

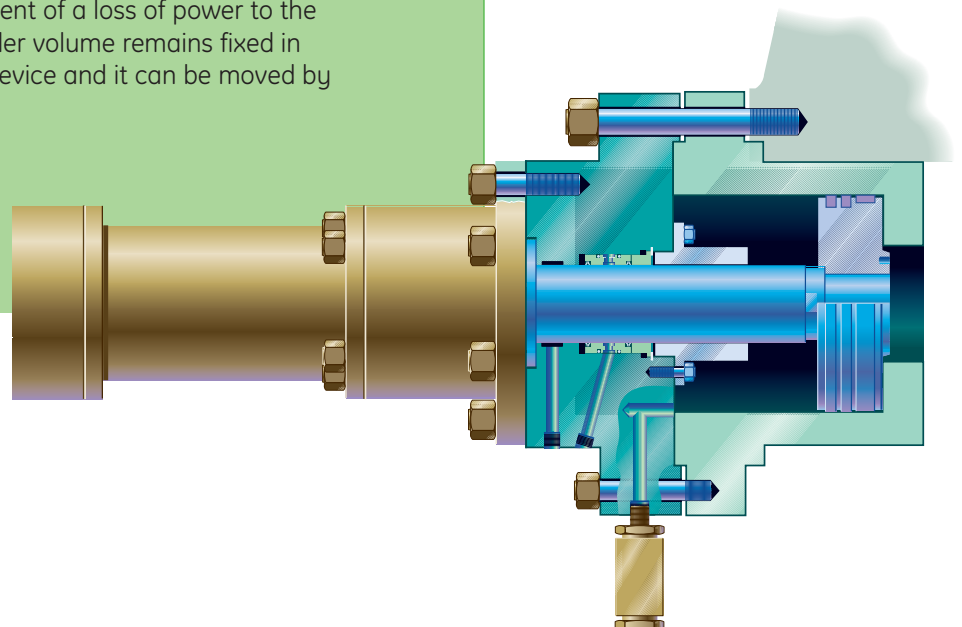
# Stepless Clearance Pocket

## Benefits

- Increased production
- Higher efficiency**
- Compliance with environmental regulations
- Availability and Reliability**
- Life extension

Our approach maintains ideal performance even under variable operating conditions with many advantages, as follows:

- **Energy savings**  
Since the GE Oil & Gas device is stepless, the capacity of the machine can be adjusted to meet the exact process needs, thereby compressing only the gas required by the process and avoiding unnecessary bleeds
- **Discharge temperature**  
Since the gas is not flowed back through the suction valves, our system doesn't produce any gas heating, avoiding high discharge temperature problems at partial load
- **Reliability**  
The regulation piston does not need to act at every compressor revolution, reducing the potential for mechanical failure and improving reliability and availability
- **Gas range**  
Designed to meet typical process operating range requirements
- **Availability**  
Unlike other types of capacity control devices, the compressor does not stop running, even in the event of a loss of power to the clearance pocket, because the cylinder volume remains fixed in the last position determined by the device and it can be moved by a manual device



## What it is

Frequently encountered problems faced by customers in controlling reciprocating compressor capacity include:

- Discontinuous suction valve unloading
- Discontinuous clearance pocket adjustment
- Reverse flow system interference with suction valves
- Speed control with special and expensive variable speed electric drives

We have eliminated all of these problems with a new capacity control system that does not interfere with the valves or other operating components of the machine.

This system allows capacity to be controlled steplessly to precisely meet customer requirements, thereby optimizing power consumption and reducing energy costs.

Whereas previous clearance pockets were manually activated, our new system is hydraulically operated and regulated by a remote control unit that automatically collects and analyzes process data and adjusts the compression volume accordingly. A configurator for analyzing the technical and economic impact on the entire compression plant has also

been developed.

The AVCP system consists of four main sub-system (see *Figure 1*):

- AVCP control unit box
- Manifold with directional valves
- Hydraulic actuator (with built-in pressure transducer)
- Hydraulic console

The AVCP control unit box elaborates the input signal coming from the capacity control regulator and operates on the directional valve mounted on the manifold (*Figure 2*) until the hydraulic actuator reaches the required position.

The hydraulic actuator (*Figure 3*) moves the regulation piston, modifying the cylinder clearance and consequently the cylinder capacity. The oil is delivered by the hydraulic console (*Figure 4*) at necessary pressure to move the hydraulic actuator.

The hydraulic console consists of the following main components:

- Gear pump driven by electric motor
- Emergency manual pump. In case of failure of electric supply, the AVCP system can be operated by the manual pump
- Instrumentation (pressure gauge and transmitter, temperature

indicator and transmitter, level gauge and switch)

- Oil filters
- Oil heater and/or oil cooler (according to ambient conditions)

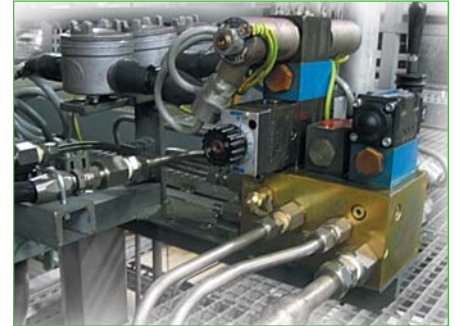


Figure 2: Manifold with solenoid and manual directional valve



Figure 3: Hydraulic actuator



Figure 4: Typical hydraulic console

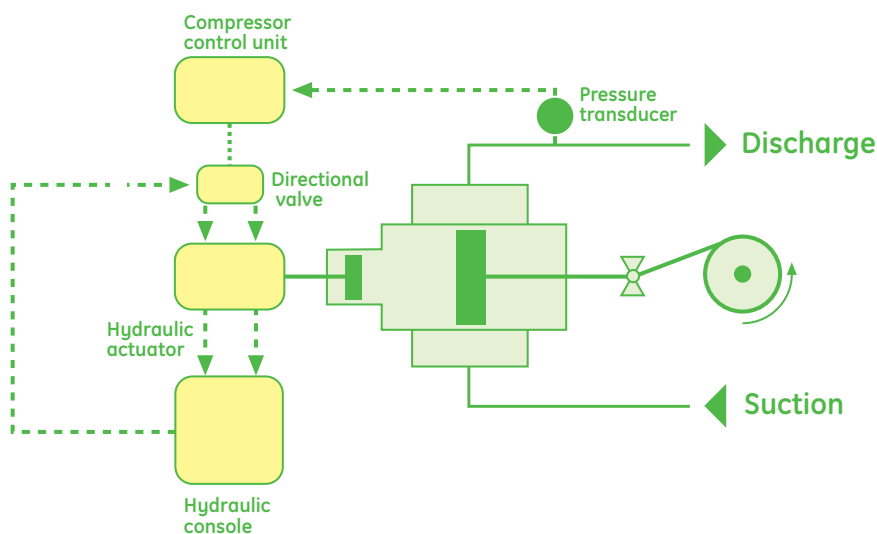


Figure 1: Typical variable clearance pocket functional scheme

## How it works

The new automatic capacity control system has been engineered to provide continuous, automatic control of compressor throughput by varying the clearance volume of each cylinder.

The operating principle of the remote control system is the same as that of the manually adjustable clearance pocket. When the variable clearance pocket system is in operation, the Pressure - Volume (P-V) cycle is modified yielding the cycle energy saving represented by areas A1 and A2.

Moreover, the new automatic system reduces energy loss at the cylinder valves thereby keeping the compression efficiency constant even under partial load. Areas S1 and D2 represent additional energy saving (see Figure 5).

The control system logic allows the compression cycle shape to be controlled in order to keep:

- constant suction pressure
- constant discharge pressure
- constant throughput
- maximum available engine/motor power

The system automatically optimizes the compression cycle using an

electronic signal from the process (e.g., by monitoring the discharge pressure with a pressure transducer). The automatic control system consists of the primary subsystems shown in Figure 1.

The compressor control unit evaluates the input signal and operates a directional valve until the required operating condition is reached.

The automatic control system can be thought of as three functional components:

- the actuator and hydraulic cylinder
- the variable clearance pocket
- the control system

After evaluating the sensor data, the control unit activates a 3-way solenoid valve until the requested capacity is reached. A hydraulic console supplies the oil pressure to the hydraulic cylinder to move the regulator piston that creates the necessary clearance pocket volume. The thermodynamic principle of the hydraulically operated system and the fixed clearance pocket is the same. By controlling the length of the effective suction stroke of the pressure cycle, only the requested

gas capacity is processed by the cylinder. In this way, the power consumption of the cylinder is limited only to the amount that is required to handle the gas demand of the plant. In addition, the same lubricating oil used in the compressor or driver can be used in the pocket control system, eliminating the need to stock additional hydraulic oils and avoiding the potential problem of cross contamination of different oils. Usually, the AVCP is a part of the compressor capacity control system as per the recycle valves that is actuated by control signals based on operating parameters (see Figure 6). The AVCP does not alter the control philosophy of the compression plant. As a matter of fact for the AVCP operation, the existing output control signal for the recycle valve is used and operates in split range with the recycle system.

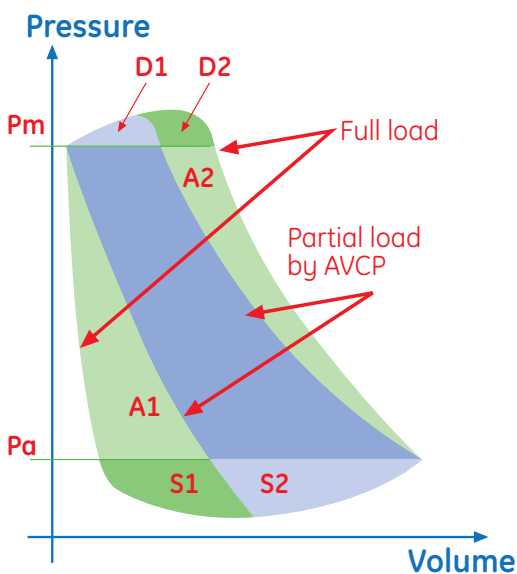


Figure 5: Compression cycle under full load and capacity control by additional volume

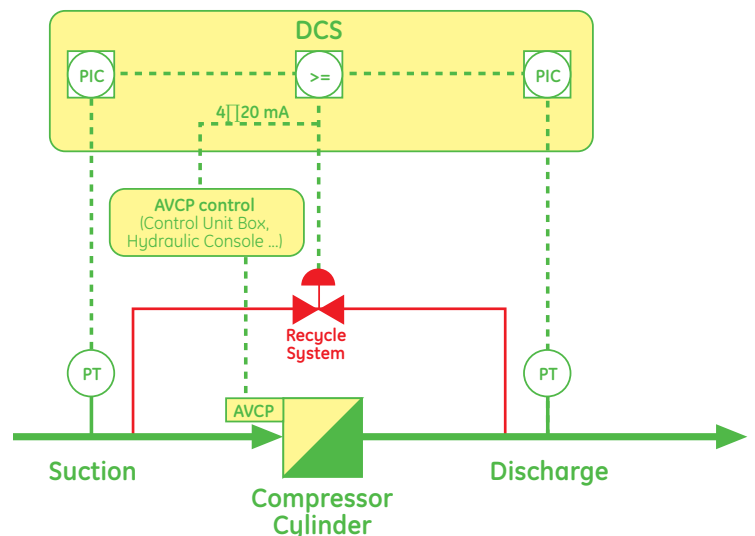


Figure 6: Typical AVCP capacity control system diagram

## How it works

The AVCP system may be controlled in two different ways:

- Auto mode: AVCP control unit box, after the elaboration of an input control signal (4÷20 mA) coming from the control system (at present acting on the recycle valve), automatically operates the directional valve until the requested compressor capacity is reached
- Manual mode: the operator manually adjusts compressor capacity by means of relevant controls (load increase/decrease), located on the AVCP control unit box

Another important feature of the AVCP system is the auxiliary hydraulic circuit, that consist of a manual pump

installed on the hydraulic console, and of the manual directional valves located on the manifold: in case of power failure (of the hydraulic console or of the control system), it will be possible to move, in any position, the regulation piston by the manual directional valves.

### Applicability

This solution is designed for GE Oil & Gas machines but it can also be applied to reciprocating compressors from other manufacturers.

The device can be designed, built and installed to meet specific customer needs.

The maximum benefit is excepted on units running for a long time under partial load conditions.

### Scope of Supply

The general scope of supply for each stage cylinder is:

- 1 cylinder head assemblies with all the internal parts (see Figure 3)
- 1 hydraulic actuator
- 1 assembly manifold valve systems
- 1 external support

In addition:

- 1 hydraulic console
- 1 AVCP control unit box, certified for safe area
- Accessories



GE imagination at work