MAN Turbo

Engineering the Future –
Since 1758.

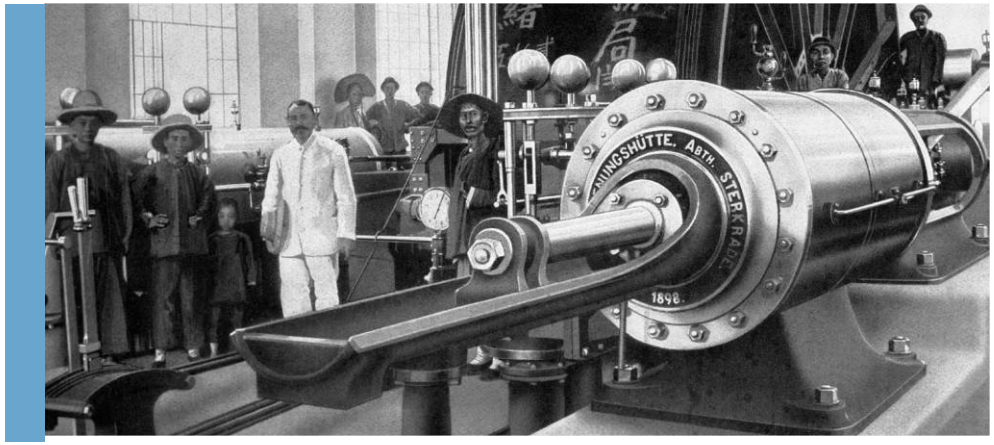
The MAN Group
250 Years MAN

250 years of experience, knowledge, competence

250 years of innovation, technology and progress

250 years of reliability, profitability and economic success

250 years



Milestones

1758	Founding of the St. Antony iron works
1782	Establishment „Gute Hoffnungshütte“ (GHH) steel in Sterkrade
1805	Establishment of the Sulzer-Escher Wyss mechanical engineering works of Zurich
1814	Start of GHH steam engine production
1857	First BORSIG compressors
1877	Establishment of Blohm+Voss Shipbuildung
1903	First Sulzer turbocompressor
1904	First GHH steam turbine
1906	Start of Blohm & Voss steam turbine production
1915	First process-gas turbine and first isotherm compressor
1934	First Sulzer axial compressor (air blower)
1950	First GHH axial compressor
1952	Production of GHH screw compressors
1977	First BORSIG Multi-shaft compressor
1991	Development of the MOPICO sealed turbocompressor product line
1994	Delivery of the first FT8 industrial gas turbine made by GHH
1996	Establishment of GHH BORSIG Turbomaschinen GmbH (integration of the turbocompressor activities of Deutsche Babcock AG)
2001	Takeover of the Sulzer AG turbomachinery activities by MAN Turbomaschinen AG GHH BORSIG
2004	New centre for the assembly and testing of large machine sets
2006	Integration of MAN DWE GmbH into MAN Turbo Group
2006	Acquisition of steam turbine division of B+V Industrietechnik GmbH

Company Headquarters & Main Locations
Berlin

Employees (28.02.2009) **: 522**

Products
Division
Oil & Gas

Small / medium centrifugal compressors

Multi-shaft compressors

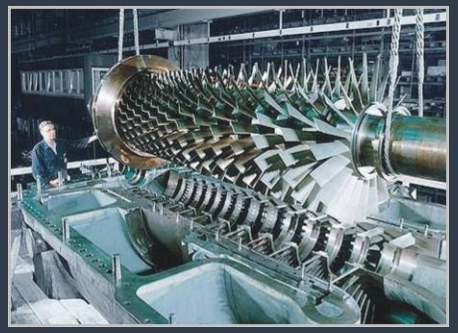
Competence centre for:

- Refining & CO_2 Applications

Locations

Sales and Service Centres

Compressors



- Axial compressors
- Integrally geared compressors
- Isotherm compressors
- Pipeline compressors
- Process-gas screw compressors
- Centrifugal compressors
- Vacuum blowers
- MOPICO / HOFIM

Compressors
Technical data

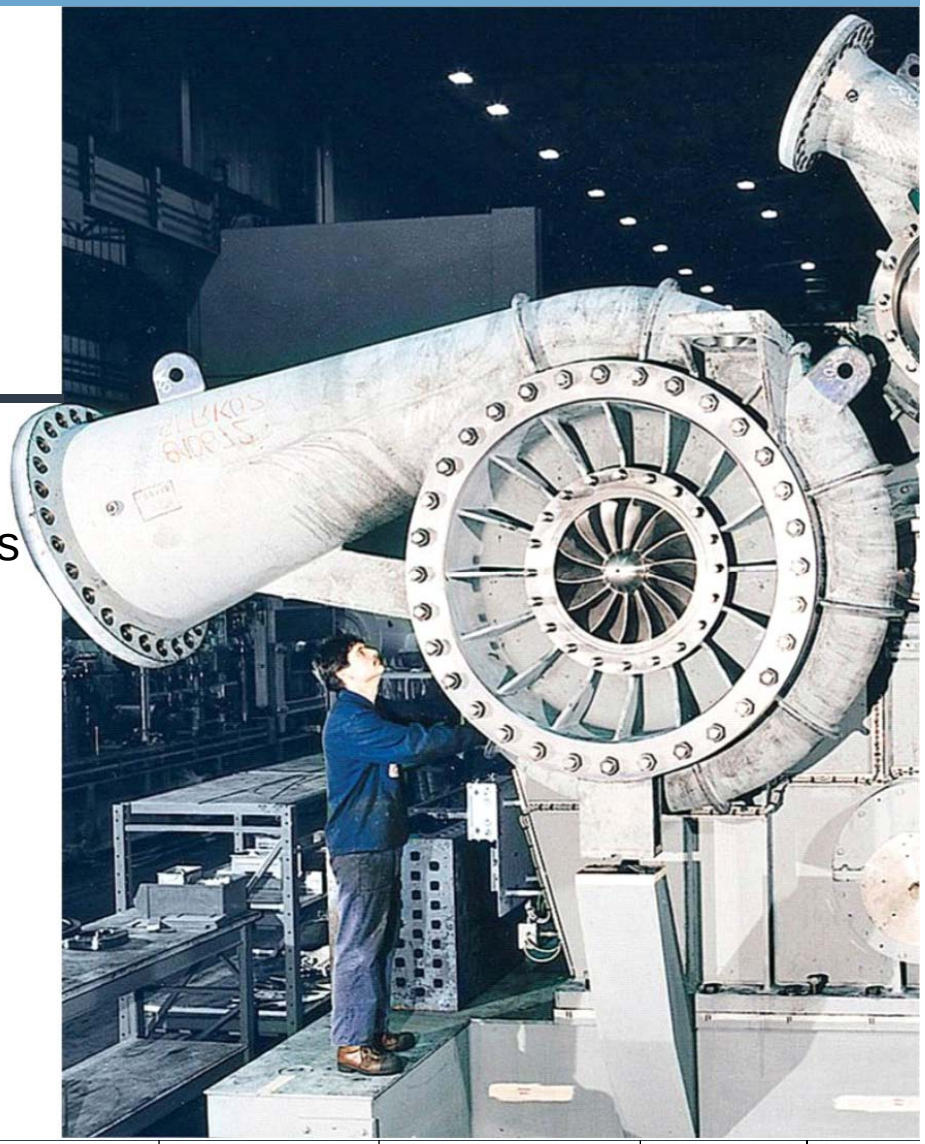
Turbo-compressors	Max. suction flow rate (m^3/h)	Max. discharge pressure (bar)
Axial compressors	1 500 000	25
Single-shaft centrifugal compressors, horizontally split	660 000	80
Single-shaft centrifugal compressors, vertically split	230 000	300
High-pressure barrel compressors	35 000	1 000
Multi-shaft centrif. compressors	350 000	225
Isotherm compressors	660 000	20
TURBAIR® vacuum blowers	200 000	Vakuum
Pipeline compressors	85 000	130

Process-gas screw compressors	Max. suction flow rate (m^3/h)	Max. discharge pressure (bar)
Screw compressors	100 000	50

Integrally-geared compressor

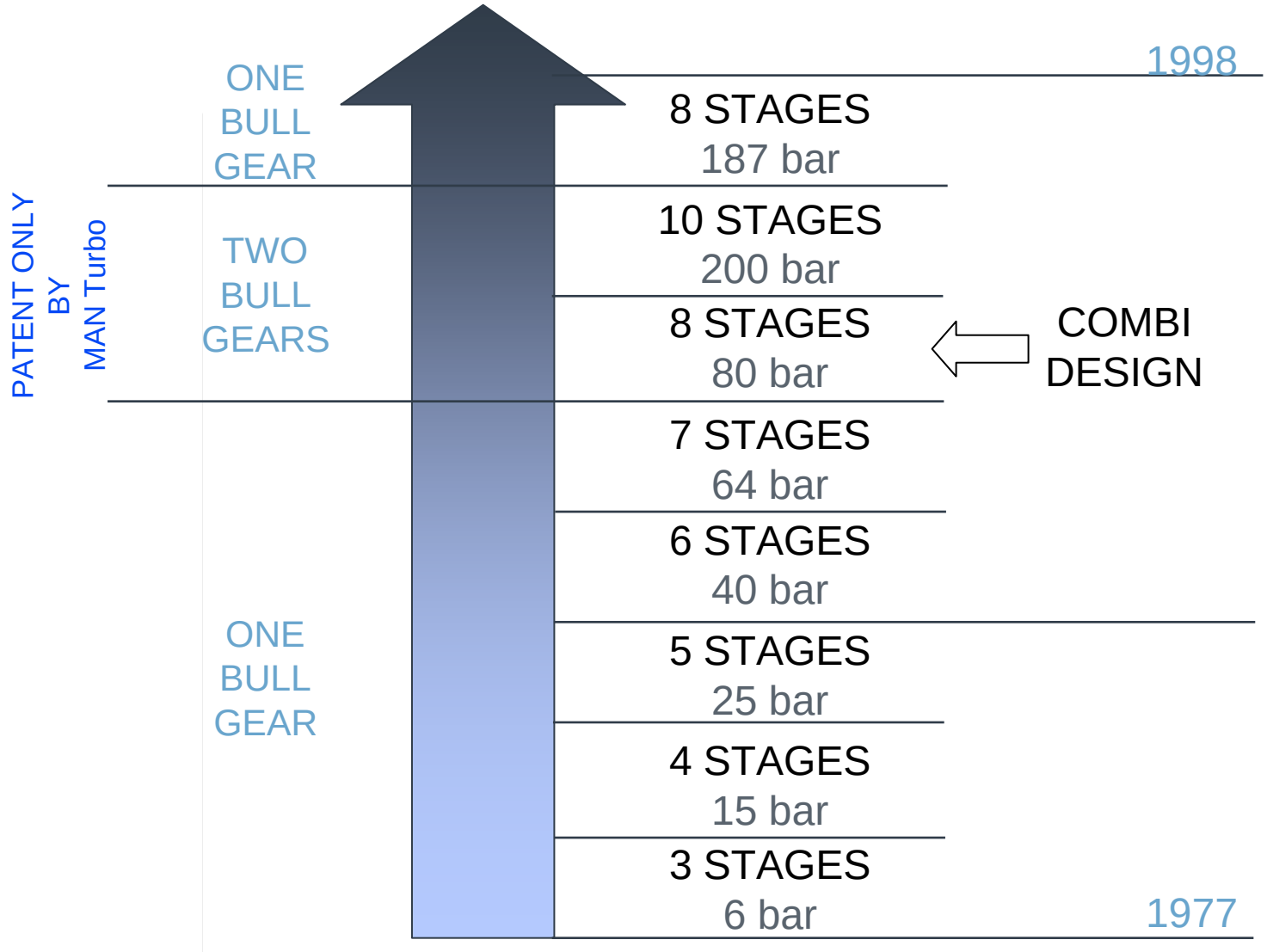
- Suction flow rates up to 350,000 m^3/h
- Max. discharge pressure up to 225 bar

- Ammonia
- Fuel gas
- CO_2 compression
- Fluid catalytic cracking
- Urea
- Air separation
- Refinery / Petrochemicals
- Nitric acid
- Oxygen
- Terephthalic acid



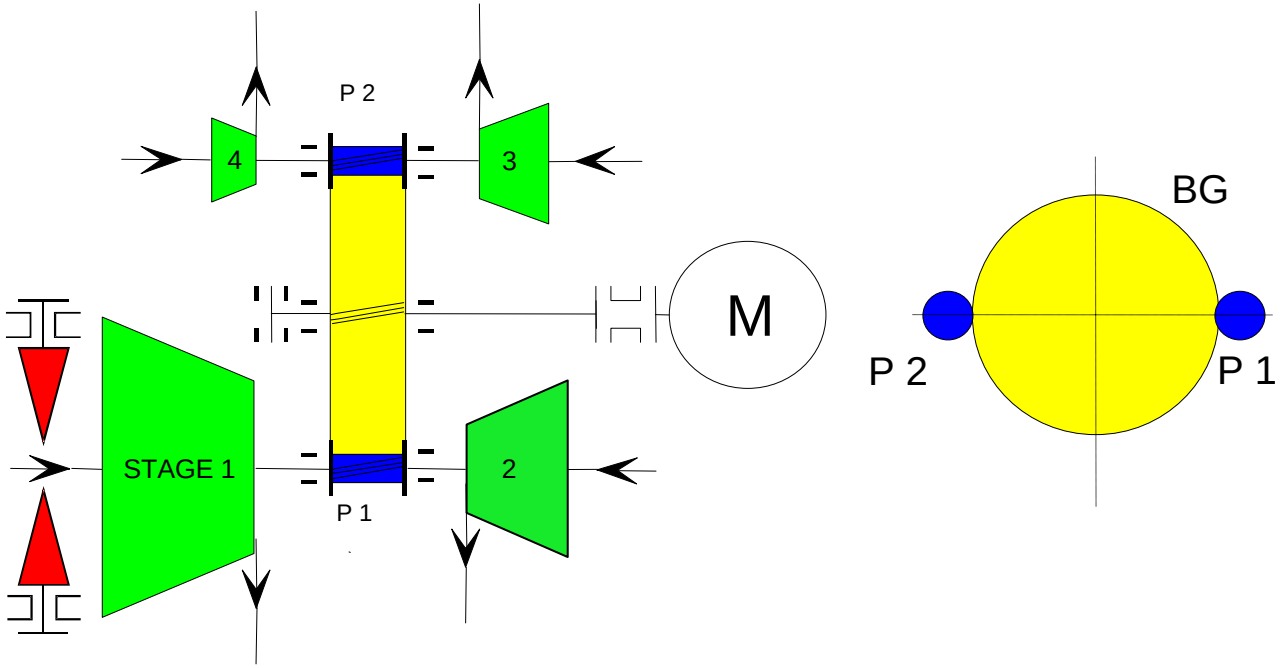
Integrally-Geared Centrifugal

History



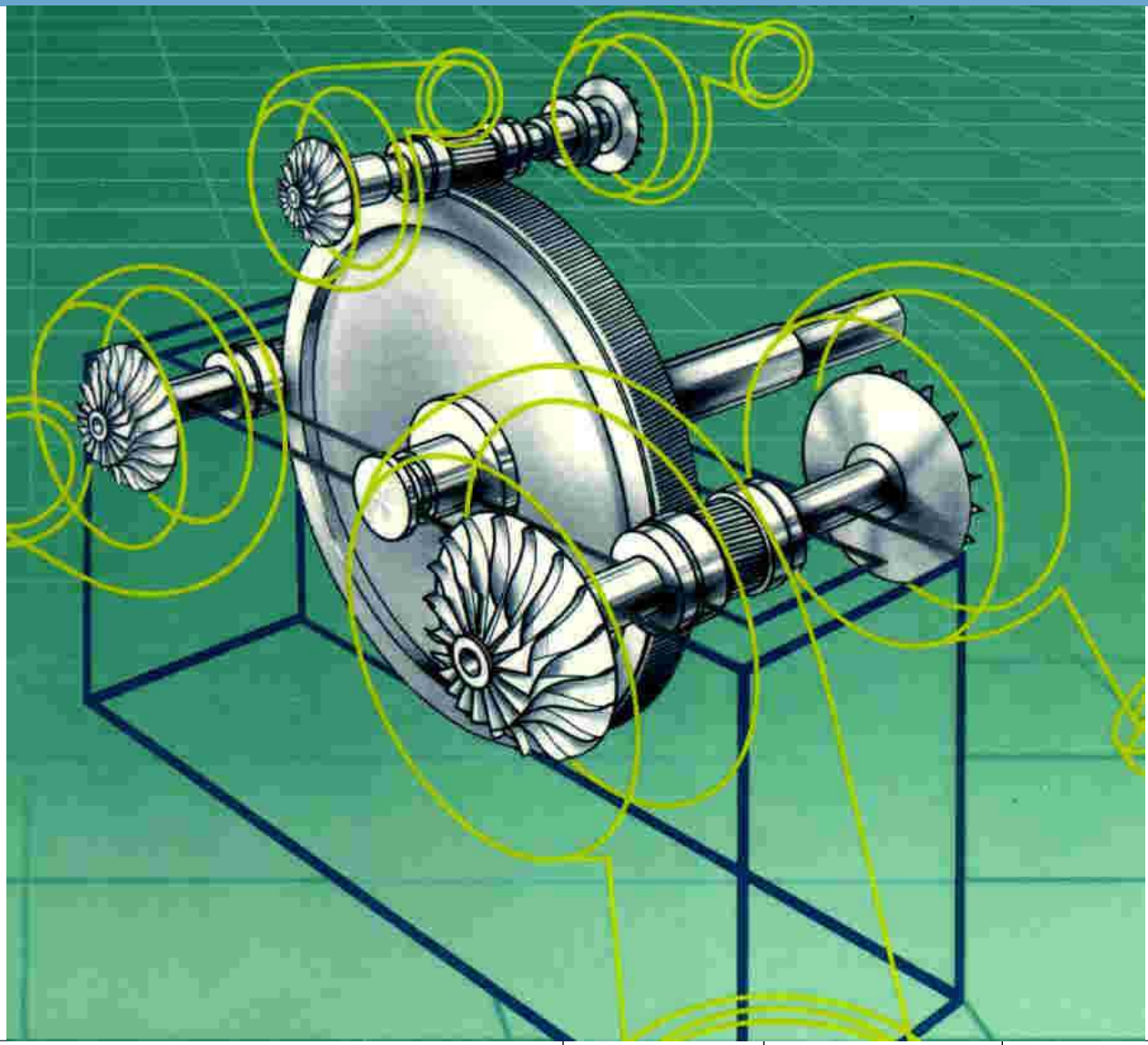
Integrally-Geared Centrifugal
Basic Design

Typical 4-Stage Arrangement



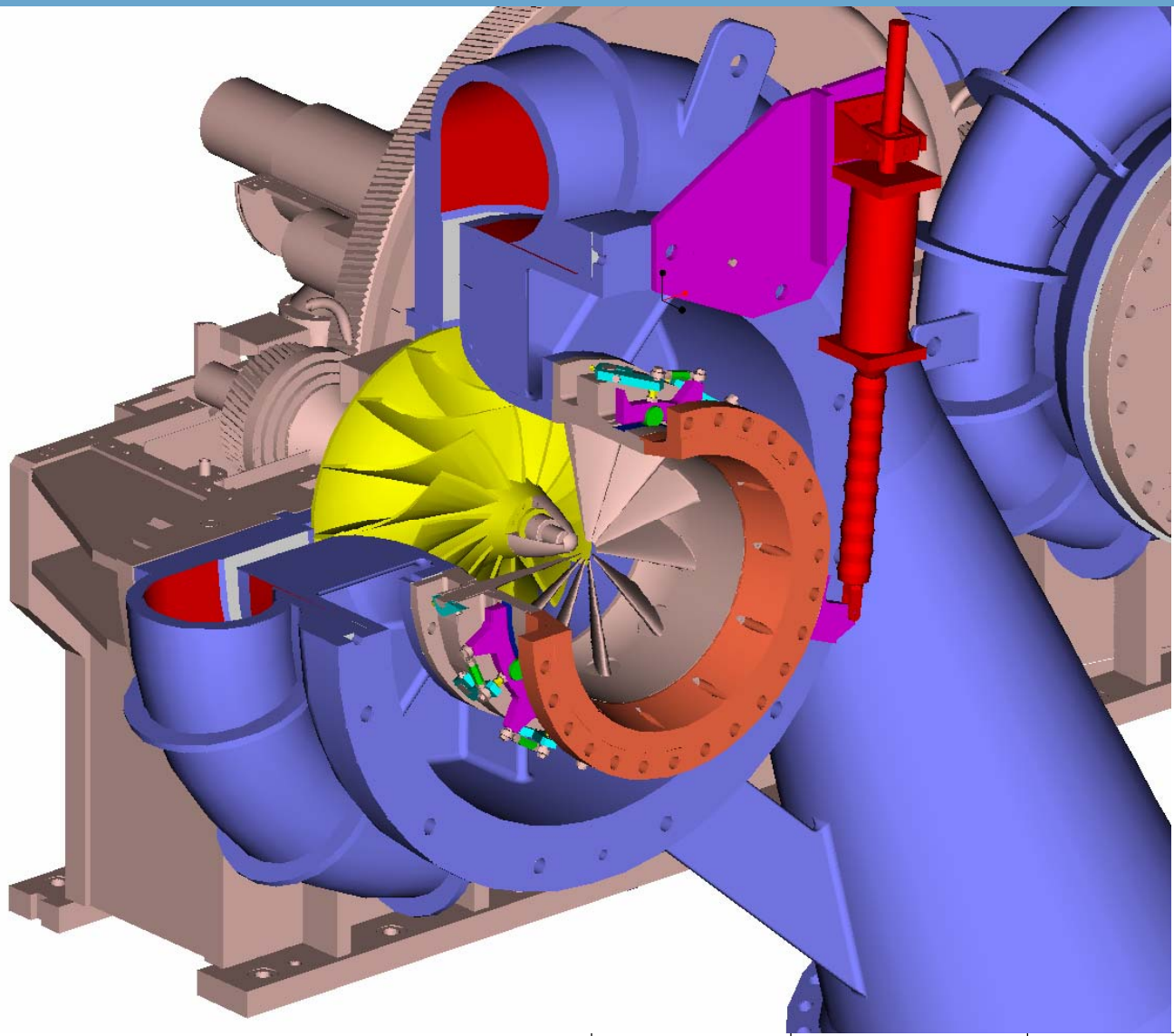
Integrally-Geared Centrifugal

Basic Design



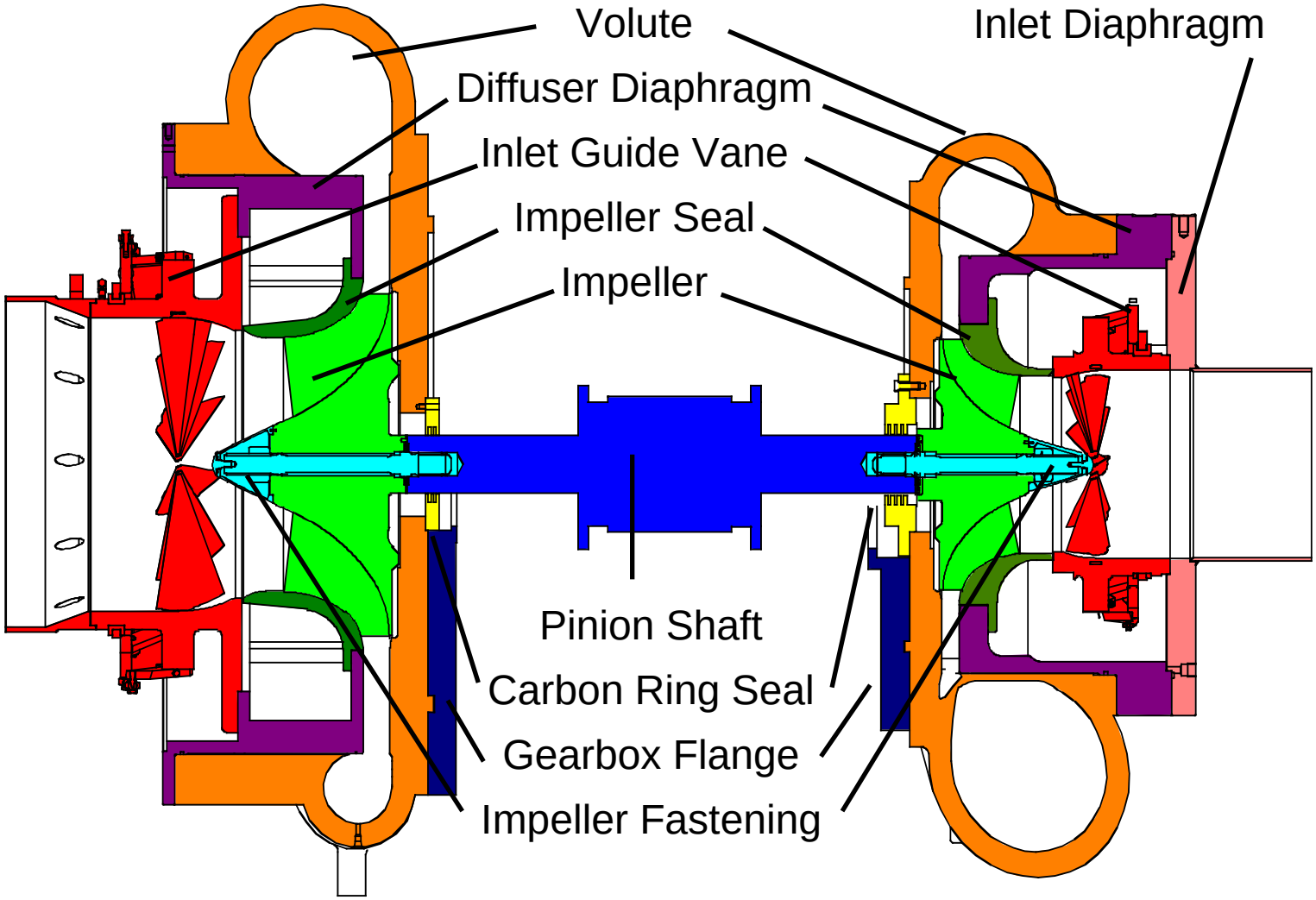
Integrally-Geared Centrifugal

Basic Design



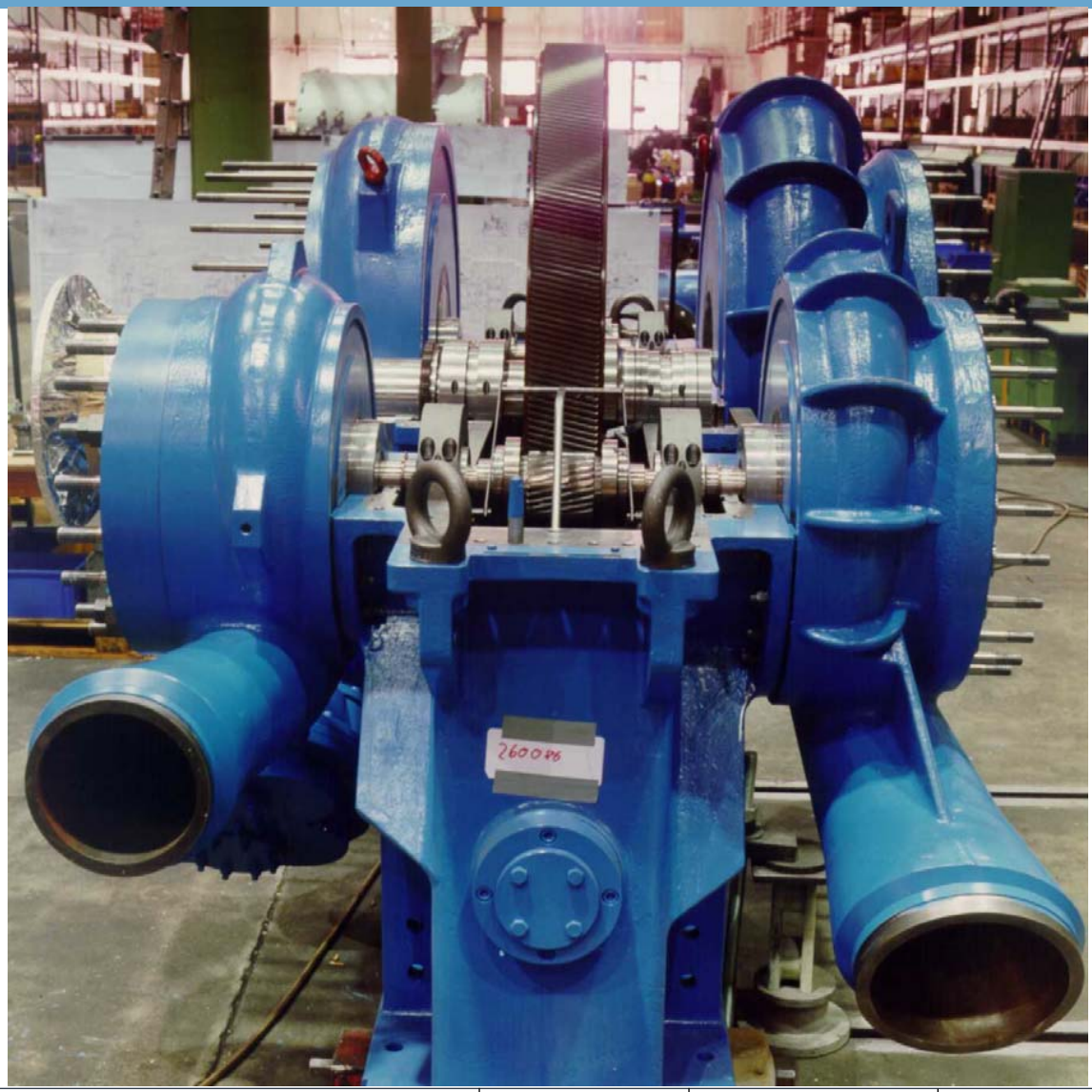
Integrally-Geared Centrifugal

Basic Design



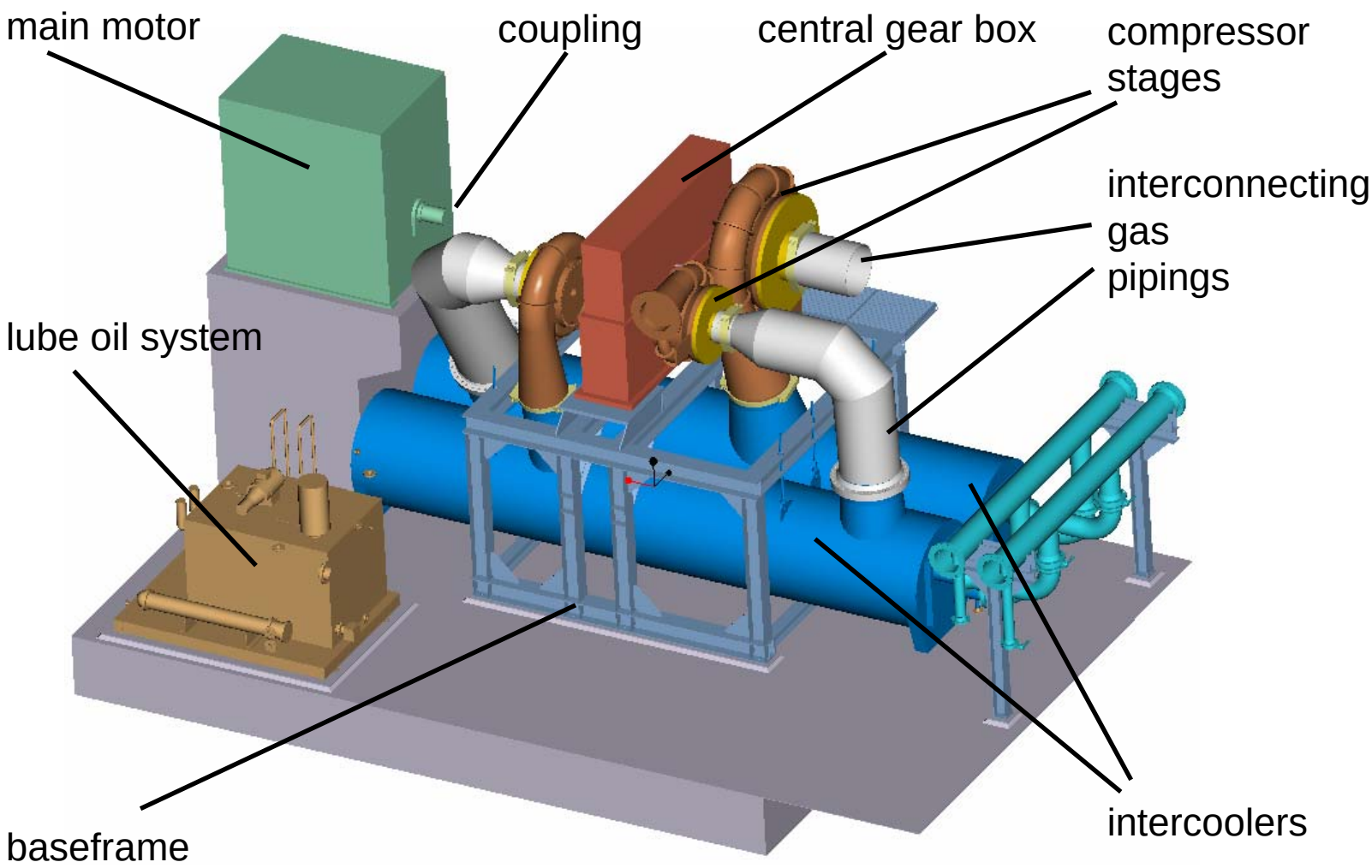
Integrally-Geared Centrifugal

Basic Design



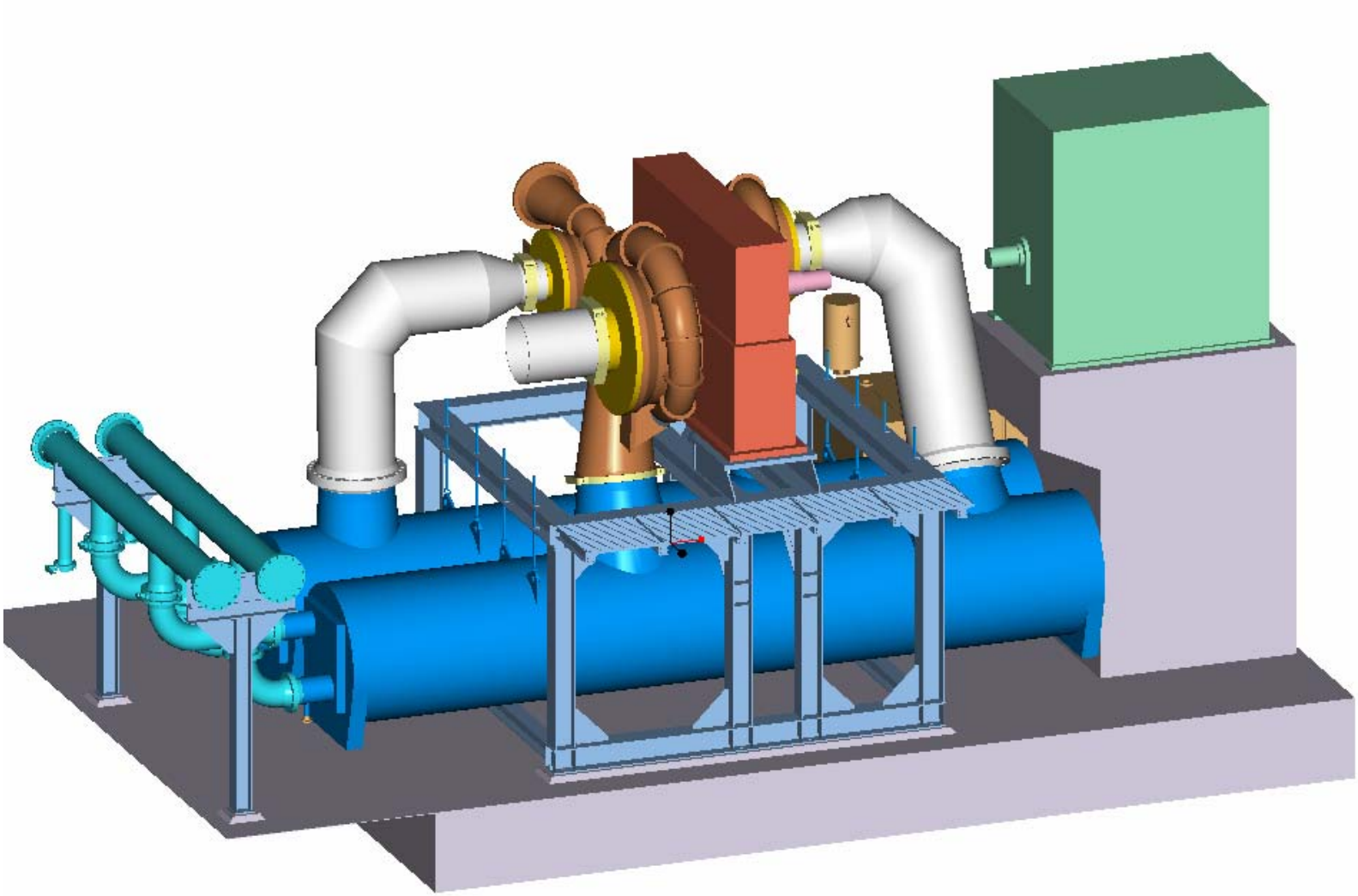
Integrally-Geared Centrifugal

Basic Design



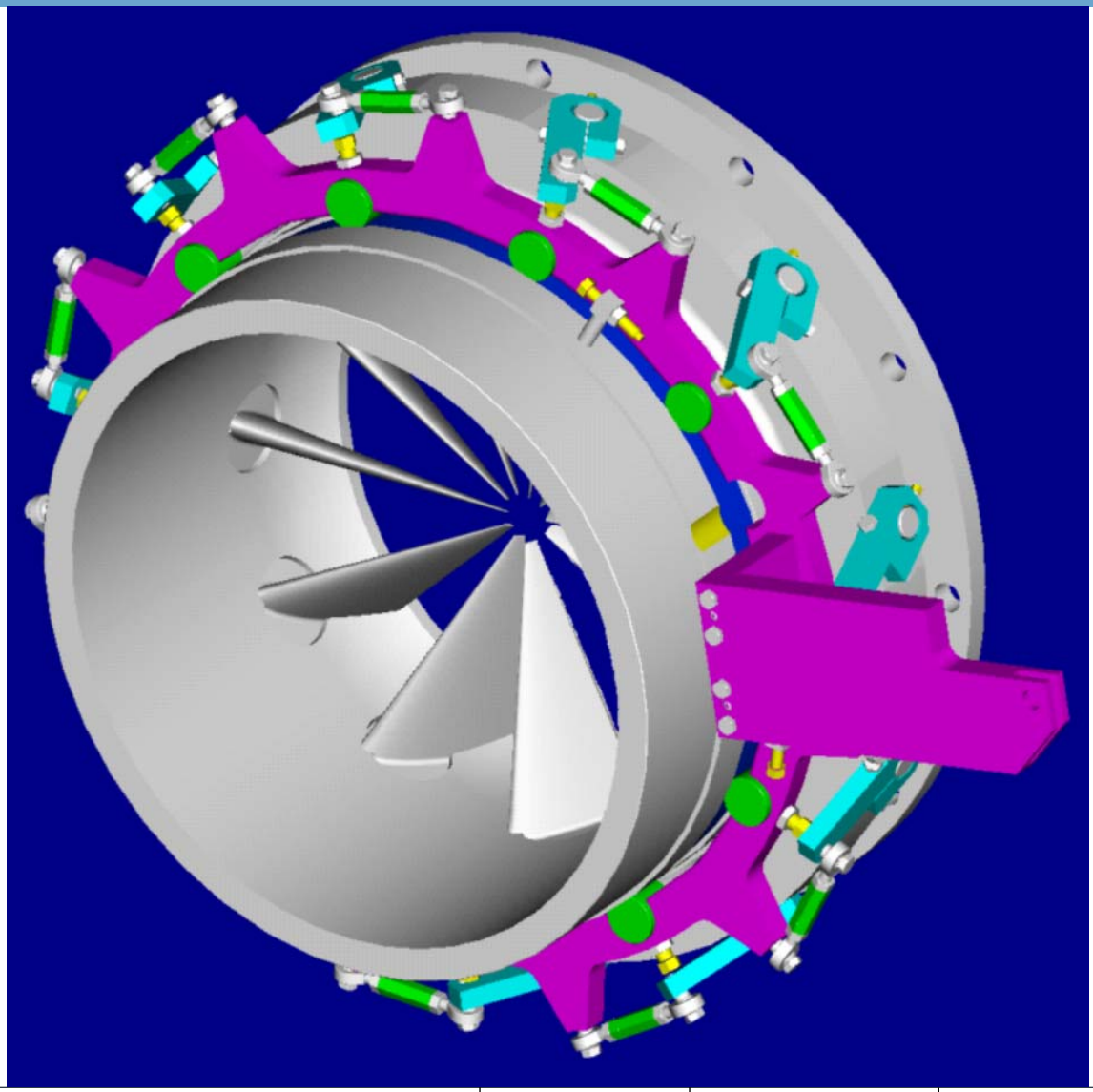
Integrally-Geared Centrifugal

Basic Design



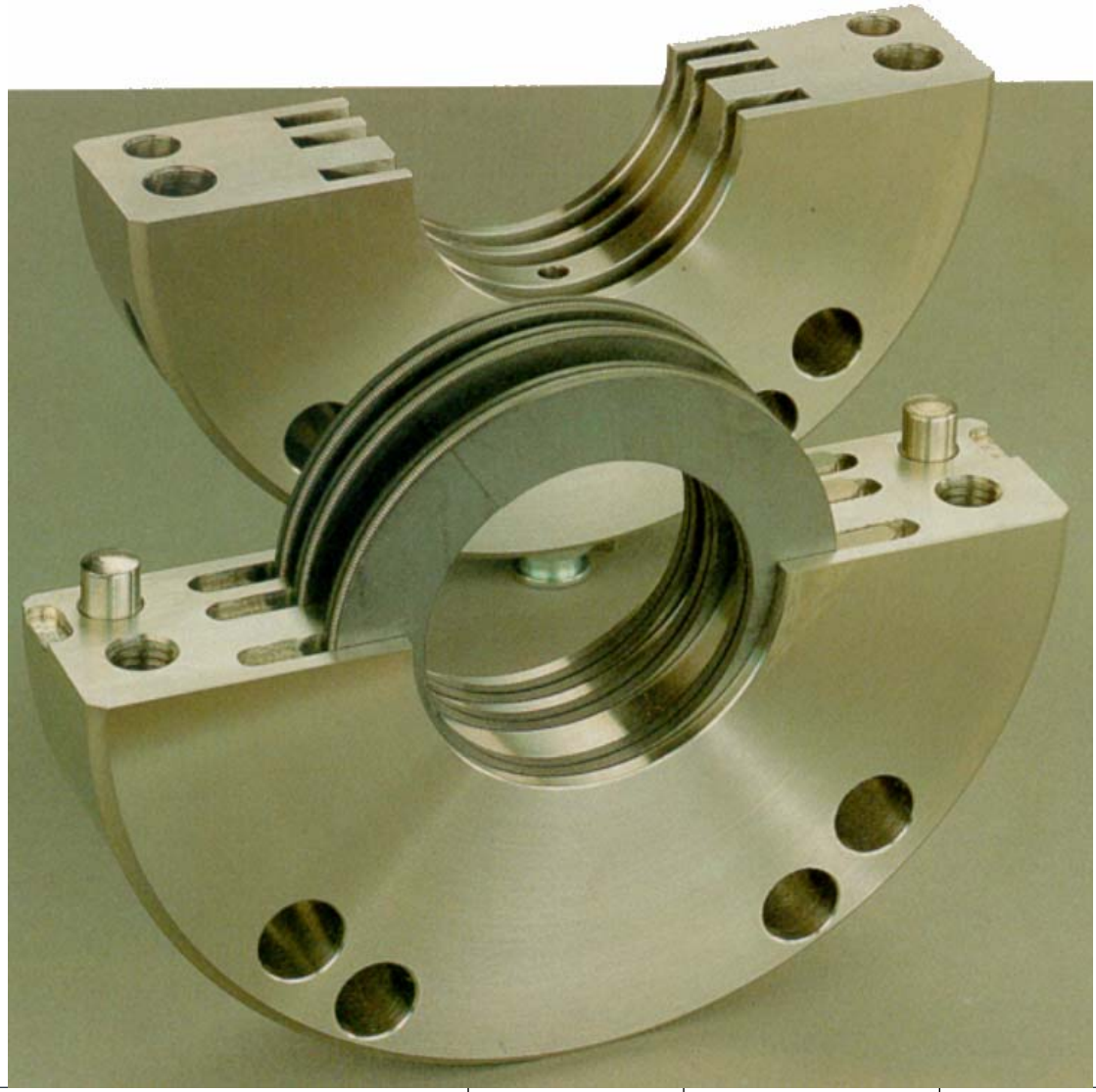
Integrally-Geared Centrifugal

Inlet Guide Vanes



Integrally-Geared Centrifugal

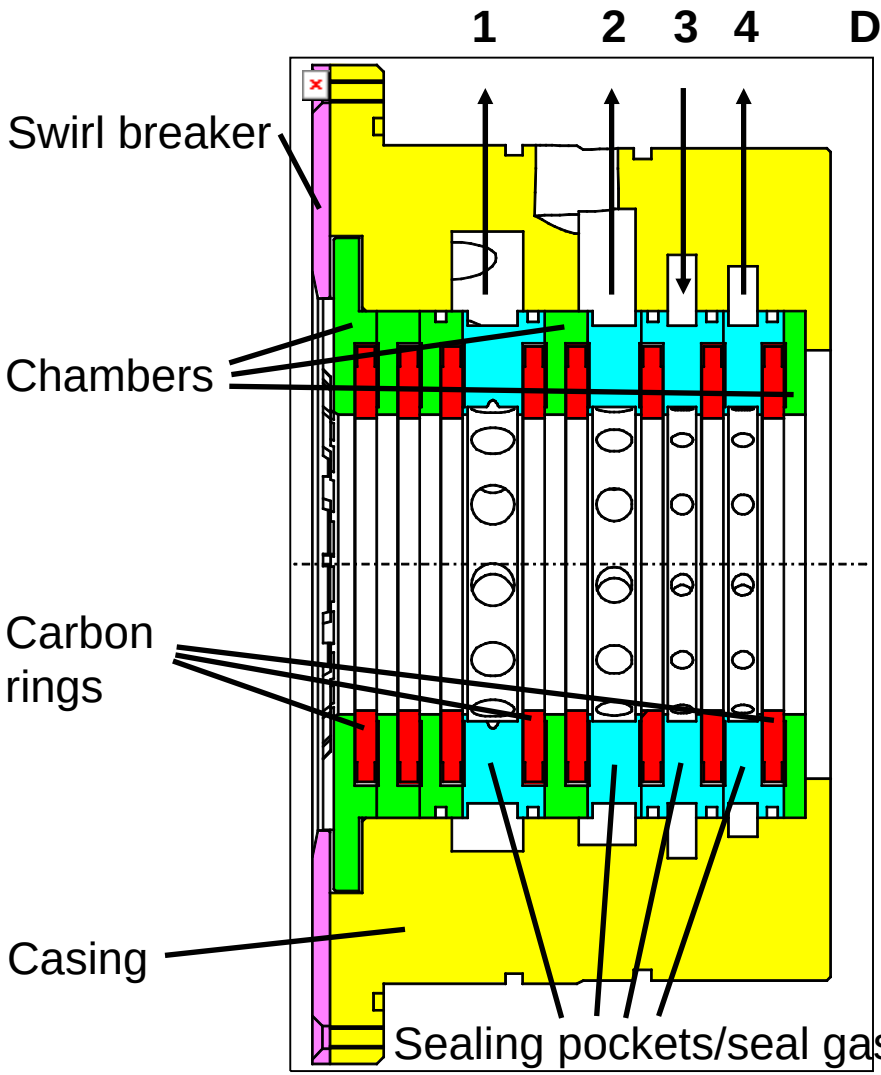
Typical Shaft Seals



Source: Espey

Integrally-Geared Centrifugal

Typical Design of a Carbon Ring Seal



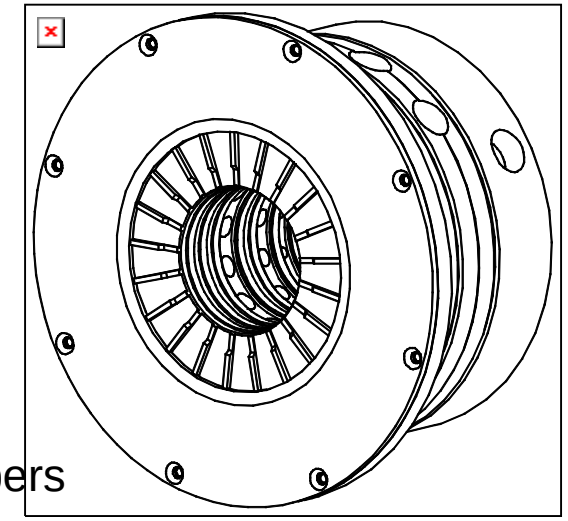
DACOPIPE Stage 8 (2350 psia)

1 Return to suction end
Stage 4 (161 psia)

2 Return to suction end
Stage 1 (17 psia)

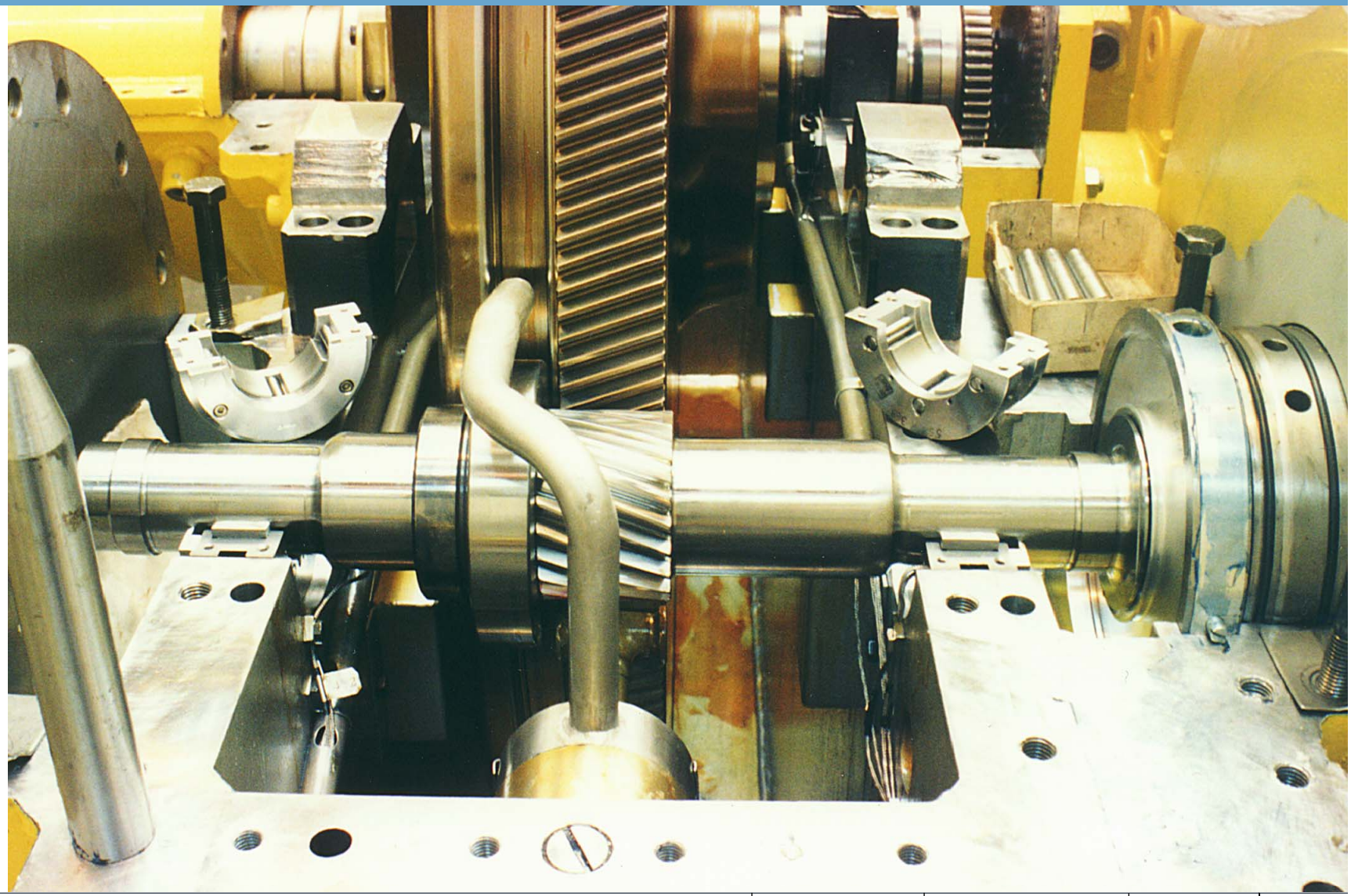
3 Nitrogen barrier gas (19 psia)

4 Atmospheric vent



Integrally-Geared Centrifugal

Thrust Collar



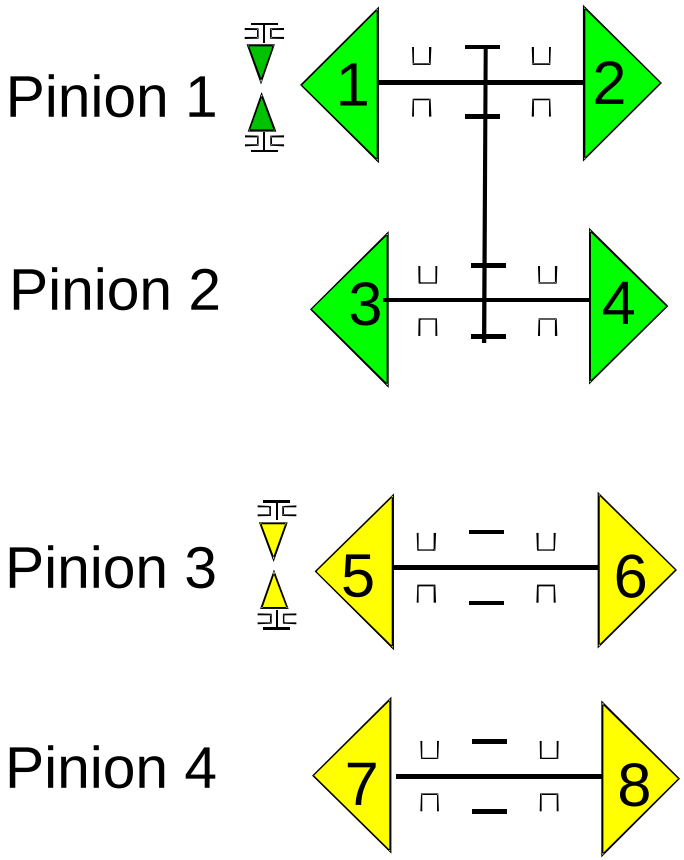
Integrally-Geared Centrifugal
Performance

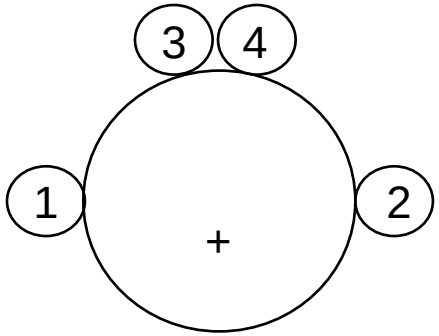
Urea Synthesis Process

- RG 40-8
- Gas Wet CO_2 Mix
- Flow 7,500 acfm
- Pressure 15 – 2,320 psia *(r = 160)*
- Power 5,700 HP

Integrally-Geared Centrifugal
Basic Design

Typical 8-Stage Arrangement

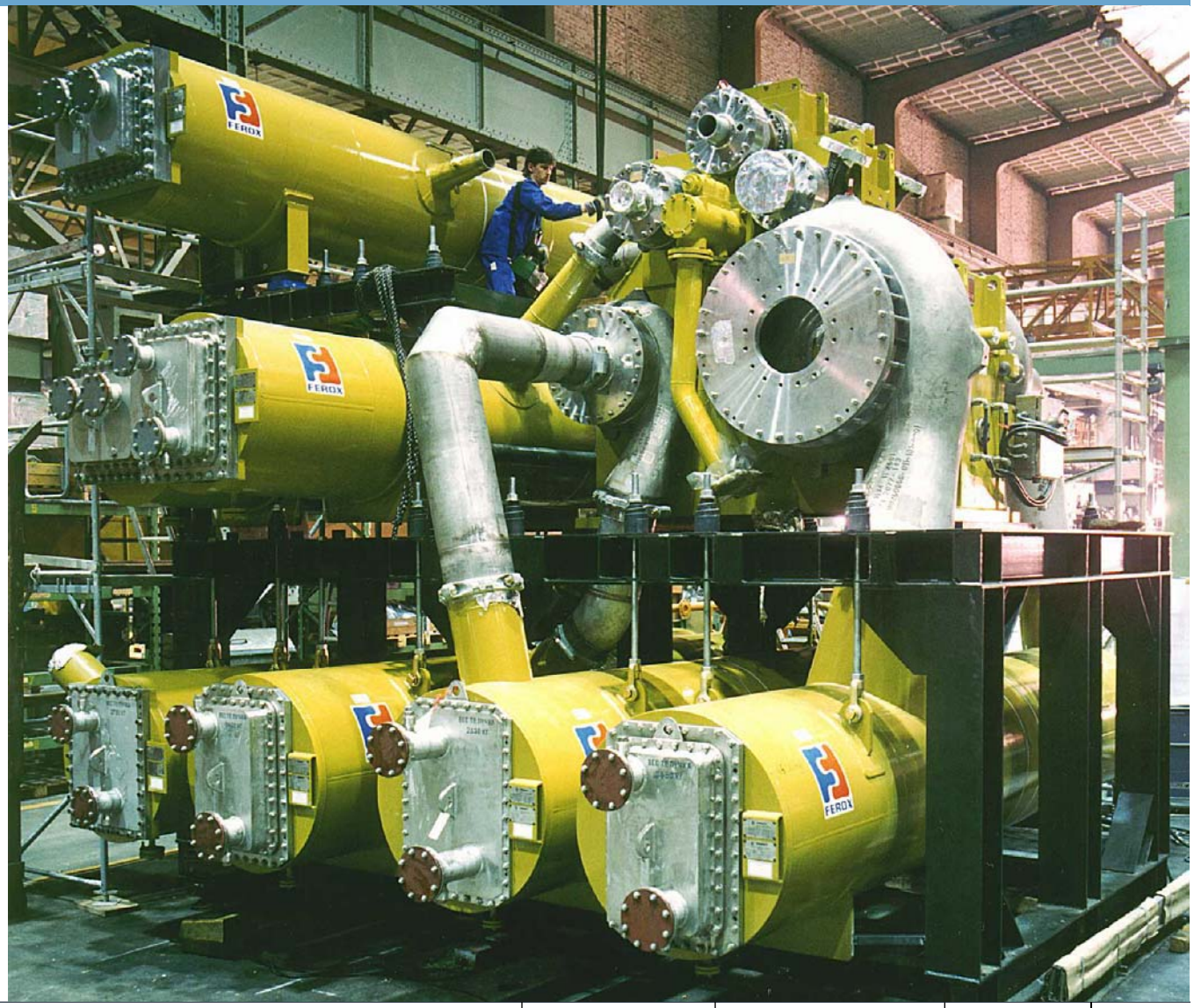




Integrally-Geared Centrifugal
Performance

Wet CO_2 Compressor

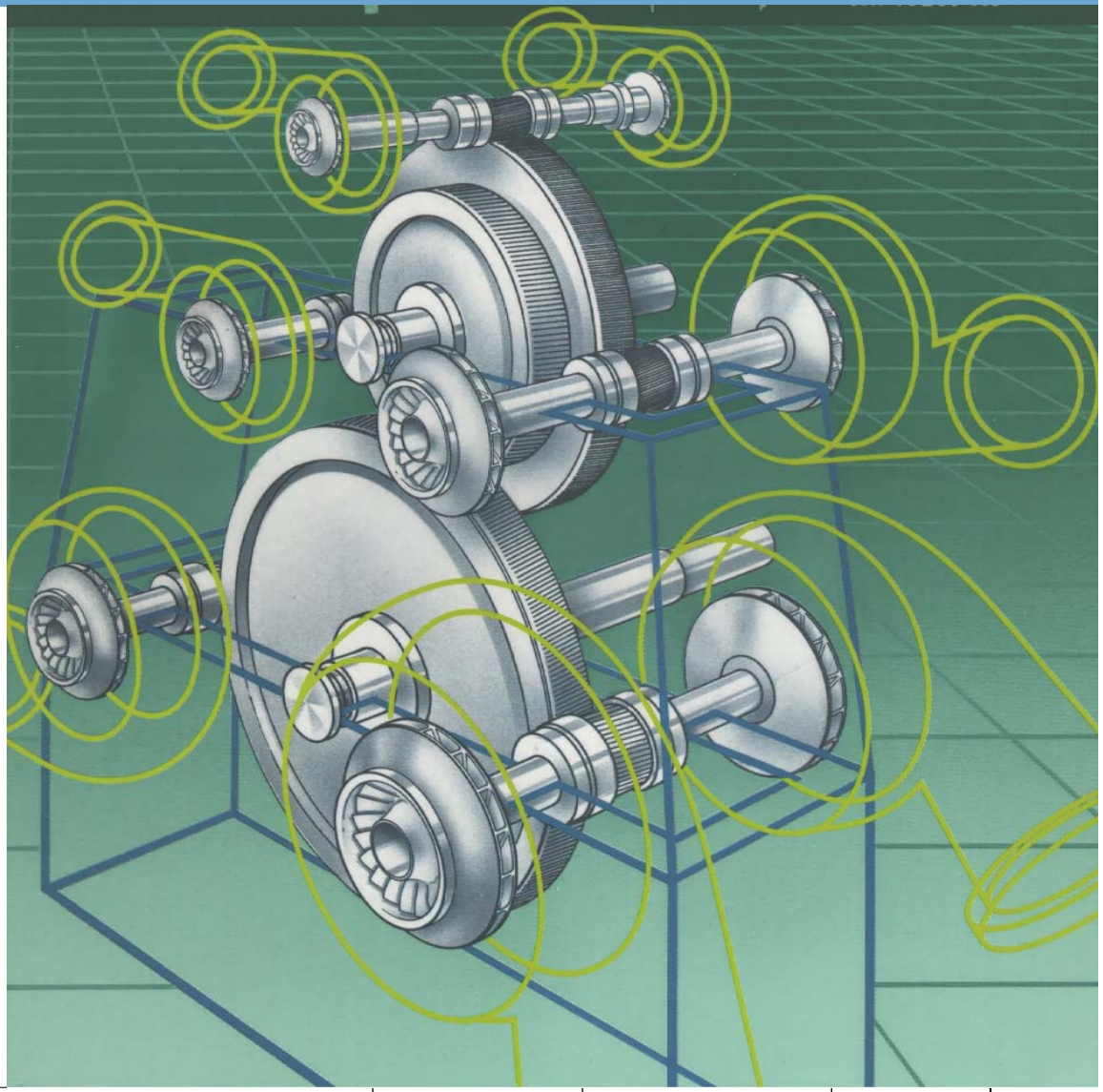
- Model RG053-10
- Inlet Volume 13,800 acfm
- Pressure 15-2,900 psia *(r=200)*
- Speed 11,000-50,000 rpm
- Power 6,200 HP



CO_2 High Pressure Geartype Compressors

First steps in the early 90s

- **World`s first double bull-gear multishaft geartype compressor patented**
- **1st 10 stage compressor for wet CO_2 service designed, fabricted and in operation for AZOT Nowomoskowsk**

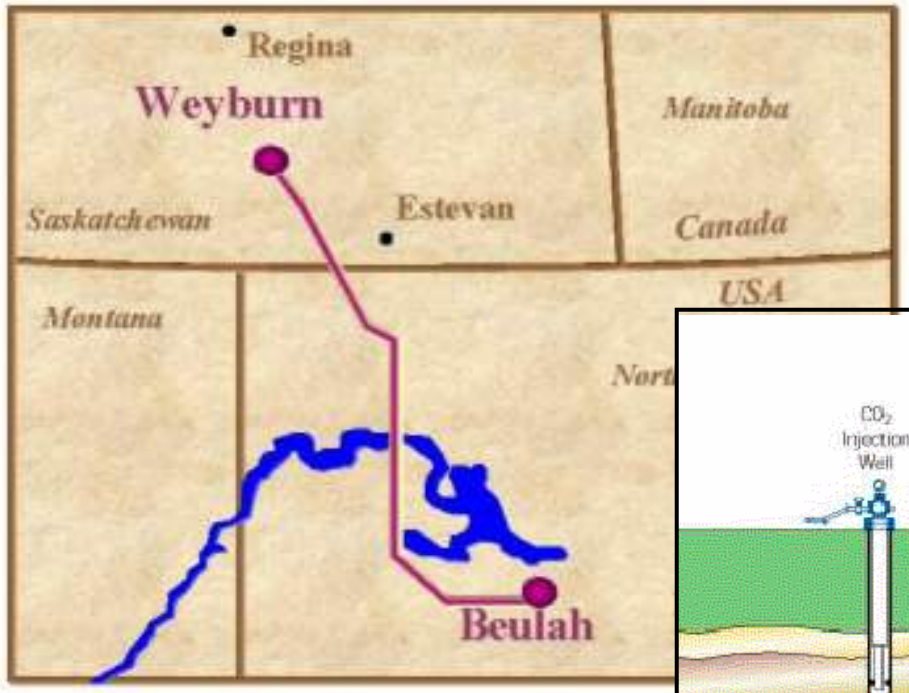


Integrally-Geared Centrifugal

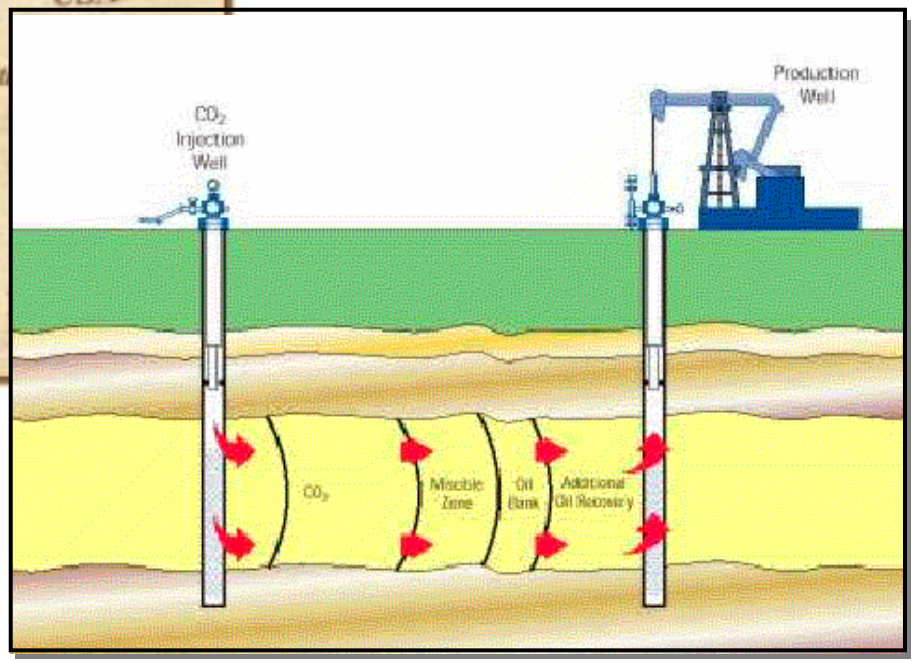
Typical Installation

Case Study – High Pressure CO_2
Compressor

Case Study – High Pressure CO_2
Compressor



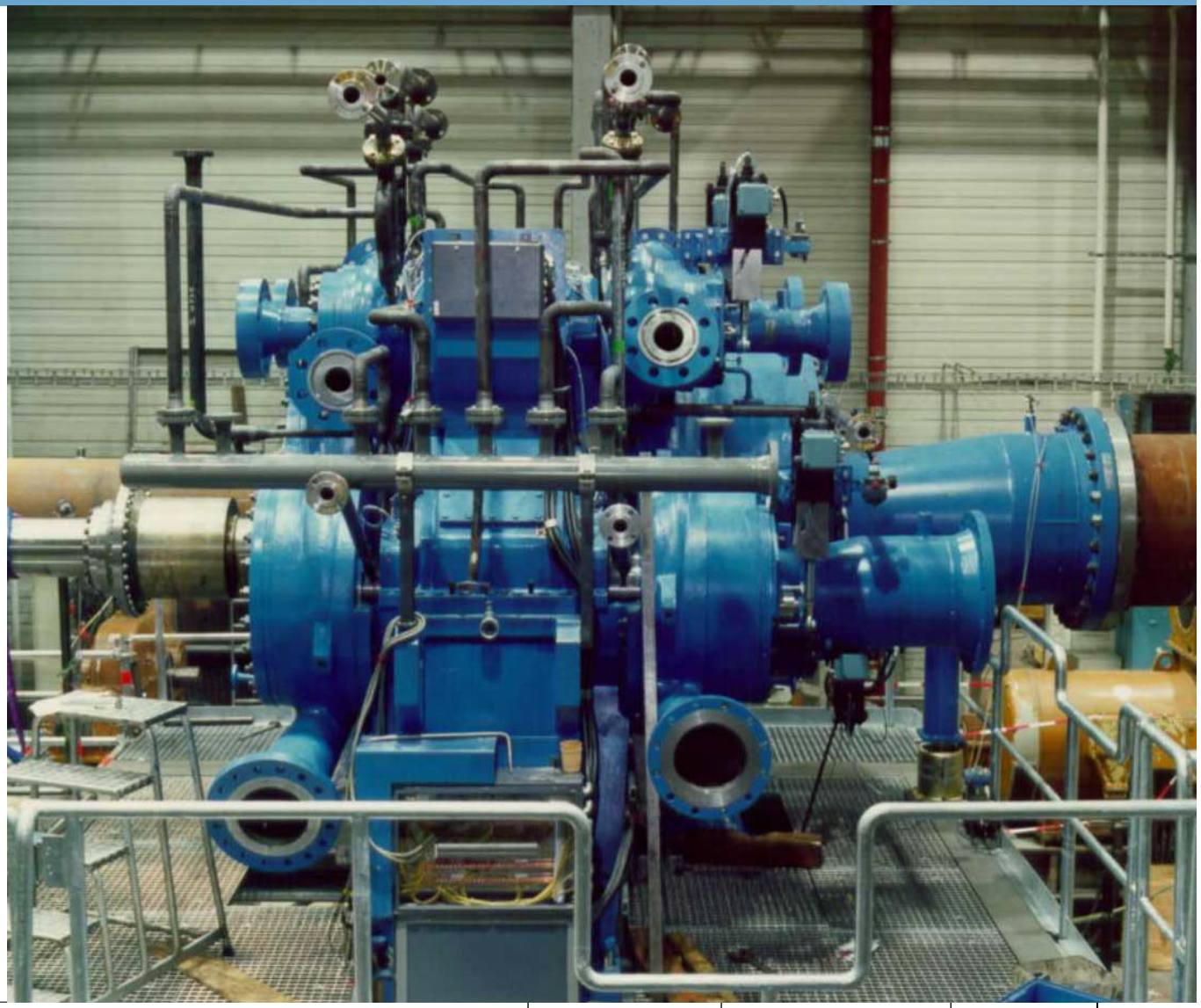
Enhanced Oil Recovery



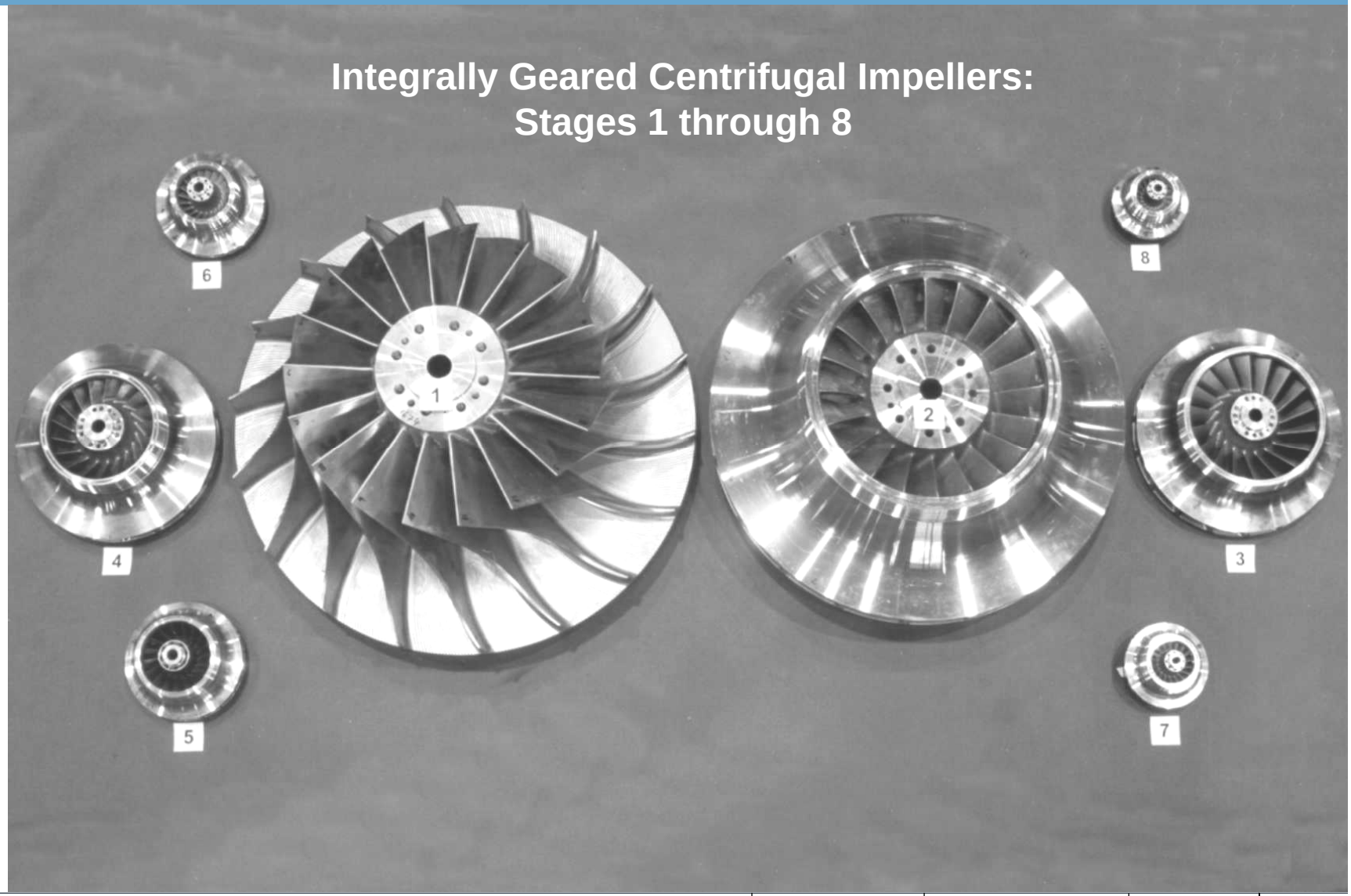
Integrally-Geared Centrifugal
8 Stages

CO_2 Compressor

- Model RG080-8
- Inlet Volume 34,242 acfm
- Pressure 17-2,717 psia *(r = 160)*
- Speed 7400-26,400 rpm
- Power 15,150 HP

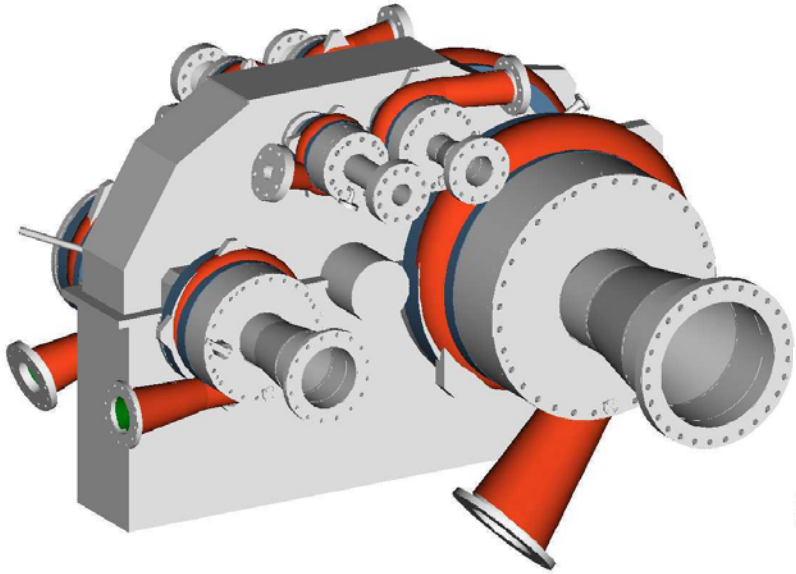


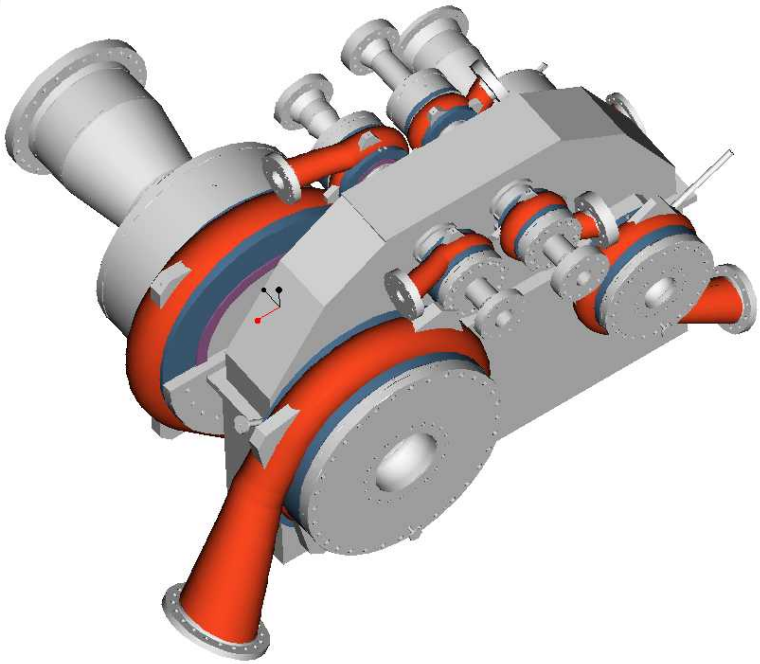
Integrally-Geared Centrifugal



Integrally-Geared Centrifugal

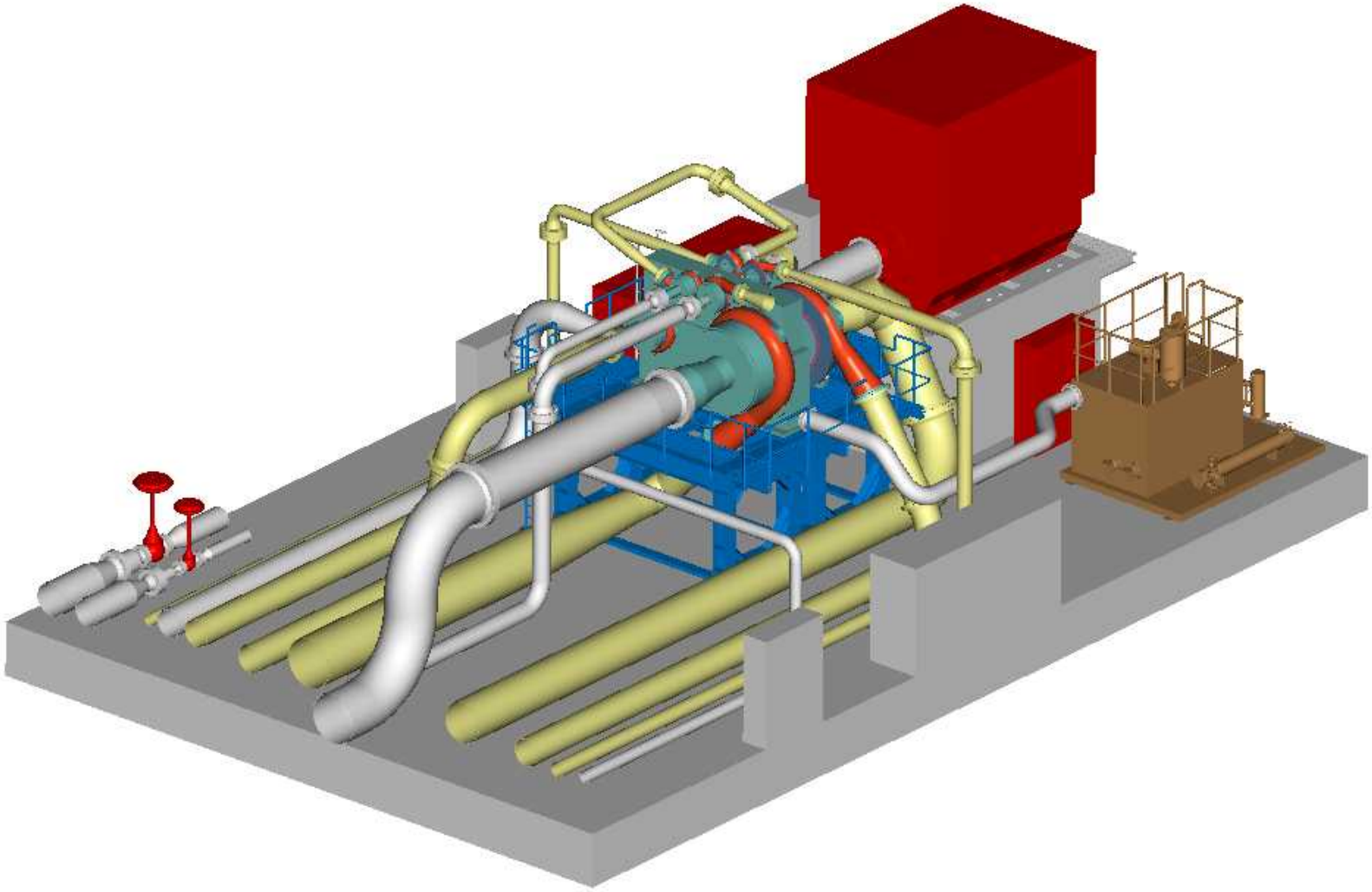
8 Stages





Integrally-Geared Centrifugal Compressor

DGC - Beulah, North Dakota

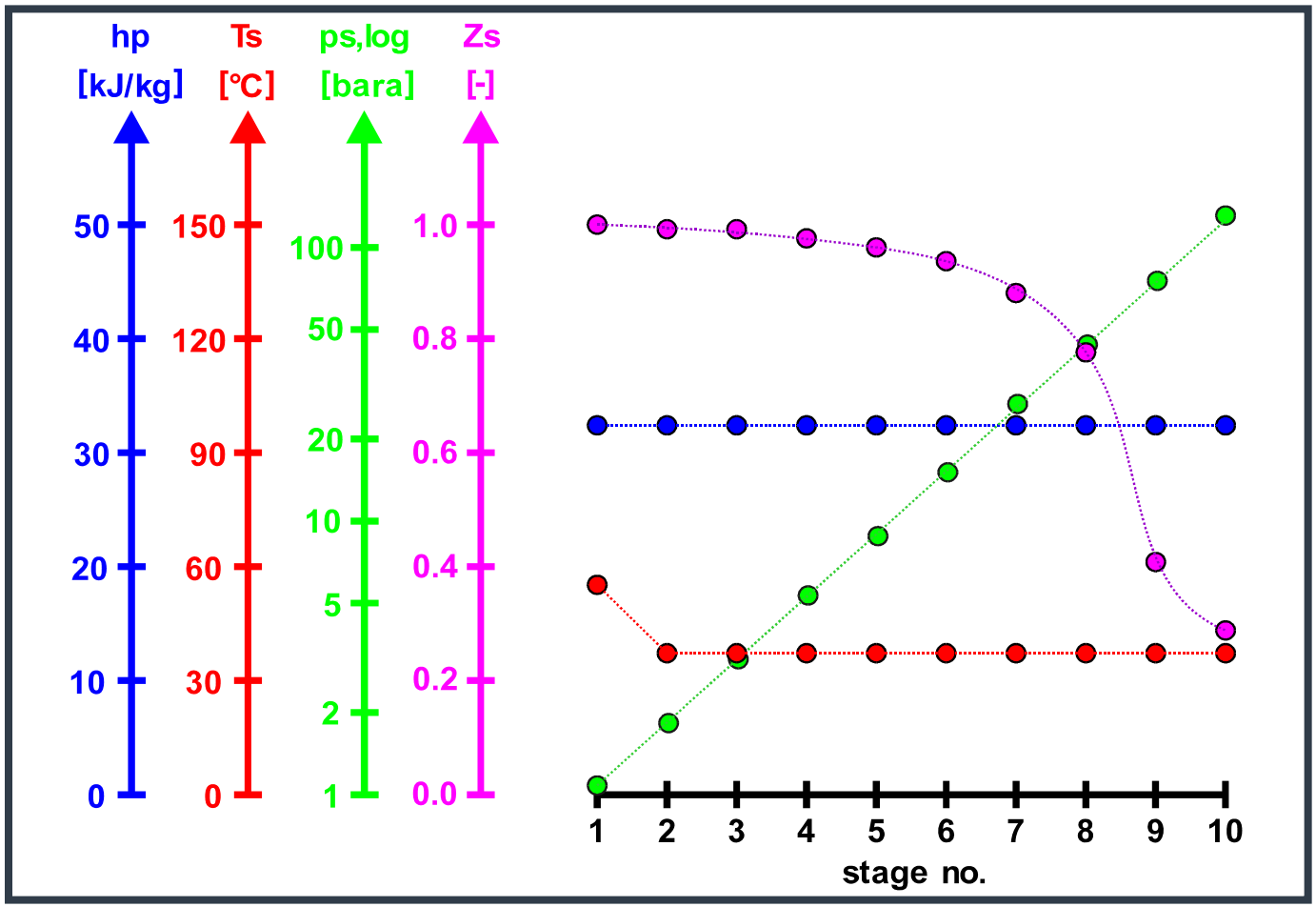


Integrally-Geared Centrifugal Compressor

DGC - Beulah, North Dakota

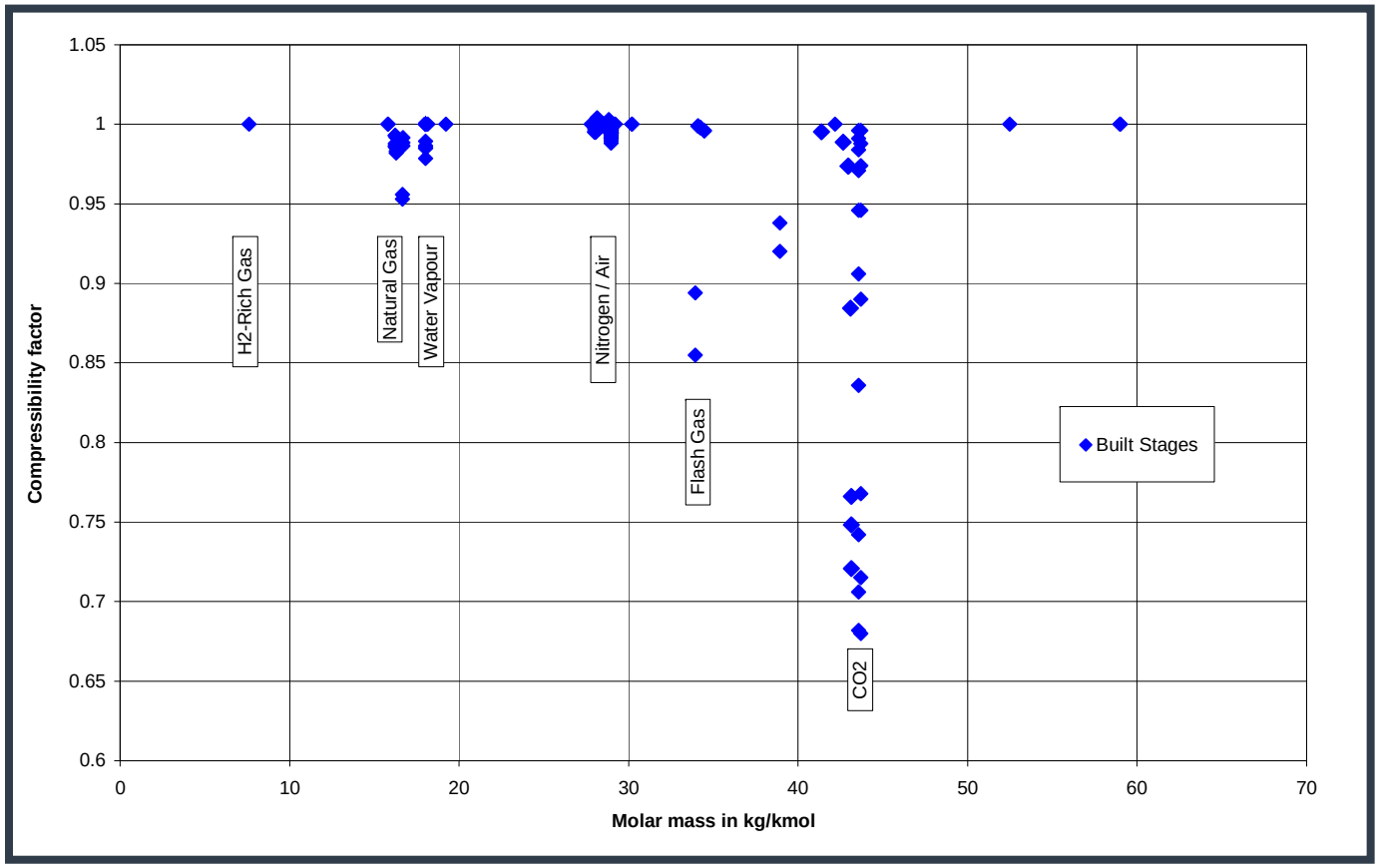
CO_2 High Pressure Geartype Compressors

Thermodynamic Design



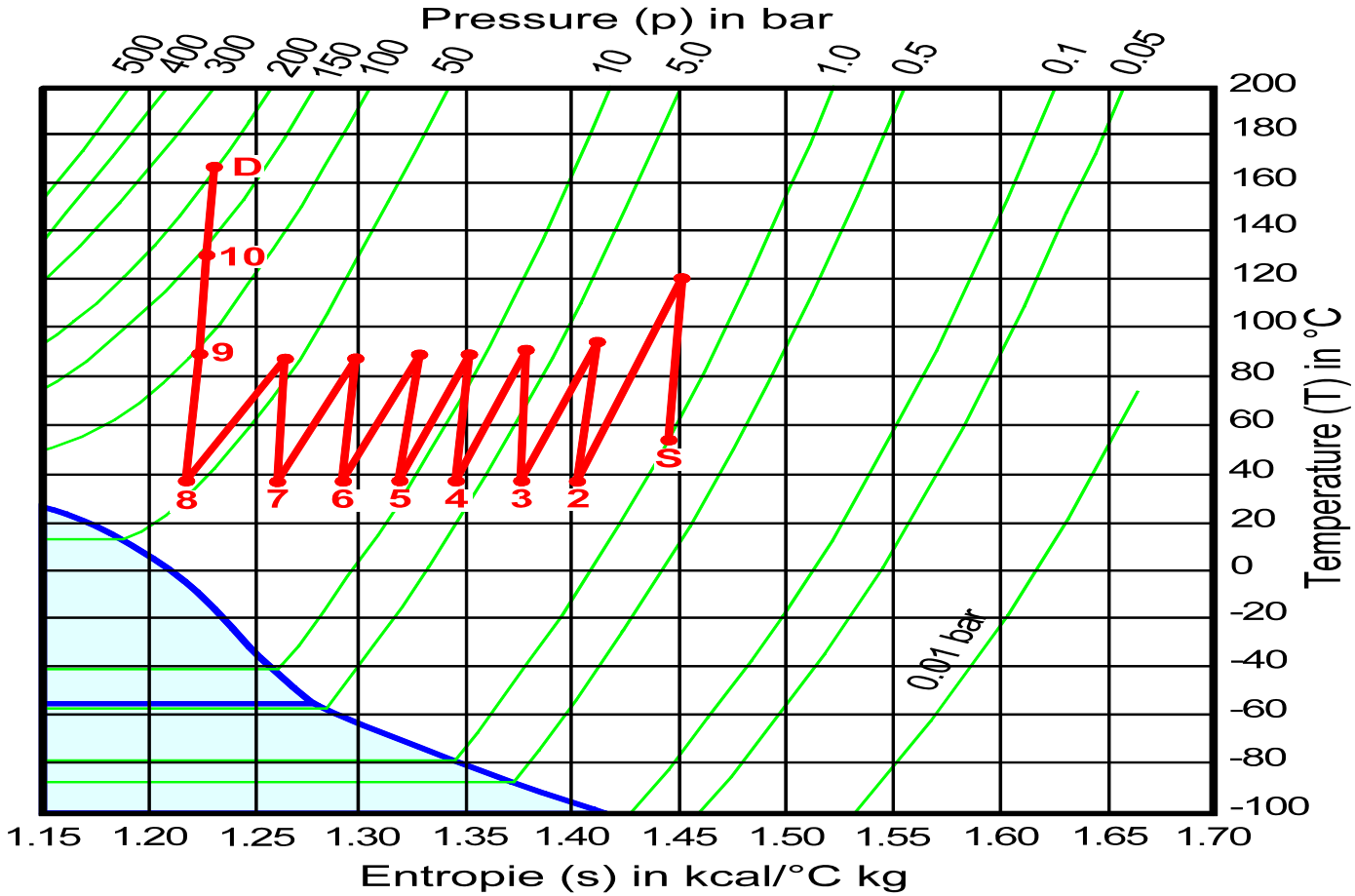
CO_2 High Pressure Compressors

Sensitivity of Real Gas Factors for Various Gases



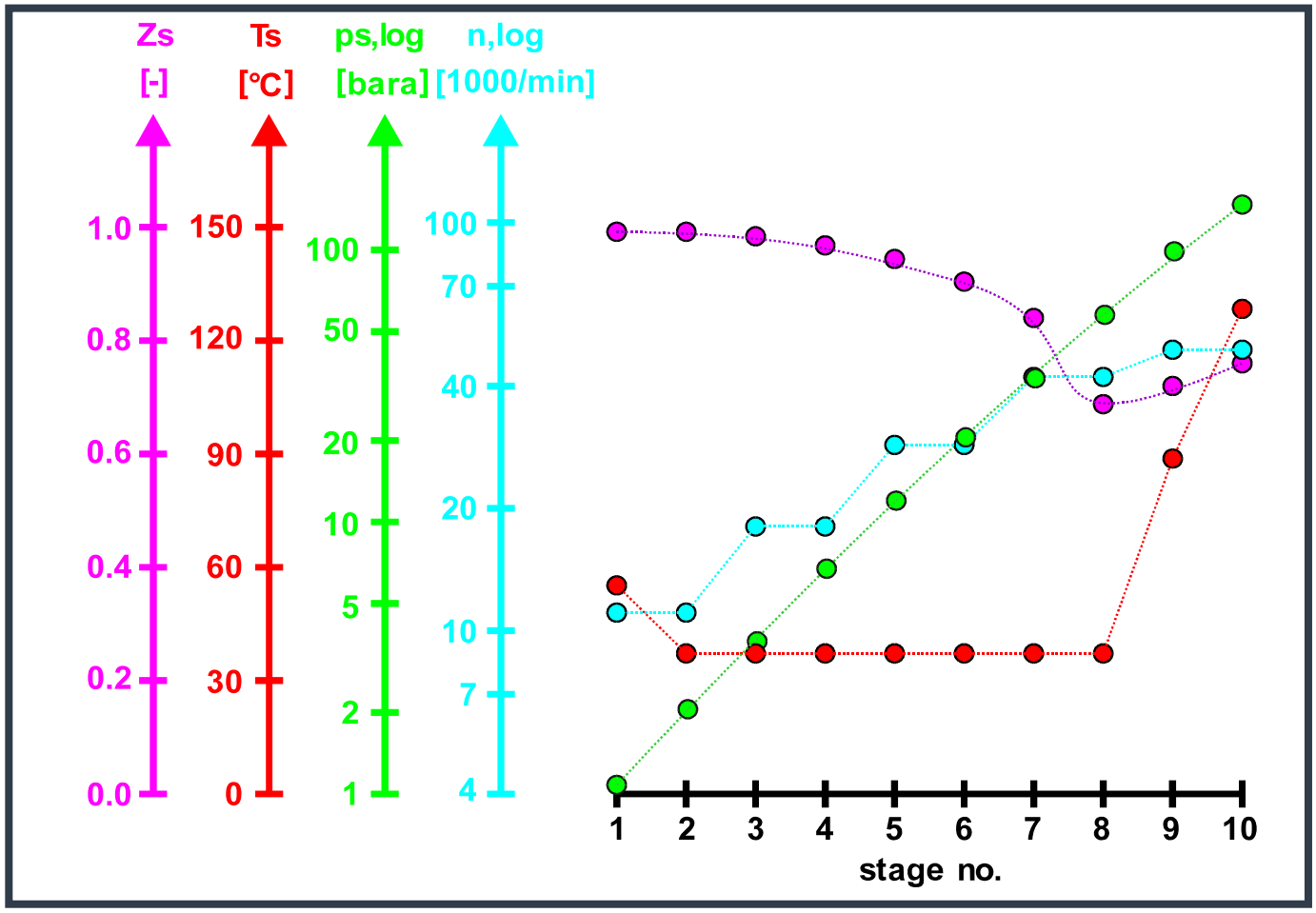
Integrally-Geared Centrifugal Compressor

Compression Path in Temperature-Entropie-Diagram



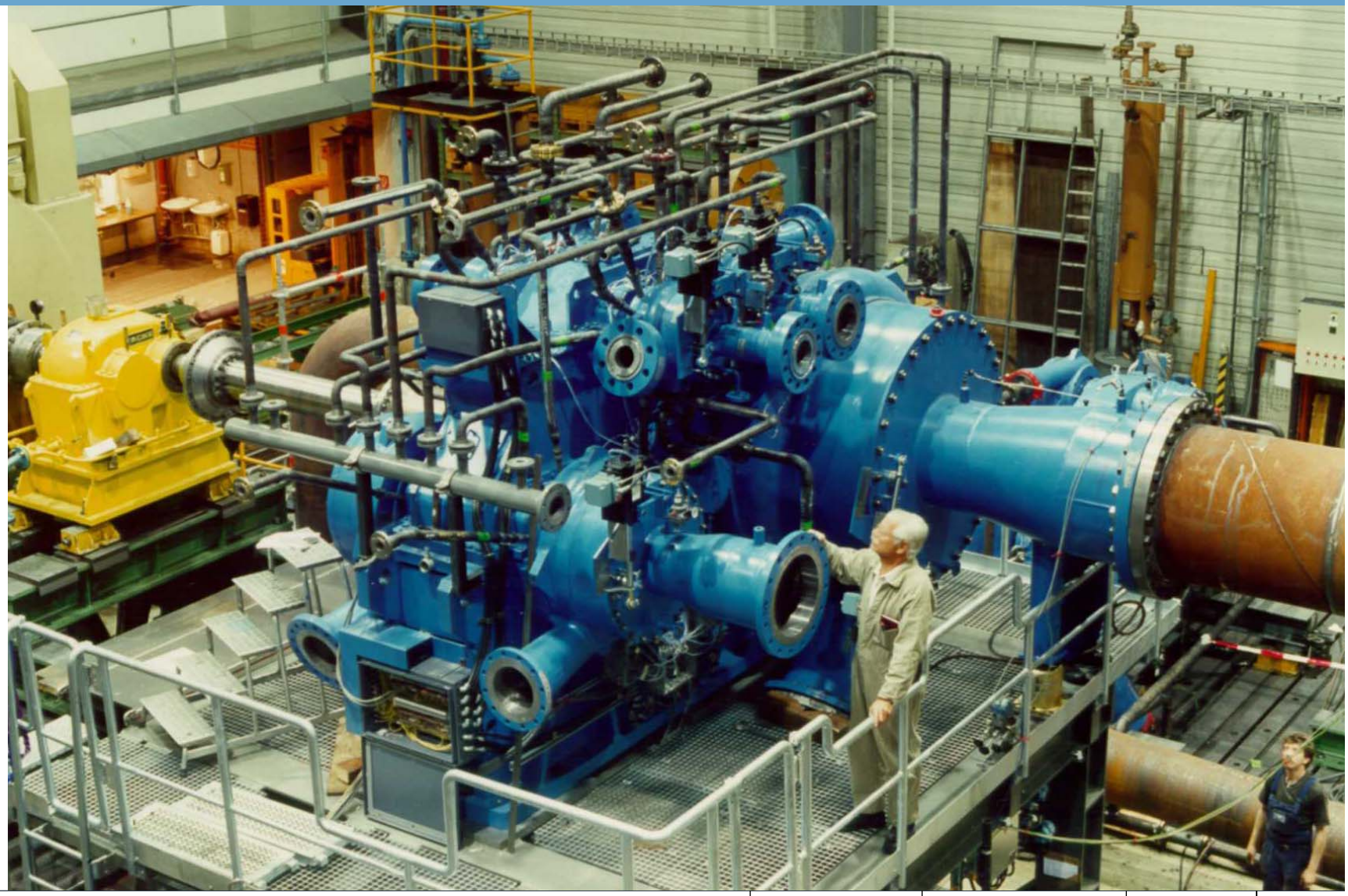
CO_2 High Pressure Compressors

Thermodynamic Design



Integrally-Geared Centrifugal

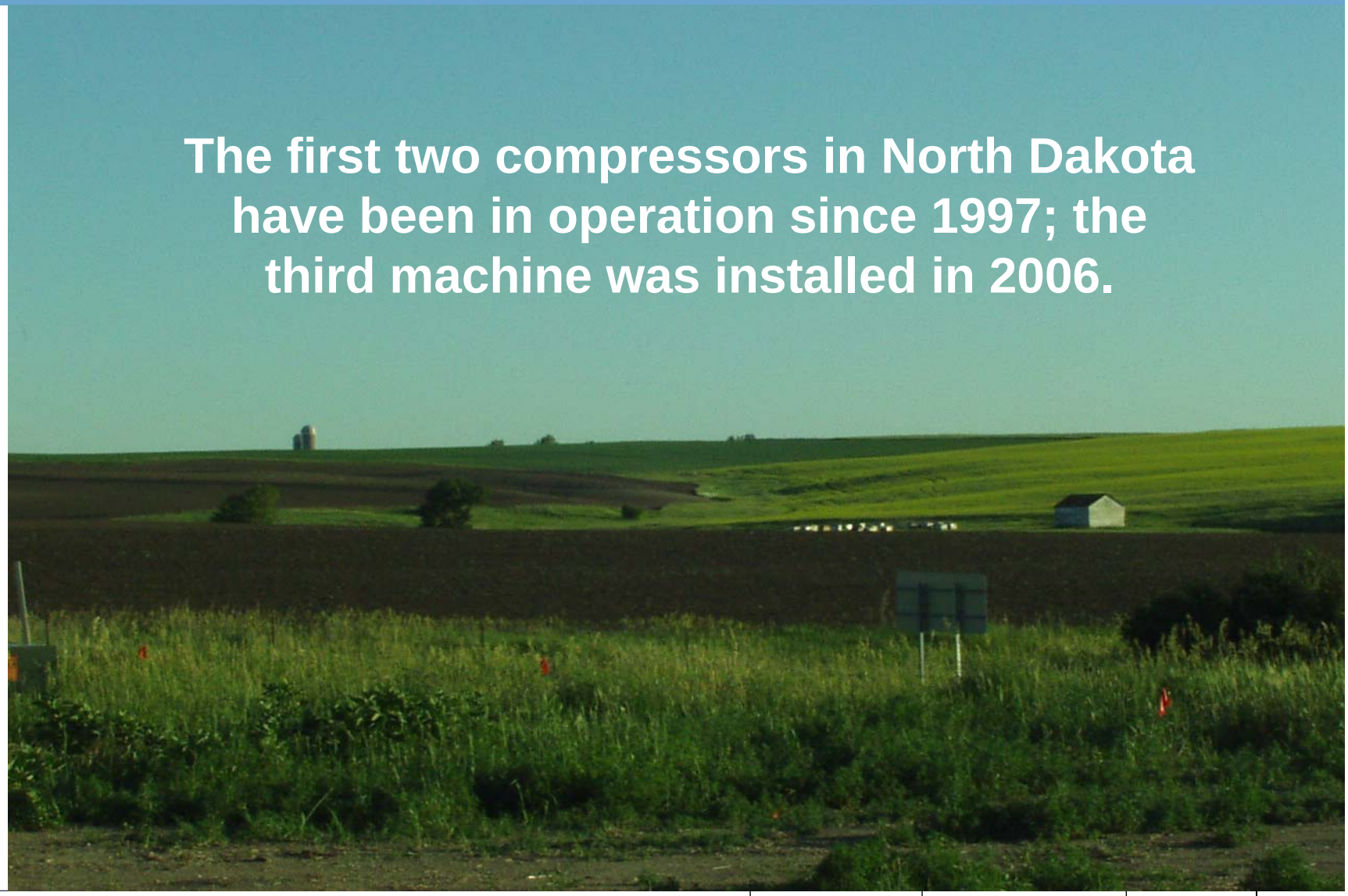
8 Stages



EnCana

Weyburn Oilfield Receiving Terminal

Integrally-Geared Centrifugals



Thank you
for your
attention

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Since 1758.