

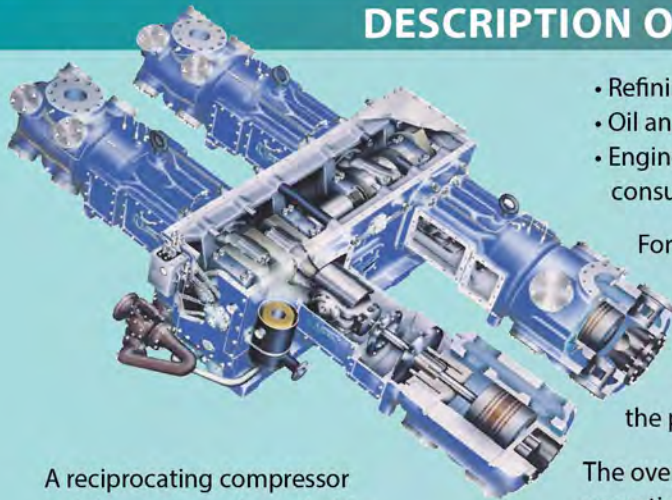
TRAINING PROGRAM ON RECIPROCATING COMPRESSORS IN THE ENERGY AND PROCESS INDUSTRIES

COURSES

ON RECIPROCATING COMPRESSORS

Basic Level • Fundamentals, Configuration & Components • 32 h.

DESCRIPTION OF THIS TRAINING PROGRAM



- Refining,
- Oil and gas field operation, and
- Engineering projects and consulting.

Forwarded to supervisors, engineers and technicians in operation, maintenance, engineering and selection of reciprocating compressors in the process/energy industry.

The overall objective is to increase operational reliability. The courses are geared towards the operator's viewpoint, and are generic, non-linked to any brand or model while trying to cover the full OEM spectrum.

The other two levels for this training program are (32 hours each):

Level 2 Intermediate Performance, Control, Special Types. Performance Softwares.

Level 3 Advanced Diagnostic and Optimization. Valve Behaviour. Levels 2 and 3 correspond to the degree of technical complexity and depth, and are sequential, IE, superior levels require the lower ones. Program oriented toward large size compressors.

Note: Another training program available in complementary area, namely, Electronic Condition Monitoring of Recip Compressors (200 h). Separate release available.

A reciprocating compressor training program intended for companies in the following areas:

- Chemical and gas processing,
- Gas Transportation

OBJECTIVES OF THE BASIC LEVEL

- Sequentially and completely familiarize the specialized engineer or technician with the reciprocating compression technology.
- Reduce the likelihood of human errors in the daily operation.
- Familiarize attendant with the design criteria, applications and behaviour of the most critical components.
- Facilitate the ranking of the decision taking process (the most important first)
- Motivate operational, maintenance and engineering folks to further research those aspects of the plant infrastructure related to their role within the company.



SKILLS THE ATTENDANT DEVELOPS

- Select the appropriate type of reciprocating compressors and components for a given application.
- Understand / anticipate the behaviour of reciprocating compressors before changes in the process and the machine.
- Identify the most likely causes of failures.
- Identify those areas susceptible to improvements.
- Propose solutions to management on repetitive technical issues.
- Address operational emergencies related to compressors, in the absence of management.

- Compute the key engineering parameters for a proposed application.
- Effectively communicate the above, using the appropriate terminology.
- Select the appropriate bibliographic material.

ECONOMIC BENEFITS

- Increased operational staff productivity (added dominion and motivation)
- Increased supervisory staff productivity (avoids having to go to the field in order to take decisions).
- Savings on parts.

- Increased Production (greater availability)

FAILURES WHICH CAN BE ADDRESSED

- High maintenance cost due to engine overload
- Crankshaft failures due to wrong load regime
- Rod breakage
- Valves
- Piston Rings
- Packings
- High discharge temperature
- Human errors

RECIPROCATING COMPRESSORS FUNDAMENTALS, CONFIGURATION AND COMPONENTS. BASIC LEVEL. 32 h

Introduction

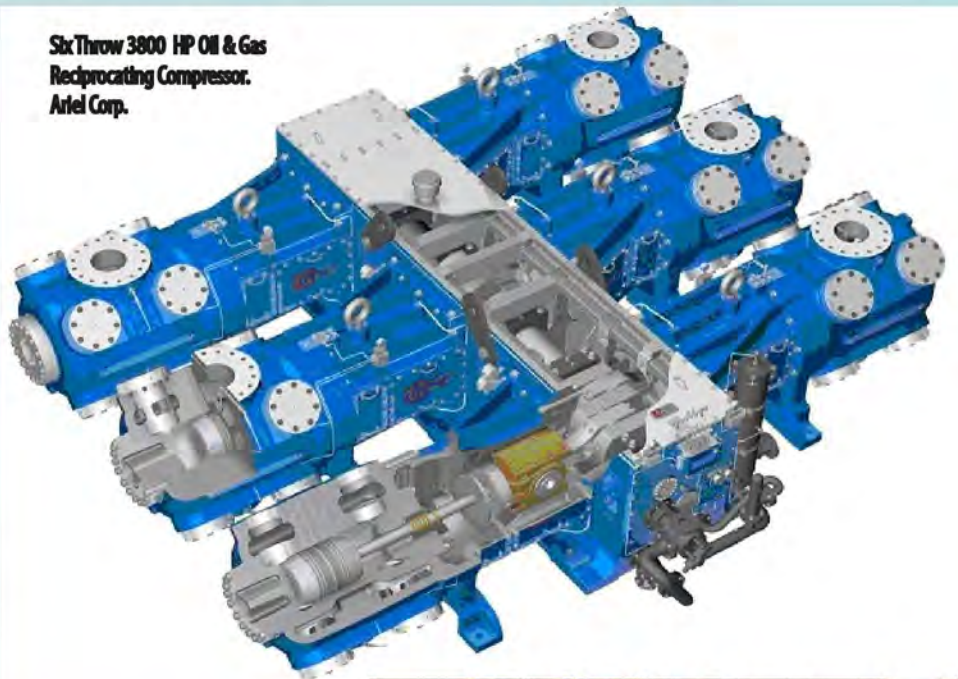
This course represents the first in a series of three which covers the main areas of knowledge for the reciprocating compression technology.

The course starts reviewing physical key parameters involved in gas compression as temperature and pressures, and others involved in machine reliability as vibration, speed, flow, torque and power. Key compressor parameters as discharge temperature, staging, rod loads, normalized flow, gas power, characteristic curves, valve functioning, are covered to fully familiarize the student with it and to prepare them to next levels, where we provide an in-depth coverage of these items.

This course summarized Turbodina experience in evaluations and investigations aimed to solve bearing failures, and will be helpful to focus the attention of the operation and maintenance staff on the key issues related to this. A separate shop is available on this subject.

This course (or equivalent instruction/-experience) is required for the next levels.

Six Throw 3800 HP Oil & Gas Reciprocating Compressor. Ariel Corp.



Packaged Hydrogen Reciprocating Compressor for a Chlorine Soda Plant. 50 bar, 2,000 HP. Nuovo Pignone.



Outlined Content:

- Basic Engineering Definitions
- PV Card
- Construction Of Reciprocating Compressors
- Expanded Content:
(More detailed content in a separate outline available)

1 • BASIC DEFINITIONS OF ENGINEERING TERMS

- Pressure
- Temperature
- Measurement
- Compression Ratio And Discharge Temperature
- Stages Of Compression
- Rod Loads (RL)

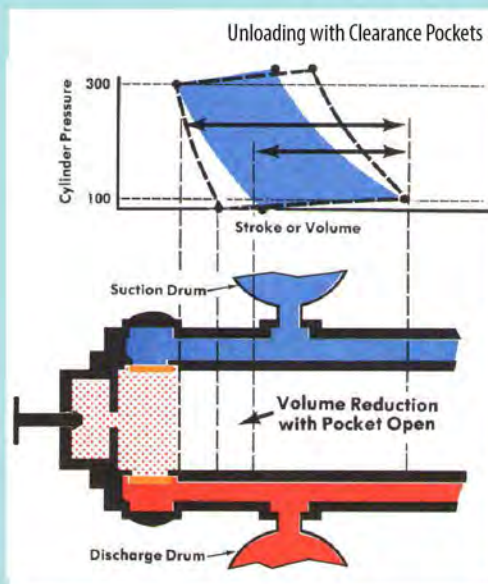
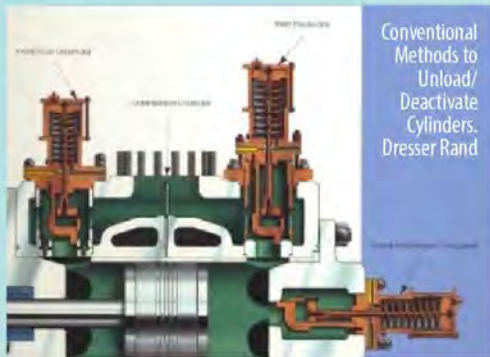
Annex 1.1.- Some Formulas Used In Recip. Compression

Annex A1.2.- Bibliography

2 • THE PV DIAGRAM

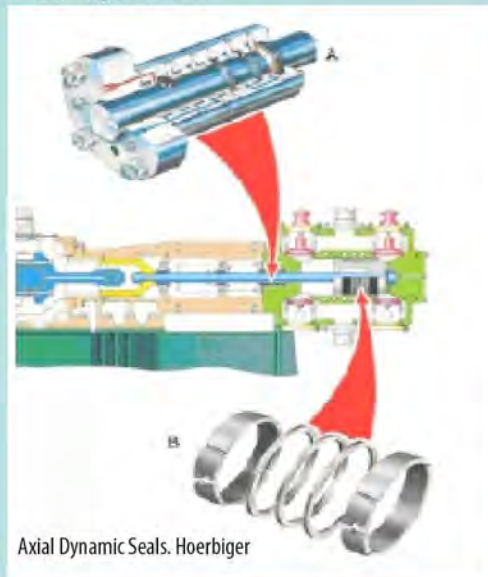
- Description of a Compressor Cylinder
- Sequence of Events in an ideal Recip Compressor Cylinder
- Mechanical Work and Power in The PV Cycle
- Characteristic Load Curves

Annex A2.1- Application Of The PV Cards.
Some Factors Affecting Recip. Compressor Performance.



3.- CONSTRUCTION OF RECIPROCATING COMPRESSORS

- Types Of Compressors In General
- Types Of Reciprocating Compressors
- Foundation
- Frame
- Cylinder Assembly And Configurations



- Distance Piece
- Cylinder Lubrication
- Compressor Valves
- Auxiliaries

Annex A3.1: A Guideline Of Best Practices To Avoid Crankshaft Failures

Annex A3.2: Bibliography

Annex A3.3: References For Images



LOCATION, DATES AND HOURLY SCHEDULE

For the latest information, please contact Farida Andriyani or Ipung Purwanti at PT Rhenium Indonesia - Rhenindo at farida@rhenindo.com or ipung@rhenindo.com.

COURSES UPDATE

We have completed an update for our courses to incorporate the following:

- Technology developed over the past decade,

- High quality figures and photos, and
- Class cases calculations.

Information sources:

- Actual case studies developed by the instructor during the past twenty years,
- Proceedings of The Turbomachinery Symposium, Texas A & M University,
- Web sites of components and accessories manufacturers,
- Textbooks on the subject,
- Brochures from major manufacturers,
- Compressor Tech 2 magazine,
- Turbomachinery Int'l magazine, Etc.

We provide literature used in some websites of leading technology companies, whose information is part of the text.

CLIENT'S LIST

Repsol YPF, Otepi-GreyStar, Tecnoconsult, Guardian Venezuela, Ameriven, Petrozuata, Sincor, BP, Dresser Rand Venezuela, Skanska Venezuela, Exterran Argentina, Hoerbiger Colombia, Petróleos de Venezuela PDVSA, Chevron Colombia, Petróleos Mexicanos PEMEX, Etc.

TURBODINA CREDENTIALS

Turbodina, with more than fifteen years in the Reliability Engineering Services for the rotating equipment in the Petroleum industry, offers this training program since 1999. We are in the Venezuelan National Contractors Register.

INSTRUCTOR

The Curriculum Vitae of the instructor is presented in a separate document. The instructor is a Senior Reliability Specialist for the Rotating Equipment in

TESTIMONIALS

"Better impossible". "In my compressor station experience, I had never seen someone who studies the subject so deep". "There is a variety of graphs in this course important to understand and dominate the reciprocating compressor analysis". Wilfredo Fuentes - Mechanical Specialist - Wilpro Energy Services (Joint Venture between Williams Int'l and Production Operators Inc. POI).
fuentesw@pdvsa.com,
fuentesw386@gmail.com;

"I finally found some time to review your training manuals. They look very good, well organized and detailed." M. Theodore Gresh - Turbomachinery Consultant, President of Flexware, Inc., Pennsylvania, USA.
mtgresh@flexwareinc.com.

"Our manuals are better than yours, but your courses as a whole are better than Dresser Rand USA ones. I am planning all of my people to go take your courses, Luis". Anwar Souki, Regional Manager, Dresser Rand of Venezuela, Caracas, Venezuela.
nur952@hotmail.com,
asouky@dresser-rand.com,

"I attended a Dresser Rand course in Le Havre, France, which was good, however Luis, after taking your course I sincerely believe yours is better!. Franklin Silva, Eastern Sales Manager, Dresser Rand of

the Petroleum Industry with 30 years of experience in the area, and belongs to the Venezuelan Engineering Association since 1980.

Degree Of Education

Formal: BSc in Mechanical Engineering, Simón Bolívar University, Caracas, 1979. Research and practice: self learning PhD-equivalent
Member of The Venezuelan Engineering Association.

Area of Interest

Turbo & reciprocating machinery engineering, troubleshooting and

Venezuela.

Fsilva2@dresser-rand.com,
silvafj@gmail.com.

"I understand the content to be developed is extremely wide, but with the help from the instructor the topics were clarified, allowing opening the way to be proficient on the equipment operation with all its utilities". Ricardo Alvarez, Neuquen District Operations Manager - Exterran Argentina, S.A., Neuquen, Argentina.
ricardo.alvarez@exterran.com.

"Luis, I checked carefully your manuals and found your courses are better than Ariel's ones and suitable even for us". Diego Bolinas, General Manager, Hoerbiger Compression Venezuela - Ariel Compressor Representative.
diego.bolanos@hoerbiger.com.

"The amount of material made it difficult to get involved and to advance with the course material". Lehman Malavé, Operations Supervisor - Orocuál 2 Compressor Station - Petroleos de Venezuela PDVSA.
malavelr@pdvsa.com.

"Excellent training, I became familiar with indispensable knowledge to be applied in the industry". Eric Boggio, Rotating Equipment Supervisor - Facilities Engineer. Heavy Crude Upgrading Complex PDVSA Petrocedeno, Venezuela.
boggioe@petrocedeno.pdvsa.com,
ericjoseboggio@yahoo.com.

dynamic analyses. Gas compression. Management and educational issues.

Professional Experience (35)

- Ingeniería Turbodina, C.A. Rotating Equipment Engineering and Consulting for the Energy Industry. Technical Director. (15 year).

- Intevep, S.A. Research and Technical Support Center, affiliate of Petroleos de Venezuela PDVSA. Rotating Equipment Specialist (10 year).

- Industrial Plants Engineering and Management. (10 year).

Full instructor's resume available upon request.

"The course goes beyond the assumptions, searching per se the root cause of the problem". Elvinson Díaz - Operator, Boquerón Compressor Station - Petroleos de Venezuela PDVSA.
diazjgs@boqueron.pdvsa.com.

REFERENCES

Edward Kelleher, Asian Region Manager, Windrock Inc., Monitoring and Diagnostic Systems for Reciprocating Machinery, Knoxville, Tennessee, EUA.
ekelleher@windrock.com. (The writer was the Latin America Instructor for Dynalco/Windrock in electronic Condition Monitoring Techniques using Recip Trap Analyzers).

Jose Castaneda, Senior Mechanical Engineer, Compressor Specialist, Mc Guffy Energy Services, Cypress, Texas, EUA. Jose.
castaneda@mcguffygroup.com.

Luis Gaspar, Infrastructure Manager, Petroleo de Venezuela Gas Anaco, Anzoátegui Venezuela.
gasparl@pdvsa.com.

Javier Nunez, Infrastructure Manager, Petroleo de Venezuela Gas San Tomé,
nunezj@pdvsa.com.

Marlon Martinez, Maintenance Superintendent, Petroleo de Venezuela E&P Furrial, martinezmao@pdvsa.com.

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PT Rhenium Indonesia- RHENINDO

Mailing Address: Kota Wisata – Canadian Broadway CBC-27, Cibubur Bogor, Jawa Barat 16968

Phone: +62 21 8493 6621 or +62 21 8493 0421 **Fax:** +62 21 8493 5274

For further Information regarding this course please contact:

Mobile: +62 818 737 800 (Farida) or +62 813 1020 2271 (Ipung),

email: info@rhenindo.com