Solar® Turbines
A Caterpillar Company

WORLDWIDE TURBOMACHINERY SUPPORT

Compressor Restaging

For Maximum Performance and Profit

Restage Your Compressors – Boost Your Profits

If you're looking for a way to increase gas compression profits, you may find it in your own equipment. Even if your *Solar*® compressors are relatively new, you could benefit from restaging. When technically justified, restaging substantially improves performance and brings dramatic return on investment.

Flow Range, Efficiency, Fuel Economy

Why restage compressors? Because, over time, normal usage and change in operating conditions – gas flow, pressure, temperature and composition – can affect your equipment's productivity or range of operation. Restaging restores your compressors to optimum performance. The benefits include:

- Extension of system life
- Greater efficiency for reduced fuel costs and increased gas production
- Increased flow range and flexibility

Renewing Performance

You can restage at any time during the life of your compression system. Restaging during a compressor overhaul minimizes equipment downtime. The restaging process changes the gas flow and head characteristics to optimize efficiency around a new set of operating conditions. It is a highly cost-effective way to get the most from your compression system. You can achieve even greater performance gains by also uprating the gas turbine driver.

San Diego Compressor Aero Test Facility

See How Restaging Pays You Back

A compressor restage brings you immediate benefits in efficiency and performance. Consider these examples:

GAS TRANSMISSION

Objective: Increased Flow

Current operating conditions:
- P1 = 565 psia (3895 kPa)
- P2 = 815 psia (5620 kPa)
- Standard flow = 275 mmscfd (307,175 Nm³/hr)
- Isentropic efficiency = 74%

INCREASED EFFICIENCY

Restaged operating conditions:
- P1 = 565 psia (3895 kPa)
- P2 = 815 psia (5620 kPa)
- Standard flow = 325 mmscfd (363,025 Nm³/hr)
- Isentropic efficiency = 84%

Result: Increased efficiency from 74% to 84%; 18% decrease in turbine fuel cost. Payback: 3 months

GAS INJECTION

Objective: Increased Discharge Pressure

Current operating conditions:
- P1 = 415 psia (2860 kPa)
- P2 = 920 psia (6343 kPa)
- Standard flow = 136 mmscfd (151,912 Nm³/hr)
- Isentropic efficiency = 81%

INCREASED PRODUCTION

Restaged operating conditions:
- P1 = 415 psia (2860 kPa)
- P2 = 1200 psia (8274 kPa)
- Standard flow = 98 mmscfd (109,466 Nm³/hr)
- Isentropic efficiency = 81%

Result: 280 psi discharge pressure; increased oil production revenue significantly.

GAS GATHERING

Objective: Decreased Suction Pressure

Current operating conditions:
- P1 = 350 psia (2413 kPa)
- P2 = 815 psia (5620 kPa)
- Standard flow = 120 mmscfd (184,040 Nm³/hr)
- Isentropic efficiency = 82%

EXTENDED FIELD LIFE

Restaged operating conditions:
- P1 = 230 psia (1586 kPa)
- P2 = 815 psia (5620 kPa)
- Standard flow = 80 mmscfd (89,360 Nm³/hr)
- Isentropic efficiency = 82%

Result: Met a 120 psi drop in suction pressure; significantly extended field life.

Let Us Calculate Your Benefits.

Solar Turbines offers a FREE evaluation that quantifies the return you can expect from compressor restaging. Contact us for details.

Knowing When to Restage

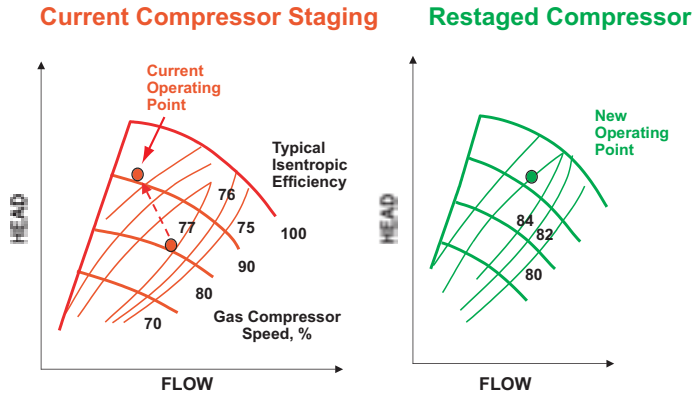
Solar Turbines utilizes a state-of-the-art compression performance modeling system to help decide whether restaging is right for you. In general, you should consider restaging when a gas compressor is operating out of its design envelope – either close to surge or near choke. A restage can also help you capitalize on opportunities, such as by changing operating characteristics to meet an increased-flow contract.

How Restaging Helps Your Operation

The accompanying graphs illustrate three potential benefits of restaging.

Improve Surge Margin

In this example (Figure 1), flow through the compressor is insufficient for the current staging, and the operating point has moved left toward the surge line. To maintain stability, the compressor must recycle gas back through the gas cooler and return it to the suction side. Consequently, the unit operates at a higher flow than it is actually sending downstream and fuel is wasted. This compressor would be restaged to a lower-flow configuration, thus placing the operating point in the middle of the map with satisfactory surge margin.

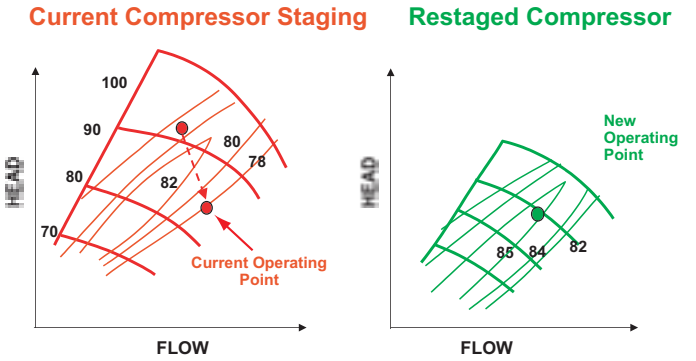


Improve Surge Margin

Figure 1

Improve Efficiency

This compressor (Figure 2) is facing higher flow demand and lower head requirement than the original design. There are now too many stages and the speed has declined, forcing the compressor to operate at lower efficiency and the turbine to operate with a higher, off-optimum speed loss. A restage would drop one or more stages in combination with a change to the remaining stages, moving the map over the current operating point and restoring lost compressor and turbine efficiency.

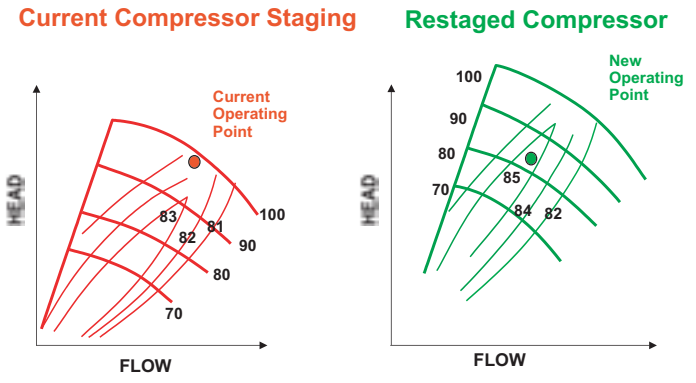


Improve Efficiency

Figure 2

Increase Head-Making Capability

In this instance (Figure 3), inlet pressure is decreasing, yet discharge pressure must be held constant. The unit, therefore, must operate at increasing speed. Eventually, the unit will reach its maximum speed and will be unable to make the required head. The solution is to add more stages to accommodate the lower inlet pressure and higher head requirement while maintaining the required discharge pressure.



Increase Head-Making Capability

Figure 3

Get the Best Return – Work With Solar Turbines

You deserve the greatest possible payback from your compressor restaging project. That's why you should choose Solar Turbines. We'll restage your *Solar* compressors with one goal in mind: To give you the highest long-term performance and profit.

Our global population of gas compressors exceeds 4,300. Restaging and overhaul are part of our core expertise – we have restaged more than 2,700 units. Because we built your equipment, we understand it down to the smallest detail. We complete all work to exacting original-equipment standards, so that your compressors will operate like new – or even better.

We can perform the restage on site, or at one of our strategically located facilities around the world. To minimize your downtime, we can furnish exchange compressor assemblies, shortening project cycle time significantly. As part of the restage, Solar can provide the necessary changes to the compressor surge control system.

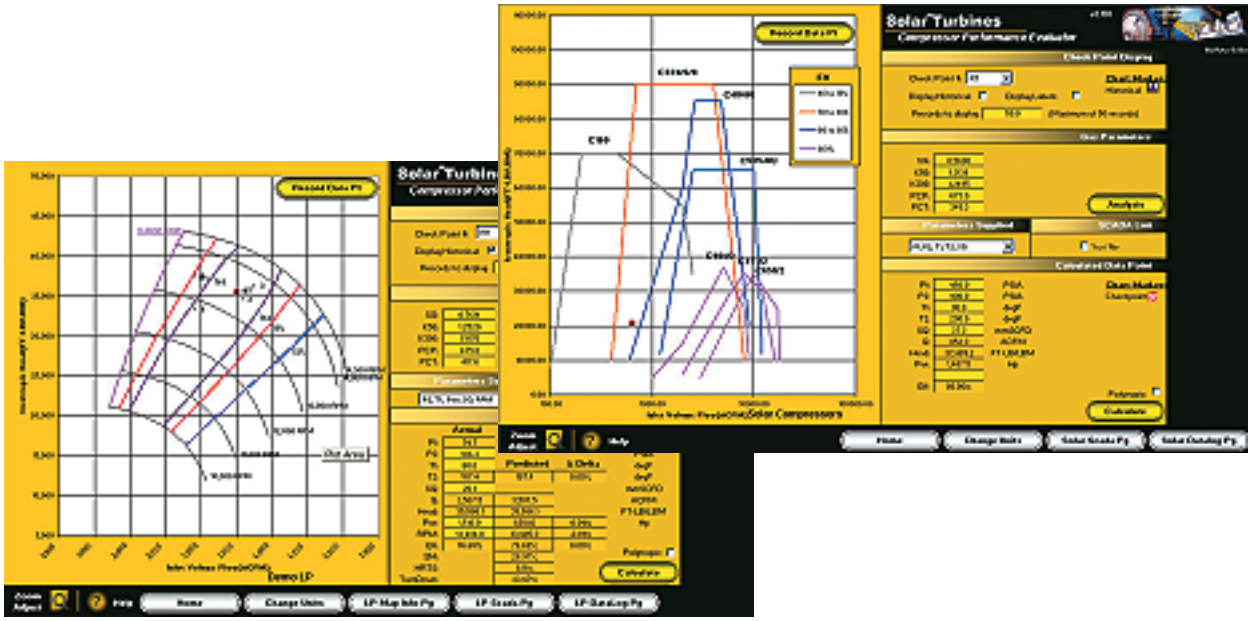
Our promise is simple: A quality job, in the shortest time practical, with a highly attractive return on your investment.

Texas Compressor Test Facility

Don't Delay – Get Your Profits Flowing

Every day you operate at peak efficiency puts money in your pocket. Solar Turbines can complete your restaging quickly and with minimal impact on your daily operations.

The first step is a free compressor evaluation. Solar Turbines experts will perform a computer analysis of your current operating conditions and future operating conditions you wish to evaluate. If the analysis points to restaging, we'll give you a budget proposal that includes your equipment's new performance capability and a financial analysis, including net present value and the payback period you can expect.



Contact Information

For more information on Solar's Gas Compressor Restaging program, contact us today by calling Solar's field office nearest you or visit us at **www.solarturbines.com.**

U.S. Offices:

Anaheim (Los Angeles), CA
Anchorage, AK
DeSoto (Dallas), TX
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