Dresser-Rand DATUM-CALC Centrifugal Calculation Program

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The information is provided for instructional purposes relating to familiarization, illustration and general information in calculating the operational performance of Centrifugal Compressors.

It is not the intent of Dresser-Rand that this program and/or material be used as a supplement to, or in lieu of, any marketing proposal, new equipment contract of sale, official publication, operating or maintenance manuals.

This program is designed to assist in the selection of Dresser-Rand DATUM compressors. However, it does not include engineering of the selection, which involves, critical speeds, bearing spans, compressor loadings, allowable compressor configurations, materials of construction, bearings requirements, torque, etc.

Should any questions arise during the selection program, consult your nearest Dresser-Rand Regional office. See http://www.dresser-rand.com/contact/.

In no event shall the user of this program be entitled to incidental or consequential damages.

Contents herein are subject to change without notice.

IF THERE ARE OPERATING PROBLEMS CONTACT:

DPatro@dresser-rand.com
DATUM-CALC Version LC, F1.0, B1.1

DATUM Centrifugal Compressor Performance Calculation Guide

DATUM-CALC Version LC, F1.0, B1.1 makes the assumption that the user is familiar with Centrifugal Compressors and the associated operating conditions required to make a compressor selection.

The program will define single or multiple section performance and will enable the user to estimate a DATUM selection including frame size, number of stages, horsepower requirement and speed. This program will calculate both section and overall data.

The type of prime mover or “driver” that is used for centrifugal compressors will be determined in most cases by the economics of the application. There are four different classes of drivers, which are considered as most suited for centrifugal compressors:

- Gas Turbines
- Steam Turbines
- Electric Motors
- Expansion Turbines

Primarily the user determines driver selection. Operating speed plays a significant role in driver selection and it is usually preferred that the compressor be directly connected to the driver without undue sacrifice in efficiency or compressor frame size. Fixed speed or low speed drivers may require a speed-increasing gearbox to best fulfill the process requirements. Note, if a gear is elected, the user should add 2% of the compressor train horsepower to the total train horsepower.

DATUM Selection

DATUM Calc Version LC, F1.0, B1.1 is an overall centrifugal compressor calculation program that is designed to assist in the calculation of the DATUM centrifugal compressor performance and to select a DATUM compressor for the application. However, it does not include engineering of the selection, which involves, reviewing critical speeds, bearing spans, compressor loadings, allowable compressor configurations, materials of construction, bearings requirements, torque, etc.

Final selections can only be made by contacting your local D-R Sales Representative.

For any given application, the following data is required for DATUM-CALC to calculate compressor performance:

- Gas Composition in Mol Percent (Mol. Wt. Or Specific Gravity)
- Inlet Pressure (Psia or Bara)
- Inlet Temperature (°F or °C)
- Discharge Pressure (Psia or Bara)
- Inlet Flow (MMSCFD, NM3/HR, LB./MIN, KG/HR)

The items usually to be determined in centrifugal compressor calculations are:

- Discharge Temperature
- Operating Speed
- Shaft Horsepower
- Frame size
- Number of Stages

Determination the speed and power is predicated upon the calculation of the "head" required for the compression.
For those applications where the discharge temperatures exceeds 380 F (193 Deg C), cooling will be utilized, and the user should input a coolant temperature or accept the default of 90 °F (32.2 Deg C).

Selection of the compressor is normally based on the inlet flow in actual cubic feet per minute (ACFM) and the maximum working pressure in pounds per square inch (PSI) DATUM-CALC Version LC, F1.0, B1.1 will calculate the flow in ACFM.

**Using DATUM-CALC Version LC, F1.0, B1.1**

Each screen has the following buttons:

- **Previous:** Backs up to the previous screen.
- **Next:** Proceeds to the next screen.

**Gas Information**

Enter the gas analysis for your process. The first information screen asks the user to enter either Mol. Wt., or Specific Gravity. The program will then make an estimated gas analysis selecting a mixture of either Hydrogen, Methane, Ethane or Propane to create a gas mixture.

If the analysis is known press the **NEXT** button, the program will go to the gas analysis input screen.

The user may accept the analysis or they may enter in their own data.  
The data is to be entered in Mol %.  
The Total must equal 100%.  
Four (4) separate gas compositions may be entered in columns 1-4 which can then be selected.  
The gas identification number is at the top of the column. This number must be entered in the data input section of the program.

**NOTE:** The program will not proceed unless each analysis entered totals to 100%.

**Caution:**  
_It is up to the user to insure the gas mixture is in the vapor region for the operating conditions. The program does not detect liquids or two-phase mixtures. Erroneous selections will result if the mixture is not a gas._

The output is the

- Mol. Wt.
- MHC Molar Cp
- Critical Pressure Psia
- Critical temperature Deg F
- Estimated K value (Isentropic Exponent).
- Estimated SG (Specific Gravity)
- Gas Type Sour or Sweet. This is determined from the % H2S
Data Entry

Enter the:

- **Units of Measure**
  Select the measurement system English or Metric

- **Suction Pressure**: Enter the suction pressure (either Psia or Bara).

- **Suction Temperature**: Enter the suction temperature (either F or C).

- **Discharge Pressure**: Enter the discharge pressure (either Psia or Bara).

- **Gas Number**: Select the gas composition to be used by entering the identifying number, either 1, 2, 3 or 4. The gas identification number is at the top of the column in the gas analysis screen.

Enter the flow in either:

- MMSCFD
- NM3/HR
- LB/MIN
- KG/HR

**NOTE**: Click in the unit cell and make your selection from the drop-down arrow.

Enter the Coolant Temperature
This will be the water or air temperature used to cool the process gas if required. (Deg F or C). It assumes a 15 Deg F (-9.44 Deg C) approach temperature.

Enter the Expected Knockout
This may only be entered in Lb./Min and will be subtracted from the inlet of each subsequent section.

Select, either the English or Metric Units of Measure button.

Press the **Next (Performance Result)** Button to evaluate the conditions and create the output.

**Results**
Once the calculation is complete, the Performance Report will appear.

This program will select up to six sections of compression. It will select a DATUM Frame or frames, which will meet the requirements. If flow or pressure is too great, it will provide warnings to the user along with some guidance.

**Supported Browsers and Mobile Operating Systems**

- Internet Explorer (IE 10 or higher)
- Google Chrome
- Mozilla Firefox
- Safari
- iOS
- Android
- Windows Device
Example

Below is an example of an application that you can use to test out DATUM-CALC Version LC, F1.0, B1.1:

General Information:
The process is Feed gas
One (1) 100% compression train is required.

A DATUM compressor will be selected per the following operating conditions:

<table>
<thead>
<tr>
<th>Gas Handled</th>
<th>Natural Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mol Percent</td>
<td></td>
</tr>
<tr>
<td>Methane</td>
<td>92</td>
</tr>
<tr>
<td>Ethane</td>
<td>6</td>
</tr>
<tr>
<td>Propane</td>
<td>2</td>
</tr>
<tr>
<td>Suction Pressure</td>
<td>50 PSIA</td>
</tr>
<tr>
<td>Suction Temperature</td>
<td>100 Deg F</td>
</tr>
<tr>
<td>Discharge Pressure</td>
<td>200 PSIA</td>
</tr>
<tr>
<td>Flow</td>
<td>110 MMSCFD</td>
</tr>
</tbody>
</table>

Instructions:

Here you have a choice of how you want to enter the Gas Analysis. Since the gas analysis is known, select the **Detailed Gas Analysis** radio button and then the **Next (Detailed Gas Mixes)** button to continue.
Enter the gas analysis:

Click the **Analyze Gas Properties** button to calculate the Mol. Wt. Your total must add up to 100% to obtain accurate gas properties. The Mol. Wt. should be 17.44. The estimated properties of the gas mixture will appear.
The output is the
Mol. Wt.
 MHC Molar Cp
Critical Pressure Psi.
Critical temperature Deg F
Estimated K value (Isentropic Exponent).
Estimated SG (Specific Gravity)
Gas Type Sour or Sweet. This is determined from the % H2S

Press the CLOSE WINDOW Button

Press the STEP3 - ENTER CONDITIONS button

NOTE: A section may be defined as one or more stages of compression where the gas is not introduced with flow, pressure or temperature differences. For example, Side Streams, Pressure drops or intercooling. Number of sections for duty is the total number of sections required to make the total compression ratio.

Enter:
Suction Pressure = 50,
Suction Temperature = 100,
Discharge Pressure = 200,

The Gas number is defaulted to 1.

Note: This is the number from the top of the Gas Analysis Page for the proper column of gas constituents.

In the units column, click on the cell where it says LB/MIN. Click on the down arrow and change the units of flow from LB/MIN to MMSCFD. Then enter the Section Flow = 110.

Leave the radio button under the Advanced Conditions set at None. The Driver Speed and Driver Power options will be discussed later.

The input screen should look like the figure below:
Press the **Next (Performance Result)** button to run the calculations. You can now review the data output document.
NOTE: For those applications where the required head exceeds that which can be developed by a single case, with the maximum number of impellers available, two or more cases in series would be utilized. For those applications where the required head can be developed within a single case, but where the discharge temperature for an uncooled compression is greater than 380 Deg F cooling will be utilized.

Advanced Options

Driver Speed
This option allows the user to input a driver speed and the program will create a selection based on that speed. This may not result in an optimum selection.

Driver Power:
This option allows the user to input a power and the program will compute the flow based on the head and power requirements. This may not result in an optimum selection. The program should also be run in the speed selection mode using the calculated flow.

Additional Features

Expand list of available gasses to choose from. The default list of gasses includes Methane, Ethane, Propane, Hydrogen and Nitrogen. If you click on the icon when it says ‘More’, the list expands to include about 20 gasses. With the list expanded the icon changes to say ‘Less’. Clicking the icon in this mode reduces the list back to the default list of 5 gasses. This feature only appears on the Gas Mixes window.

Information

Display extended description of header topic. The default display of these windows is the screen function title. This option is available in the following windows: Gas Information, Gas Mixes, Operating Condition and Performance Data.

By selecting the Information icon, the heading will expand to display a brief description of how to use the current page.

Clicking the same icon will hide the help documentation.
Shortcut

Provide instructions to set up a shortcut from the current page to your desktop or device for a variety of formats.

The following platforms are support and displayed by clicking the option from the drop down menu:

Home

Returns the application to the DATUM-CALC Home Page.
Full Screen

Expand current window in a new browser tab to full screen mode. Only available in Performance Data and Gas analysis data windows.

Print

Formats DATUM-CALC details in a report and opens a Print module. Report includes Gas Mixes, Gas Constituents, Operating Conditions and Section Properties.

Email

Prepare and send Email in selected format to designated addressee(s). Note: If more than one addressee is desired, separate each with a Semicolon. (ex: JohnDoe@domain.com; MaxwellSmart@domain.com; MickeyMouse@domain.com).

- Enter Email address
- Select HTML or PDF format
- Click on the Send button to forward report.

PDF

Create a PDF format of the DATUM-CALC report. With a single button click, the report will be created as a PDF file.

Note: PDF option is not available for iDevices. These devices do not allow PDF downloads from web.
Mobile Devices

DATUM-CALC can be customized to fit on your smart devices (Phone / Tablet).

From your mobile device, the screens contain the same content as the web-based app.

Touching the Menu bar will expand the menu and display the same options:

- Home
- Gas Information
- Gas Mixes
- Operating condition
- Performance Data
- Gas Analysis Data

Select one of the active (blue) command lines to continue or touch the Next (Gas Info) bar at the bottom of the screen.

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Revision Record

Rev.01, 9/27/2016, P.Farris

Page 4 - Supported Browsers: Internet Explorer (IE 10 or higher) was IE 11 or higher