Pressurized enclosure systems

Protection class „Ex-p“

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Ex-p systems for Division 1 solutions
Fundamental idea of protection class „Ex-p“

Idea:

Holding off the explosive atmospheres from the standard „non-Ex“ components.

Realization:

• Running of all components inside a pressurized Ex-p-enclosure (housing).
• The inner of the housing is protected against intruding of external explosive atmosphere by a permanent overpressure. (mbar!)
• Before start-up of the components, the inner of the housing must be purged, to remove present ignitable gas or vapor.
Basically two different methods to purge an Ex-p-enclosure:

- **Time-based purging method (conventional method):**
  - Choice of purge volume as product of preselected minimum flow rate [liters/sec.] and time [sec.].
  - Preselected minimum flow rate is monitored at the output of the enclosure.
  - Volume flow of purge medium depends on prepressure [bar] and a defined nozzle cross section of a digital working valve (Ø 1..6 mm).
  - In normal operation phase, the inflow volume must be greater than the preselected minimum flow rate (availability!).

Inflow volume – leakage losses > preselected minimum flow rate
Purging of the enclosure

A1 + A2: considered purge gas volume with “integrating” purge method!

A2: unconsidered purge gas volume (wastage)

A1: considered purge gas volume at conventional (time-based) purging

Flow

Minimum flow

Prepressure at valve

P\text{min} \quad P\text{max}
Improved solution:

- „Integrating“ purging method:
  - The real gas flow at the outlet of the Ex-p-housing is measured with a proportional sensor technology and integrated.
  - Additionally, a minimum flow is monitored. At undershooting of this minimum, the integration is stopped.
    → Ensures a safe purging phase!
  - Increased inflow volume into the cabinet automatically leads to a shortening of time for purging.

→ Very fast and efficient purge method!
→ Shortest start-up times!
After the purging phase, a minimum overpressure (e.g. 0.8 mbar) must be sustained inside the cabinet.

- **Use of a digital (on/off) inlet valve:**
  - Digital inlet valve is switched to open position for high inflow Volume during purging phase.
  - Following: closing of valve; leakage losses are compensated by an adjustable valve bypass (Ø 0.3...1 mm).
  - The overpressure inside the cabinet is monitored continuously during normal operation phase.

→ If leakage losses cannot be compensated by the bypass, the enclosure is switched off!
Improved solution:

- Use of a proportional working inlet valve:
  - Proportional valve “shuts down” to a smaller inflow.
  - The proportional valve is the actuator of a digital-working PID-control loop.
  - Activation of the valve by the proportional pressure sensors in combination with a valve-control electronic.
  - “Input-sided” total pressure control for Ex-p-cabinet.

→ Adaptive compensation of leakage losses of the Ex-p-encapsulation!
Adaptive compensation of leakage losses

1: Typical air consumption of a standard Ex-p application
2: Theoretical leakage compensation of conventional Ex-p-system (standard bypass nozzle)
3: Fluctuating leakage compensation (caused by fluctuating prepressure at the fixed nozzle)
4: High air requirement of conventional Ex-p-system (securing of system availability)
5: Increasing air requirement of Ex-p-enclosure by time (e.g. caused by aging of gaskets etc.)
6: Danger of early failure with conventional Ex-p-system!
1: Typical air consumption of a standard Ex-p application

2: Adaptive compensation of leakages with FS850 system and proportional inlet valve
   → PID-controlled pressures during purging and normal operation phase
   → Highest system availability, lowest purge gas consumption

3: Increasing air requirement is corrected automatically!
Advantages of the pressure regulation

• Main advantages:

- Dramatically decreased consumption of purge gas.
- Increased availability of the application, based on constant pressure inside Ex-p-housing; Higher leakages e.g. by aging of gaskets etc. will be compensated.
- Minimization of streaming noise.
- Easy adjustment of pressure levels to specifications of Ex-certificate.

• Further advantages:

- Exact regulation of pressure also during purging phase.
- By defined pressure inside cabinet, pressure sensible parts like foil keyboards, windows etc. will not be damaged.
Patent: „Pressure control and integrating purging method“

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Patent nach Einspruchverfahren beschrankt auf den Beifugten

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(54) Bezeichnung: Verrichtung zum Betreiben von elektrischen Geräten in einer störanfälligen Atmosphäre


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Pneumatic block diagram of FS850 Ex-p-System

Mechanical valve
Orifice plate

Spark barrier
(fence)

Ex-p cabinet

Operation with proportional valve
Clamps at FS850

Operation with digital valve
Clamps at FS850

Nozzle
Adj. Bypass-Nozzle
Ex-p controller FS850U for the US market (Division 1 & 2)
Ex-p-application samples
„made by Gönnheimer“
Label-printer for Ex-Zone 1 with FS850S control system.
PID-control of purge gas supply for compensation of unsteady leakage at paper throw-off slot.
Analysis- and measuring hardware for Ex-Zone 1 with nitrogen purging.
PID-control of internal housing pressure as well as integrating purge method for minimization of purge gas consumption.
Standard laser printer for dust-Ex-Zone 21 with FS850S.

- Customer specific housing with integrated door contacts for paper removal.
- PID-controlled pressure inside housing for high system availability.
Samples

Standard Siemens or Rockwell-HMI-Panels for Ex-Zone 1 with FS850S.

→ PID-controlled internal housing pressure during purging- and normal operation phase to protect front foils and keyboard against delamination.
Production robots for Ex-Zone 1 and 21.

- Fastest start-up, supported by integration during purging phase.
- Highest system availability based on PID-controlled purge- and operation pressure.
- Space-saving installation of FS850-compact system. No additional boxes, sensitive pressure switches or vents needed!
Annex
## Classification of Zones / Divisions

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