



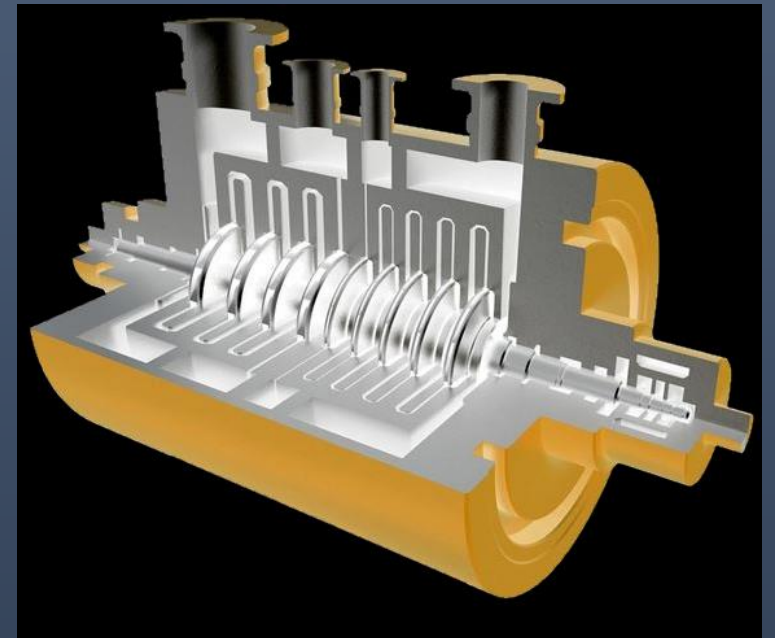
A Performance Map Simulation and Data Trending Software for Process Centrifugal Compressors Designed to API617 (Oil & Gas / Refinery & Petrochemicals)

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Rotating Equipment

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Summary

- Introduction
- Modeling Process & Software Description
- Benchmarking & Demo (Case Study)

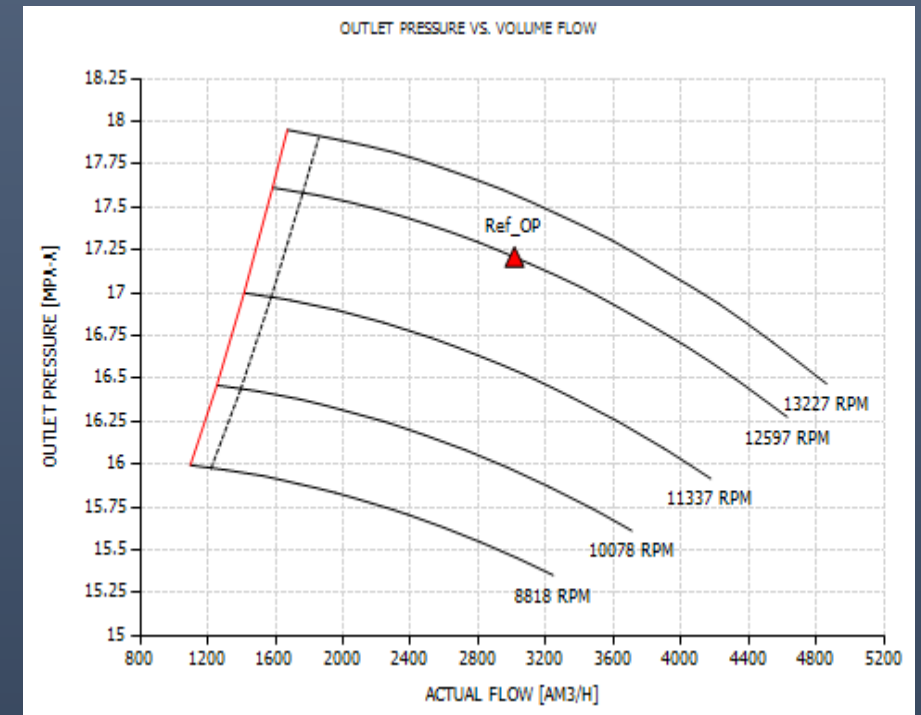
Introduction



Illustration of Existing Compressor

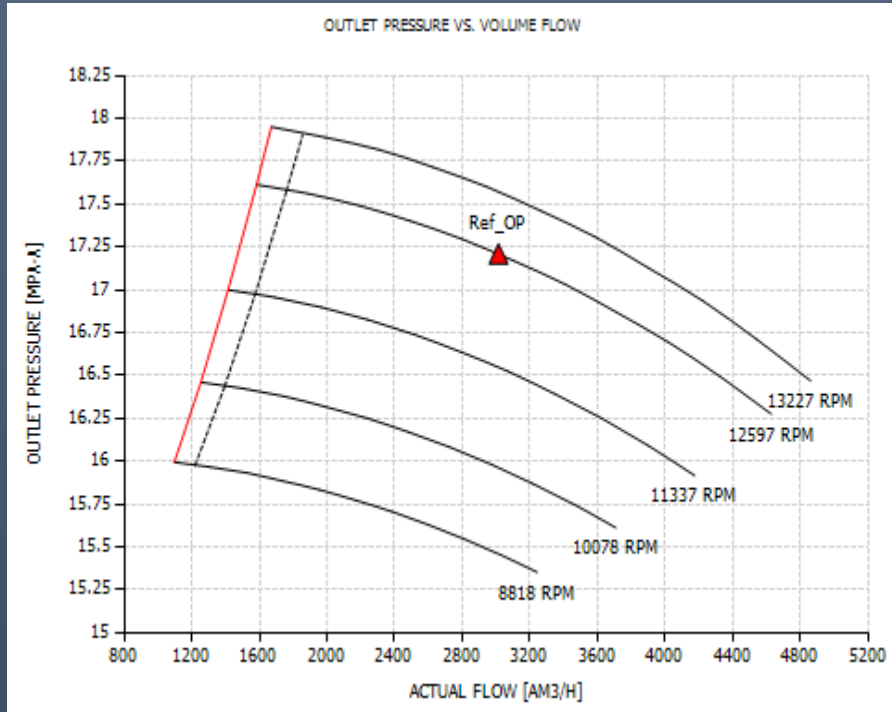
Photo: Siemens Energy

Reference Compressor Map (provided by Vendor as part of Databook)



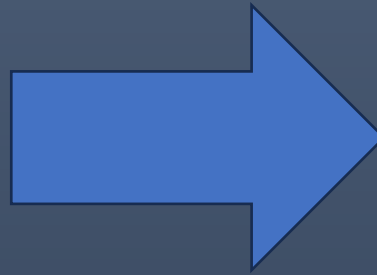
Introduction

Centrifugal compressor map is dependent upon inlet conditions



Compressor operating
@ REFERENCE conditions

Changes in field
conditions, gas
composition etc.



Compressor operating
@ NEW conditions

Introduction

- Tandem Train / Multi-Casing & Back-to-Back Compressors
- Changed Field Conditions and Gas Composition
- Higher Pressures (Compressibility ↗ ↗)



Ctrend simulates performance output @ new conditions based on reference map information

Modeling Process & Software Description

STEP 1

Obtain existing
compressor process data
and impellers information
(datasheet)

Obtain existing
compressor map
(convert in tabular format)

Define design condition
and speed

STEP 2

Enter data into CTrend and
generate automatically a
so-called thermodynamic
signature of the existing
compressor section

STEP 3

Simulate
off-design and new
conditions
performance

Modeling Process & Software Description

The screenshot shows the CTrend software interface with several red annotations pointing to specific features:

- PROCESS SECTION SELECTOR**: Points to the 'Process Section' tree on the left, showing 'PS1' selected.
- OPERATING CASES**: Points to the 'Process Case' tree on the left, showing 'Design', 'N2', and 'Ref_OP' (selected).
- SPEED CURVES**: Points to the 'Speed Curves [100%=12597 RPM]' tree on the left, showing 'Curve No.1 (80%)', 'Curve No.2 (90%)', 'Curve No.3 (105%)', and 'Curve No.4 (70%)' (selected).
- TRAIN CONFIGURATION**: Points to the 'Train' section on the left, showing 'DRIVER', 'COUPLING', and 'PS1' (selected).
- COMPRESSOR SECTION INTERNALS**: Points to the 'Stage - PS1' section, showing 'D2 mm' and a list of stages (1-11) with 'Speed' selected for the search criterion.
- PROCESS DATA MASK**: Points to the 'Alternative Case: Ref_OP' section, showing a table of molar fractions for various gases.

The 'Alternative Case: Ref_OP' section displays the following data:

Molar Fraction (Mol. %)	
Methane	1.25
Nitrogen	0
Carbon Dioxide	0
Ethane	0.38
Propane	0.61
n-Butane	0.12
Isobutane	0.3
n-Pentane	0.011
Isopentane	0.059
n-Hexane	0.14
n-Heptane	0
n-Octane	0
n-Nonane	0
n-Decane	0
Hydrogen	97.06
Oxygen	0
Carbon Monoxide	0
Water	0.07
Hydrogen Sulfide	0.002
Helium	0
Argon	0
Sum %	--
Normalize	<input type="checkbox"/>

The 'Alternative Case: Ref_OP' section also displays the following data:

Alternative Case: Ref_OP	
Search Criterion	Speed
Inlet Pressure	14.53 MPa-a
Inlet Temperature	317.15 K
Massflow	45556 kg/h
Outlet Pressure	17.21 MPa-a
Shaft Speed	BY PROG. RPM
Mol. Weight	2.969 g/mol

Filename: AdvancerHC_PA.prj

Modeling Process & Software Description

Ctrend

Project Programs Help

Process Section

PS1

Process Case

- ☒ Design
- ☐ Ref_OP
- ☐ CASE1
- ☐ CASE2A
- ☐ CASE2B
- ☐ CASE3
- ☐ ALT_LOW_MW

Speed Curves

Stage - PS1

D2 mm

1 450

2 450

3 450

4 450

5 --

6 --

7 --

8 --

9 --

10 --

11 --

Train

DRIVER

COUPLING

PS1

Generate Thermodynamic Signature

OEM Tabulated Map Parameters Selection Mode

Variables (HPol., Etap) vs. Vol. Flow

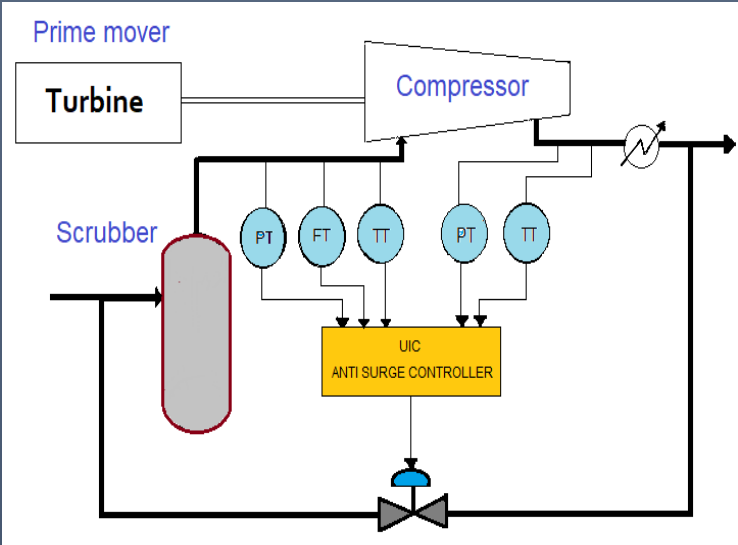
Design Speed (RPM) 11222

RPM	Inlet Flow Am3/h	Polytropic Head kJ/kg	Polytropic Efficiency %	Condition Basis
11222	7128.6	145.348	72.619	Design
11222	7197.24	145.069	72.777	Design
11222	7401.08	144.459	73.279	Design
11222	7600.77	143.857	73.753	Design
11222	7798.38	143.249	74.26	Design
11222	8000.14	142.217	74.553	Design
11222	8199.83	140.939	74.831	Design
11222	8399.51	139.414	75.062	Design
11222	8601.28	137.639	75.215	Design
11222	8803.04	135.587	75.33	Design
11222	8998.57	132.293	74.927	Design
11222	9200.34	127.563	74.153	Design
11222	9402.1	118.652	71.709	Design
11222	9499.86	113.528	70.15	Design
11222.01	5573.85	140	71.951	CASE1
11222.01	5798.12	138.493	72.494	CASE1
11222.01	5999.29	136.991	72.989	CASE1
11222.01	6200.47	134.97	73.1	CASE1
11222.01	6398.35	132.158	73.12	CASE1
11222.01	6596.23	129.55	73.079	CASE1
11222.01	6800.71	126.31	72.982	CASE1
11222.01	6998.59	121.901	72.133	CASE1
11222.01	7196.47	116.714	71.078	CASE1
11222.01	7397.64	109.409	69.061	CASE1
11222.01	7493.29	105.415	67.908	CASE1
11222.3	7511.86	145.765	72.707	CASE2A

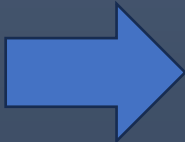
Filename: CS5-K3-4_PA.prj

OEM
REFERENCE
MAP DATA

Modeling Process & Software Description



Monitoring
& Trending



MODBUS
CONFIGURATION

MODBUS & Sampling Settings

Protocol

TCP/IP

Format

WORD16+

Server Unit ID

1

First Register

300001

Timeout (Second)

TCP/IP

Server IP Address

127.0.0.001

Server Port

502

RTU/ASCII

Parity

NONE

Port (COM)

1

Baud Rate

9600

Stop Bits

1

Scanning Settings

Screen Buffer Size (No. Sample)

100

Scan Delay (T1) (>= 1 sec)

5

Second

Signal Averaging

No. Sample

1

Scan Interval (mSecond)

100

Filter (ModRSim2 Simulator)

Interval (mSecond)

100

Constant

1E-7

Apply

Cancel

ModRSim2 Filter

Scan Only

Scan+Predict

Scan Status

Stopped

Analog Inputs

Plot Setup

Log Data

Units

Pressure

MPa-a

Temperature

K

Flow

kg/h

ID	Tag	Description	Address	Data Low	Data High	EU Low	EU High	PS
1		FLOW	300001	0	65535			1
2		SUCTION PRESSURE	300002	0	65535			1
3		SUCTION TEMPERATURE	300003	0	65535			1
4		DISCHARGE PRESSURE	300004	0	65535			1
5		DISCHARGE TEMPERATURE	300005	0	65535			1
6		SHAFT SPEED	300006	0	65535			1

PS	Mixture	Map Basis	Speed Ratio%	Threshold PR.Ratio%	Threshold Efficiency%	Threshold Power%
1	Design	Design	100	0.5	0.5	0.5

Benchmarking & Demo (Case Study)

Benchmarking

- NIST Data (US Institute of Standards and Technology)
- GASCALC Software

CTrend Case Study

Fixed speed machine application

Utilities Demonstration

- NACE risk analysis tool
- QHmap tool
- GERG head calculation tool