Capacity Control Suite

HELPS CLIENTS SAVE ENERGY – AND MONEY

RECIPROCATING COMPRESSORS ARE a critical component in producing the energy and products we use every day. Dresser-Rand's reciprocating compressors and integral gas engines are found in refining, petrochemical, natural gas transmission and in general industrial applications. For compressor operators, maximizing efficiency and minimizing energy costs are key.

Because of industry standards and other unknown variables, compressors are typically built oversized to run over capacity. The positive displacement nature of process reciprocating compressors is such that you basically run it at full capacity or you turn it off. As such, they often require devices to regulate (reduce) capacity and help operators maintain process control. This is typically done with a combination of stepped unloading systems and a gas recycle loop, usually referred to as a bypass. However, the bypass that's necessary for process control wastes energy by re-compressing gas that's already been compressed and sent back to suction at reduced pressure. Thus, stepless control devices are necessary to eliminate the need for a bypass: enter Dresser-Rand's suite of capacity control options.

Dresser-Rand's capacity control (CapCon) suite is comprised of three variable control systems – (1) infinite step control (ISC); (2) gas-controlled stepless pockets (GSP); and (3) hydraulic variable volume clearance pockets (HVVCP). Each technology allows variable output from stepped or fixed output compressors over a wide range of operating conditions.

THE NEED FOR CAPACITY CONTROL

Process reciprocating compressors work much in the same way as the cruise control mechanism in a car. As the car goes uphill and the cruise control is set at a specific speed, the car increases its throttle to maintain the specified speed; going downhill, it decreases is throttle. Because reciprocating compressors are not variable capacity machines, "cruise control" – variable capacity control – is necessary to minimize wasted energy and thus reduce energy costs.

Why do I need Capacity Control?

- Decrease operational costs
- Minimize wasted energy (less gas to bypass)
- Greater freedom of capacity (control down stream pressures and flows)

Our variable capacity control system gives operators an infinite number of intermediate steps so the compressor can run at less than full design capacity and use less energy when appropriate. Simply put, you want to be able to close the bypass and maintain process control (e.g., pressure) although your flow requirements are constantly changing. Exerting this throttle over the compressor allows you to save operating energy and reduce energy costs.

The key to selecting the right capacity control system is working closely with an experienced compressor OEM, such as Dresser-Rand.

HISTORY OF STEPLESS CAPACITY CONTROL

The beginning of stepless capacity control dates back to the 1950s when Ingersoll-Rand developed a pneumatic hydro-mechanically controlled infinite step capacity controller (ISC) that held the suction valve open and provided variable end unloading. (The hydraulically operated variable volume clearance pockets, HVVCP, concept was also developed during this

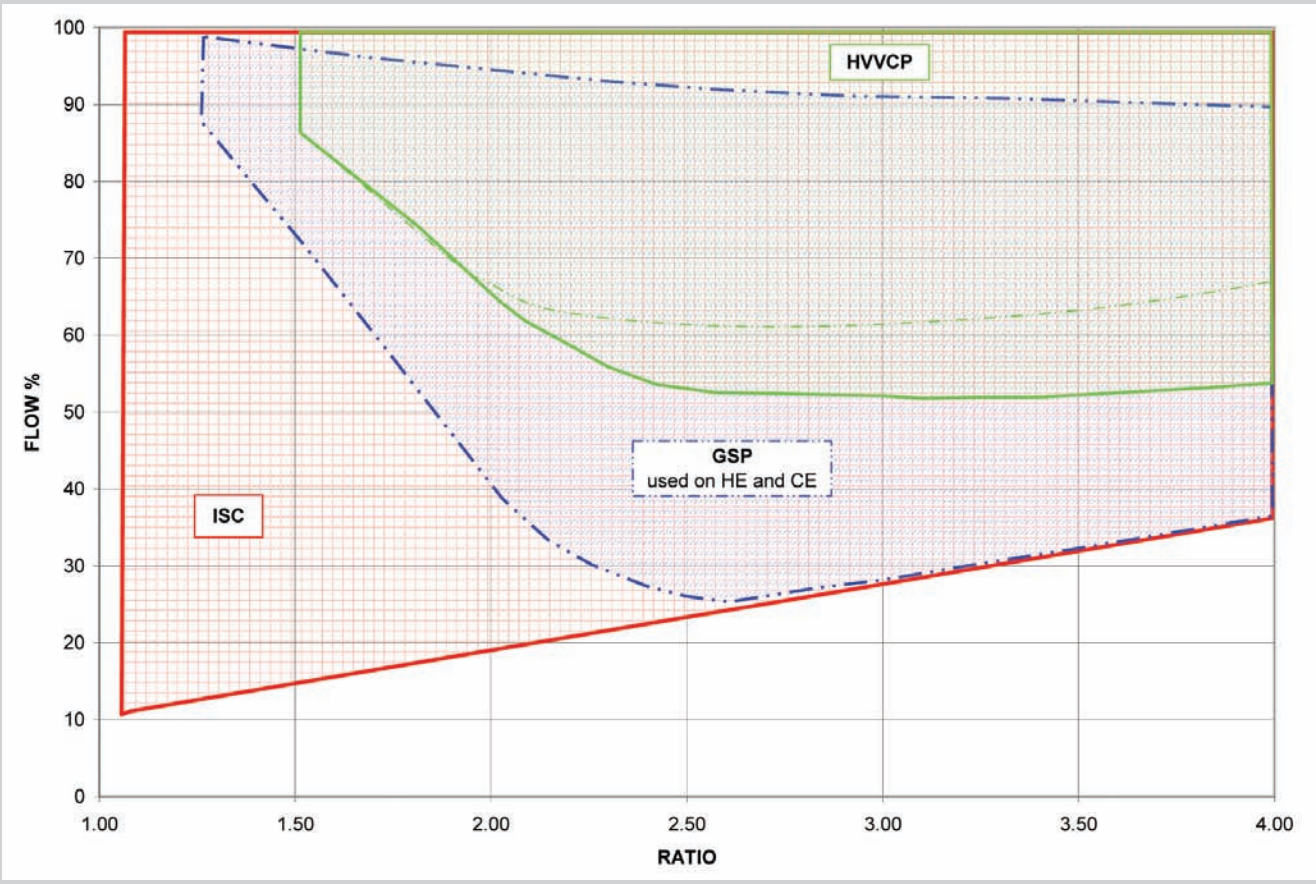

Figure 1 – CapCon suite turndown chart.

time.) The ISC technology proved successful with integral gas engines through the 1970s, but wasn't actively pursued in the process market until more recently. In the late 1990s, Dresser-Rand began using electronic controls on gas engines and began adapting these products for variable capacity control of reciprocating compressors for process applications around 2000 (updated ISC control system).

INFINITE STEP CONTROL (ISC)

The infinite step control (ISC) system eliminates fixed, discrete load steps and serves as a replacement for traditional port, plug and fixed clearance pocket unloader systems – which allows the recycle (or bypass) valve to remain closed. One of its advantages is that it offers a greater flow control range than variable pockets – 100 to 30 percent and zero percent (see Figure 1). Because of this, it's gaining increased popularity, especially among clients in the process market.

The ISC system is a computer-controlled, hydraulically activated, finger unloader system that comprises three distinct subsystems – the electronic, hydraulic and unloader subsystems. The ISC electronic controller provides start/stop controls, safety shutdowns and calculations for precise capacity control (including unloading at start-up and control of interstage pressure to avoid excessive rod loading).

HOW THE ISC SYSTEM WORKS

The ISC system basically eliminates fixed, discrete load steps, so reciprocating compressor efficiency is optimized by controlling capacity over a wide range of operating conditions.

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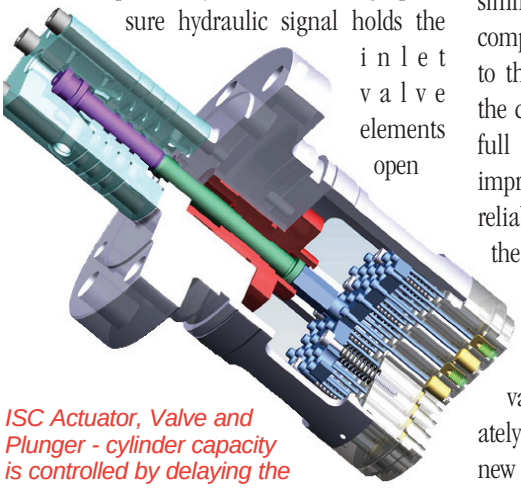
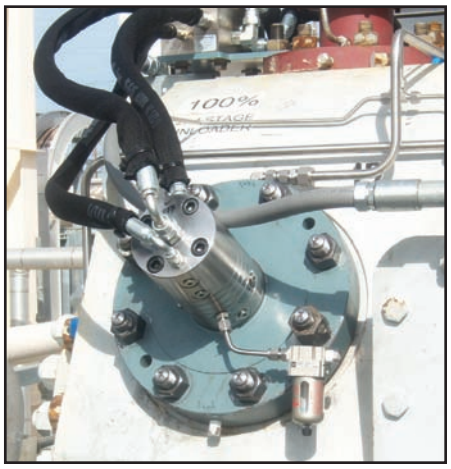
It works like this. The electronic controller's high-speed module converts capacity set-point signals into timing signals that are fed to electric servo valves that control the pressurization of the valve actuators. A hydraulic signal is then sent to each inlet valve unloader on the compressor cylinders. This high-pressure hydraulic signal holds the inlet valve elements open



ISC Actuator, Valve and Plunger - cylinder capacity is controlled by delaying the closing of the inlet valves.

for a precise percentage of the discharge stroke. Upon activation, the fingers travel rapidly toward the open elements. As they get close to the end of their stroke, hydraulic damping decelerates the fingers so that they land gently on the elements. On the return stroke, the fingers move up at a controlled speed to allow proper valve closing, then move slightly off the valve elements before gently coming to rest. The compressor capacity is reduced or increased by accurately varying the timing of the hydraulic signal. This precise functionality provides infinite variable control of compressor capacity.



ISC installation.

We developed the electronically controlled ISC system several years ago to specifically address a client need. The client asked if we had a similar capacity control offering to that of a competitor, so we designed a unique upgrade to the old mechanical ISC system to provide the client (a gas transmission company) with full control over compressor capacity while improving the controller reliability. Also, the reliable Magnum® valve was incorporated into the ISC system to improve overall system reliability. And it was far less complex and less costly than the competitor's computer-controlled, delayed suction valve-closing system. The client immediately issued a purchase order for two of the new ISC system upgrades, and placed five more orders thereafter.

GAS-CONTROLLED STEPLESS POCKETS (GSP)

Dresser-Rand's gas-controlled stepless pocket (GSP) system allows reciprocating compressor cylinder capacity to be continuously varied over a range set by the pocket's volume and can be adjusted manually or automatically. The GSP – patented by Gas & Air Specialty Products, Inc. and licensed to Dresser-Rand – uses common, easily maintained parts and doesn't require hydraulics.

With the GSP system, the cylinder clearance volume is altered by varying the pocket control pressure. The amount of turndown available depends on the pocket size and the pressure ratio of the cylinder.

HOW THE GSP SYSTEM WORKS

The GSP system uses a fixed volume pocket, but the usual plug-type valve or piston is replaced with a specially designed pocket control valve compressor valve – typically a D-R Magnum valve. The valve's guard is designed so that control gas (typically process gas) can be introduced to the guard side of the elements. Control pressure determines capacity and is adjusted between cylinder suction and discharge pressure. The valve opens when the cylinder pressure is greater than the control pressure and closes when it is less than the control pressure. If the control pressure is set partway between cylinder suction and discharge, the pocket is open for only part of each cycle, and part load operation results. Different partial loads can be achieved by adjusting the control pressure. (The control pressure is constant and does not vary with compressor rotation; therefore, no flywheel timing, hydraulics, high-speed electronics, or high-speed solenoid valves are required.)

GSP installation.

There's the option for head-end or crank-end installation, so it's flexible because it allows control on both ends of the compressor cylinder. Furthermore, no hydraulics or dynamic seals are required. This simplifies installation and maintenance and virtually eliminates seal maintenance and fugitive

GSP - cylinder clearance volume is altered by varying the pocket control pressure.

emissions. It's a great, cost-effective option for upgrades and revamps where upfront cost is crucial.

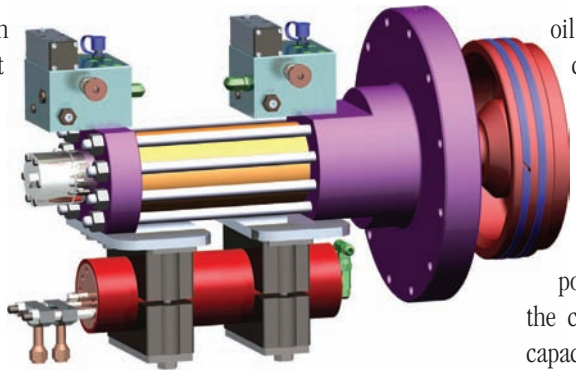
THE HVVCP – A FLEXIBLE ALTERNATIVE FOR CONTROLLING COMPRESSOR LOAD

The innovative hydraulic variable volume clearance pocket (HVVCP) capacity control technology offers the highest efficiency rates of the three products in Dresser-Rand's CapCon suite. The position of the clearance piston is controlled by a hydraulic cylinder; moving a clearance piston alters the cylinder clearance volume.

The HVVCP is mounted in the outer head of a reciprocating compressor cylinder. It's a hydraulically activated clearance pocket that can be applied to virtually any reciprocating compressor and to any process gas (including sour gas). It allows infinite step capacity adjustments within the limits of the clearance pocket volume and the stage ratio of compression.

The HVVCP is designed to replace manual hand-wheel operated VVCPs, but can be configured to operate manually or automatically.

Compressor cylinder pressure, combined with the opening and closing of control valves, provides a flexible capacity control capability to respond instantaneously to changes in process demand while the compressor is running under load. As a replacement for hand-wheel operated clearance pockets that typically require the compressor to be shut down and the cylinder depressurized before capacity changes can be made, the HVVCP virtually eliminates the associated maintenance and operational costs. And it's safer and more reliable than hand-wheel operated clearance pockets because it's self-contained and enables capacity adjustments to be made while the compressor is running under load.



HVVCP - cylinder pressure alternates between suction and discharge, resulting in an alternating force on the pocket piston and rod. By opening one of the control valves the hydraulic piston is allowed to move towards the open valve.

HOW THE HVVCP SYSTEM WORKS

Compared to hydraulically operated compressor valve unloader systems, the HVVCP is much less complicated, more reliable, has higher efficiency, lower cost, and the easily maintained 'bolt-on' system doesn't interfere with valve maintenance. The HVVCP is self-contained and does not require an external hydraulic power supply.

With the HVVCP system (Figure 2), when a capacity change is required and a control valve is opened, the hydraulic system acts as a ratchet, enabling the clearance pocket piston to move in one direction. For example, if valve B is opened and valve A is closed, hydraulic oil flows from the outer end of the hydraulic cylinder through valve B into the inner end of the hydraulic cylinder through check valve C. This occurs during that part of the stroke when the compressor cylinder pressure force is greater than the balance pressure force. The clearance pockets piston is then free to move to open the clearance pocket and reduce compressor capacity and horsepower.

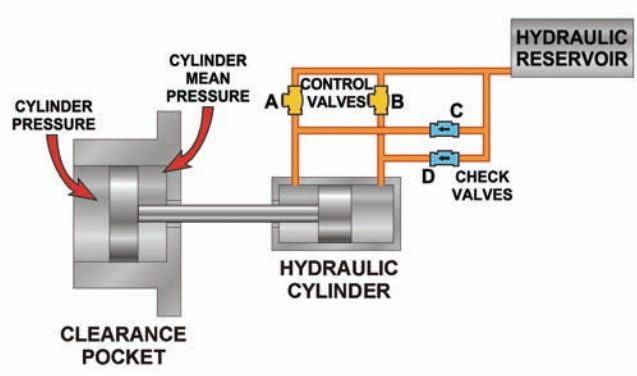
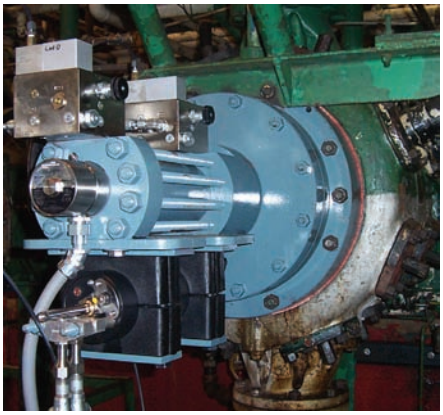


Figure 2.

Similarly, if valve A is opened (and valve B is closed), the clearance pocket piston is free to move to increase compressor capacity. This occurs during that part of the stroke when the balance pressure force is greater than the compressor cylinder pressure force. When both control valves are closed, the clearance pocket piston is locked in position, thereby maintaining the desired capacity setting.



HVVCP installation.

CHOOSING THE RIGHT CAPACITY CONTROL SYSTEM

Variable capacity control devices are becoming more prevalent in the process market because of increased energy costs and the desire to save energy and related expenses whenever possible. Dresser-Rand's history in the reciprocating compressor industry dates back to the late 1800s. So our experience, backed by OEM expertise and knowledge, makes us the obvious choice to help clients select the right capacity control system for their specific operating requirements. ■