



SHIMADZU LC-10/20 PUMP

Clarity Control Module

ENG

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Contents

1 Shimadzu LC-10/20 Pump	1
2 Requirements	2
3 Installation Procedure	3
3.1 Shimadzu LC-10/20 Pump communication	3
3.2 Clarity Configuration	5
4 Using the control module	7
4.1 Method Setup - LC Gradient	7
4.1.1 Gradient Options	10
4.2 Method Setup - Advanced	11
4.3 Device Monitor	12
4.3.1 LC Control Manual Flow	14
4.4 Shimadzu LC-10/20 Pump Setup	15
5 Report Setup	17

To facilitate the orientation in the **Shimadzu LC-10/20 Pump** manual and **Clarity** chromatography station, different fonts are used throughout the manual. Meanings of these fonts are:

Instrument (blue text) marks the name of the window to which the text refers.

Open File (italics) describes the commands and names of fields in **Clarity**, parameters that can be entered into them or a window or dialog name (when you already are in the topic describing the window).

WORK1 (capitals) indicates the name of the file and/or directory.

ACTIVE (capital italics) marks the state of the station or its part.

The bold text is sometimes also used for important parts of the text and the name of the **Clarity** station. Moreover, some sections are written in format other than normal text. These sections are formatted as follows:

Note: Notifies the reader of relevant information.

Caution: Warns the user of possibly dangerous or very important information.

Marks the problem statement or trouble question.

Description: Presents more detailed information on the problem, describes its causes, etc.

Solution: Marks the response to the question, presents a procedure how to remove it.

1 Shimadzu LC-10/20 Pump

This manual describes the setting of the **Shimadzu LC-10/20 Pump**, which may be used to create high-pressure or low-pressure gradient. The control module enables direct control of the **LC-10ADvp**, **LC-10ATvp** and **LC-20A** (whole series, **LC-10** emulation mode) over serial line.

Caution: The **Shimadzu LC-10/20 Pump** control module can not be combined with **Shimadzu LC-10/20 System** control module on a single PC where Microsoft .NET Framework is installed.

The **Shimadzu LC-10/20 Pump** control module can control only a single pump on a single PC, which means that it is not possible to control more than one (of above mentioned) pump on a single PC through this control module.



Fig 1: Shimadzu LC-10ADvp Pump

Direct control means that the pump can be completely controlled from the **Clarity** environment. Instrument method controlling the analysis conditions will be saved in the measured chromatograms.

2 Requirements

- **Clarity** Installation CD ROM with LC Control module (p/n A24).
- Free USB port in the PC.
- Opt-USB convertor (p/n OPT01).

Note: The **DataApex Opt-USB** converter conforms to the similar **Shimadzu** converter (Shimadzu p/n 22-35480-91).

- Pump firmware version 2.2 or greater.

Caution: Minimal required firmware version for **LC-10ADvp** is **5.26** and for **LC-10ATvp** is **5.27**.

3 Installation Procedure

3.1 Shimadzu LC-10/20 Pump communication

The **Shimadzu LC- 10/20 Pump** is controlled by serial (RS232) communication. The communication is provided via the Optical to USB convertor connected to the computer via USB A-A cable (p/n SK10) and to the pump via optical cable (p/n SK15). Both of these cables are part of the **DataApex Opt-USB** converter set (p/n OPT01), but can also be ordered separately.

Optical to USB converter

For communication an OPT-RS232 converter is needed. It can either be the **DataApex Opt-USB** converter (p/n OPT01) or **Shimadzu** adaptor (Shimadzu p/n 22-35480-91).

Pump Settings

Communication parameters should be set on the pump in the *SERVICE MODE* (see pump documentation) as follows:

Baud rate 2400, parity N, bits 8, stop bit 1.

SYS (Set System Parameter) has to be set to 5 for isocratic mode or to 6 for gradient mode from the pump keyboard.

Caution: These values are not documented in the pump manual.

The other Pump system parameters should be set to:

Local=0 (Remote)

ADRS= any value (not used)

CBM LINK=0 (not used)

Shimadzu LC-20 settings

Shimadzu LC-20 pumps have to be set to the **LC-10** emulation mode in order to be able to work in **Clarity**. This is done from the pump's keyboard according to this procedure:

- Press the **VP** button on the pump's front keyboard until the *CALIBRATION* inscription is shown on the pump's display.
- Press the **func** button to enter the pump's configuration. The password has to be filled in.

Note: The default password is 00000.

- Press the **func** button repeatedly until the *OP MODE* inscription is shown on the pump's display.
- Enter the desired number (1) to switch the pump to the **SCL-10Avp** emulation mode and press the **enter** button.
- Switch the pump off and on again. The new communication parameters should be saved and used.

The procedure is in detail described in the **LC-20** hardware manual provided by the **Shimadzu** company.

3.2 Clarity Configuration

- In the **System Configuration** dialog press the **Add** button (① on Fig 5) to invoke the **Available Control Modules** dialog.

Fig 2: Available Control Modules

- Select the **Shimadzu LC-10/20 Pump** in the **LC** section and press the **Add** (② on Fig 5) button.
- The **Shimadzu LC-10/20 Pump Setup** dialog will appear.

Fig 3: Shimadzu LC-10/20 Pump Setup

- Select the correct communication *Port* and fill the other necessary parameters in this dialog.

Note: Other fields and parameters of the **Shimadzu LC-10/20 Pump Setup** dialog are described later in the manual (for more details see the chapter **Shimadzu LC-10/20 Pump Setup** on pg 15)..

- The **Shimadzu LC-10/20 Pump** item ③ with the number of solvents set in the **Shimadzu LC-10/20 Pump Setup** dialog will appear in the **Setup Control Modules** list of the **System Configuration** dialog.
- Drag the LC chromatograph icon ④ from the **Setup Control Modules** list on the left side to the desired **Instrument** tab ④ on the right side ⑤, or use the → button ⑥ to do so.

Note: The **Shimadzu LC-10/20 Pump** can be used for the low-pressure gradient with the use of switching valves as the pump can handle up to 4 solvents.

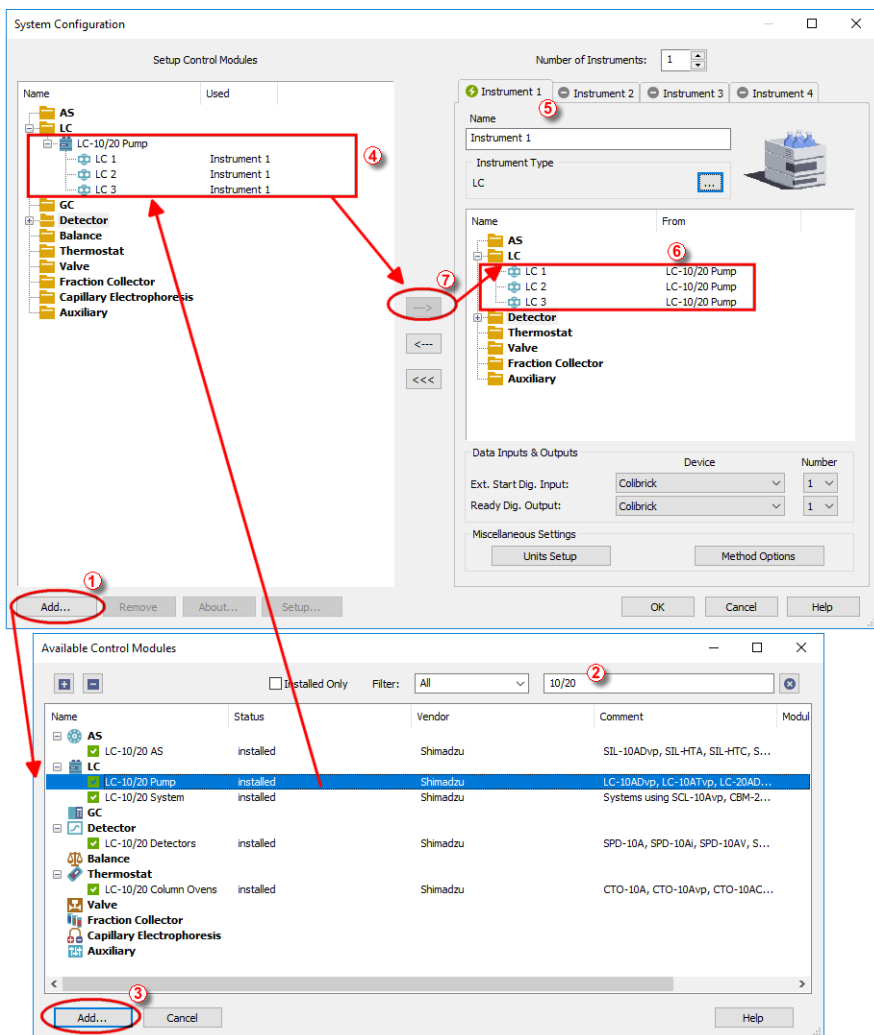


Fig 4: System Configuration

4 Using the control module

New **LC Gradient** tab appears in the **Method Setup** dialog, enabling the setting of the LC gradient program.

4.1 Method Setup - LC Gradient

The **Method Setup - LC Gradient** dialog serves for setting up the LC instrument method.

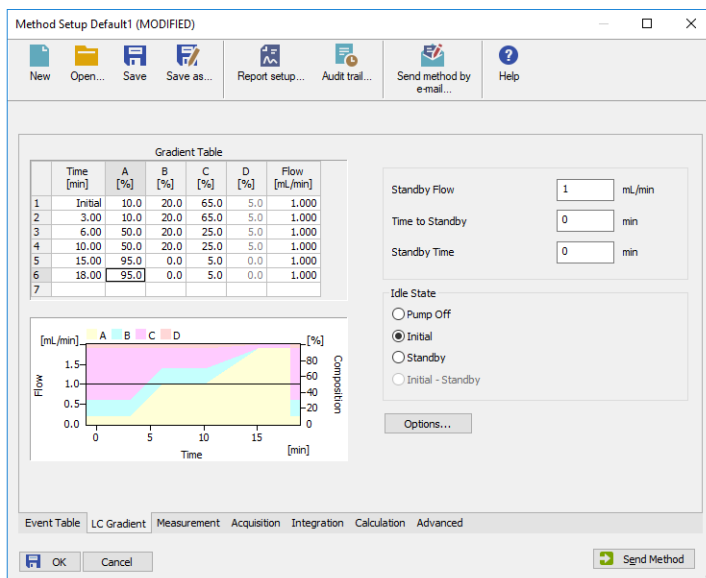


Fig 5: Method Setup - LC Gradient

Gradient Table

A table for setting the composition of the mobile phase and the overall flow rate as a function of time. Operation is analogous to that of spreadsheets (Excel, Quatro Pro, etc.). To prepare the cell to receive values, click it by the left mouse button; the cell will highlight by dots. A cell that fails to highlight is not available for editing.

Time [min.]

Sets the time at which the ratio of flow rates and the overall flow rate correspond to the values entered in the corresponding row. (These values vary continuously from one time to the next in a manner ensuring that the conditions specified in the next row are satisfied).

XXX1 (..4) [%]

Represents the percentage of a component. The designation **XXX1-4** is in fact replaced by the name of the component (items *Solvent 1 - 4*

in the **Gradient Options** dialog). Should you enter a component value such that the sum of all values exceeds 100 %, the percentage in the last column is automatically adjusted; if the percentage of the last compound is already zero, the value of the currently entered component is adjusted instead. The flow rate of a compound is calculated by multiplying the overall flow rate (indicated in the *Flow* column) by the corresponding percentage divided by 100.

Flow [ml/min]

Indicates the overall flow rate through the column. The entered value applies to the time specified in the corresponding row.

Graph

The graph depicts the percentage of components as a function of time together with the overall flow rate. Data are taken over from the **Gradient Table**. Changes effected in this table are immediately reflected in the graph. Legend in the header of the graph indicates the assignment of colors to individual components. The assignment is fixed and individual components are displayed in the graph from bottom to top. The flow rate is displayed as a black line.

The graph has two vertical axes: the axis on the left refers to the mixing ratio, the one on the right to the overall flow rate.

Parameters

Standby Flow

Sets the overall flow rate through the column in the *STANDBY* state reached after the last row of the table has been performed and the time period defined in the *Time to Standby* field has passed. The duration of this state is defined by the *Standby Time* item. The ratio of individual components in the respective *STANDBY* and *IDLE* states is given by the first row of the **Gradient Table** (the *Initial* row).

Time to Standby [min]

Indicates the time during which the flow rate and mobile phase composition changes continuously between the last values entered in the table and the values defined by *Standby Flow* field and the *Initial* row mobile phase composition.

This time is included in the analysis time (the Instrument is in the *CONTROL* state). In case when the *Time to Standby* is zero, there is step change from flow and components percentage specified on the last row of gradient table to that specified for *STANDBY* state.

Standby Time [min]

The time during which the flow rate is maintained at *Standby Flow*. This time is included in the analysis time (the Instrument is in the *CONTROL* state).

Initial - Standby

The **Shimadzu LC-10/20 Pump** control module doesn't support this option.

Idle State

An item specifying the overall flow rate through the column outside the instrument method. The following options are possible:

Pump Off

The flow rates of all components are zero.

Caution: Be careful as this setting may damage the column in some cases.

Initial

The flow rate is defined by the first row of the gradient table (the *Initial* row).

Standby

The flow rate is the same as in the *STANDBY* mode and, accordingly, corresponds to the value entered in *Standby Flow* field.

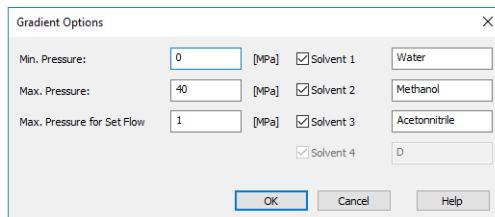
The *IDLE* state comes into effect each time an Instrument is opened, at the end or after abortion of an analysis by the *Abort* command, and is also maintained after the **Clarity** program is shut down.

The mixing ratio of individual components in both the *IDLE* and *STANDBY* states is given by the first row of the **Gradient Table** (the *Initial* row).

Note: There is a step change in the flow and components percentage from the values specified for the *STANDBY* state to those specified for the *IDLE* state if the *Idle State* field is not set to *Standby*.

4.1.1 Gradient Options

Invoke the *Options...* button in the [Method Setup - LC Gradient](#) dialog to open the [Gradient Options](#) dialog. This dialog allows to set the custom name for particular solvents, to switch whether they are used or not in the gradient and to set the warning levels for pressure to prevent the damage to hardware.



Parameter	Value	Unit	Solvent	Checked	Name
Min. Pressure	0	[MPa]	Solvent 1	<input checked="" type="checkbox"/>	Water
Max. Pressure	40	[MPa]	Solvent 2	<input checked="" type="checkbox"/>	Methanol
Max. Pressure for Set Flow	1	[MPa]	Solvent 3	<input checked="" type="checkbox"/>	Acetonitrile
			Solvent 4	<input checked="" type="checkbox"/>	D

Fig 6: Gradient Options

Min. Pressure

Sets the minimum pressure for the given pump. When pressure drops to the set value, the pump will shut down. This prevents the solvent leakage.

Max. Pressure

Sets the maximum pressure for the given pump. When pressure reaches the set value, the pump will shut down. This serves to prevent the damage to the pump when the column is blocked.

Max. Pressure for Set Flow

Sets the maximum pressure to be used in the [Set Flow](#) dialog in the [Device Monitor](#). Initial value is 1 MPa.

Solvent 1 (..4)

It is possible to enable/disable particular solvent, as well as to set custom name to it.

4.2 Method Setup - Advanced

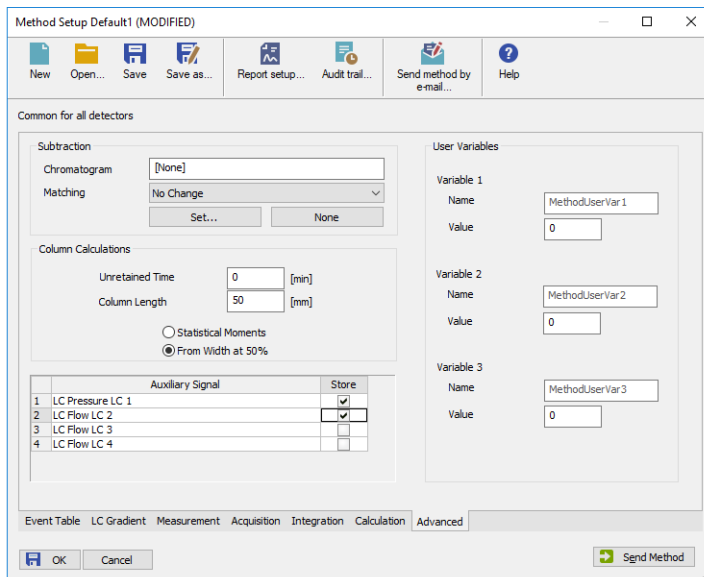



Fig 7: Method Setup - Advanced

Shimadzu LC-10/20 Pump provides the pump flow and pressure auxiliary signals for use in **Clarity**. To save the auxiliary signals into each chromatogram measured according to the given method, check the particular checkbox in the lower section of the **Method Setup - Advanced** dialog.

4.3 Device Monitor

The pump status dialog can be invoked by the *Monitor - Device Monitor* command from the **Instrument** window or using the Device Monitor  icon. It displays the actual flows of particular solvents, as well as the total flow, the total pressure and the analysis time. In the individual section of the **Shimadzu LC-10/20 Pump** the status of the pump may be seen.

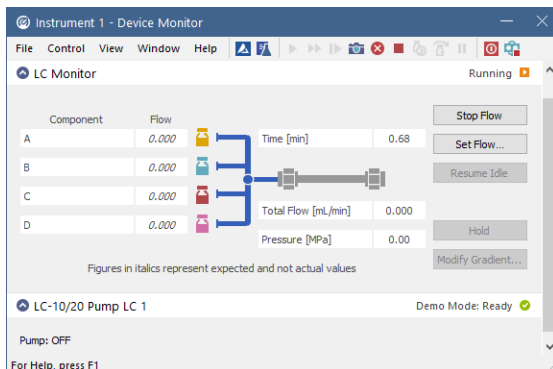


Fig 8: LC Monitor

Stop Flow

The pumps can be stopped from this window using the *Stop Flow* button. This action will stop the pump only, the analysis run will continue and must be stopped or aborted separately by the *Stop/Abort* button in the toolbar.

Set Flow...

Sets the desired total flow and solvent ratios in the opened **Set Flow** dialog. *Max. Pressure* allows to set a different pressure than set in the "Gradient Options" on page 10 of a given method.

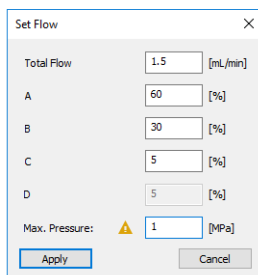


Fig 9: Set Flow

Resume Idle

Returns the pumps to *IDLE* state as defined in the appropriate field on the [LC Gradient](#) tab of the [Method Setup](#) dialog.

Hold/Resume

Clicking on the *Hold* button will keep the current gradient conditions until *Resume* is clicked.

Modify Gradient...

Opens the [LC Control Manual Flow](#) dialog allowing to set custom flow and mobile phase composition, disregarding the **Gradient Table** set in the method. The command is only available during the analysis run.

4.3.1 LC Control Manual Flow

The **LC Control Manual Flow** dialog accessible through using the *Modify Gradient ...* button from **Device Monitor** window allows the user to set a custom mobile phase composition and flow while the analysis is running. It resembles the **Method Setup - LC Gradient** tab in functionality.

The dialog box is titled "LC Control Manual Flow" and contains the following elements:

Gradient Table						
Time [min]	A [%]	B [%]	C [%]	D [%]	Flow [mL/min]	
1	Initial	10,0	10,0	20,0	60,0	1,000
2	1,00	10,0	10,0	20,0	60,0	1,000
3	3,00	50,0	20,0	30,0	0,0	1,000
4	4,00	50,0	20,0	30,0	0,0	1,000
5						

Below the table is a graph showing Flow [mL/min] on the left y-axis (0,0 to 1,5) and Composition [%] on the right y-axis (0 to 80) against Time [min] on the x-axis (0 to 4). The graph displays four components: A (yellow), B (pink), C (light blue), and D (orange). Component A is constant at 10%. Component B increases from 10% at 1 min to 50% at 3 min. Component C decreases from 10% at 1 min to 20% at 3 min. Component D decreases from 60% at 1 min to 0% at 3 min. The flow rate is 1,000 mL/min until 3 min, then drops to 0,0 mL/min.

Control settings on the right:

- Standby Flow: 1 mL/min
- Time to Standby: 0 min
- Standby Time: 0 min
- Idle State:
 - Pump Off
 - Initial
 - Standby
 - Initial - Standby

Buttons: OK, Cancel

Fig 10: LC Control Manual Flow dialog

The **LC Control Manual Flow** dialog is only available during the analysis run. When it is invoked and the **OK** button is pressed, the original **Gradient Table** from the acquisition method is discarded and replaced by the **Gradient Table** from the **LC Control Manual Flow** dialog. Any such operation is recorded in the audit trail of the measured chromatogram.

Caution: After the analysis run which used manual flow changes ends, the original method is automatically sent to all controlled devices to make sure **Clarity** station returns to the original method.

4.4 Shimadzu LC-10/20 Pump Setup

Shimadzu LC-10/20 Pump Setup dialog (accessible through the [System Configuration](#) dialog) is used to set the connection to the pump, select its type and set some other basic parameters.

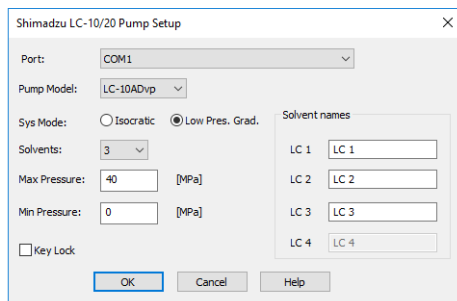


Fig 11: Shimadzu LC-10/20 Pump Setup

Port

Sets the COM port to which the **Shimadzu LC-10/20 Pump** pump is connected.

Pump Model

Allows to select from several types of Shimadzu pumps. **LC-10ADvp** and **LC-10ATvp** models are supported at the moment.

Note: If any **LC-20** type pump should be connected, it is necessary to set the **LC-10 emulation mode** on the pump (for more details see the chapter **Installation Procedure** on pg 3)..

Sys Mode

Sets the pump operation mode. *Isocratic* and *Low Pres. Grad.* options are available.

Note: The pump hardware must be set accordingly (for more details see the chapter **Installation Procedure** on pg 3)..

Solvents

Sets the number of solvents when the *Low Pres. Grad.* mode is used.

Max Pressure

Sets the maximum pressure allowance of the pump. This value is sent to the pump and when the pressure exceeds this value, pump will react on it. The pressure check is also present in **Clarity**, in the [Method Setup - LC Gradient - Gradient Options](#) dialog. Value of *Max Pressure* set there should be lower than in the [Shimadzu LC-10/20 Pump Setup](#) dialog, as **Clarity** reacts on exceeding of that value and should react before the pump does so.

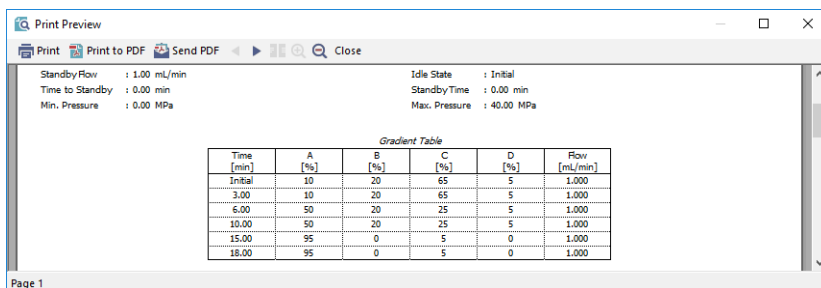
Min Pressure

Sets the minimum pressure allowance of the pump. This value is sent to the pump and when the pressure falls below this value, pump will react on it. The pressure check is also present in **Clarity**, in the [Method Setup - LC Gradient - Gradient Options](#) dialog. Value of *Min Pressure* set there should be higher than in the [Shimadzu LC-10/20 Pump Setup](#) dialog, as **Clarity** reacts on falling below that value and should react before the pump does so.

Key Lock

Serves for making the **Shimadzu LC-10/20 Pump** keyboard inactive.

5 Report Setup



The screenshot shows a 'Print Preview' window for a Shimadzu LC-10/20 Pump report. The window title is 'Print Preview' and it includes standard window controls (minimize, maximize, close) and a toolbar with 'Print', 'Print to PDF', and 'Send PDF' options. The report content is displayed in a light gray background. On the left, there are system parameters: StandbyFlow (1.00 mL/min), Time to Standby (0.00 min), and Min. Pressure (0.00 MPa). On the right, there are Idle State parameters: Idle State (Initial), StandbyTime (0.00 min), and Max. Pressure (40.00 MPa). In the center, a 'Gradient Table' is presented as a table with columns for Time (min), A (%), B (%), C (%), D (%), and Flow (mL/min). The table contains seven rows of data, starting with an 'Initial' row and ending with a row at 18.00 minutes. The flow rate is constant at 1.000 mL/min throughout the run.

Time [min]	A [%]	B [%]	C [%]	D [%]	Flow [mL/min]
Initial	10	20	65	5	1.000
3.00	10	20	65	5	1.000
6.00	50	20	25	5	1.000
10.00	50	20	25	5	1.000
15.00	95	0	5	0	1.000
18.00	95	0	5	0	1.000

Page 1

Fig 12: Shimadzu LC-10/20 Pump report preview

All general LC settings (such as the **Gradient Table** from the [Method Setup - LC Gradient](#) tab) are reported as a part of the data displayed by the use of *Instrument Control* checkbox of the [Report Setup - Method](#) dialog.