

Reciprocating Compressor Optimum Design and Manufacturing with respect to Performance, Reliability and Cost

A. Almasi

Abstract—Reciprocating compressors are flexible to handle wide capacity and condition swings, offer a very efficient method of compressing almost any gas mixture in wide range of pressure, can generate high head independent of density, and have numerous applications and wide power ratings. These make them vital component in various units of industrial plants. In this paper optimum reciprocating compressor configuration regarding inter-stage pressures, low suction pressure, non-lubricated cylinder, speed of machine, capacity control system, compressor valve, lubrication system, piston rod coating, cylinder liner material, bearing device, pressure drops, rod load, pin reversal, discharge temperature, cylinder coolant system, performance, flow, coupling, special tools, condition monitoring (including vibration, thermal and rod drop monitoring), commercial points, delivery and acoustic conditions are presented.

Keywords—Design, Optimum, Reciprocating compressor.

I. INTRODUCTION

RECIPROCATING compressors are the most common type of compressors found in industrial applications [1]-[4]. **Worldwide installed reciprocating compressor horsepower is approximately three times that of centrifugal compressors** and maintenance costs of reciprocating compressors are approximately three and half times greater than those for centrifugal compressors [3]. Design and manufacturing of a reciprocating compressor shall be involved optimization process with respect to full array of compressor data. Otherwise, it may end up with equipment that may not be suitable over the full operating cases, reliability level, commercial terms or power requirement for which the manufacturer and client expect.

II. MACHINE DESIGN

A. Inter-stage Design Pressures

Discharge pressure of each stage is normally protected by pressure relief valves, high pressure discharge switches are seldom seen [2]. Optimum inter-stage pressures can be obtained by formulation and optimization of performance and investment for compressor and inter-stage facilities. **Inter-**

stage pressures based on just compressor without respect to inter-stage facilities, are not justified. Inter-stage pressures are going to increase during part load operation and high suction pressure. If not tolerate-able, additional clearance pocket on first stage cylinder and part load operation inhabitation by the controlling logic, can be studied. Generally it is compromise to fix PRV-Pressure Relief Valve set points (and inter-stage facility design pressure accordingly) based on worst case of part load operation and process variations (such as high suction pressure). For common design cases (50% and 75% part load steps and around 5%-7% suction pressure variation), PRV pressure set points will be around 10-15% higher due to part load operation and suction pressure variations.

B. Low Suction Pressure with Full Flow

Sometimes, due to process requirements, reciprocating compressors shall be capable to operate at lowest suction pressure and full design flow at normal discharge pressure. It can have strong effect on electric motor sizing as well as compressor sizing and machine frame rating (for example more than 35% electric motor power increase for 20% suction below normal). It is absolutely necessary to respect this condition for motor and compressor sizing. It is optimum to respect them in basic design and design stage to avoid costly changes.

C. Maximum Speed Lubricated Cylinder

Reliable machine is involved low speed (around 350 RPM) and lubricated cylinder. Optimum piston speed is 3-4.4 m/s. Optimum configuration: horizontal cylinder(s), discharge nozzle on the bottom side. For small compressor selection, it may be necessary to deviate lubricated cylinder or low speed. **Optimum option is lubricated cylinder with available lowest speed machines.** Probably less than 20% of all reciprocating compressors are designed for non-lubricated operation just because of process demands (oxygen, high pressure air, down stream facilities sensitive to oil such as some catalysts, etc) [2].

D. Unloader and Capacity Control System

Step-less capacity control system uses finger type unloader, is pneumatically actuated, and unloads the suction valve for only a portion of compression cycle to achieve adjusted

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Reciprocating Compressor Optimum Design And Manufacturing

David Kirk



Reciprocating Compressor Optimum Design And Manufacturing:

This book delves into Reciprocating Compressor Optimum Design And Manufacturing. Reciprocating Compressor Optimum Design And Manufacturing is a crucial topic that needs to be grasped by everyone, from students and scholars to the general public. This book will furnish comprehensive and in-depth insights into Reciprocating Compressor Optimum Design And Manufacturing, encompassing both the fundamentals and more intricate discussions.

1. The book is structured into several chapters, namely:
 - Chapter 1: Introduction to Reciprocating Compressor Optimum Design And Manufacturing
 - Chapter 2: Essential Elements of Reciprocating Compressor Optimum Design And Manufacturing
 - Chapter 3: Reciprocating Compressor Optimum Design And Manufacturing in Everyday Life
 - Chapter 4: Reciprocating Compressor Optimum Design And Manufacturing in Specific Contexts
 - Chapter 5: Conclusion
 2. In chapter 1, the author will provide an overview of Reciprocating Compressor Optimum Design And Manufacturing. The first chapter will explore what Reciprocating Compressor Optimum Design And Manufacturing is, why Reciprocating Compressor Optimum Design And Manufacturing is vital, and how to effectively learn about Reciprocating Compressor Optimum Design And Manufacturing.
 3. In chapter 2, the author will delve into the foundational concepts of Reciprocating Compressor Optimum Design And Manufacturing. This chapter will elucidate the essential principles that need to be understood to grasp Reciprocating Compressor Optimum Design And Manufacturing in its entirety.
 4. In chapter 3, this book will examine the practical applications of Reciprocating Compressor Optimum Design And Manufacturing in daily life. This chapter will showcase real-world examples of how Reciprocating Compressor Optimum Design And Manufacturing can be effectively utilized in everyday scenarios.
 5. In chapter 4, the author will scrutinize the relevance of Reciprocating Compressor Optimum Design And Manufacturing in specific contexts. The fourth chapter will explore how Reciprocating Compressor Optimum Design And Manufacturing is applied in specialized fields, such as education, business, and technology.
 6. In chapter 5, the author will draw a conclusion about Reciprocating Compressor Optimum Design And Manufacturing. This chapter will summarize the key points that have been discussed throughout the book.
- This book is crafted in an easy-to-understand language and is complemented by engaging illustrations. It is highly recommended for anyone seeking to gain a comprehensive understanding of Reciprocating Compressor Optimum Design And Manufacturing.

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