Sucessfull Experiences with Vortex Tube Technology at Epe Cavern Storage of RWE Energy

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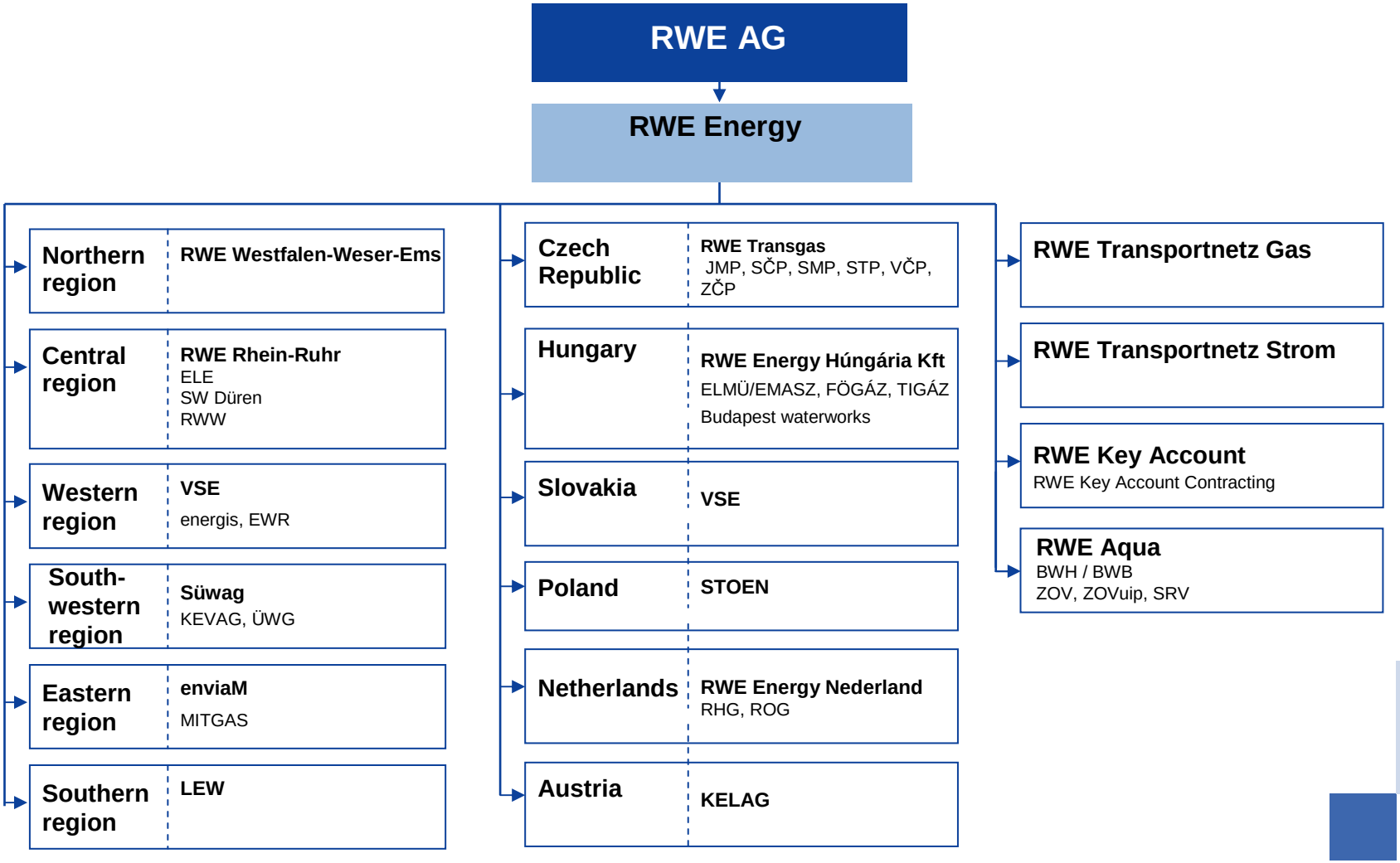
agenda

- company presentation
- principles vortex tube
- conceptual design
- operational experiences
- future design
- discussion

company presentation

structure of RWE Energy



regional companies in Germany

North region

RWE Westfalen-Weser-Ems
Dortmund

Central region

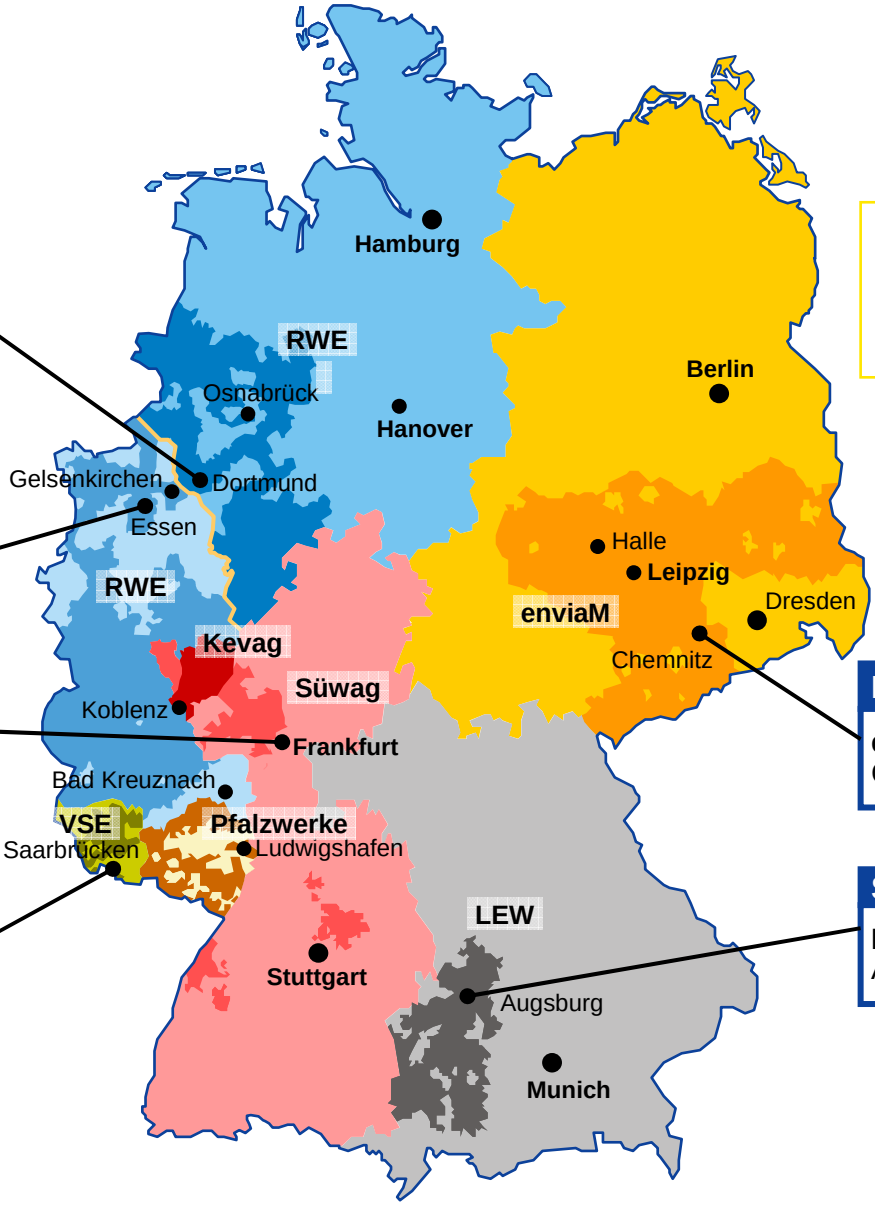
RWE Rhein-Ruhr
Essen

Southwest region

SÜWAG
Frankfurt

West region

VSE
Saarbrücken



Light colour
= Sales region

Dark colour
= own Grid within sales region

East region

enviaM
Chemnitz

South region

LEW
Augsburg

company presentation

foreign regional companies

Netherlands

RWE Energy Nederland
Hoofddorp

Poland

Stoen
Warsaw

Slovakia

VSE
Kosice

Czech Republic

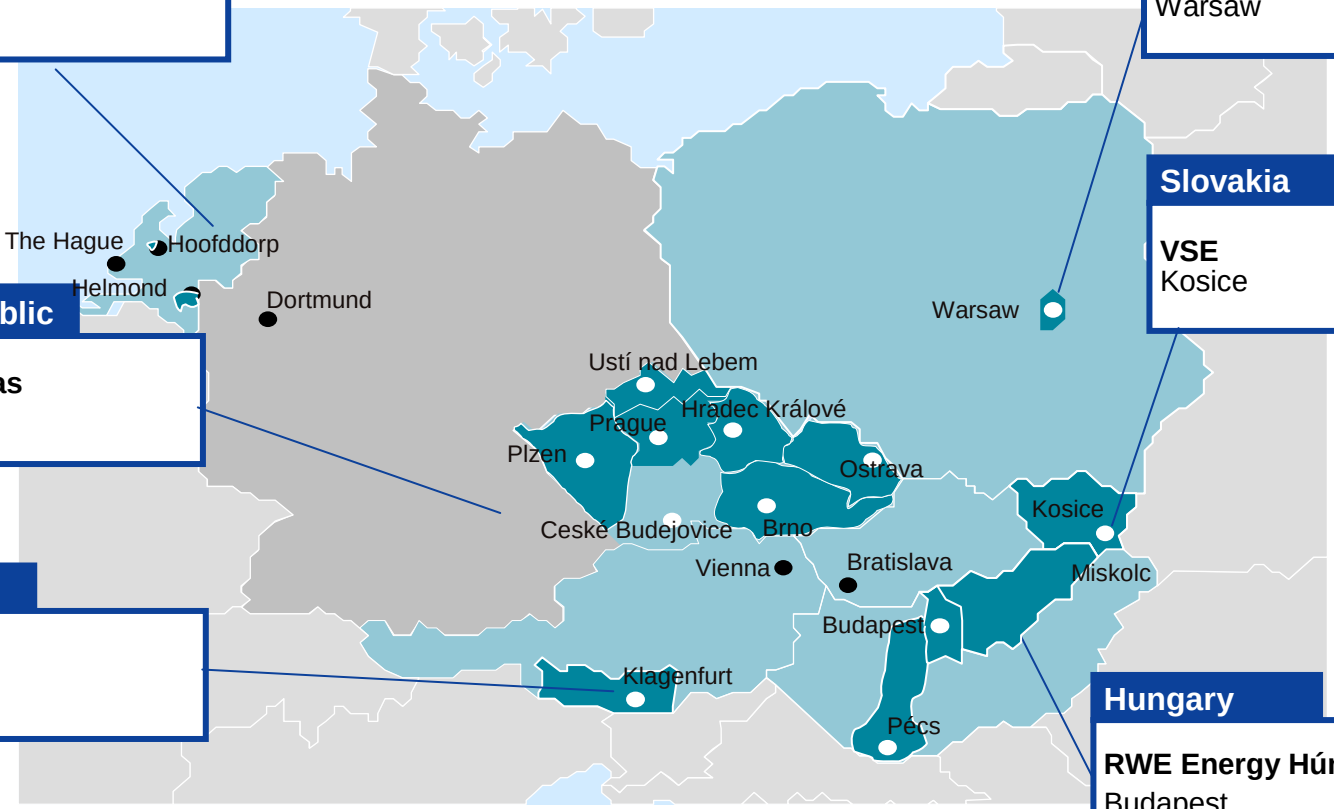
RWE Transgas
Prague

Austria

KELAG
Klagenfurt

Hungary

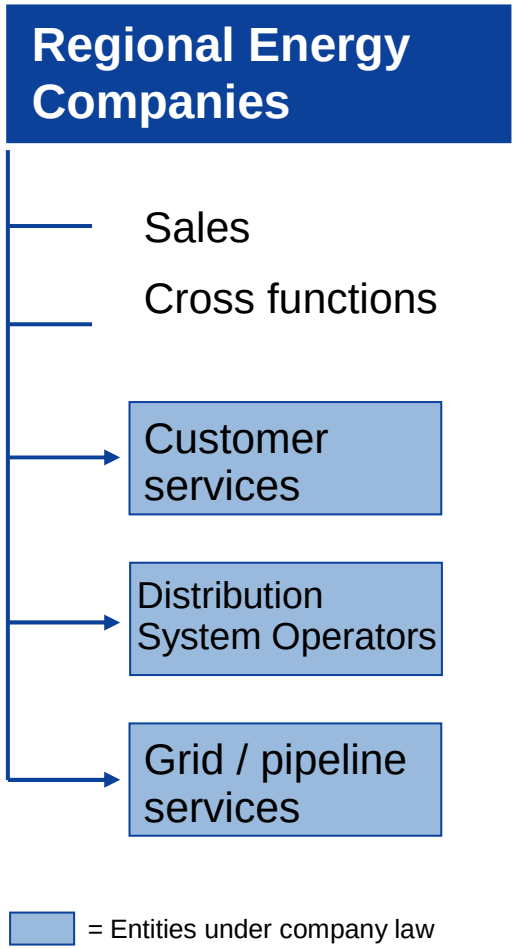
RWE Energy Húngária
Budapest



Dark colour = supply regions

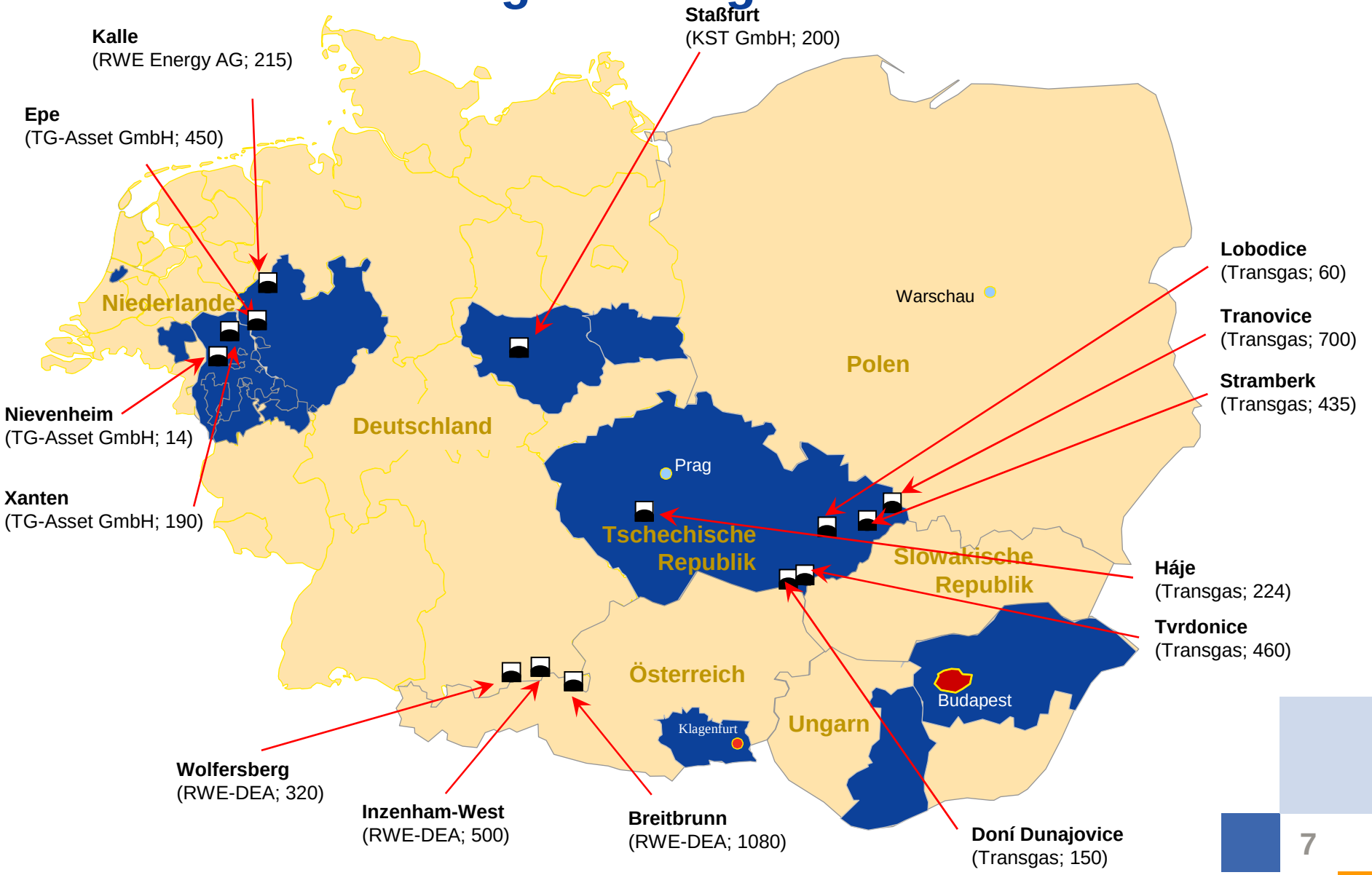
structure and tasks of the regional energy companies

- Bundled sales responsibility in the respective regions for electricity, gas and water
- Management of municipal utility investments
- Central commercial functions
- Clear and transparent profit centre structure
- Independent companies for customer services and the grid / pipeline sector



company presentation

location of natural gas storages of RWE



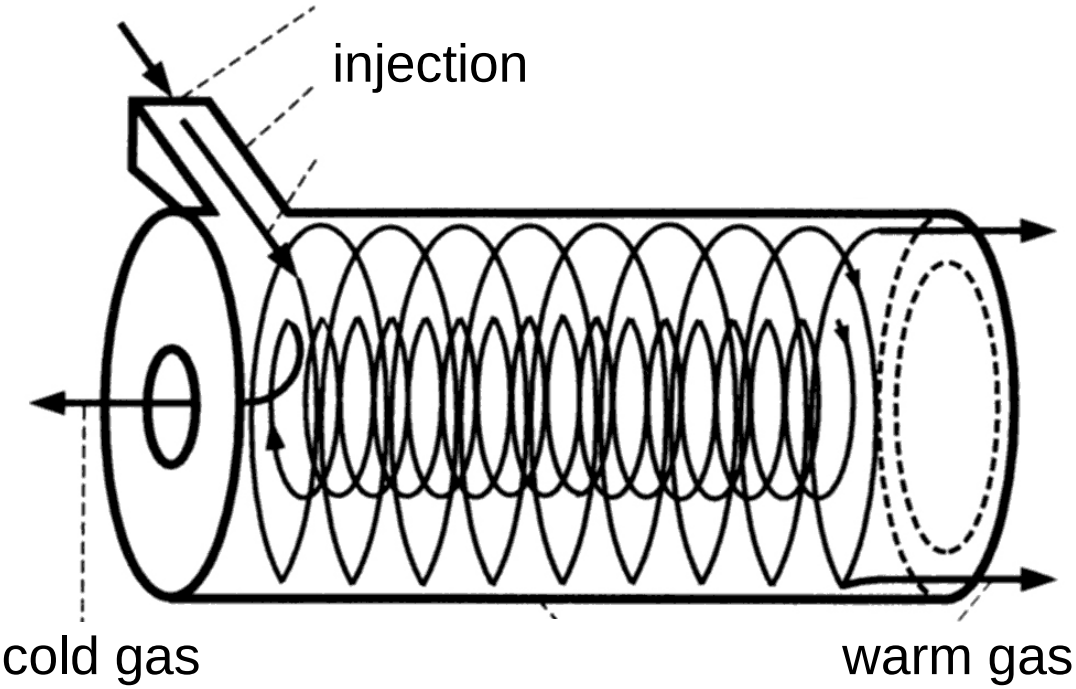
Ohne Darstellung angemieteter Kapazitäten; in Klammern: Eigentümer des Speichers und Volumen in Mio. m³ (AGV)

company presentation

salt cavern storage Epe

parameter:	
working gas volume:	362. Mio. m^3
number of caverns:	8
injection capacity:	170.000 m^3/h
withdrawal capacity:	520.000 m^3/h
withdrawal trains:	4

separation of warm- and cold gas due to Rangue-Hilsch effect



characteristics of flow is complex

- 3-dimensional
- compressibel
- viscous
- turbulent
- multiphase

$$\frac{\partial}{\partial t}\rho + \nabla \bullet (\rho V) = 0$$

$$\frac{\partial}{\partial t}\rho u + \nabla \bullet (\rho u V) = -\frac{\partial}{\partial x}\rho + ...$$

$$\frac{\partial}{\partial t}\rho v + \nabla \bullet (\rho v V) = -\frac{\partial}{\partial y}\rho + ...$$

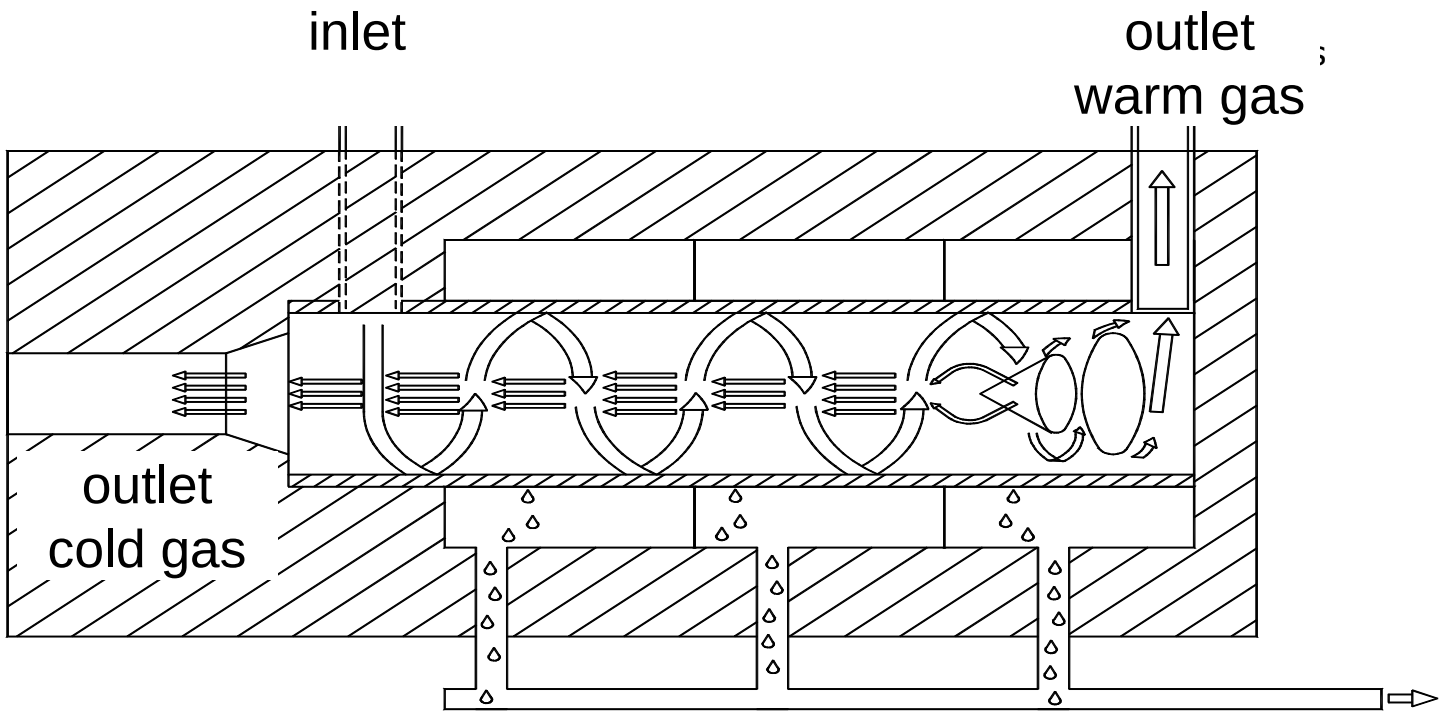
$$\frac{\partial}{\partial t}\rho w + \nabla \bullet (\rho w V) = -\frac{\partial}{\partial z}\rho + ...$$

$$\frac{\partial}{\partial t}\left[\rho\left(e + \frac{V^2}{2}\right)\right] + \nabla\left[\rho\left(e + \frac{V^2}{2}\right)\right] = ...$$

coupled set of partial differential equations

analytical solution not possible !!!

flow paths in vortex tube for gas dehydration



conceptual design

scope of variants

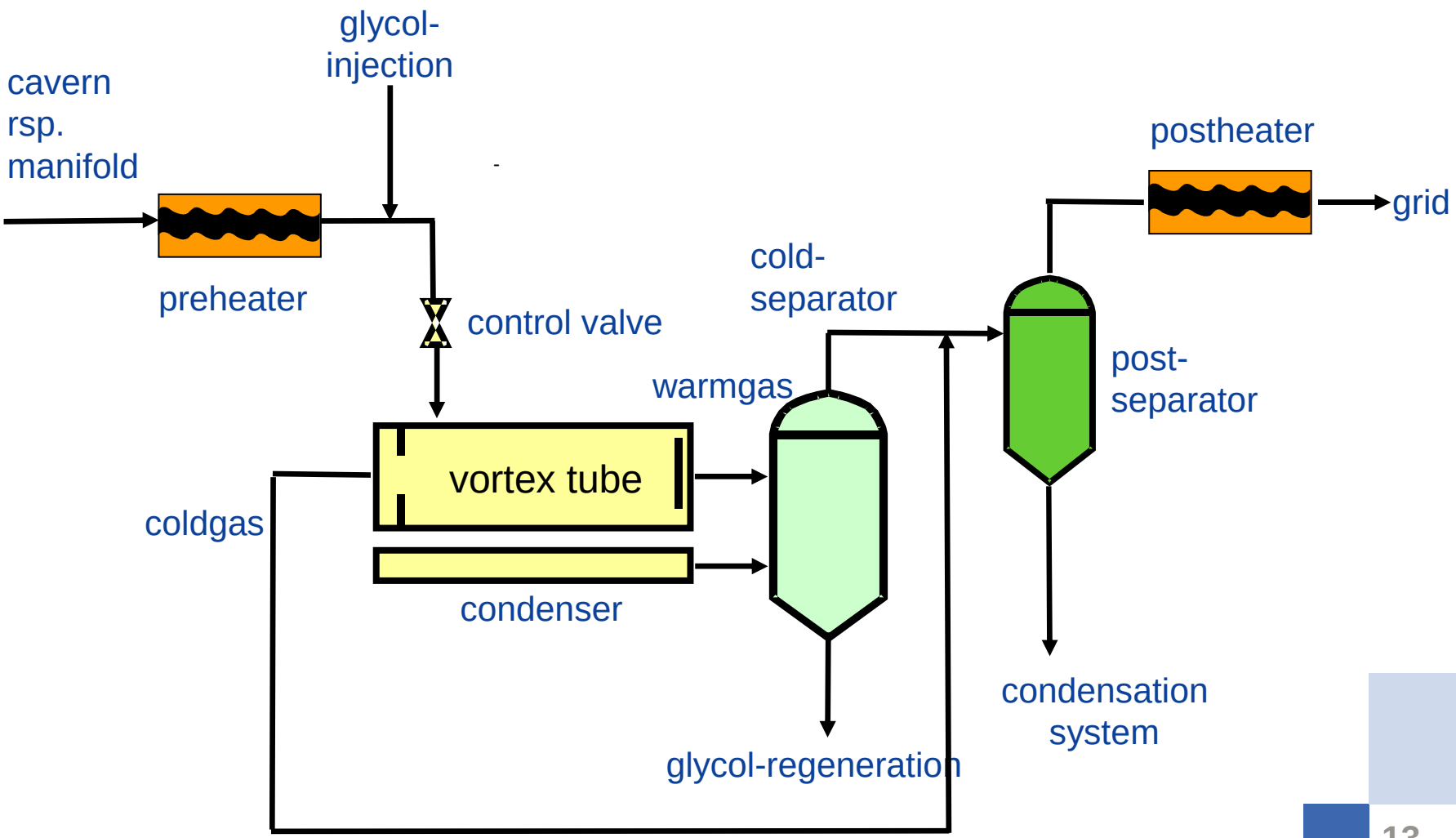
target: increase of withdrawal capacity by 140.000 Nm^3/h

- process of adsorption
- conventional absorption process by glycol
- glycolfree dehydration with drying pellets (salt)
- dehydration with vortex tube technology

➢ best solution: vortex tube plant

conceptual design

process scheme

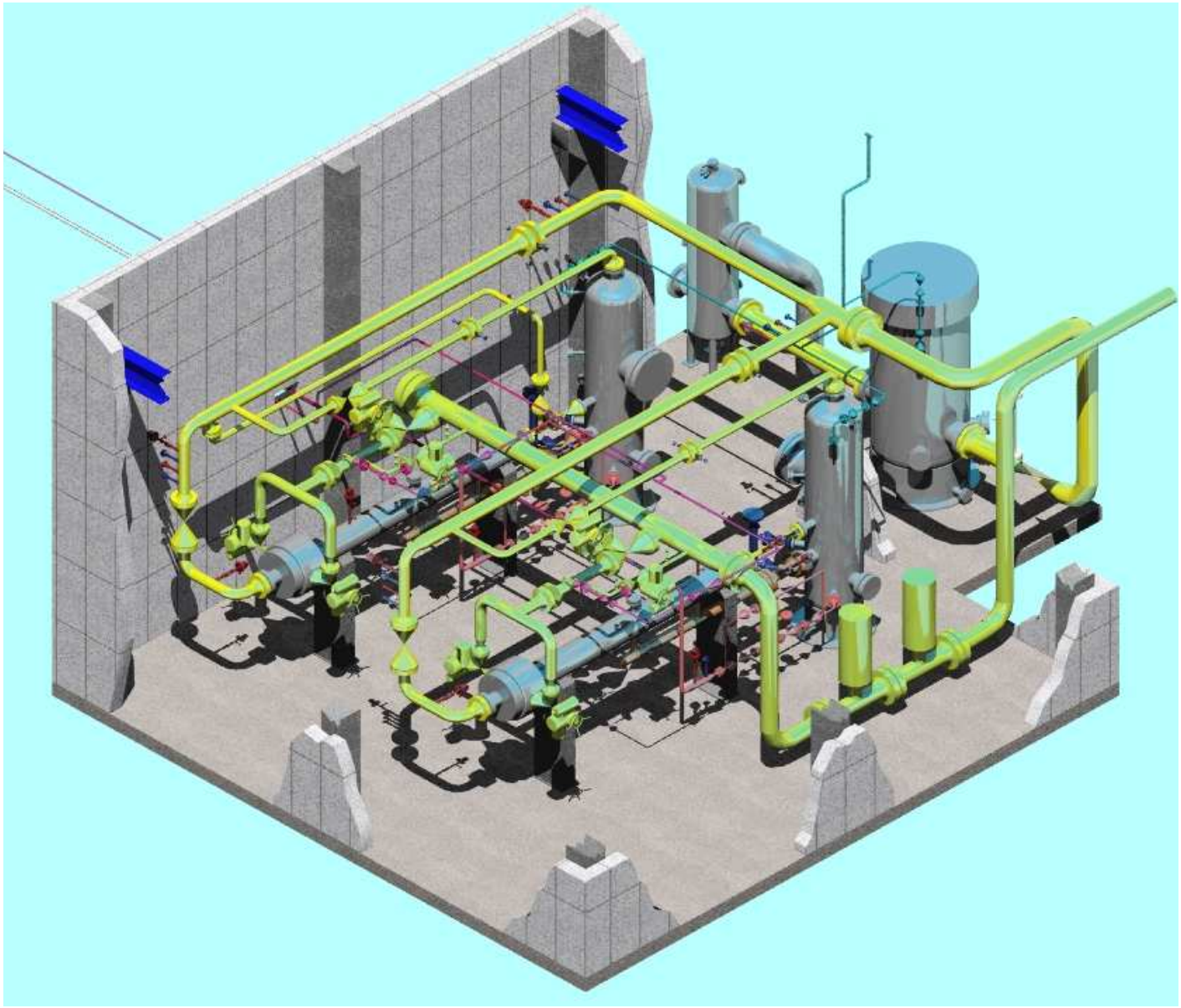


conceptual design

design parameters

capacity:		
Volumen flow:	min.	20.000 m³/h
		140.000 m³/h
	max.	220.000 m³/h
input condition:		
pressure:		175 bar
(water-) dew point:		saturated
output condition:		
pressure:		33 bar
(water-) dew point:		- 10 ℃

conceptual design



details:

capacity is realised by 2 vortex tubes

housing

pre - and post-heater and separator are located outside

operational experiences

glycol only to avoid formation of hydrats

advantages in relation to conventional dehydration technology:

- volume of glycol reduced by appr. 90 %
- glycol regeneration plant much smaller
- volume flow of glycol only 200 litres / 100.000 m³(Vn)/h
- only 95 % selectivity needed
- significant reduction in energy consumption
- environmental effects reduced

operational experiences

optimisation of separation by temperature control

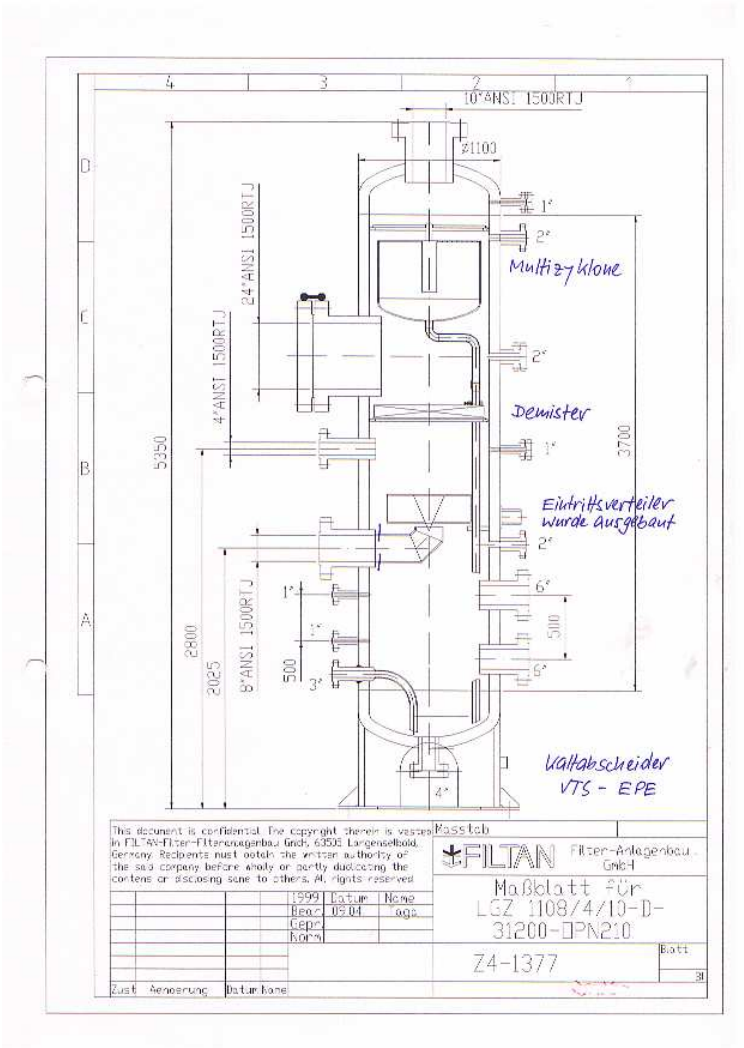
- temperature important process parameter
- avoid separation of higher hydrocarbons
- output temperature at post heater approx. 2-5 ℃ (abso rption: 10-20℃)

- ➢ lower energy consumption for heating
- ➢ fast start up, because preheating of regeneration plant not necessary

operational experiences

flexible ratio of warm- / coldgasflow

- up to now fixed ration:
  - -70 % coldgas-;
  - -30 % warmgasflow
- foam formation in cold separator due to condensate
- ➢ modfication of separator
- ➢ flexible ratio of cold gas - and warm gas flow planned

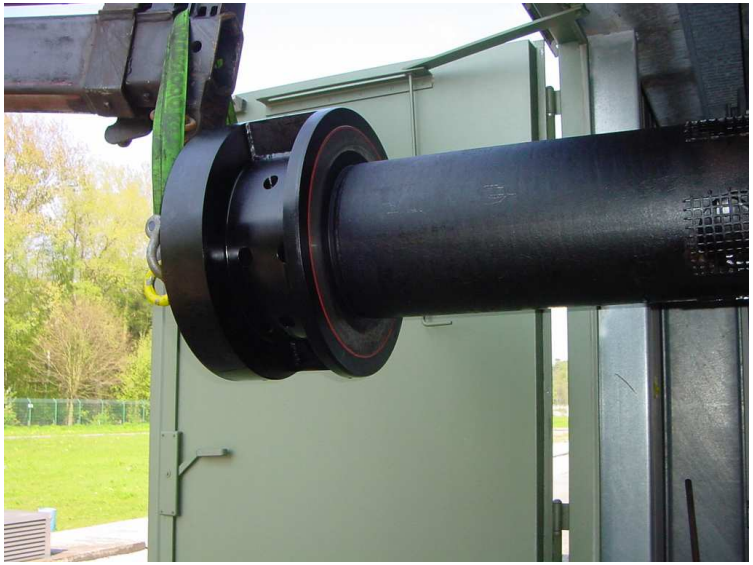


operational experiences

inspection of vortex tube

result of internal inspection in 2005:

- no wear identified
- no damages



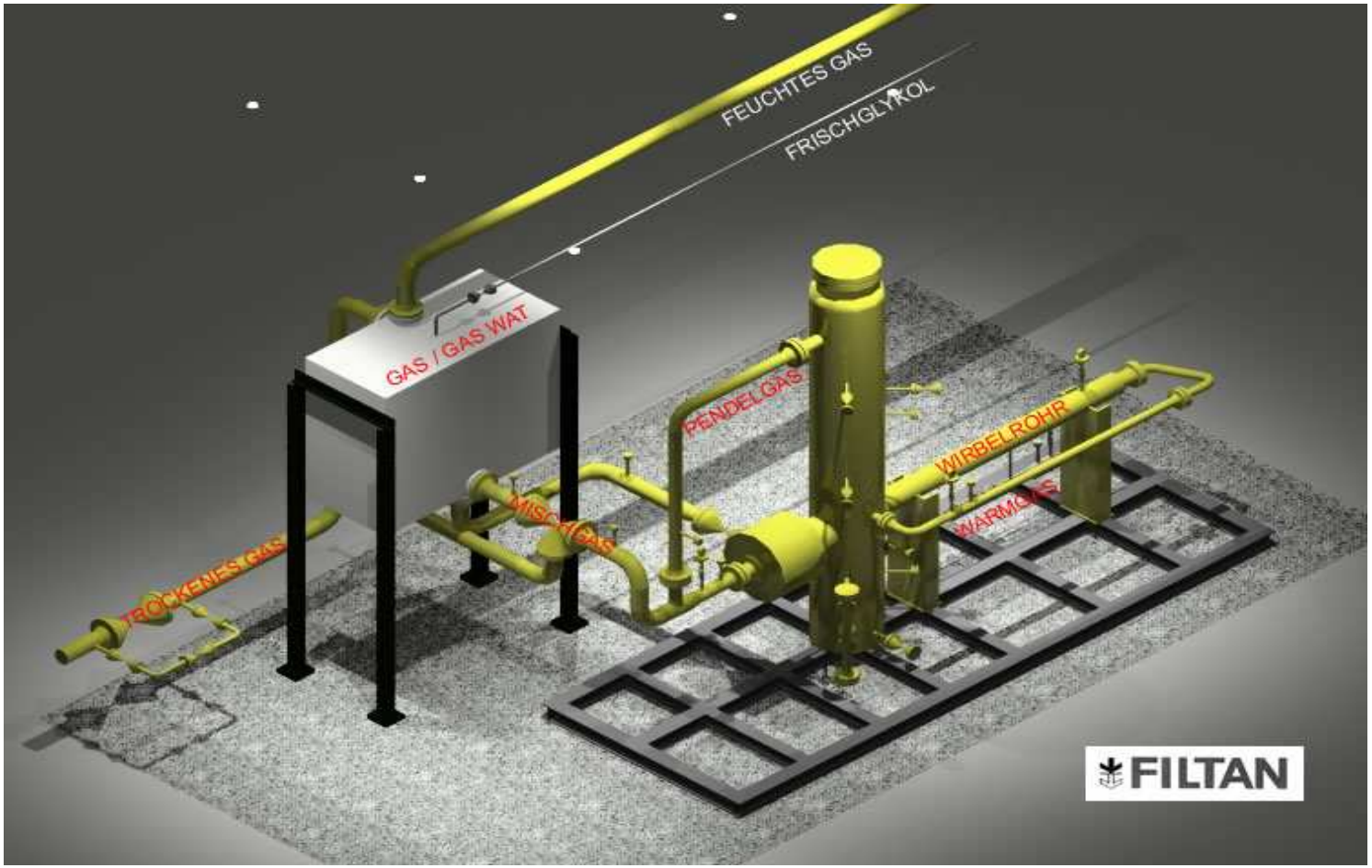
operational experieces

performance of technology in operation has been confirmed

- advantages of vortex tube process have been confirmed
- reduction of operational expenses have been confirmed
- positive internal inspection
- low acoustic emission
- no vibrations detected

future

integration of vortex tube and separator



discussion