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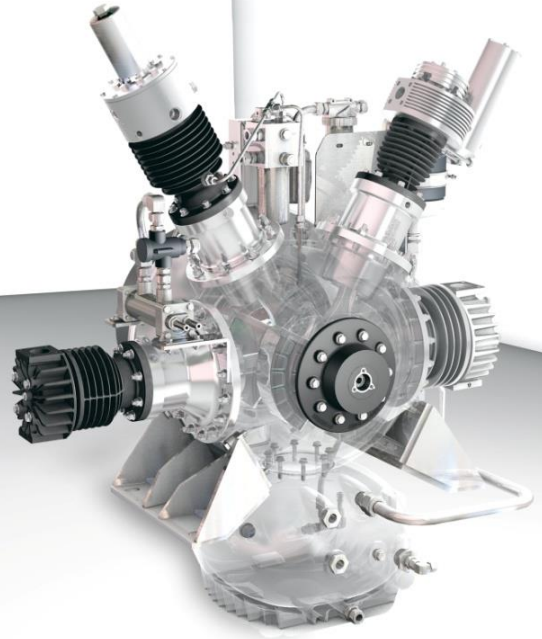
OIL REMOVAL IN INDUSTRIAL APPLICATIONS THROUGH CATALYSIS

DEN HELDEN, 07.10.2015



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What is oil?

Oil according to ISO 8573-1:
All hydrocarbons with 6 or more carbon atoms per molecule
are "oil" within the meaning of the standard.

This wide range of compounds places high demands on measurement technology.
What does this mean in practice?
The following organic compound classes (hydrocarbons) are therefore "oils" within the meaning of the standard:

- Solvents (such as toluene and hexane)
- VOCs (Volatile Organic Compounds)
- Adhesives
- Cooling emulsions
- Compressor oils
- Thread and surface sealants
- Fragrances (air fresheners, perfumes,…)
- Detergents / cleaning agents

AIR QUALITY IN INDUSTRIAL APPLICATIONS

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Compressed air according to ISO 8573-1:2010

ISO8573-1:2010 CLASS	Solid Particulate				Water		Oil
	Maximum number of particles per m³			Mass concentration mg/m³	Vapour Pressure Dewpoint	Liquid g/m³	Total Oil (aerosol liquid and vapour) mg/m³
	0.1-0.5 micron	0.5-1 micron	1-5 micron				
0	As specified by the equipment user or supplier and more stringent than Class 1						
1	≤ 20.000	≤ 400	≤ 10	-	≤ -70°C	-	0.01
2	≤ 400.000	≤ 6.000	≤ 100	-	≤ -40°C	-	0.1
3	-	≤ 90.000	≤ 1.000	-	≤ -20°	-	1
4	-	-	≤ 10.000	-	≤ +3°C	-	5
5	-	-	≤ 100.000	-	≤ +7°C	-	-
6	-	-	-	≤ 5	≤ +10°C	-	-
7	-	-	-	5-10	-	≤ 0.5	-
8	-	-	-	-	-	0.5-5	-
9	-	-	-	-	-	5-10	-
X	-	-	-	> 10	-	> 10	➢10

AIR QUALITY IN INDUSTRIAL APPLICATIONS

What does the limits of class 1 (0.01mg/sm³) and class 0 (0.0025mg/sm³) mean in Reality?

1mg of oil in 1sm³ of air is equivalent to	0,773	ppm by weight
	773	ppb by weight
0.01mg of oil in 1sm³ of air is equivalent to	7,73	ppb by weight
	7730	ppt by weight
0.0025 mg of oil in 1sm³ of air is equivalent to	1,93	ppb by weight
	1932,5	ppt by weight

This is (roughly) equivalent to one cube of sugar dissolved in tank the volume of 10 Super Tankers

STANDARD APPLICATIONS

Examples for typical applications:

- Gas generation with membrane systems to protect the membranes against oil pollution
  - E.g. Membrane system for oxygen enriched air
  - E.g. Nitrogen generators (~ 10 installed for shipping industry for transport of Bananas in nitrogen atmosphere
- Paint shops, especially in automotive industry
- Food and Beverage Industry

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STANDARD APPLICATIONS

B-TROX MEMBRANE SYSTEM

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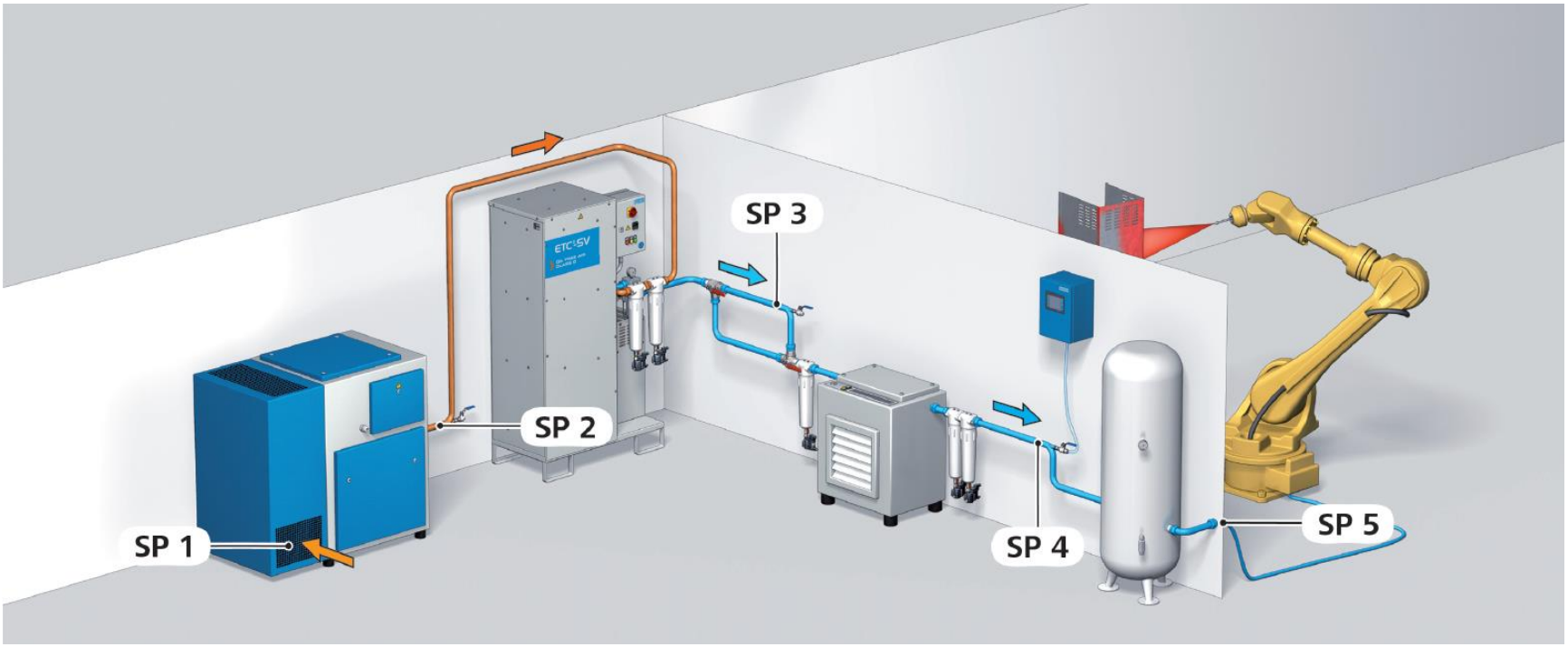
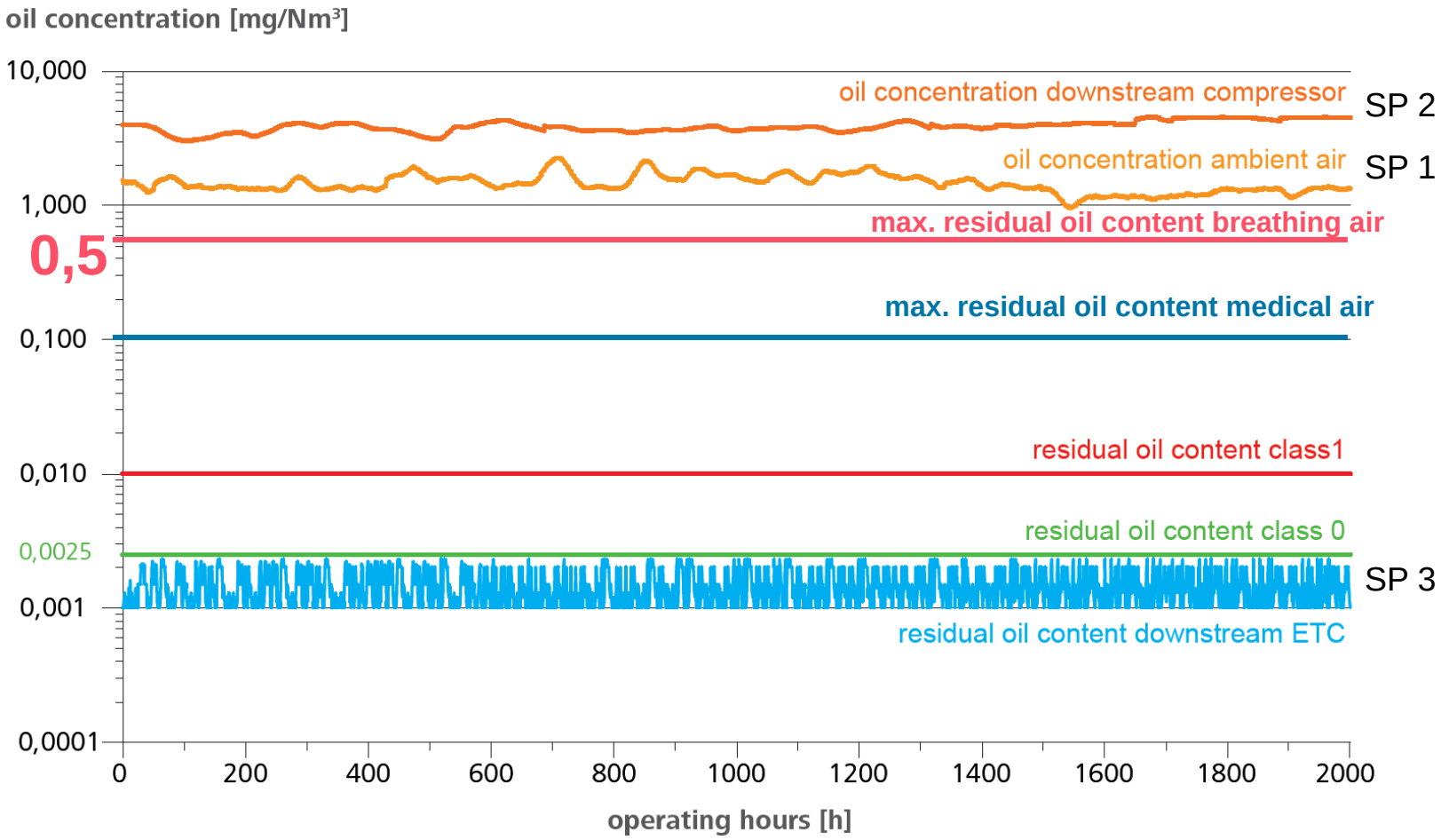
Typical setup for a paint shop



RESIDUAL OIL CONTENT



THE ETC® - SYSTEM

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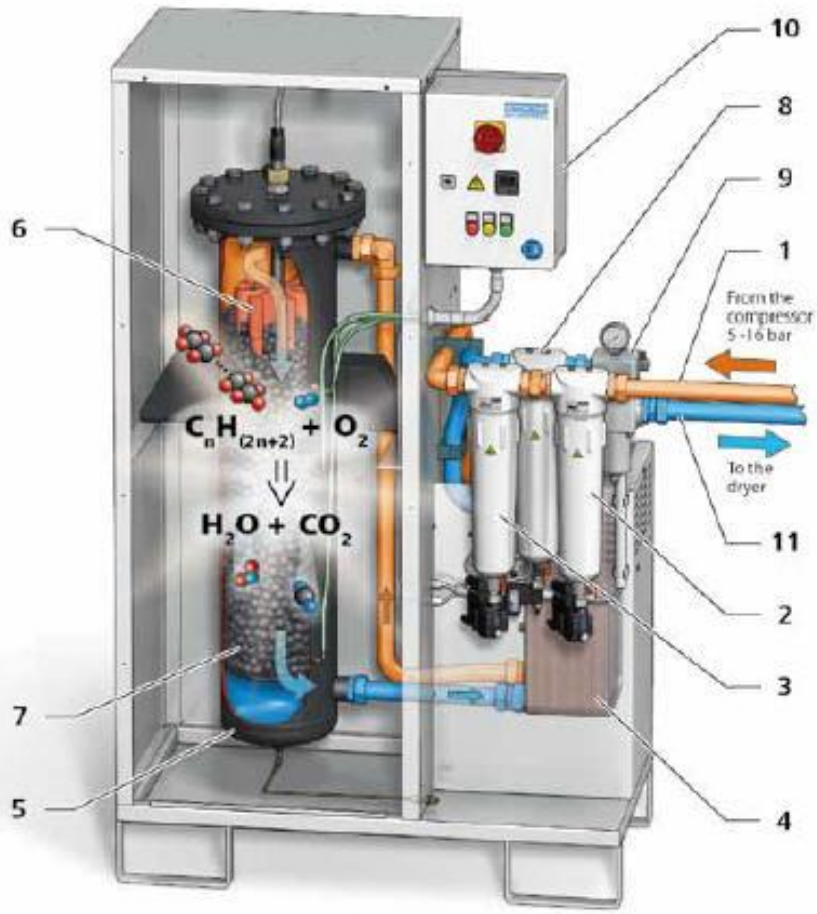
ETC®-SV layout



1 Compressed air containing oil from compressor
2 Pre-separator (VS)
3 VS module (optional)
4 Heat exchanger
5 Converter vessel
6 Electric heater
7 Catalyst
8 Particle filter (optional)
9 Minimum pressure closing valve (DHSV)
10 Controls
11 Oil-free compressed air to dryer

THE ETC® - SYSTEM

HOW THE PURIFICATION MODULE WORKS

The PURIFICATION MODULE is based on an ETC converter

1. The compressed air is fed from the LOW PRESSURE MODULE to the PURIFICATION MODULE with an oil charge of approx. 3-5 mg/Nm³.

2. The air, already preheated in the integrated heat exchanger to approx. 190°C, is now further heated to approx. 210° C in the ETC converter using an electric heater and fed through the ETC catalytic filling.

3. The oil molecules in the air are separated off in the catalytic filling and oxidised there into CO_2 and water in a similar process to an automotive catalytic converter.

4. The catalytically purified air now leaves the converter with a maximum residual oil content of 0.0025 mg/Nm³ (equivalent to one cube of sugar dissolved in the tanker volume of 10 super tankers). Now optimally purified by the heat exchanger and downstream particle filter, it is fed into the NITROX MODULE.

THE ETC® - SYSTEM

Technical data

Model	Nominal flow at 7 barg	Max. over-pressure	Weight**	Width**	Depth**	Height**	Specific energy consumption during operation	Energy consumption at nominal flow
	[Nm³/min]	[bar]	[kg]	[mm]	[mm]	[mm]	[kWh/Nm³]	[kWh]
ETC-SV04	0.4	16	60	700	340	1400	0.009	0.2
ETC-SV1	1	16	140	860	455	1455	0.009	0.5
ETC-SV2	2	16	160	860	455	1655	0.009	1.1
ETC-SV5	5	16	360	1175	620	1890	0.007	2.1
ETC-SV7	7	16	410	1175	620	1890	0.006	2.5
ETC-SV10	10	16	590	1630	815	2100	0.005	3.0
ETC-SV15	15	16	770	1630	880	2100	0.005	4.5
ETC-SV20	20	16	900	1900	1140	2150	0.005	6.0
ETC-SV30	30	16	1100	1900	1140	2150	0.005	9.0
ETC-S40	40	16	1500	2200	900	2240	0.005	12.0
ETC-S50	50	16	1700	2250	900	2240	0.005	15.0

** Weight and dimensions without pre-separator, VS module and particle filter

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Some features and possible advantages

- Guaranteed oil-free compressed air in accordance with ISO8573-1 Class 0
- Guarantee on the operation of the catalyst for 5 years for hydrocarbon concentrations at the ETC inlet of up 200mg/Nm3 in standard applications
- Lower energy consumption to a max. of 0.01 kWh/m3 through Improved insulation of converter and housing
- Minimizes significant the bacteria, fungus and microbialdiversity content in the compressed and purified air
- Pure and neutral condensate (Ol < 2mg/l; pH-Wert: 6 –7, nearly complete demineralized) after ETC
- Increased service life for downstream dryer and membranes

Thank you for your attention.

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