Pressure/Vacuum Cycling

General Description

The proposed system is a mobile platform for inducing a pressure and vacuum cycle on a set of plastic fuel tanks.

The size of the mobile enclosure is approximately 6 ft high, 6 ft in length and 3 ft wide. All piping is to be stainless steel and welded where possible noting many components are only available as threaded. Instrument and signal air connections will be nylon tubing.

The system will include acoustical insulation to maintain noise levels below 70 dB. A cooling fan and vent are included at the top of the unit to remove the heat generated by the vacuum pump.

Performance:

The machine is guaranteed to produce a continuous cycle within 5% of setpoint for the test specifications mentioned below.

Test Specifications

Positive Cyclic Testing
Cyclic Duration 1~10 seconds (Ref. TS NMQA input, TMC support
Pause between cycles 0~10 seconds
Cycle Count 999,999 cycles
Cycle Maximum Pressure 50 kPa
Waveform Control sawtooth to sine wave
Controlled Negative Pressure added to achieve quicker return to Atmospheric pressure

Negative Cyclic Testing
Cyclic Duration 1~10 seconds
Pause between cycles 0~10 seconds
Cycle Count 999,999 cycles
Cycle minim Pressure -50kPa
Waveform Control sawtooth to sine wave
Controlled Positive pressure added to achieve quicker return to Atmospheric pressure

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Positive/Negative Cyclic Testing
Cyclic Duration 1~10 seconds
Pause between cycles 0~10 seconds
Cycle Count 999,999 cycles
Cycle Maximum Pressure 50 kPa
Cycle minim Pressure -50kPa
Waveform Control sawtooth to sine wave
Negative Pressure added to achieve quicker return to Atmospheric pressure

Positive Static
Peak Pressure 70 kPa
Manual Control of peak pressure
Hold of Peak pressure

Negative Static
Minimum Pressure -50Kpa
Manual control of Minimum Pressure
Hold of Minimum Pressure

Process Description

The system utilizes a 15HP vacuum pump with its suction piped to a vacuum vessel and its discharge routed exterior to the cart and through a muffler. The second pressure vessel receives compressed air from the plant and a manual pressure regulator keeps the vessel at constant pressure. These vessels are carbon steel with an epoxy liner and are ASME coded. Each vessel has a site glass for detecting accumulated condensate.

The vacuum pump is speed controlled by either open loop or closed loop with feedback from the pressure/vacuum transmitter mounted to the vessel.

The pressure and vacuum imparted on the test subjects is controlled with an I/P transducer in conjunction with a volume booster. By plumbing the exhaust lines of these components to a controlled Piab vacuum source, their effective range is absolute rather than gauge. This allows for a bumpless transition at 0 psig. The I/P transducer is housed in the control cabinet with tubing connection to the volume booster.

The pressure/vacuum source is isolated from the test subjects by a ball valve automatically controlled with a spring return actuator. Another valve opens to atmosphere removing pressure or vacuum from the test tank. These actuators are interlocked with the emergency stop circuit. Should the e-stop be engaged or the controller is in certain alarm conditions, these valves will fail to a position which opens a path from the units under test to atmosphere.

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A leak test function is included where the test tank is pressurized to a set level and then fully isolated. The control then monitors the pressure decay for a period and if the tank integrity is deemed adequate, cyclic testing is allowed to continue.

Controls & DAQ

Electrical controls are housed in a Nema 12 cabinet with cooling fan. A small form factor PC connects directly to the National Instruments DAQ System. A keyboard and mouse tray are mounted to the front of the cabinet with a 22" monitor on an articulating vesa arm.

Master Start and Emergency Stop buttons are mounted to the panel face. This circuit disconnects power to the vacuum blower and isolation valve. All other functions are accessed through the PC.

The cabinet contains the I/P transducers and solenoid valves for ball valve control. The outputs are connected through bulkhead fittings on the panel.

The system is PC based the IO interface through a National Instruments CompactDAQ model cDAQ-9178 USB in an 8-slot chassis.

1. (16) Analog inputs 500 S/s, 24-bit resolution, 4-20mA for:
    - (2) For connection to pressure transmitters wired to bulkhead.
    - (2) for connection to storage tank pressure transmitters
    - (1) for pump speed feedback (Internal)
    - (11) Unwired Spares

2. (8) analog outputs, 0 to 20 mA, 16-Bit, 100 kS/s
    - (2) for connection to I/P
    - (1) for pump speed (Internal)
    - (5) Unwired Spares

3. (4) Thermocouple Inputs
    - (2) For connection to pressure transmitters wired to bulkhead.
    - (2) Unwired Spares

4. Digital I/O is as required with 25% spare

5. The chassis has (4) spare slots.

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The PC based software is written in Labview. The control and data acquisition system will perform pressure control in manual and profiled control schemes. It records the required parameters in a TDMS file that can be viewed with the proper Excel Plug-In. A USB Port is included on the enclosure exterior and used for transferring data to a flash drive.

Control System Features

A) Computer controls of all functions of the fuel tester. A single controller is used.
B) Controls a closed loop system to provide feedback from the unit under test provide manual tuning of the test parameters.
C) Computer collects test data and store it to a user selected location i.e. writeable disc or hard drive and has network and wireless capability.
D) Live test data can be reviewed and analyzed while the test is running.
E) Computer can generate test reports in usable format that can be view on the network using Microsoft office application I.e... Excel
F) Fuel tank tester can be synced with current Environmental chamber and water bath safety interlocks
G) Tester has a visual alert system i.e... Light stack and Alarm to indicate faults.
H) Tester provides remote network notification of test and machine faults. Using text messaging.
I) Tester includes a Smart Emergency power backup with network notification if system has a power failure.
J) Tester is capable of testing two Fuel tanks with different test parameters.
K) Tester has settable over limit and under limit alarms shutdown test if out of test specs.
L) Provisions are provided to accept external input and sync with live test.
M) Data collection rate will capture complete cycles for 1 to 10 sec. @ 10ms.

The following Screen shots are provided for reference. The proposed system will differ as required.

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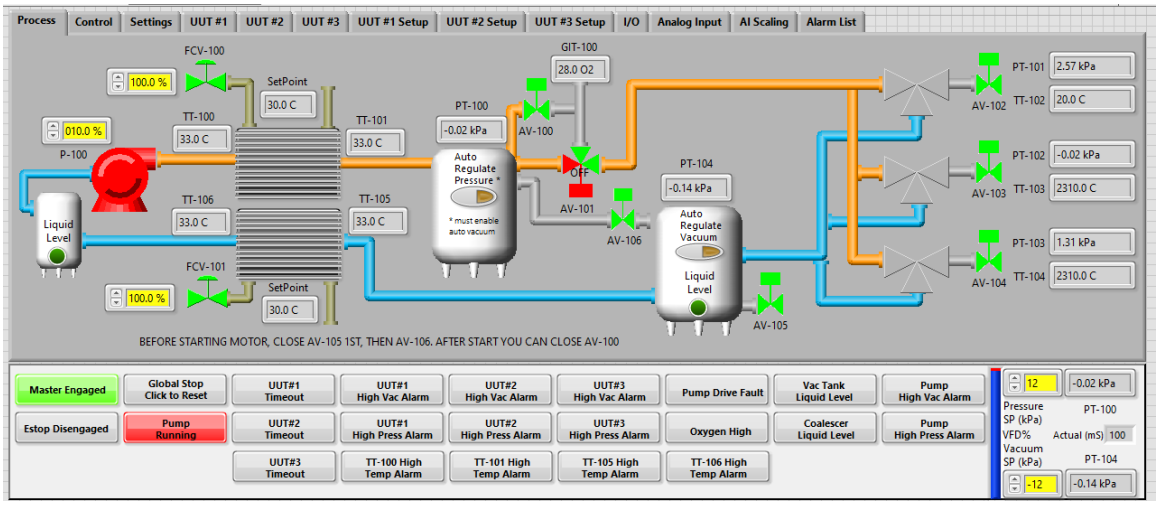

Figure 1
The process page graphically presents the system status.

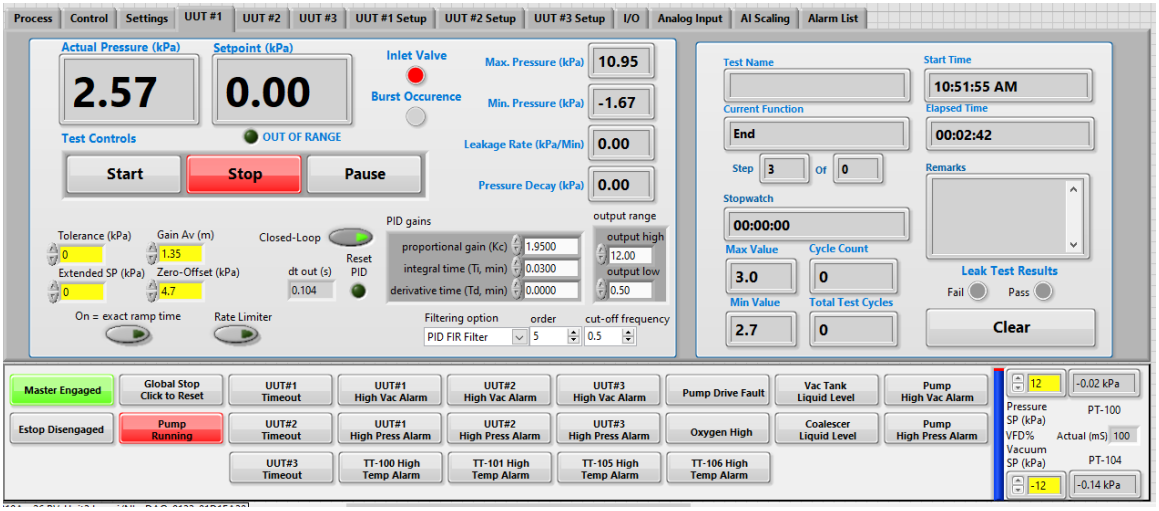

Figure 2
A status page is provided for each UUT, showing the state of the active test routine.

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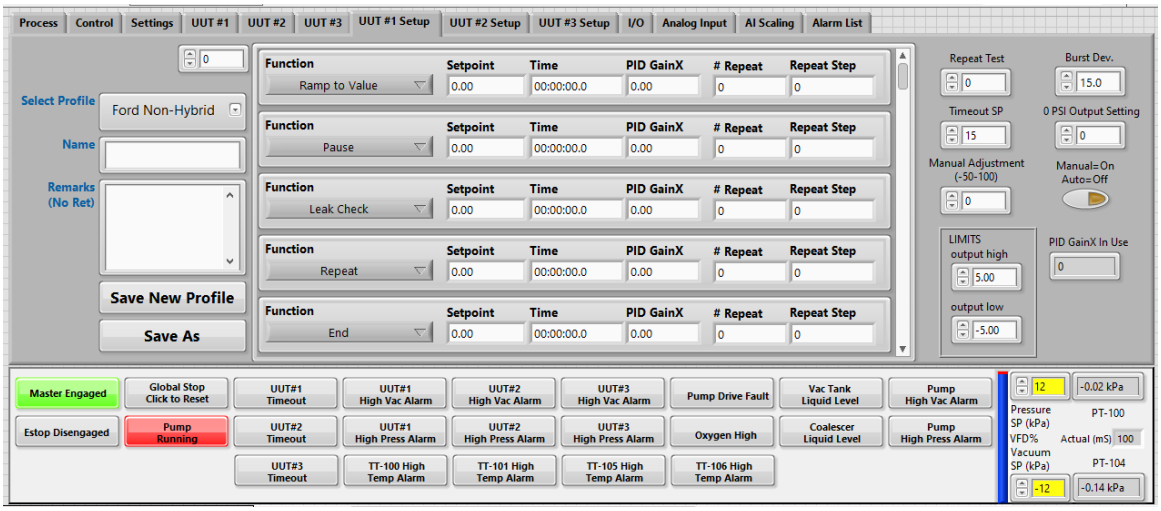

Figure 3
Each UUT has a setup page for its test routine. The user can select ramp to value, pause, leak test, repeat, and end. Each routine can be saved for later retrieval.

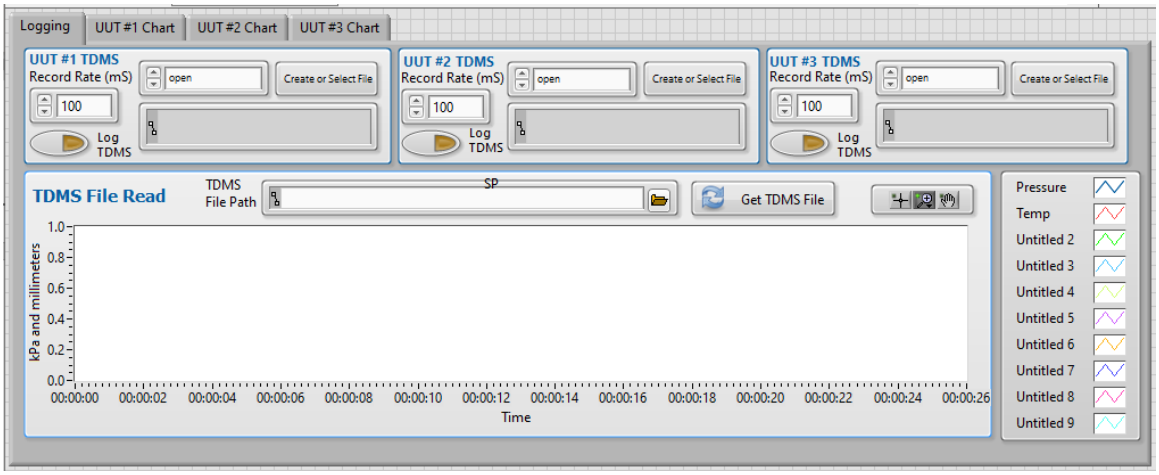

Figure 4
Each UUT has an inpependant TDMS High-Speed Log File. This file can be retrieved and viewed on a graph or further explored in an Excel File.

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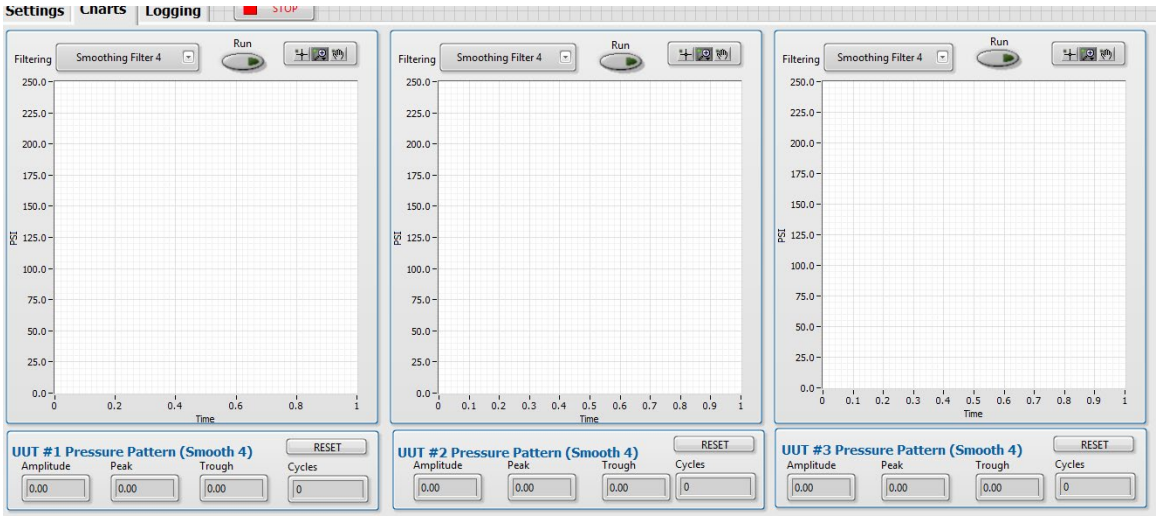

Figure 5
The pressure patterns on each UUT are displayed on a graph.

Appendix A

Item	Function	Remarks
1	Single control of all functions of the Fuel tester	Controller is a PC connected to National Instruments CompactDAQ. No other controller is present.
2	Have a closed loop system that will provide feedback from the unit under test and manually tuning of the test parameters.	System is closed loop from pressure/vacuum transducer mounted on the tank. All tuning parameters are accessed from the HMI
3	The tester will collect test data and store it to a user selected location i.e.. writeable disc or hard drive and has network and wireless capability.	The tester is PC based running Windows 10. All networking functions are available.
4	Tester must have a visual alert system i.e... Light stack and Alarm to indicate faults.	A light stack is installed on the machine and its function complies with Toyota facilities' standards
5	Smart Emergency power backup and network notification if system has a power failure.	A UPS is provided for power all devices except for the vacuum pump.
6	Able to set over the limit and under limit alarms stop test if test is out of spec.	Adjustable Pressure alarms are included
7	The ability to capture and record data at a minimum of 10ms for each test cycles	Adjustable data collection rates to 100 Hz are included.
8	Perform full System Validation after calibration/ repair and Pretest.	Programming and procedures for this function will be included.
9	Tester capable to test N=2 Fuel tanks with different test parameters.	Machine will perform pressure cycles on (2) 32 gallon empty tanks. Performance vs. HP to be discussed.
10	Generate test reports in usable format that can be viewed on the network using Microsoft office application I.e... Excel	Data is stored in a TDMS file which can be viewed using a free Excel plug-in.
11	Live test data can be reviewed to validate the Min and Max of each test cycle while the test is running.	Live test data can be viewed and analyzed without interrupting data collection.
12	Tester must able to create a sinewave to display a smooth transition of atmospheric, positive, and negative pressures during the test cycle.	The unit has programmable cycle type. The method we use provides a bumpless transfer between positive and negative pressure.
13	Fuel tank tester must be synced with current Environmental chamber and water bath safety interlocks.	Interlocks are provided.
14	Tester can connect to up to 16 external inputs and sync with live test	Provisions and space are provided for adding future inputs. The program will be written to accommodate these.

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