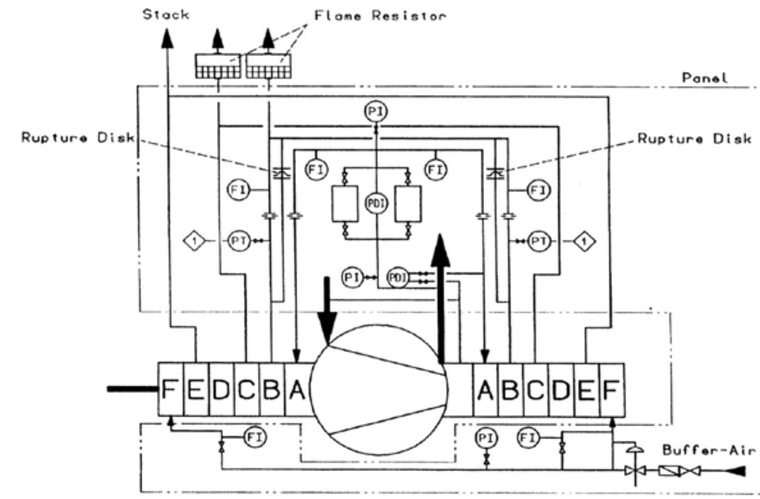
An auxiliary system not so auxiliary…

We heard about a recent very costly mishap at a world scale HCP plant allegedly caused by dirty dry gas seals (DGS) in their major compression train. As we looked back at our experience with compressor gas seals a colleague wrote: '*Remember, at pre-startup trials of our gas seal buffer gas supply system we detected some very fine iron oxide particles in the seal gas flow. This was evidenced by the fouling of the magnetic follower in the armored seal gas flow meter. Then you had the lines cleaned, the control valve removed and cleaned. It had been assumed these auxiliary lines were clean…*'.

Our experience has shown that a continuous supply of clean and dry buffer gas is one of the most important requirements for trouble-free operation and long DGS life. Unfortunately, this key requirement is often ignored throughout the various planning, commissioning and operating steps. This shortcoming, particularly during commissioning, is almost guaranteed to result in multiple seal failures that cause delays in plant start-up and business loss.

Seal or buffer gas filters are generally made of stainless steel with coalescing, duplex filter elements and continuous transfer valves. The filters shown schematically in our Figure are typically sized for a minimum of 3 times the normal flow, or the required flow rate for the seal failure case, whichever is greater. For a saturated or heavy condensing seal gas consider installing filters downstream of the throttling device to maximize the removal of condensate. Consider designing seal gas filters in accordance with applicable pressure vessel codes.



Typical schematic of a buffer gas supply system for a tandem dry gas seal – filter transfer valves not shown.
A Primary seal buffer gas supply; B Primary seal leak-off; C Secondary seal leak-off; D Secondary seal buffer gas supply – not used; E Tertiary seal leak-off; F Tertiary barrier gas supply.

Although these control systems typically offer elaborate monitoring and regulation features, filtration is often overlooked. In most cases, users and contractors initially choose standard filters on virtually every application, regardless of gas composition and/or presence of liquid, or condensation occurring in certain gas mixtures. One competent seal manufacturer's documented project histories show this shortcoming to be the root cause of the majority of seal failures, particularly during the commissioning phase, but also during "normal" operation periods.

Recognizing that most control systems feature inadequate filtration systems, the only advantage of incorporating sophisticated monitoring devices is to indicate when a seal is in trouble. At best then, these monitoring systems serve to point at the cause of seal failures, yet do little - if anything - to prevent them.

Experienced machinery engineers and failure analysts know that clogging the seal face grooves will cause failures. In recent years, gas conditioning units (GCU's) have greatly enhanced the reliability of dry gas seals by solving critically important gas supply issues. They require minimal customer interface connections and have self-checking, or self-regulated functions. Unlike conventional gas panels that only incorporate coalescing filters, a modern GCU features a knock-out filter and coalescer vessel that removes solid particulates as well as free liquids and aerosols. A heater-controller also monitors and maintains gas temperature. Maintaining gas temperature above its dew point prevents condensation of aerosols in the process gas stream. Therefore, the collective features of successful GCU's must effectively manage liquids to ensure the cleanest possible gas supply is always available.

In start-up, slow-roll and settling-out conditions, a thoroughly engineered GCU will maintain adequate gas flow using a seal gas pressure intensifier or similar device. Typically, a flow switch signals the intensifier control, which automatically activates and deactivates the intensifier as needed. The intensifier then provides sufficient seal gas flow to prevent unfiltered process gas from working its way back to the seal faces across the inboard labyrinth.

In summary, the key to minimizing seal failure is a thorough review of the components of the plant and their impact on the total system. In order of importance, the following factors should be considered in examining dry seal support systems for centrifugal compressors[1]:

- *Gas Composition:* Understanding the actual gas composition and true operating condition is essential, yet often overlooked. For example, it is necessary to understand when and where phase changes and condensation will occur in the sealing fluid.

- *Commissioning Procedures:* Is clean and dry buffer gas available? Is the seal protected from bearing oil? How is the compressor pressurized or de-pressurized? How is the machine brought up to operating speed? Are all personnel familiar with the compressor maintenance and operating procedures? Is the full control system included and adequately described in the operating manuals?

- *Control and Supply System Design:* Is clean and dry buffer gas available at all times? Consider automatic switch-over of buffer gas supply from a continuously pressurized system, e.g., a customer supply line, to compressor discharge once the compressor is up and running. If the process gas is not absolutely clean some other clean and compatible medium must be found. Similarly, provision of a reliable source of clean purge gas must be made also for the tertiary seal to avoid ingress of lube oil into the DGS. It is important to not only review the control system, but one must also understand the system's design philosophy. Further, it is crucial to review the buffer gas conditions. Is a heater required? What is the temperature setting for the heater? It is necessary to analyze the connecting piping structure, size, material and type to avoid liquid entrapment.

- *Interface between the compressor, seals and control system:* Review startup and shutdown sequence, liquid removal if applicable, alarm settings, shutdown settings

[1] See Bloch, H. P. and Godse, A., "*Compressors and Modern Process Applications*," John Wiley & Sons, Hoboken, NJ, (2006) ISBN 0-471-72792-X.

and flow measurement units. Be sure to recognize signs of problems within the startup and shutdown points. Also, in terms of the logic and the interface, what control setting do you want? Remember that you cannot design one control system to fit every scenario.

- *Plant specifications, including tubing versus piping, pipe sizing, logic system and wiring diagrams:* Sometimes, the plant specification is totally different from a supplier's recommendation, but for good reason. For example, a plant may specify tubing instead of piping, or a different type of welding procedure. Or, while a supplier may recommend a shutdown on a specific setting, the plant may opt for a coordinated shutdown to avoid process upset.

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