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“

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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.

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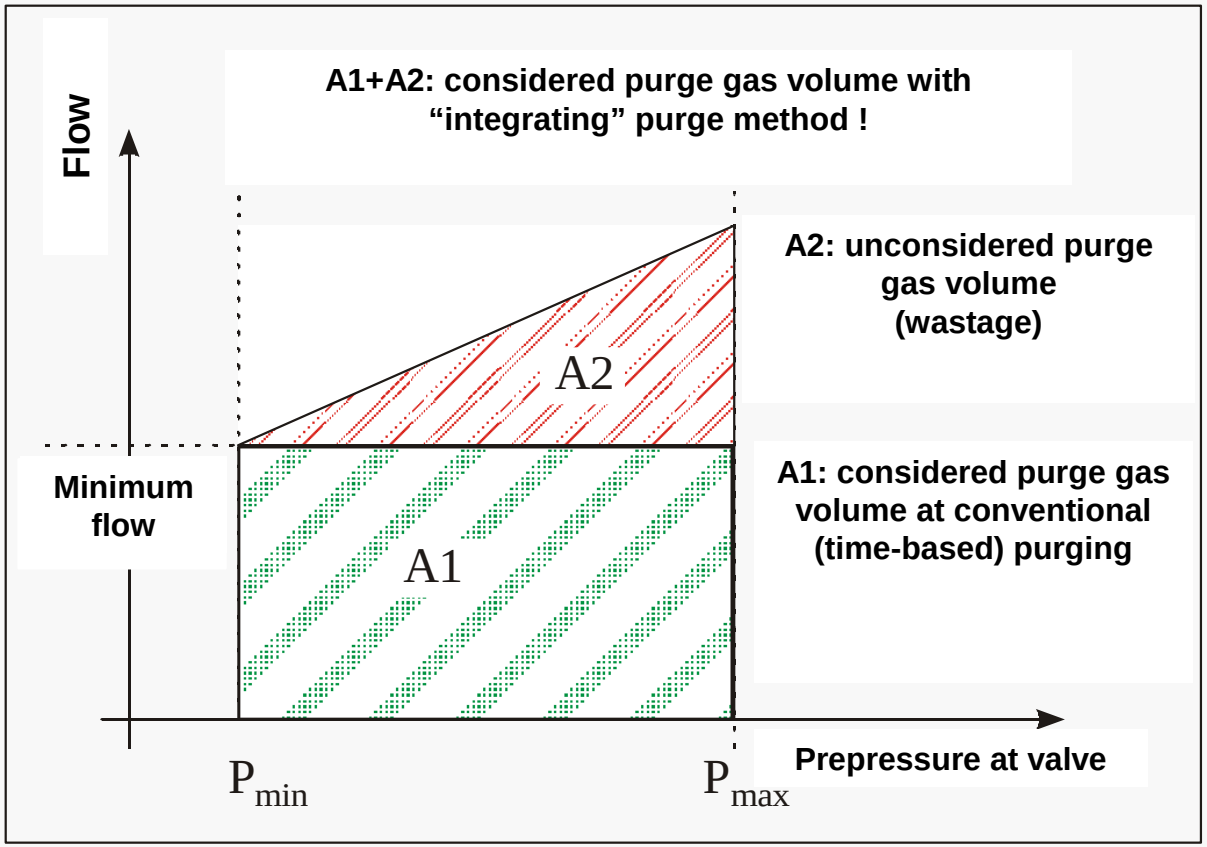
Basically two different methods to purge an Ex-p-enclosure:

- 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



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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!

„Normal operation“ of Ex-p-system after purging phase

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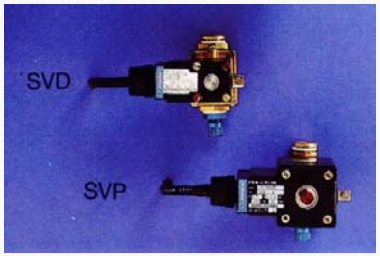
After the purging phase, a minimum overpressure (e.g. 0.8 mbar) must be sustained inside the cabinet.

- 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!



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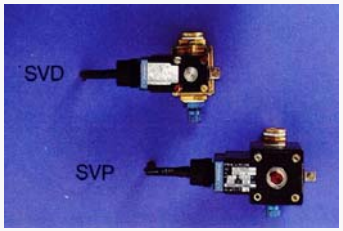
Improved solution:

- 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

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1: Typical air consumption of a standard Ex-p application

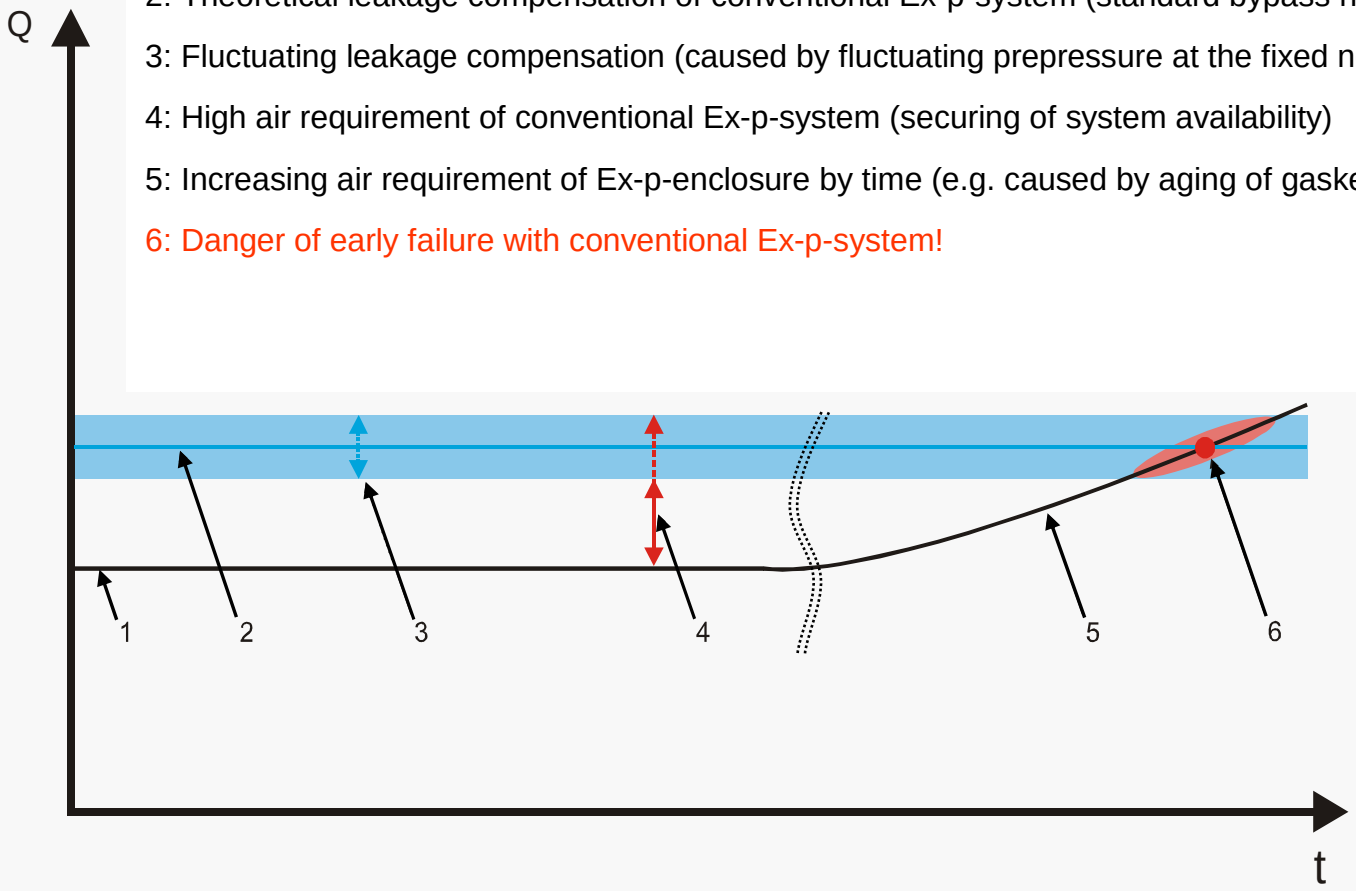
2: Theoretical leakage compensation of conventional Ex-p-system (standard bypass nozzle)

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!



Adaptive compensation of leakage losses

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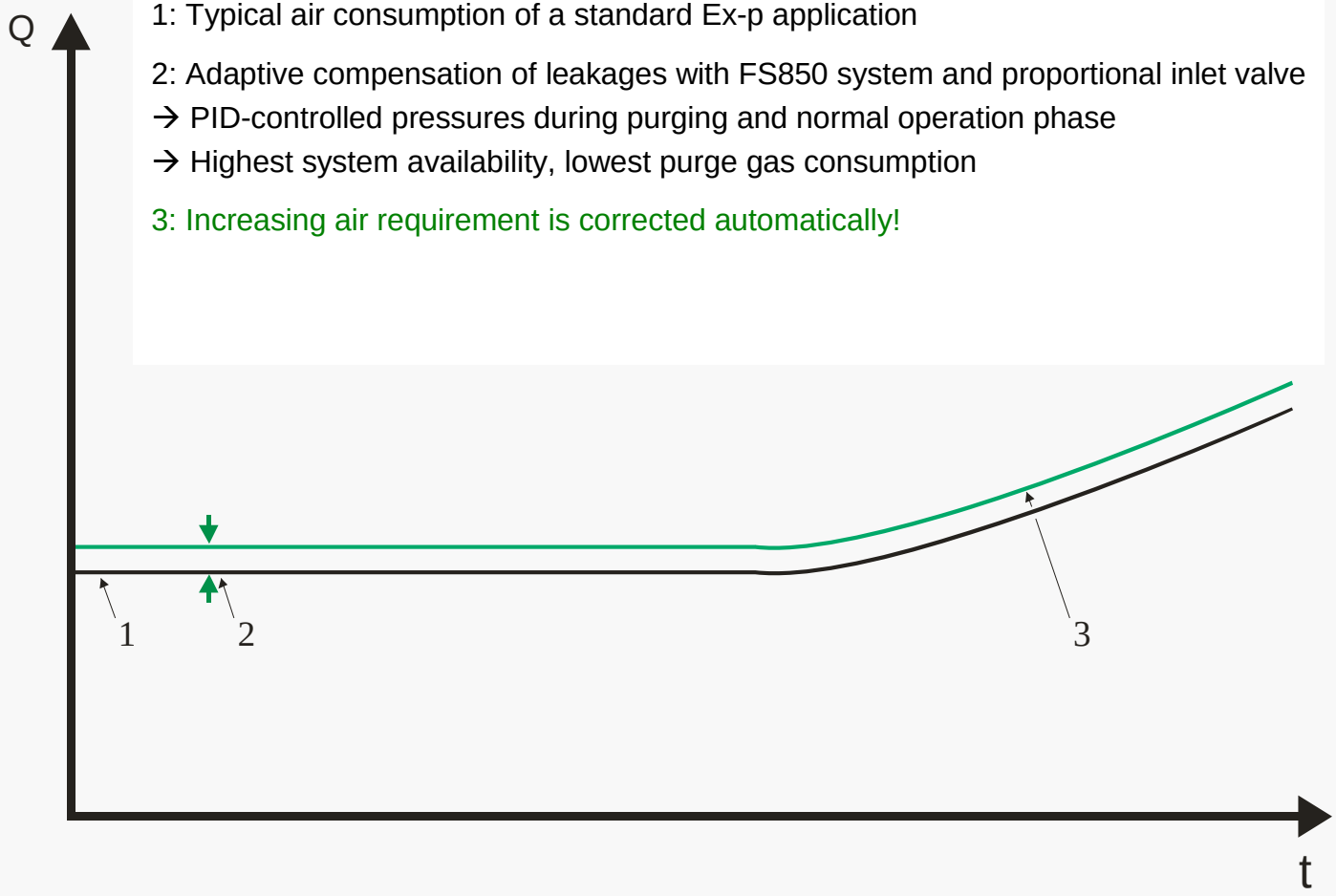
1: Typical air consumption of a standard Ex-p application

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

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- 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 Einspruchsverfahren beschränkt aufrechterhalten

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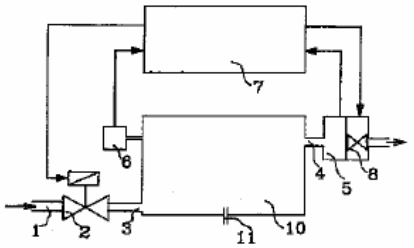
(56) Für die Beurteilung der Patentfähigkeit in Betracht gezogene Druckschriften:
DE 40 18 016 C2
DE 32 37 230 A1
DIN EN 50016;
BACHMANN, H.: Explosionsschutz durch Überdruck-kapselung in Elektro-Anzeiger, 26. Jg., 1973, Nr. 14, S. 307, 308;

(54) Bezeichnung: **Vorrichtung zum Betreiben von elektrischen Geräten in einer zündfähigen Atmosphäre**

(57) Hauptanspruch: Vorrichtung zum Betreiben von elektrischen Geräten, die mit einem Gehäuse (10) mit der Zündschutzart „Überdruckkapselung EExp nach DIN EN 50016" ausgerüstet sind, in einer zündfähigen Atmosphäre, umfassend das Gehäuse (10), einen Spülgas-Einlaß (1, 3) mit Druckreduziervorrichtung, einen Spülgas-Auslaß (4) mit Aßsperrventil (8) und Überdruckmesser (6) und eine übergeordnete Meß- und Steuereinrichtung (7), dadurch gekennzeichnet, dass in den Spülgas-Auslaß (4) eine Durchflußmessvorrichtung (5) und in den Spülgas-Einlaß (1, 3) ein Proportional-Ventil (2) eingesetzt ist und dass die Meß- und Steuereinrichtung (7) den Gehäuse-überdruck mit dem Proportional-Ventil (2) konstant hält, wobei über den Spülgas-Auslaß (4) das Gehäuse (10) verlassende Spülgasmenge in der übergeordneten Meß- und Steuerin-richtung (7) integrierd wird



Pneumatic block diagram of FS850 Ex-p-System

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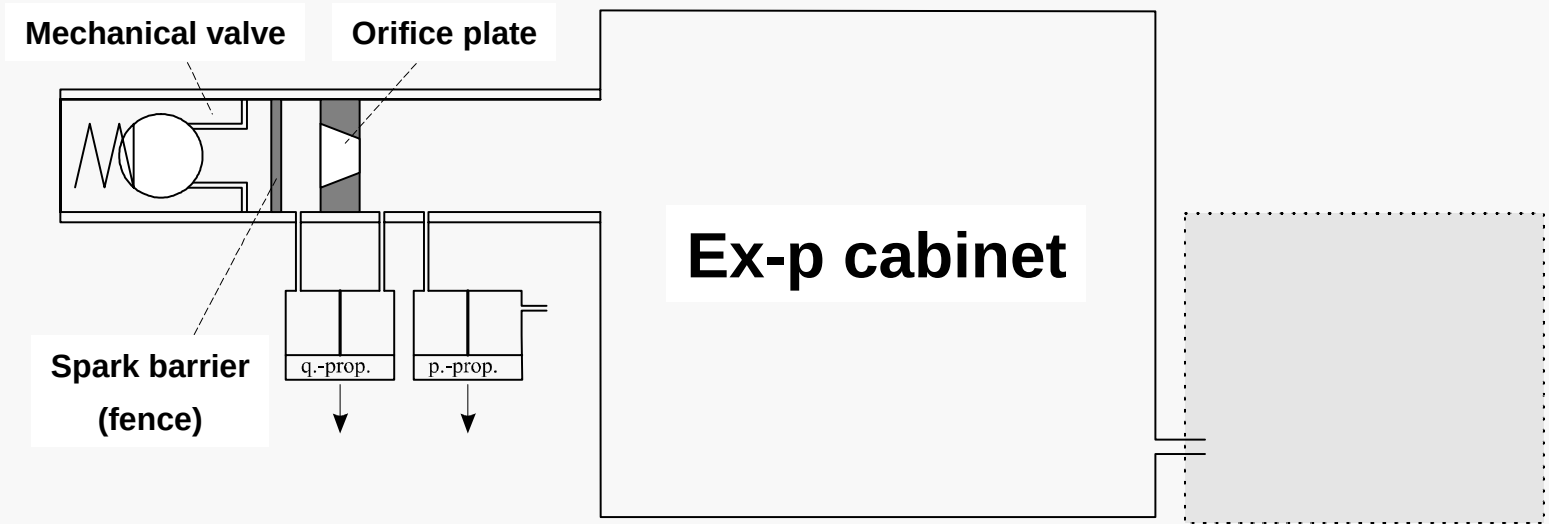
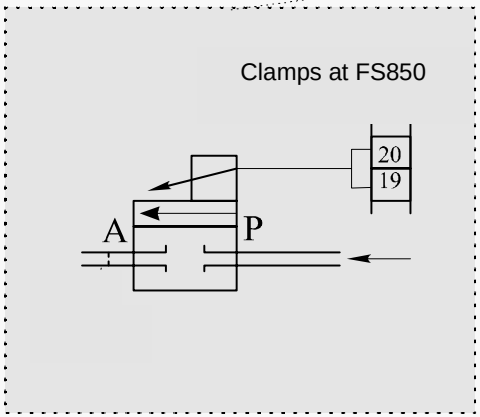
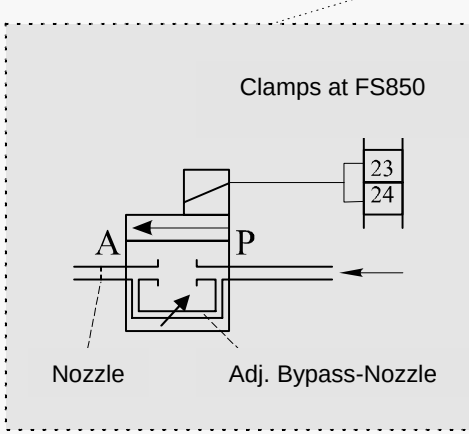




Operation with proportional valve



Operation with digital valve

Ex-p controller FS850U
for the US market (Divison 1 & 2)

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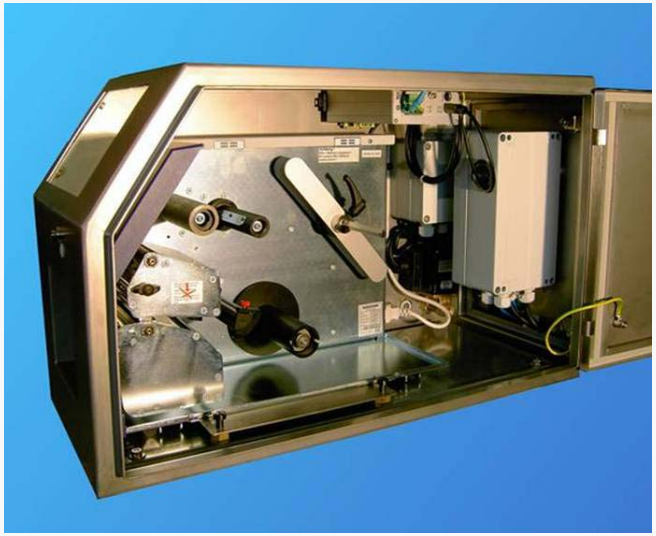
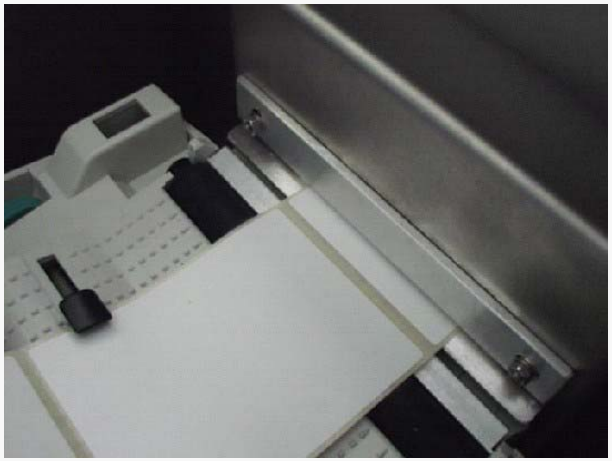
Ex-p-application samples „made by Gönnheimer“





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.

Samples

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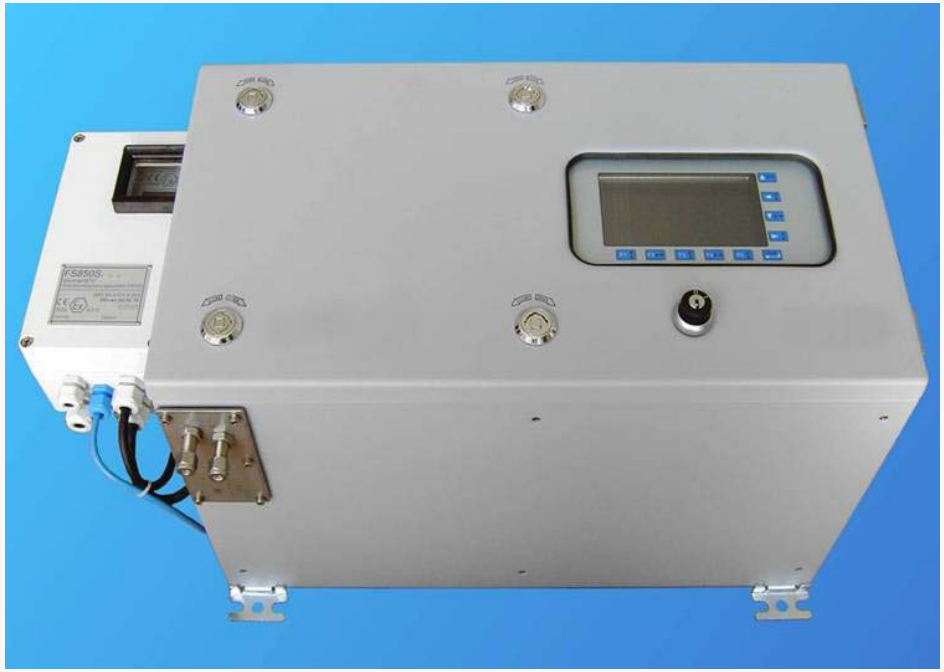

Analysis- and measuring hardware for Ex-Zone 1 with nitrogen purging.

→PID-control of internal housing pressure as well as integrating purge method for minimization of purge gas consumption.

Samples

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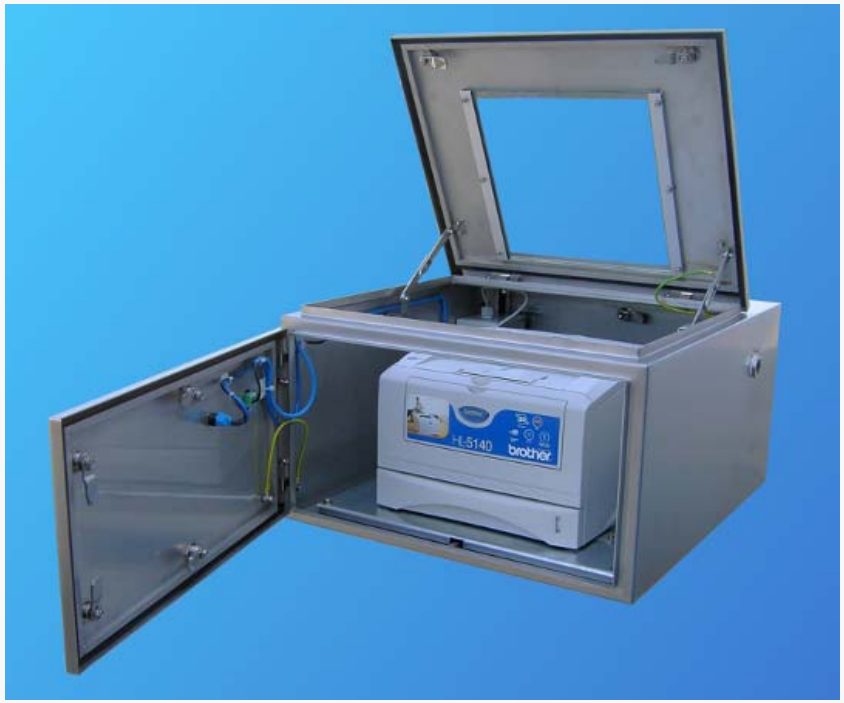

Standard laser printer for dust-Ex-Zone 21 with FS850S.

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

Samples

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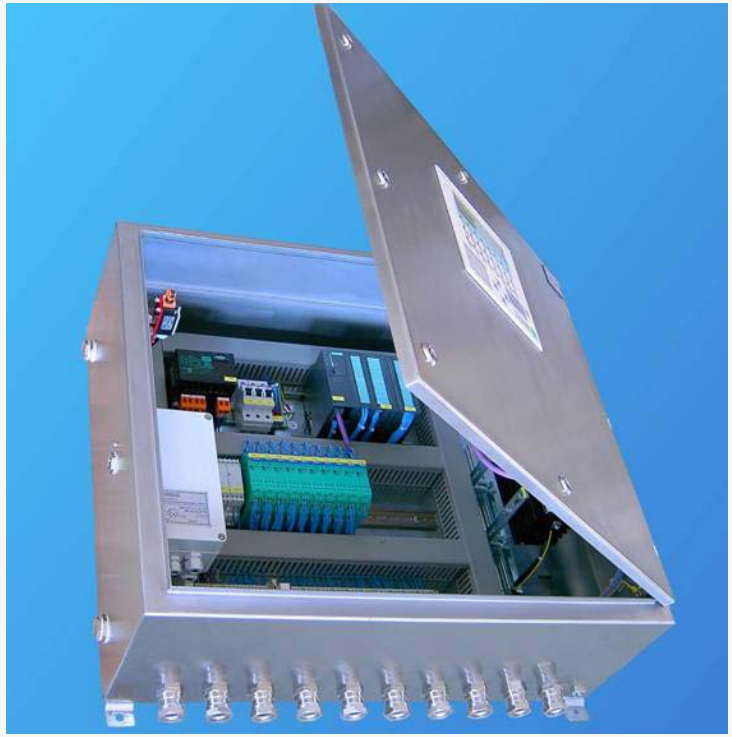

Standard Siemens or Rockwell-HMI-Panels for Ex-Zone 1 with FS850S.

→ PID-controlled internal housing pressure during purging- and normal operation phase to protect front foils and keyboard against delamination.

Samples

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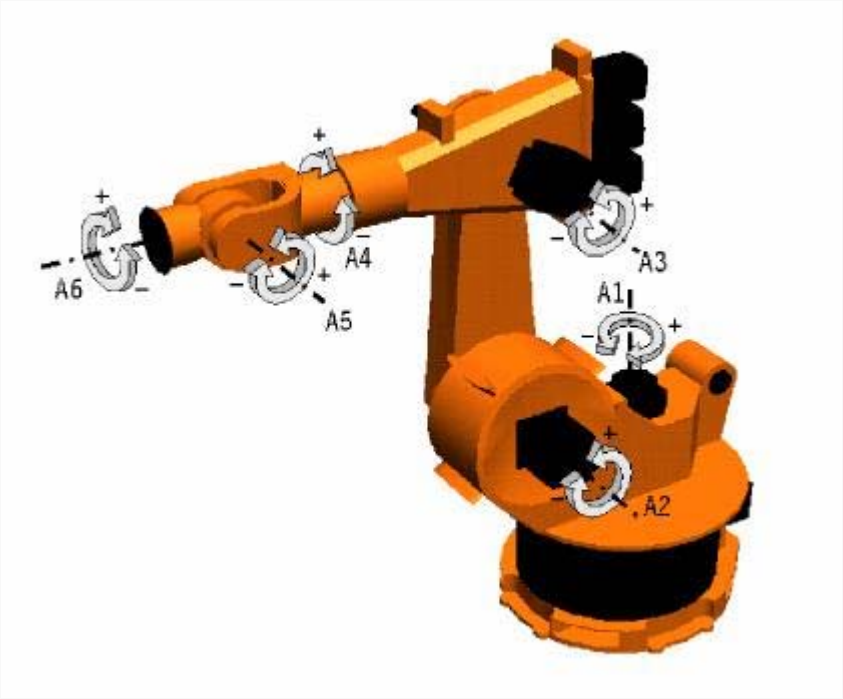

Production robots for Ex-Zone 1 and 21.

→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

Standards EU - USA

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IEC 60079-X

Europe

EN 50014
EN 50016
EN 50020
EN 50028
EN 50019
…

IEC 60079-0
IEC 60079-2
IEC 60079-11
IEC 60079-18
IEC 60079-7
…

Zone-model

USA

Basis NEC 500

UL Underwriters Labs

UL 2279
…
…
NFPA 496
…

FM Factory Mutual

FM 3600
FM 3610
FM 3615
FM 3620
…

Division-model

Basis NEC 505

IEC 60079-0
IEC 60079-2
IEC 60079-11
IEC 60079-18
IEC 60079-7
…

Zone-model

Classification of Zones / Divisions

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Hazardous areas	Zone 0		Zone 1	Zone 2		
USA Hazardous areas	Zone 0		Zone 1	Zone 2		
USA Hazardous areas	Division 1			Division 2		
	Explosive substance	**Class**	**Group**	**Explosive substance**	**Class**	**Group**
	Gas / vapor or fluid	I	A, B, C, D	Gas / vapor or fluid	I	A, B, C, D
	Dust	II	E, F, G	Dust	II	F, G
	Fibers	III	-	Fibers	III	-