

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

Terry C. Jones



Reciprocating Compressor Optimum Design And Manufacturing:

Proceedings of the ... International Compressor Engineering Conference--at Purdue ,1988 **Catalytic Ammonia Synthesis** J.R. Jennings,2013-06-29 The phenomenon of catalysis is found in many homogeneous and heterogeneous systems undergoing chemical change where it effects the rates of approach to the equilibrium state in processes as diverse as those found in the stars the earth s mantle living organisms and the various chemistries utilized by industry The economies and the living standards of both developed and developing countries depend to varying degrees upon the efficacy of their chemical industries Con sequently this century has seen a wide exploration and expansion of catalytic chemistry together with an intensive investigation of specific essential processes like those contributing to life supporting agricultures Prime among the latter must surely be the fixation of atmospheric nitrogen by catalytic hydrogenation to anhydrous ammonia still the preferred synthetic precursor of the nitrogenous components of fertilizers In each decade contemporary concepts and techniques have been used to further the understanding as yet incomplete of the catalyst the adsorbates the surface reactions and the technology of large scale operation The contributors to the present volume review the state of the art the science and the technology they reveal existing lacunae and suggest ways forward Around the turn of the century Sabatier s school was extending the descriptive catalytic chemistry of hydrogenation by metals to include almost all types of multiple bond The triple bond of dinitrogen which continued to be more resistant than the somewhat similar bonds in carbon monoxide and ethyne defied their efforts **Summary of International Energy Research and Development Activities, 1974-1976** Smithsonian Science Information Exchange,1977 Presents animal sounds in many different languages [Summary of International Energy Research and Development Activities 1974-1976](#) Sam Stuart,2013-10-22 Summary of International Energy Research and Development Activities 1974 1976 is a directory of energy research and development projects conducted in various countries such as Canada Italy Germany France Sweden and the United Kingdom between 1974 and 1976 A limited number of projects sponsored by international organizations such as the International Atomic Energy Agency are also included This directory consists of nine chapters and opens with a section on organic sources of energy such as coal oil and gas peat hydrocarbons and non fossil organic sources The next sections focus on thermonuclear energy and plasma physics fission sources and energy production geophysical energy sources conversion technology and environmental aspects of energy conversion and use Energy transport transmission utilization and conservation are also covered The final chapter deals with energy systems and other energy related research on subjects ranging from car sharing and urban passenger transport to nuclear power plants energy supply and demand models and high power molecular lasers This monograph will be a valuable resource of information for those involved in energy research and development *Applied Mechanics Reviews* ,1988 *Annual Index/abstracts of SAE Technical Papers* ,1987 **Annual Report - Engineering Experiment Station, University of Wisconsin--Madison** University of Wisconsin--Madison.

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