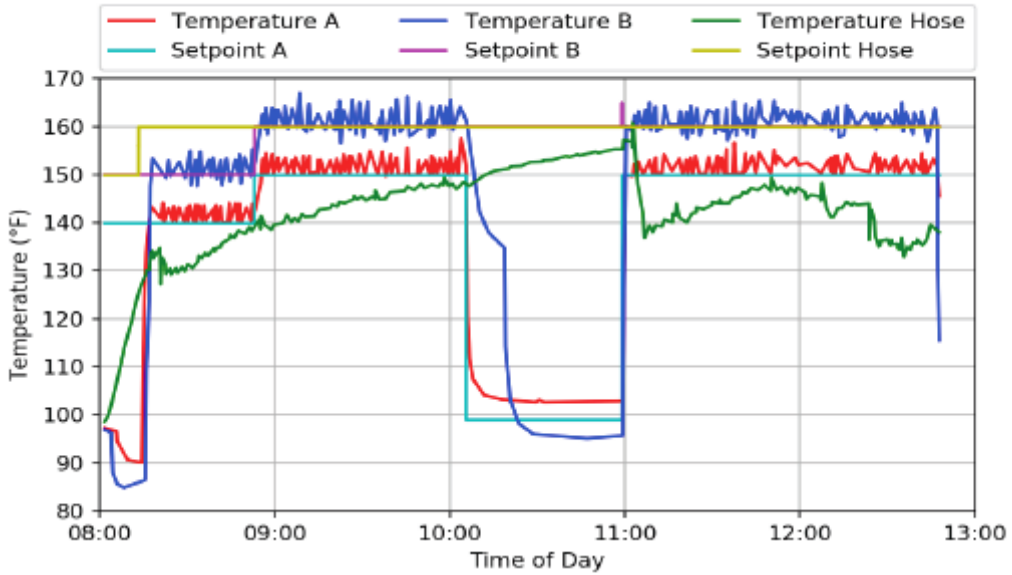
Reactor Alarm Report 2019-02-11 to 2019-02-17

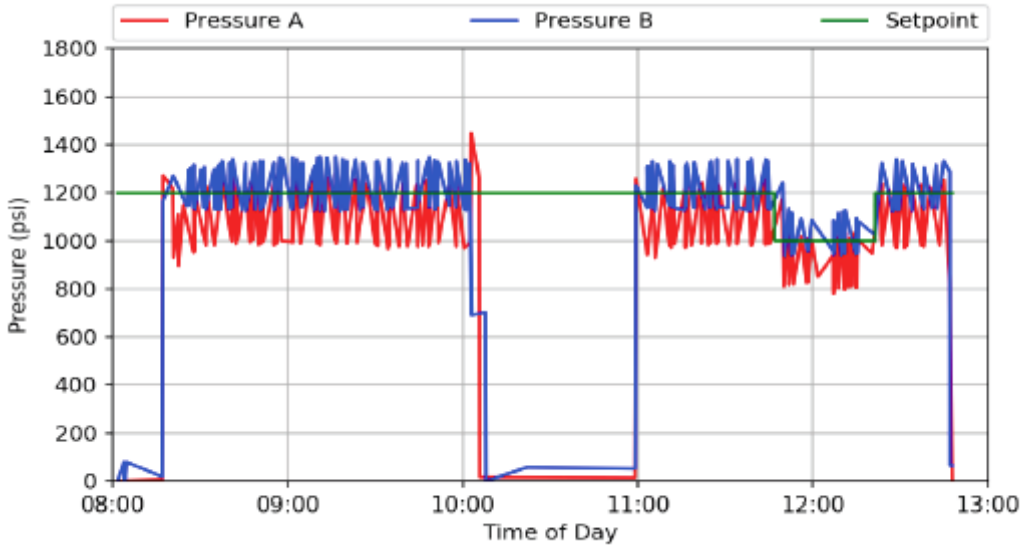
February 26, 2019

IMEI	Reactor Name	Event Date and Time	Event Code	Event Description
111111111111111	Graco #1	02/14/19 10:33:29	T6DH	(E04) Sensor Error Hose
111111111111111	Graco #1	02/14/19 10:40:12	A4DA	High Current A
111111111111111	Graco #1	02/14/19 10:42:41	P1FA	Low Inlet Pressure A
111111111111111	Graco #1	02/14/19 10:44:53	P1FA	Low Inlet Pressure A
111111111111111	Graco #1	02/14/19 10:51:31	P7AX	(E24) Pressure Imbalance A High
111111111111111	Graco #1	02/14/19 10:57:11	P7AX	(E24) Pressure Imbalance A High
111111111111111	Graco #1	02/14/19 13:31:46	P7AX	(E24) Pressure Imbalance A High
111111111111111	Graco #1	02/14/19 14:54:21	P7AX	(E24) Pressure Imbalance A High
111111111111111	Graco #1	02/15/19 14:02:07	P6Ax	Pressure Sensor Error A
222222222222222	Graco #2	02/11/19 14:08:41	T6DH	(E04) Sensor Error Hose
222222222222222	Graco #2	02/12/19 12:08:27	R4D0	Off Ratio Low Flow B
222222222222222	Graco #2	02/12/19 14:15:51	R4D0	Off Ratio Low Flow B

Temperature/Pressure Graphs

Reactor Temperature/Pressure Graphs
January 2, 2019
System Name: 358832070063338
IMEI: 357520076057146
System Type: E-30





For More Information

Graco Website: www.graco.com/ratioassurance

- White Paper
- Brochure
- Sample App Reports
- Single Point Variable Table
- Product Manual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