Continuous Monitoring of Ultrasonic Meters

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Introduction

There are many in our industry who would consider the advancement of the ultrasonic meter to be the greatest improvement in gas measurement in the past twenty years. It's my opinion that the immense improvement in gas measurement is not so much the ultrasonic meter itself. Instead, I believe it is the meter's ability to detect conditions that would compromise its own accuracy and ability to communicate those conditions to the user. It is in the area of communicating those conditions, that we often under-utilize the meters capabilities.

Employing electronic flow computers and SCADA systems to collect and analyze ultrasonic meter data can provide many benefits for today's natural gas pipeline company.

The natural gas pipeline industry has seen tremendous changes in the past twenty years, including a smaller multi-skilled workforce. The reality of today's pipeline work force is fewer technicians performing a wider range of tasks. Much of their measurement work is performed with less frequency, and on more complex equipment than ever before. Gaining the proficiency needed to recognize and troubleshoot ultrasonic meter problems, requires time and experience to learn. By bringing the meter's diagnostic data into our SCADA system, we can provide alarms and trending capabilities that are not dependent on the frequency at which a Technician can visit a measurement facility. Furthermore, it is not dependent on whether a Technician has necessary expertise to recognize potential meter problems.

Another change our industry has seen are meter stations with larger, but fewer meters. With the high turn down capabilities of ultrasonic meters, large volume meter stations that before would have been built with four or more orifice meters are now built with one or two larger ultrasonic meters. Fewer meters, means we are placing a higher liability on each meter.

One factor that has not changed is the expectations of a tight pipeline balance. In fact, most of us have seen our lost and unaccounted for objectives reduced to a level that would have been impossible to meet twenty years ago. Fortunately, our ultrasonic meters are more accurate than the meters we used in the past, and provide us with enough data to warn us when their accuracy is in question. Unfortunately, our testing practices are not much different than the way we've tested orifice meters twenty years ago. When testing orifice meters we made sure the plate was clean, flat and sharp and then calibrated the transmitters. Similarly, with our ultrasonic meters we look at the software display, pull a two minute log file, calibrate the transmitters, and then assume all is well until the next test cycle. You can be quite confident the old sayings "ignorance is bliss" and "what you don't know can't hurt you" do not apply when you're searching your pipeline system for lost gas.

Benefits of Continuous Data Gathering

While today's ultrasonic meters provide tremendous amounts of diagnostic data, if that data is only reviewed once a month or less, we may still find ourselves months behind the curve when we begin looking for measurement problems. In order to make measurement corrections, we end up spending countless hours combing massive amounts of data pulled from the meter. Historical data may not be available in many older ultrasonic meters, making it even more difficult to determine when the meter's problems began.

Consider the benefits that can be derived from polling for this data even once every five seconds. Instead of having a two minute snap shot of the meters health each month, you have over half a million snap shots of that data every month. Bringing this data into the SCADA system then stores it in a location that is readily accessible for review. By utilizing our flow computers and SCADA systems to gather and analyze data, we can monitor our ultrasonic meters continuously, making the data readily available to Technicians, Data Analysts and Gas Controllers.

Meter Alarm Monitoring via SCADA

Storing this data in your SCADA system can provide you with instantaneous and predictive methods of monitoring. Utilizing discrete type alarms and base line data for limits provides instantaneous alarms that can be identified by inexperienced users. These alarms provide Gas Controllers, who may have no ultrasonic meter training at all, with the ability to identify potential meter problems, as well as the confidence necessary to call the problem to the technician's attention.

Trending of this diagnostic data provides a detailed history that can be used to reveal shifts over time. This data can be utilized to uncover a variety of subtle changes in a meter that would be difficult to detect viewing maintenance logs once a month. Historical data can be used to tighten alarm limits as well. Analyzing this data would require examination by someone with ultrasonic meter experience, but with the data stored in the SCADA system, it would be readily available to employees that are trained to perform such tasks.

We have found that SCADA monitoring of this data not only provides us with instant and predictive monitoring of our meters, it also provides a means of monitoring our meters at stations that do not flow on a routine basis. Additionally, it provides the ability to monitor for intermittent problems.

Ultrasonic meters at peaking power plants can be difficult to monitor, because they tend to run at unscheduled times throughout their generating season. Technicians may often find it difficult, especially during shoulder months, to catch these stations when they're flowing to perform meter tests. SCADA monitoring of ultrasonic meters not only provides warnings of possible measurement inaccuracies for these meters, it could also provide support for extending meter test frequencies on meters that flow continuously.

As we all know, intermittent problems with any equipment can be difficult to find. Prior to our polling one particular 12-inch ultrasonic meter with our flow computer, we found a bolt sleeve from an insulating gasket lying up against the flow conditioner. We caught this by chance when our Technician noticed an unusual profile factor during a meter test. Apparently, the sleeve would lie on the bottom of the pipe until the velocity increased to a point high enough to stand it up, which was the only time it created a profile disturbance. Since there was a strainer upstream of the meter, one can only assume the sleeve had been in there since the station was built. That being the case, it took nearly 5 years for someone to be there at the right time to catch it. Imagine trying to monitor your pipeline for H_2O or H_2S by performing a dragger tube test once a month to check for slugs coming through your pipeline. Collecting two minute logs every month would give you about the same odds of discovering an intermittent problem with the meter.

Getting Started

The basic concept behind continuous monitoring of ultrasonic meters is to utilize the Modbus communications capabilities of the flow computer and meter to transfer data between the two devices. This data can then be used to execute the same or similar diagnostics performed by the meter's software or a Technician reviewing a maintenance log.
The diagnostic data in the flow computer can then be polled by a SCADA system which makes the data available offsite.

The process of polling ultrasonic meters for data has been an ongoing process for us that began in 2004. New meters, the availability of new data, and new calculation capabilities, such as the ability to calculate the speed of sound in the flow computer, have required us to make some occasional changes. For the most part, future changes to polling routines and calculated data can be avoided or at least reduced with proper planning.

With that in mind, you need to start by asking yourself a few questions. What data do you want to see? Do you want to poll for all the data or do you want to poll for some of the data, and calculate some of the meter health alarms? Do you want to pull the raw data into your flow computer and perform the diagnostics there, or simply pass the data on and perform the diagnostics in your SCADA system?

There is far more data available in most ultrasonic meters than you likely want to collect. The first step is to list the meter health conditions you want to monitor. Once you have created that list, you will then need to determine the Modbus registers that contain those particular meter health alarms, or the data you will need to calculate those alarms. The Modbus register documentation is available from the manufacturer, and is listed in the Modbus references at the end of this paper.

At this point, you'll find, depending on the type of meter, whether you can simply poll for all the meter health data wanted, or if you will have to poll for some of the data, and use that data to calculate the meter health alarms. Depending on the meter manufacturer, you may find it simpler to calculate some of the alarms rather than make multiple polls to gather all the meter health data. Calculations of meter health alarms can be performed in the flow computer or a SCADA system. This would depend on the flow computer, and the SCADA system's capabilities, as well as the availability of someone to program these calculations into the system.

We opted to do a combination of polling for some of the meter health alarms we wanted, and to calculate some of them. We chose this method primarily because of the number of older ultrasonic meters we own that do not have all the meter health data we wanted assigned to Modbus registers.

Depending on the meter type, we are polling for all or some of the following data: corrected flow rate, uncorrected flow rate, average velocity, average speed of sound, as well as velocities and speed of sound for each path. We are also polling for turbulence, swirl, path performance, cross flow, AGC levels, signal to noise ratios and path status. We use the path level velocities and speed of sound data to calculate the profile factor, symmetry, and path speed of sound spread. We then perform several calculations and comparisons to provide various alarm points using the original flow calibration data as a baseline for alarm parameters.

As stated in the previous paragraph, one of the pieces of data we want from the meter is the corrected flow rate. To accomplish this requires we provide the meter with the necessary data for it to perform the appropriate calculations. The pressure, temperature, and gas quality values can be given to the meter several ways, depending on the meter manufacture. The pressure and temperature values can be conveyed into some meters through an analog input, as well as setting up some meters to poll an onsite GC. The pressure and temperature values and gas quality or compressibility can also be written to the meter through the same Modbus connection you use to read data from the meter. Other meters require writing the data to provide a continuous update of these values. We have meters set up both ways, but primarily we write the data to the meters, because we do not have an onsite chromatograph at many of our ultrasonic stations. In this case, the gas quality being used by the flow computer for calculations is written to the meter.

To set up a meter poll in our flow computer, the Technician would select the meter type from a drop down menu. The meter type setup is illustrated in figure 5. The meter type signal tells the flow computer how to configure the master port used to poll the meter. We also utilized the different meter default protocol and communication settings to minimize meter set up changes.

The port configuration set by the meter type signal sets the appropriate floating point format, bit, byte, word orders, start register, and the number of registers to poll. Additionally, the Modbus data will be in metric units for some meters and imperial units for others. They may contain the data in metric and imperial units depending on the registers you poll. The meter type signal tells the flow computer to covert the incoming data when necessary.

The polled data is then mapped to different signals, and is then used for the various calculations we want to perform. This allows us to use the same flow computer program whether the meter station has Instromet, Daniel, or Sick Maihak meters. The fewer types of meters you have will help simplify the process.

"Self-Diagnostic" Alarming

Originally, we used the data polled to calculate a profile factor, symmetry, speed of sound spread, and to compare the meter's speed of sound to one we calculated in the flow computer. This data is displayed in the RTU and shown in figure 6. In recent years, we explored the benefits of gathering additional data from our meters. We worked with Sick Maihak and Daniel Industries to establish some additional diagnostic logic in our flow computers for their meters. With our Daniel meters, we used the methodology described in a paper written by Dan Hackett called "Advanced Diagnostics Firmware for Ultrasonic Meters", to detect different conditions such as, a blocked flow conditioner, meter contamination, and liquid in the meter. We performed similar calculations to provide these same alarms for our Sick Maihak meters based on information we were given by John Lansing. There are some differences in the calculations they recommend to detect several of the alarm conditions. Although, because both are chordal type meters, most of the logic used is identical. We used similar logic for the Instromet meters based on what data was available. The RTU display for this data is shown in figure 6.

For the Instromet meters, we are alarming on path performance, swirl, AGC level, and path status all from data we poll directly from the meter. We also generate alarms for profile factor, speed of sound spread, speed of sound error, frequency input error, and gas quality by performing various calculations in the flow computer.

With the Daniel meters, we are alarming on path performance, swirl, AGC level, path status, path turbulence, and cross flow, all from data we poll directly from the meter. We then generate alarms for profile factor, speed of sound spread, speed of sound error, frequency input error, volume calculation error, blocked flow conditioner, meter contamination, liquid, and gas quality by performing some calculations in the flow computer.

On the Sick Maihak meters, we are alarming on path performance, swirl, AGC level, path status, path turbulence, and signal to noise ratio, all from data we poll directly from the meter. We then generate alarms for profile factor, speed of sound spread, speed of sound error, frequency input error, volume calculation error, blocked flow conditioner, meter contamination, liquid, and gas quality. We compare the four path meter's flow rate and speed of sound to the single path meter by performing various calculations in the flow computer.

Our objective has always been to provide warnings for our meters without creating nuisance alarms and call-outs. For that reason, we require the velocity to be at least 5 feet per second and most alarm conditions must be true for 5 minutes in order to activate an alarm.

Self-Checking Redundant Measurement

Having the meter's data in the flow computer, allows us to perform some additional diagnostics that cannot be accomplished by the meter or flow computer alone. By comparing the data from both devices, we are able to perform a number of additional measurement system examinations. All of the data necessary to perform these health checks is already available we simply need that data in one location to utilize it. By adding an additional pressure transmitter and temperature transmitter to use for reference we can take our analysis one step further. The addition of a reference pressure and temperature values combined with the data from the meter and flow computer, gives us all the fundamental information necessary to build a complete self-checking redundant measurement system. The RTU display for the advanced diagnostic data is shown in figure 7.

For example, if two temperature transmitters agree and two pressure transmitters agree, and a four path meter and single path meter speed of sound values agree, and then have a measured speed of sound that does not agree with the calculated speed of sound, we can make a logical assumption that the calculated speed of sound is using different gas quality than what is actually flowing through the meter. This condition indicates a problem with the chromatograph or some type of gas quality issue. In the case of the Daniel and Instromet meters, we are using the speed of sound spread to establish that the measured speed of sound is correct.

With the meter calculating a corrected flow rate, we can compare that value to the flow computers corrected flow rate. This comparison validates the flow calculation performed in our flow computer, as well as providing backup measurement. When you combine these checks with other real time diagnostics being performed to insure a good flow profile, meter performance and meter stability, we are able to significantly reduce our measurement uncertainty in the field, and provide a redundant self-checking measurement system at a minimal additional cost. A system such as this could also be used to develop a "Condition Based Maintenance System". This system would be capable of informing the user when maintenance and calibrations are necessary, rather than performing these tasks on some repetitive schedule. Obviously, there would be some savings associated with the reduced maintenance and travel to meter stations using a system such as this.

Other Applications

This same concept can be applied to other types of smart meters as well. Micro Motion Coriolis meters can be purchased with the ability to perform what the manufacturer refers to as, "Smart Meter Verification". The verification is performed without measurement interruption so it can be executed without having someone onsite. The meter can be set up to perform the verification on a schedule, and the results of that verification, as well as other meter data can be polled via Modbus from a flow computer. It is then passed on to a SCADA system for monitoring and historical trending.

We have several Coriolis meters that were purchased with the verification capabilities. We configured the meter to schedule the verification once a day, and then poll for the verification registers. This data provides us with, Test Run Status, Test Abort Status, Test Completion Status, and Tube Stiffness pass or fail Status. We also poll for an alarm register that can be decoded to individual alarm points, and registers that provide the raw tube frequency, pickoff voltages, the drive gain and the live zero value.

Lessons Learned

As we have worked through this process over the years, we have made some changes and learned what works best for us. We found that using our SCADA system to set alarms around raw data values did not always provide the results we wanted. Analyzing the data in the SCADA system would work well for some, but was somewhat problematic for us. Our issues were primarily associated with alarm parameters not set properly, as well as requiring additional set up to handle the data for our already over worked SCADA programmers. Much of an ultrasonic meter's health indicators provide adequate information necessary to determine the health of the meter when analyzed by someone with some ultrasonic meter expertise. A less experienced user, such as a new Technician or Gas Controller, may not be equipped with the experience necessary to perform these tasks. Performing the diagnostic logic in the flow computer enabled us to more effectively provide decipherable statuses for each meter health indicator in our SCADA system. This established a more consistent means of alarming.

Performing the diagnostics in the flow computer gave us better control over our base line and alarm settings as well. On the other hand, performing these diagnostics in the flow computer requires some programming expertise. Evaluating the method that works best for you may depend on the availability of personnel to perform these tasks.

No matter the method chosen to gather and diagnose the meter's health, once it is stored in your SCADA system it will be available for Technicians, Data Analysts and Specialists to use for in-depth analysis and trending purposes. Another lesson learned, was if the data was difficult to find, view or trend in the SCADA system, then the process of additional analysis or trending of the data just didn't happen. Originally, our diagnostic data was buried in a detail display that listed every piece of data that was being polled or calculated. Consequently, when our Measurement Technicians went into our SCADA system to review the data, it took far too much time to find and view. To resolve this problem, we worked with our SCADA programmers to display the data where it was easy to access in a format that allowed users to quickly view the data, and determine if further investigation was needed. The SCADA display is shown in figure 8.

When we began modifying our polling logic for the redundant self-checking diagnostics, we realized this was a lot of individual alarms to bring into the SCADA system. To resolve this problem, we grouped the self-checking alarms into three floating point alarm signals. Each alarm signal contains 6 or 7 normal/alarm statuses. These three alarm floating point registers can then be decoded by converting them to binary values to identify the specific alarms. Alarm signal UMAC_1A contains alarms for profile factor, symmetry, path performance, AGC levels, path status, signal to noise ratio, and four plus 1 meter profile. Alarm signal UMAC-1B contains alarms for swirl, cross flow, blocked conditioner, turbulence, contamination, and liquid. Alarm Signal UMAC-Calc contains alarms for frequency input, speed of sound error, speed of sound spread, gas quality, temperature, pressure, and flow calculation.

Analyzing Historical Data

Figure 1 shows an example of the alarms we would expect a partially blocked flow conditioner to generate. Here we have a UMAC_1A alarm value of 65, indicating a 4 + 1 profile alarm and a profile factor that is outside its alarm limits. This condition is indicated again in UMAC_1B with a value of 12, indicating high turbulence and a blocked flow conditioner.

Figure 1.

UMAC-1A	65					
4+1 Profile	SNR Warn	Path Status	AGC Warn	Perf Warn	Symm Warn	Profile Input

1000001

UMAC-1B	12					
NA NA	Liquid Warn	Contam Warn	Turb Warn	Block Cond	Cross Flow	Swrl Warn

1100

In the next example, shown in figure 2 we have a UMAC_CALC value of 18. This indicates a Temperature warning and a VOS / Speed of Sound warning. This tells us that the difference between the measured speed of sound, and the calculated speed of sound, is outside its alarm limits. It also indicates that the difference between the primary temperature transmitter and the reference temperature transmitter is outside its alarm limits. We can discern from this information, that the most probable cause of the speed of sound difference is a temperature transmitter that needs to be calibrated.

Figure 2.

UMAC-CALC	18					
Calc Warn	Static Warn	Ftemp Warn	GC Warn	VOS Spread	VOS Warn	Freq Input

10010

Figure 3 illustrates how we can also trend these values over time to look for re-occurring problems and to build a history of the meter.

Figure 3.

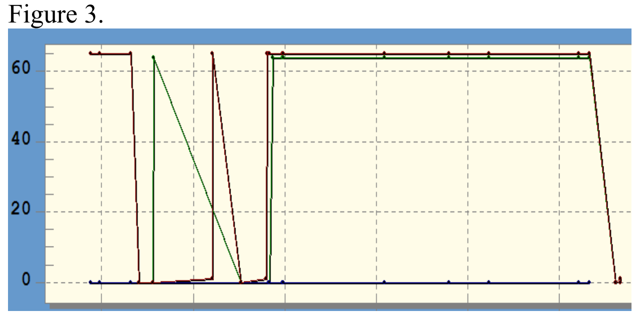
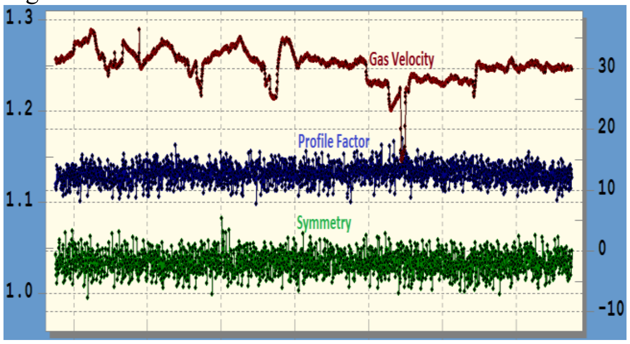


Figure 4 displays how a Technician or Analyst can perform quick seven day trends of all of this data from the SCADA system, by simply right clicking on the values wanted, and adding them to a graph. Longer trends can be performed as well, by accessing the data wanted in an ADHOC report, and then building the graph in Excel. The seven day trends are a quick and easy way for a Technician to use the SCADA system to find data on a meter he was unable to test when the meter was flowing. By trending the velocity, the Technician can locate a section of time when the meter was flowing and trend additional data such as, profile factor, symmetry, etc. during that same section of time.

Figure 4.



Utilizing a combination of Normal / Alarm statuses and analog historical data that can be trended over time provides us with an immediate indication of alarm conditions for the entire measurement system, as well as the ability to trend data to look for subtle changes over time. Currently, this data is stored in our SCADA system, at a scan-by-scan level for 1 year, then rolled up to hourly and daily averages for 5 years. This type of data analysis requires more time and skill to utilize. It may not even be used until there are imbalance issues, but it makes the data readily available when needed.

Logging Meter Alarms

Along with bringing the data into the SCADA system, we set up the flow computer to log the ultrasonic meter alarms. This provides documentation of these alarms in the measurement accounting data base with a date and time stamp. Meter alarm logging also provides us with another line of defense to catch and document potential measurement problems.

Summary

We are currently polling data from 38 of the ultrasonic meters on our system. We have been polling data from a number of these meters for several years, and some have been updated to include the "self-diagnostic" polling in the past few years. We have also initiated the practice of installing redundant pressure and temperature transmitters on new ultrasonic meter stations.

The initial research and code writing to perform the meter polling was admittedly time consuming. Taking the time to automate much of the set up process for the flow computer made the field set up relatively simple. As expected, it can be challenging to find the time to analyze and trend data. Having the data stored in an accessible location is the only feasible means we've found of accomplishing such a task.

In summary, this provides a means for Gas Control, and Technicians to tell at a glance if they have a potential problem with a meter. When the Technicians are unable to get to a meter while it is flowing to perform a meter test, they can now easily look at historical data in the SCADA system to review the diagnostic data polled when the meter last flowed. Furthermore, the historical data provides easily accessible data for an in-depth analysis.

Diagnostic References

Advanced Diagnostics Firmware for Ultrasonic Meters
Continuous Flow Analysis Firmware version 1.70 New Firmware Features New CUI 5 Features

Written by Dan Hackett, Emerson Process Management

SICK FLOWSIC600 Gas Ultrasonic Redundancy Information, and How to Significantly Reduce Field Measurement Uncertainty

Written by John Lansing, Sick Maihak

Modbus References

Mark III Modbus Table
Instromet Modbus RTU Protocol
OI_FLOWSIC600_ModbusSpecification_V4-1
OpenBSI, Custom – Gould Modbus / Open Modbus Interface
Micro Motion, Modbus Interface Tool v5

Acknowledgements

John Lansing: For spending a few days with me at our Roswell facility and providing the information necessary to develop the Sick Maihak self-diagnostic logic.

Figure 5, Meter Polling Setup Screen from RTU

Modbus Parameters		Port Settings	
Name	**Value**	**Name**	**Value**
Enable	Enabled	Serial Com Address	1
Floating Point Type	32 Bit FP,2 Reg	IP Address	192.168.1.15
Bit Order	High Bit First	Poll Type	Sick Maihak Ultrasonic Mete
Byte Order	High Byte First	View Pol	Custom Poll Daniel Ultrasonic Meter Sick Maihak Ultrasonic Meter Instromet 3 Path Ultrasonic Mete Instromet 5 Path Ultrasonic Mete
Word Order	High Word First		
Start Register	7001		
Num of Registers	20	Function Execution Successful	
Poll Function	3		
Poll Delay Time	2.00		
IP Poll Enable	Enabled	Change Parameters	Submit Changes
Port	5		

Figure 6, Meter Polling Basic Diagnostic Screen

Sick Maihak Ultrasonic Meter Polled Data			
4 + 1 Poll	Enabled		
Average SOS	1413.235		
Average Velocity	27.595		
Uncorr Flow Rate MACFH	4620.541		
Cord 1 SOS	1413.825	Cord 1 Velocity	25.707
Cord 2 SOS	1412.597	Cord 2 Velocity	28.410
Cord 3 SOS	1412.614	Cord 3 Velocity	28.277
Cord 4 SOS	1413.902	Cord 4 Velocity	24.113
Symmetry	1.045	Profile Factor	1.11319
Base Line Symmetry Factor	1.00000	Base Line Profile Factor	1.11000
Profile / Symmetry Alarm Percent	5.000	Profile / Symmetry Alarm Percent	5.000
Symmetry Factor Alarm	Normal	Profile Factor Alarm	Normal
Cal Flowrate Select	Run 1	Bidir Sta / Sta 2 Mtr Select	Run 1
Calculated SOS	1411.58	Calculated Flowrate	4532
Meter SOS	1413.23	Meter Flowrate	4621
Cal / Live SOS Pct Error	-0.117	Cal / Live Flowrate Pct Error	-0.077
SOS Alarm Percent	0.500	Path Velocity Spread	4.297
SOS Error Alarm	Normal	Path SOS Spread	1.306
SOS Spread Alarm	Normal	Write Press, Temp & Gas Quality to Meter	Enabled
		Data Write Delay Time in Sec	0.000

Figure 7, Meter Advanced/Self Diagnostic Screen

UnLatched	Push to Reset	Single Path Com ID	2
Path Performance	Normal	Path Status	Normal
Path AGC Level	Normal	Path Turbulence	Normal
Profile Factor	Normal	4 Plus 1 ACF Comparison	Normal
Symmetry Factor	Normal	Frequency Input	Normal
Gas Quality Check	Normal	Temp Check	Normal
SOS Error	Normal	Static Pressure Check	Normal
Calculation Check	Normal	SOS Spread	Normal
Blocked Flow Cond	Normal	Mtr Contamination	Normal
Signal to Noise	Normal	Liquid	Normal

Advanced Diagnostics Setup

Press / Temp Mode	Primary	Reference			
Dual Press / Temp	Run 1	Run 2	Primary	Reference	Difference
Pressure			885.44	885.18	0.26
Temperature			73.53	73.49	0.04
RTU to Meter Corrected Flowrate			8000.253	8002.229	-0.00
4 Path to 1 Path SOS			1397.3	1395.6	1.79
4 Path to 1 Path Uncorrected Flowrate			5009.239	5030.212	-0.00
RTU to 4 Path Uncorrected Flowrate			5004.000	5009.239	0.00

4 to 1 Max Flowrate % Limit	0.100	Max AGC Limit	45.000
1 Path Adjust Factor	1.000	Min Performance Limit	80.000
Max Turbulence Limit	8.000	RTU to Mtr Max Flowrate % Limit	1.000

Figure 8, Data displayed in SCADA

Click Here	SOS Err	Prof. Factor	Symmetry	vg Speed Of Sour	Avg Velocity	SOS Err Alarm	Prof Fac Alarm	Symmetry Alarm	SOS Spread Alm.	UMAC-1A	UMAC-1B	UMAC-C
_RUN1	0.0729	1.57872	0.14823	1408.191	0.05652	NORMAL	NORMAL	NORMAL	NORMAL			
_RUN1	-0.23203	1.125	1.02	1396.969	29.95425	NORMAL	NORMAL	NORMAL	NORMAL	0	0	0
_A_RUN1	-0.09148	1.13949	0.98585	1416.589	20.59407	NORMAL	NORMAL	NORMAL	NORMAL	0	0	0
_RUN1	0.36696	-0.65843	-1.58437	1421.968	-0.02215	NORMAL	NORMAL	NORMAL	NORMAL	0	0	0
RUN1	-0.00281	-1.06938	1.	1409.093	0.00635	NORMAL	NORMAL	NORMAL	NORMAL	0	0	0
_RUN1	-0.376	1.00521	0.95897	1333.522	16.86827	NORMAL	NORMAL	NORMAL	NORMAL	0	0	0
_RUN2	0.25694	-0.12652	-2.71294	1411.901	-0.00115	NORMAL	NORMAL	NORMAL	NORMAL	0	0	0
_RUN1	0.13175	5.49984	-0.79131	1411.901	-0.00449	NORMAL	NORMAL	NORMAL	NORMAL	0	0	0
_B_RUN1	0.13955	0.61757	0.04301	1400.567	0.10856	NORMAL	NORMAL	NORMAL	NORMAL			
_A_RUN1	-0.00136	1.1549	0.79928	1380.188	1.67264	NORMAL	NORMAL	NORMAL	NORMAL	0	0	0
_RUN1	0.19603	-0.36245	-2.18254	1427.666	0.00128	NORMAL	NORMAL	NORMAL	NORMAL	0	0	0
_RUN1	-0.26439	1.05077	0.84318	1345.285	1.57727	NORMAL	NORMAL	NORMAL	NORMAL			
_RUN1	-0.0509	3.16973	5.52549	1376.161	0.00541	NORMAL	NORMAL	NORMAL	NORMAL	0	0	0
_RUN2	-0.0955	-0.43415	-1.63406	1423.356	0.00423	NORMAL	NORMAL	NORMAL	NORMAL	0	0	0
_RUN1	-0.46903	1.21509	-0.43698	1408.475	0.00667	NORMAL	NORMAL	NORMAL	NORMAL	0	0	0
_RUN1	5.12582	0.69821	-0.52976			NORMAL	NORMAL	NORMAL	NORMAL			
_RUN2	-0.3112	1.29247	1.	1424.885	0.01299	NORMAL	NORMAL	NORMAL	NORMAL			
_RUN1	-0.7676	1.12194	0.99021	1357.135	14.66242	ALARM	NORMAL	NORMAL	NORMAL	0	0	8
_RUN1	100.	1.	1.	0.	0.	NORMAL	NORMAL	NORMAL	NORMAL			
_B_RUN1	100.	1.	1.	0.	0.	NORMAL	NORMAL	NORMAL	NORMAL			
_A_RUN1	100.	1.	1.	0.	0.	NORMAL	NORMAL	NORMAL	NORMAL			