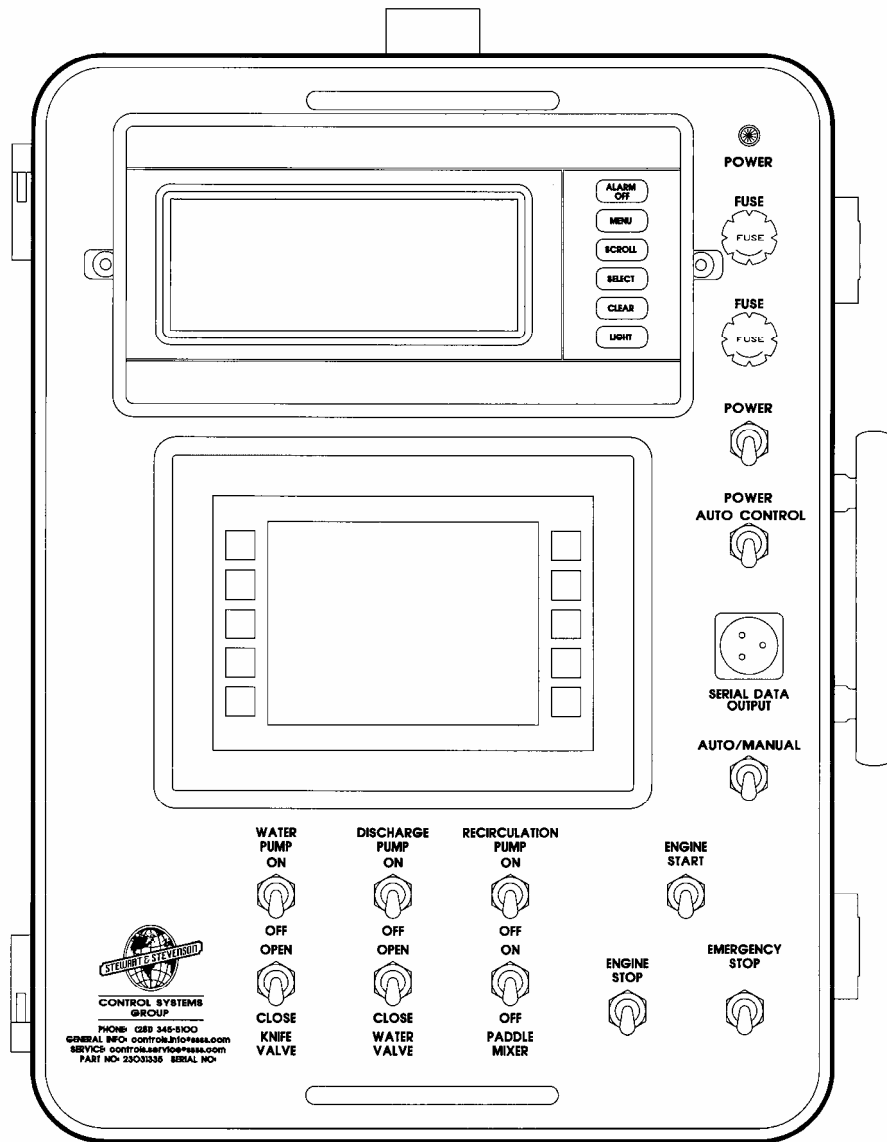


# **Automated Cement Blending System**

# Suitcase

Operation of the cementer is carried out from the control suitcase. The suitcase consists of a Detroit Diesel control panel, a touch screen, several switches, fuses and a serial data port.



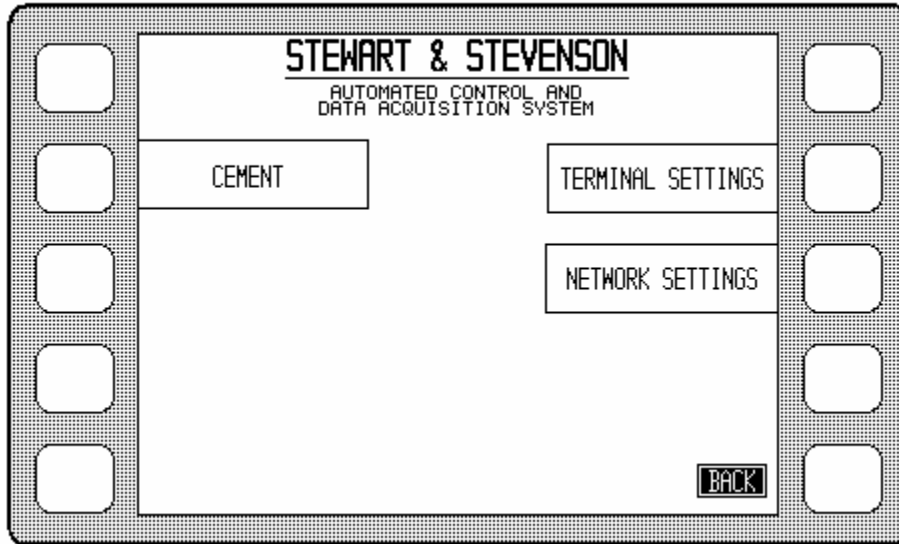
The Detroit Diesel panel can be used for monitoring the diesel engine, for further details please refer to the Detroit Diesel manual. To start and stop the engine there is a start and a stop switch in the lower right corner of the suitcase. If the normal stop switch for some reason doesn't work, there is also an emergency stop switch. The monitoring and control of the cementing will be carried out with the touch screen and the switches underneath.



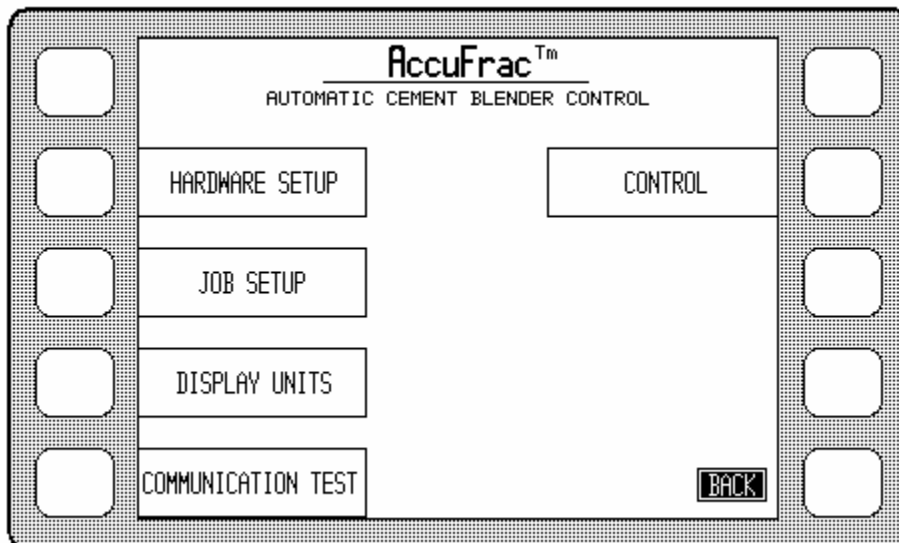
The data port on the suitcase is used for loading the programs to the touch-screen and to the network controller inside the suitcase. The data port can also be used for recording data while running the unit. The data transmitted on the port is a stream of data separated by commas. The best way to monitor and record this data is with the DAS4XX program from Stewart & Stevenson, which can be downloaded from <http://www.ssss.com/petroleum/download.asp>.

## Using the Q-term

When the suitcase is turned on the Q-term will start up on the initial page showing the Stewart & Stevenson logo. Touch anywhere on the initial page to change the screen to an initial menu selection with the choice to go to *CEMENT*, *TERMINAL SETTINGS* or *NETWORK SETTINGS*.



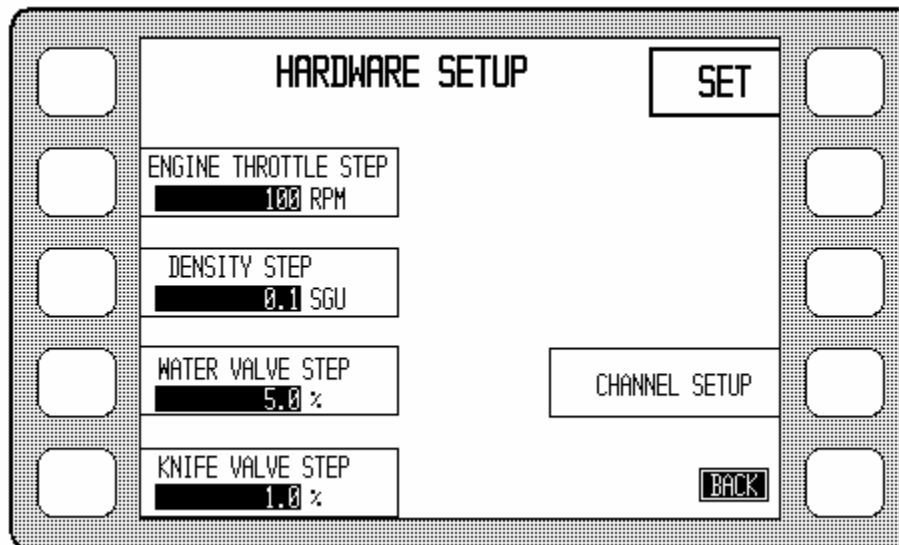
The *TERMINAL SETTINGS* gives basic tools for adjusting brightness and contrast of the display. The *NETWORK SETTINGS* can be used to verify software versions in the control system and to set the time of the controller. Select *CEMENT* on the initial menu to go to the main screen for the automated cementer.



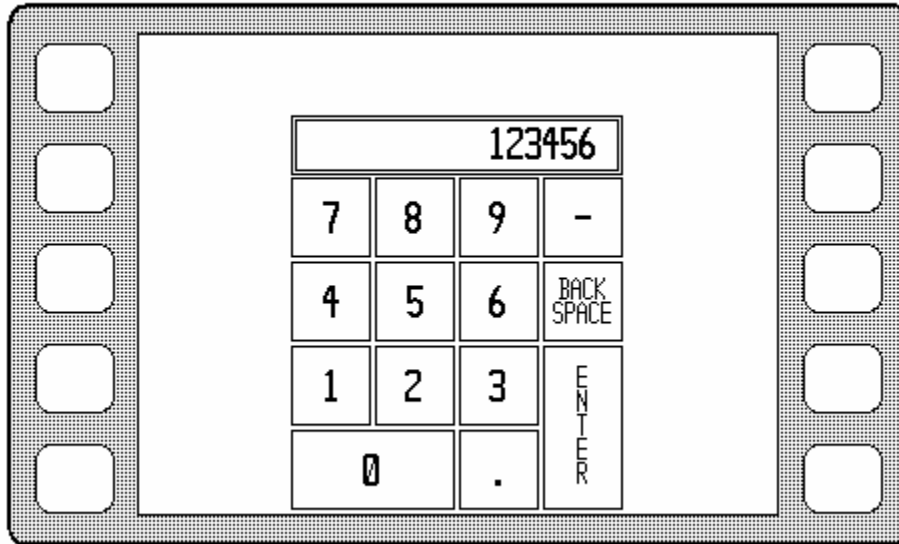
The cementer main page has a number of functions for setting up the system and a *CONTROL* function for operating the cementer. The *HARDWARE SETUP* is the most basic setup which configures all the I/O in the system, sets up the PIDs and determines step increments. The *JOB SETUP* allows for up to 10 preconfigured density set points that can be stepped through during a cementing job. The *DISPLAY UNITS* allows selecting which units to use for display purpose. And the *COMMUNICATION TEST* is a tool to verify that communications are working correctly.

### **Setup of cementer**

Before operating the cementer the I/O needs to be configured and calibrated. A one-time setup of display units and step increments of the throttle, water valve, knife valve and density set point is required. From the cementer main menu select *HARDWARE SETUP* to bring up the screen for setting the incremental steps. This screen also has a button for accessing the setup of I/O channels, *CHANNEL SETUP*.



When data is entered for changing any setting in the system a numeric keypad will pop-up:



When data has been entered press *ENTER* to return to the configuration screen where the *SET* button has to be pressed to accept any changes.

## Configuring an Analog Input using the Auto-Scale

In most cases, the coefficients for the channel can be configured using the *Auto-Scale Analog Input* screen. The *Auto-Scale Analog Input* screen displays the following data:

*Min-Scale Reading* - low-end units which display at the moment when the **Calibrate Min-Scale** button is pushed.

*Calibrate Min Scale* - adjusts the unit to read correctly at a low-end set point.

*Full-Scale Reading* - upper-end units which display at the moment when the **Calibrate Full-Scale** button is pushed.

*Calibrate Full-Scale* - adjusts the unit to read correctly at a high-end set point.

*Average Counts* - the number of readings used to acquire an average value.

*Low Limit* - not used on this screen.

*High Limit* - not used on this screen.

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**NOTE:** If the curve for an input channel is not linear, you must use the *Analog Inputs* screen to enter the data for channel. The Analog Inputs are configured like the analog outputs using a third order polynomial.

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The screenshot shows a control panel for configuring an analog input. At the top, it displays '1 CHANNEL' and 'AUTO-SCALE AI MIXING TANK LEVEL'. Below this, there are several input fields and buttons:

- MIN-SCALE READING**: A field with a blacked-out value and a **SET** button to its right.
- CALIBRATE MIN-SCALE**: A button with a small blacked-out area to its right.
- FULL-SCALE READING**: A field with a blacked-out value.
- CALIBRATE FULL-SCALE**: A button with a small blacked-out area to its right.
- AVERAGE COUNTS**: A field with a blacked-out value.
- LOW LIMIT**: A field with a blacked-out value.
- HIGH LIMIT**: A field with a blacked-out value.
- BACK**: A button located below the CALIBRATE FULL-SCALE button.

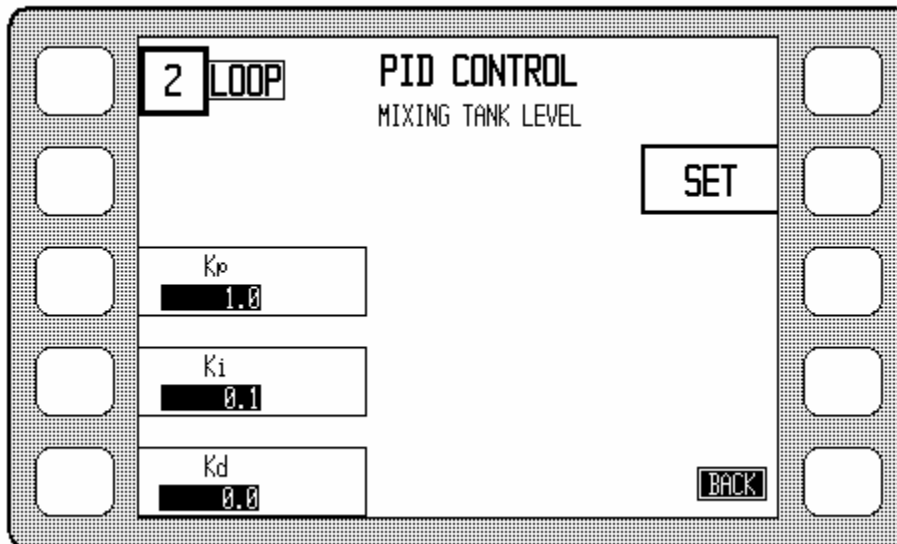
## Configuring the PID Controller Screen

The **PID Controller** screen allows you to set the parameters for the PID Error Control. The PID Error Control adjusts the output of the control system to correct any error between the desired value and the value acquired. The goals of tuning a PID controller include stability, quick reaction, and reduction of steady state error. The controller parameters are described below. The  $K_i$  and  $K_d$  gains are per-scan gains. The scan time of the controller is 200 ms.

$K_p$  - (gain for the proportional term) - the controller outputs (target value) + [ $K_p$  \* (error term)].

$K_i$  - (gain for the integral term) - the controller outputs (target value) + [ $K_i$  \* (integral of the error term)].

$K_d$  - (gain for the derivative term) - the controller outputs (target value) + [ $K_d$  \* (derivative of the error term)]. The derivative equates to the rate of change of the error term.



## Configuring the Frequency Input Screen

The following data can be configured on the *Frequency Input* screen:

*Average Counts* - controls how many readings are used to acquire an average value.

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**NOTE:** Increasing *Average Counts* will reduce the effect of noise on the value. A large *Average Counts* will result in a slowed system response.

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*K-Factor* - Converts a frequency to an engineering unit. The frequency input is divided with the K-factor which will be entered in units of pulses/engineering unit.

*Current Value* - the current external value of the channel used to calculate the K-factor using the auto-scale feature.

The image shows a graphical user interface for configuring a frequency input. The screen is titled "1 CHANNEL FREQUENCY INPUT" and "SUCTION RATE". It features four input fields: "AVERAGE COUNTS", "K-FACTOR" (with "pulses/" as a unit), "CURRENT VALUE", and "AUTO-SCALE". A "SET" button is located to the right of the first two fields, and a "BACK" button is at the bottom right. The screen is framed by a grid of small squares, with larger empty square buttons on the left and right sides.

## Configuring an analog output

The configuration of the analog outputs is based on third order polynomials. The output is determined by the engineering value E and the coefficients C0-C3.

$$Out = C0 + C1 * E + C2 * E^2 + C3 * E^3$$

*Coefficient 0-3* – C0-C3.

*Low Limit* – Minimum engineering value.

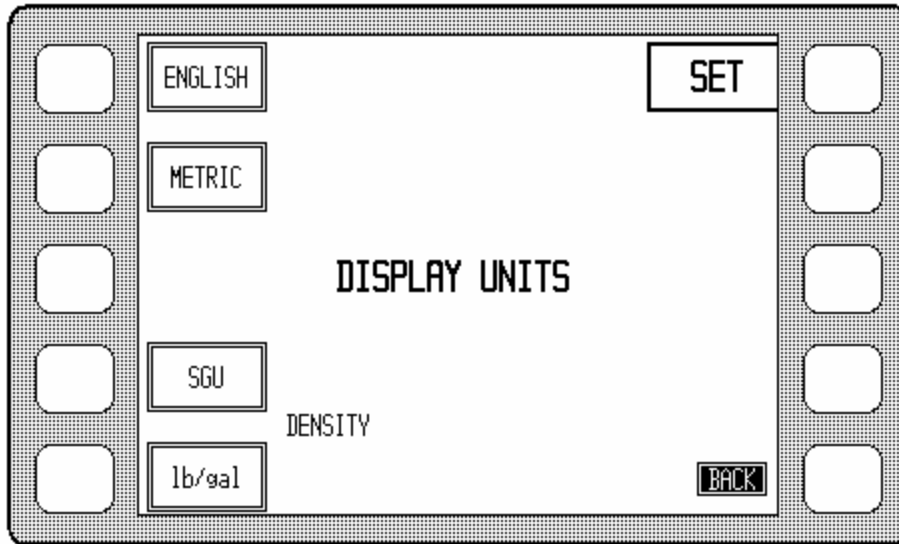
*High Limit* – Maximum engineering value.

1 CHANNEL ANALOG OUTPUT  
KNIFE GATE VALVE

COEFFICIENT 0	SET
COEFFICIENT 1	AVERAGE COUNTS
COEFFICIENT 2	LOW LIMIT
COEFFICIENT 3	HIGH LIMIT
BACK	

## Display units

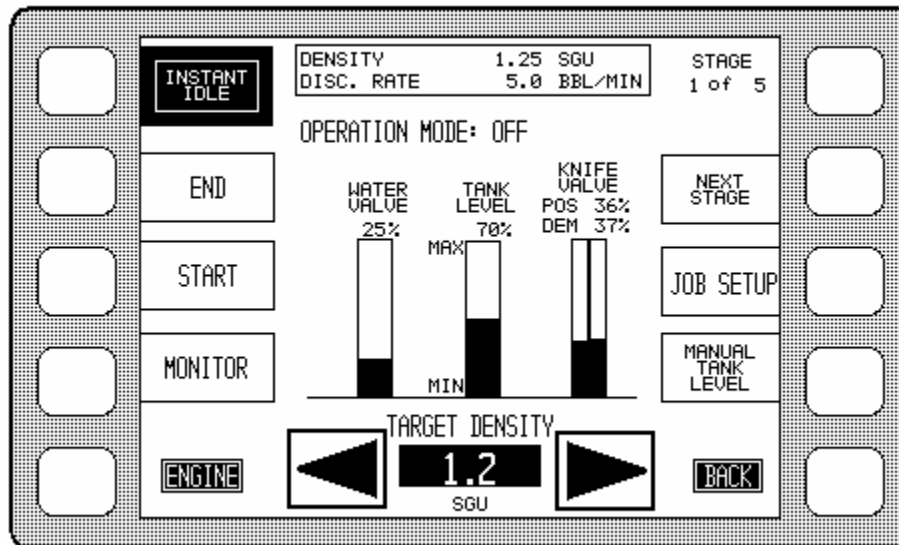
There is an option to choose the units for display. From the main cementer screen select *DISPLAY UNITS* and the following screen will be shown.



There is an option to select between *ENGLISH* and *METRIC* units, and for the flow units there is a selection between *SGU* and *lb/gal*, with metric units only *SGU* can be selected. The selected units will be highlighted. When the right units are selected press *SET* to confirm otherwise the selection will be lost and the display will revert to previous units.

## Operation of the cementer

The cementer is primarily operated from the control screen. This screen shows basic information like valve positions, density, and discharge rate, and will provide the operator options to control the job. The screen has access to other screens (MONITOR, ENGINE and JOB SETUP) for further monitoring and control.



## Operation of pumps

The cementer is fitted with three pumps: a discharge pump, a recirculation pump and a water pump. Each of these pumps can be controlled completely individually by their switches on the suitcase. Though the recirculation pump is controlled by the switch it also has some logic associated with it, so when the operator turns the recirculation pump off a closing signal to the butterfly valve will be sent. There will be a short delay to allow the butterfly valve to close before the recirculation is turned off. The two other pumps will have an immediate response.

### Off – mode

To get the cement controller in off mode press **END** at any time. The off mode immediately closes the water valve and the knife valve; it will not be possible to operate these valves while in off mode. The pumps and the paddle will be operational in off mode as long as the engine is running. The running of the Diesel Engine is completely independent from the operation mode.

### Manual – mode

To get into to manual operation mode put the *AUTO/MANUAL* switch in manual. If the cementer was already in automatic mode it will switch immediately to manual mode. Otherwise, if the cementer is in off mode, press **START** to enable the manual mode.

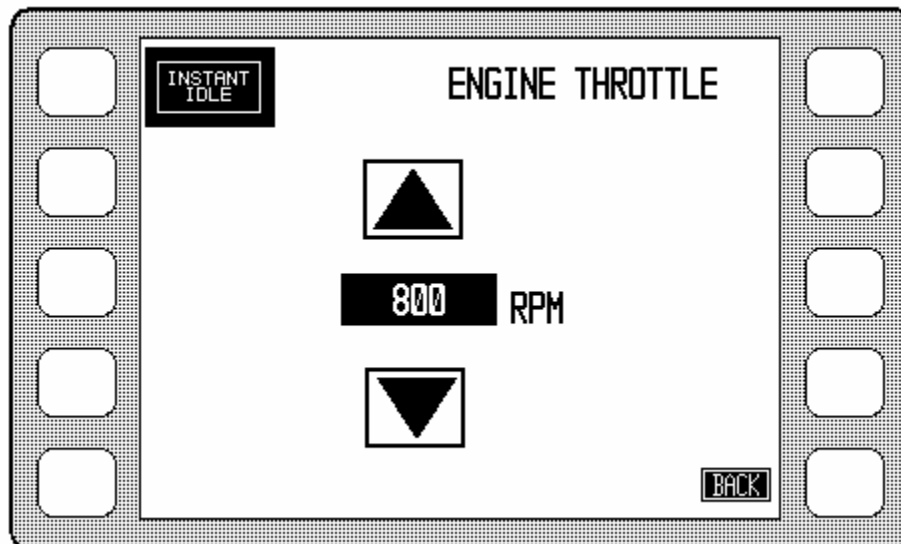
When the cementer is in manual mode the operator will have control of the knife gate and the water valve using the open and close switches on the suitcase. The operator has the option of putting the water valve in automatic mode, controlling the tank level at 70%. To change between automatic and manual water valve (tank) mode press **AUTO/MANUAL TANK LEVEL**. The text on the button indicates the current mode.

### **Automatic – mode**

Automatic mode can only be reached from manual mode. If START is pressed with the *AUTO/MANUAL* switch in the auto position, a message screen will be displayed reminding the operator to start in manual mode. When the unit is operating in manual mode, changing the *AUTO/MANUAL* switch to auto will immediately put the cementer in automatic operation mode. In this mode the control system will run the controls of both the knife valve and the water valve, trying to maintain the density at the target and keep the tub level at 70%.

### **Engine throttle**

From the main control the ENGINE throttle screen can be accessed to adjust the RPM of the diesel engine. The RPM's can be increased or decreased in steps as specified in the hardware setup.



## Data monitor

For more detailed information than what can be found on the control screen, the MONITOR screen can be selected from the CONTROL screen. In addition to the information displayed on the CONTROL screen the MONITOR screen will show run time information of discharge and water totals, and give an option to reset these totals. Also the water rate is displayed.

