

# ENSURING STABLE OPERATION

## COMPRESSOR OPERATORS NEED TO BE MADE AWARE OF THE IMPACT OF SURGING ON FATIGUE LIFE OF MACHINES

**T**he conception of new compressors, pumps and blowers is both a science and a design art, with multiple engineering disciplines involved. Each facet of the design process is interesting and important, but one stands out as critical for success: *Stability*.

It is not enough to meet power, pressure, and flow in a cost-effective machine; it is also critical to have good stability and durability. Without aerodynamic stability, one cannot achieve much durability. Many compressors have been introduced into commercial usage with stability problems. Some of these machines have paralyzed the process, whereas others have proven to have mild issues.

What are stability issues? They range from noise and rough running on the less critical side to system surge with heavy fatigue damage on the critical side. Surge is always a system stability problem, but it is greatly influenced by compressor characteristics.

A system surge may be established if the system has an energy input (the compressor) and certain energy storage (piping and gas storage chamber), while pipe resistance influences the response frequency. These elements can exhibit full dynamic system behavior, resulting in periodic flow (full reversals of the flow through the compressor). The time constant of this surge cycle is set by the actual numbers, and there are both hard and soft response systems. The energy levels involved can be high, and real damage can be done to a compression system. It should be obvious that compression systems should not be surged!

I recently reviewed several major professional society test codes to see just what they indicate about surge. They are replete with much necessary advice about testing (truly essential), but most of them do not even mention the most basic advice (it is only implicit): *Do not surge*.

To practicing engineers with even a little experience, this statement would seem quite obvious. Yet, most codes just explain how to test for surge and even how to set a surge control device, while saying little about the damage possible from surging a system.

Compressor systems are not designed to indefinitely withstand the repeated fatigue cycles that result. At a typical interval of about 1 Hz, one achieves 86,400 cycles in one day; this is easily enough to consume the fatigue life of many system designs. And yet, every year, some operator carelessly allows a machine to operate in surge for a full shift or even longer, evidently unaware of

the utter foolishness and certain damage sure to result from such operation.

This brief synopsis of some current practice raises several questions: Can we be sure that a design is adequate, and can we be sure that a proper machine is used correctly? The first question requires the careful expertise of competent designers, which is often available at qualified suppliers; in some cases, however, there exists a degree of contradiction in currently available theories. For instance, some theories for rotating stall (often a precursor to surge) treat the flow as intrinsically viscous, while others treat it as inviscid flow and teach that surge onset rests principally with boundary conditions. In cases such as this, experience is the best guide and must be introduced to establish confidence in a design approach.

But what can be said about user operation? Again, issues abound. The first point must be the operational guidelines from the manufacturer, including methodologies to set any surge control system that might be applied. In all cases, this is the essential starting point, which is then supplemented with operational experience from the field.

Training of operators is essential, and machine owners must take full responsibility to see that such training is provided. This training is best obtained from the manufacturer or through inhouse (owner's) tutorials prepared by experienced engineers who bring together basic theory, manufacturer's recommendations and field experience.

Recently, this writer encountered a case where the compressor operator had only received operational training in his union shop (possibly missing some or all of the three aspects just mentioned). He had only heard of surge on a casual basis, and his boss claimed to have no idea what surge was. Not surprisingly, they had operated a machine in surge for many hours, with unpleasant results. **TI**

### Author

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