SPE Workshop

Gas Field Developments – Pushing the Limits

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New 3S-technology of CO2 Recovery from Natural Gases

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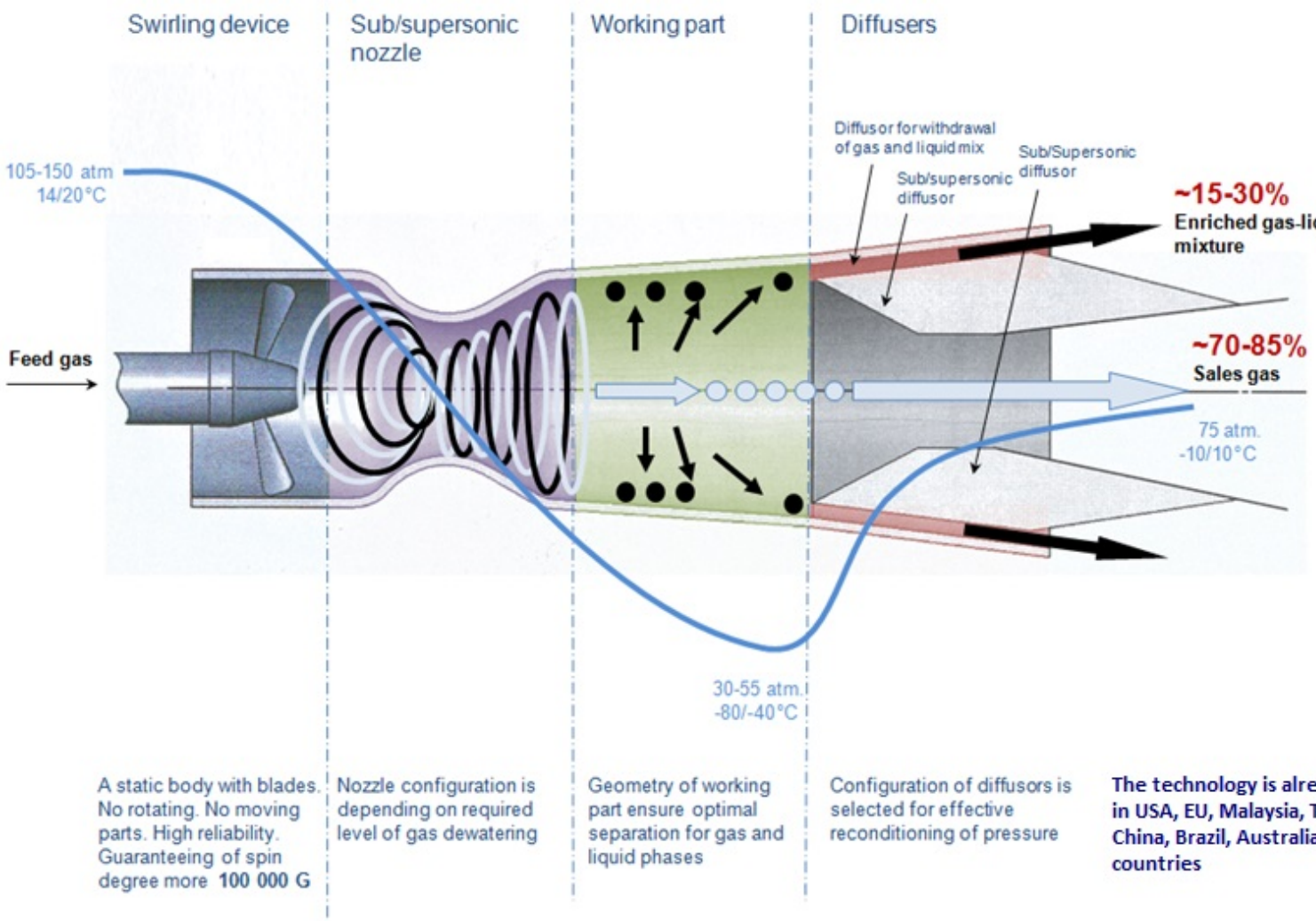
Basic Scheme of SuperSonic Separator

3S-SEPARATOR



Realized 3S-technology projects

Zapolyarnoe GCF

2009-2010
Capacity: 10 000 nm3/h of natural gas
Pinput/Poutput=125 atm/76 atm

Gubkinskoe and Severo-Komsomol'skoe OGCF

Gubkinskoe:
2007
Capacity: 86 000 nm3/h of natural gas
Pinput/Poutput=86 atm/54 atm

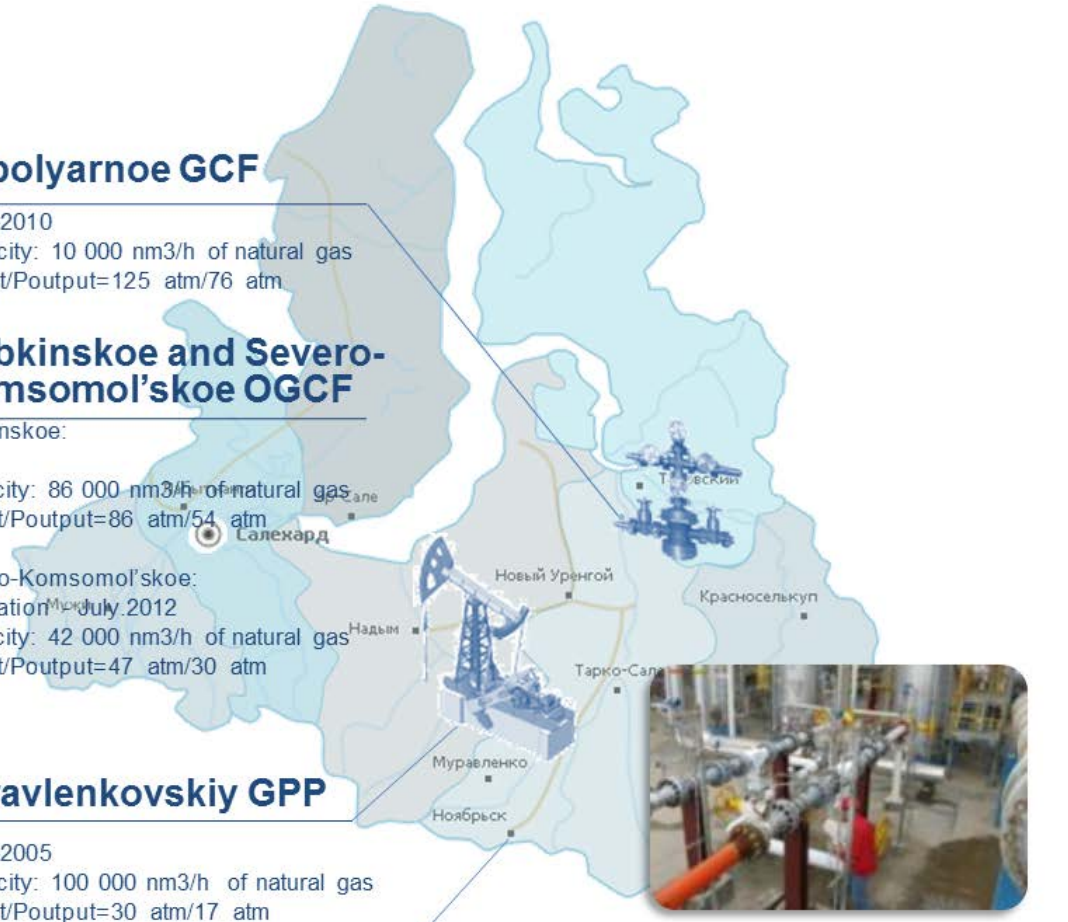
Severo-Komsomol'skoe:
Installation – July.2012
Capacity: 42 000 nm3/h of natural gas
Pinput/Poutput=47 atm/30 atm

Muravlenkovskiy GPP

2004-2005
Capacity: 100 000 nm3/h of natural gas
Pinput/Poutput=30 atm/17 atm

Vyngapurovskiy GPP

2012-2013
Capacity: 200 000 nm3/h of associated gas
Pinput/Poutput=12 atm/10 atm

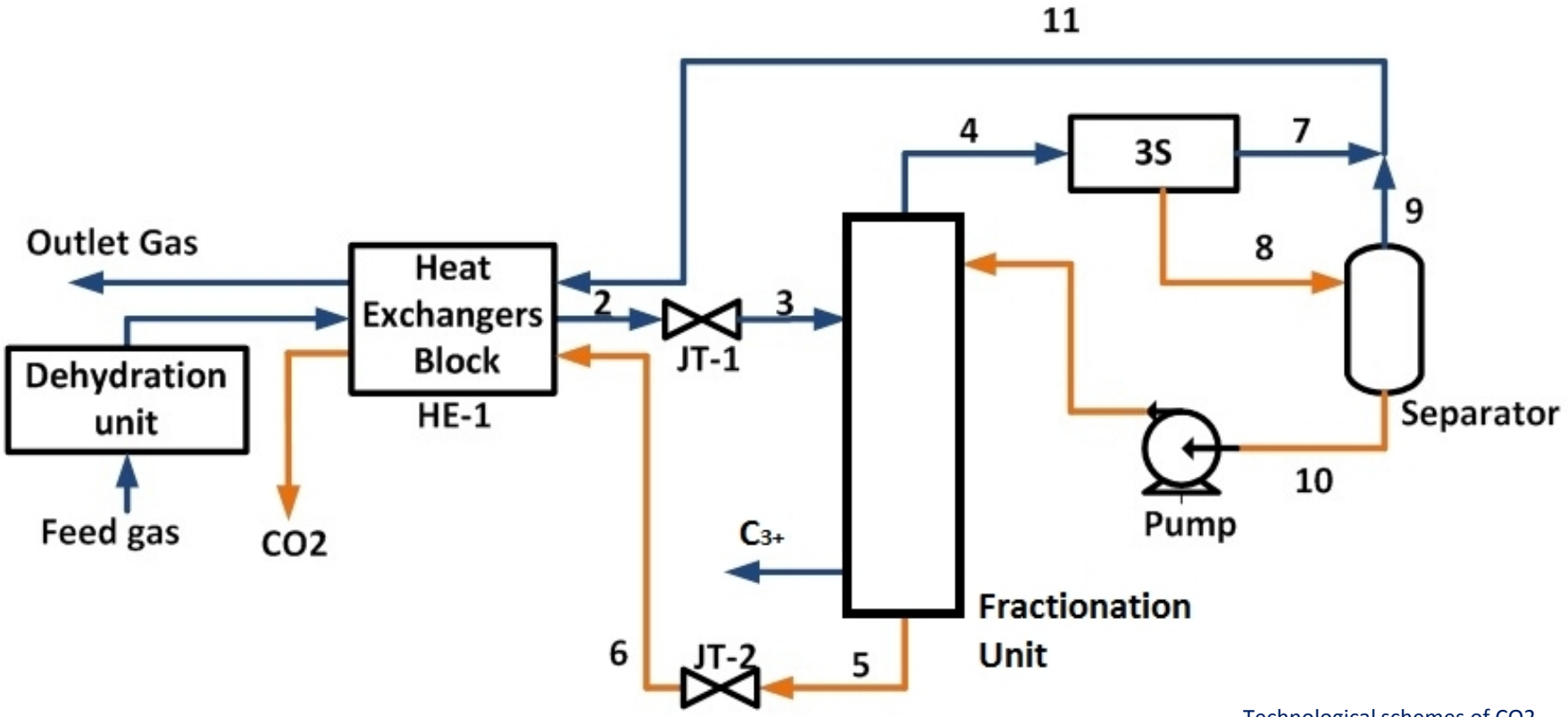


Talimu (China)

2011
Capacity: 159 000 nm3/h of natural gas
Pinput/Poutput=108 atm/70 atm

Basic principles of 3S-technology for CO2 recovery

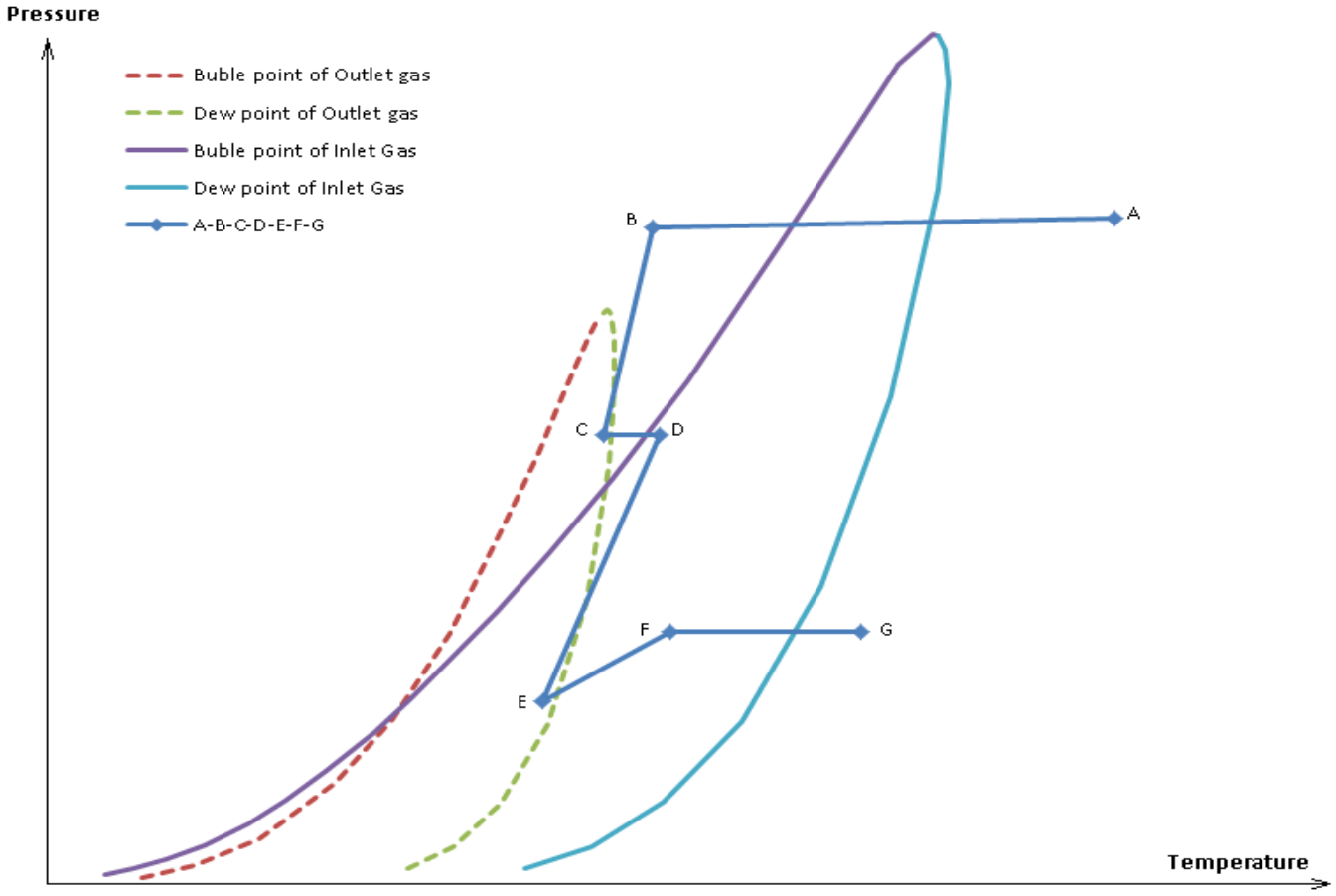
Basic scheme of 3S-separation unit for CO2 recovery from natural gases



Technological schemes of CO2 recovery is in patenting process in USA, EU, Malaysia, Thailand, China, Brazil, Australia and other countries

Basic principles of 3S-technology for CO2 recovery

Phase diagram of 3S-process on the pressure-temperature plane



Parameters of inlet and outlet streams in 3S-separation unit

Example 1

	Unit	Feed Gas	CO2	Outlet Gas
Temperature	*C*	45,0	-10,0	-9,6
Pressure	*MPag*	6,7	0,1	2,5
Molar Flow	*m3/h*	11776,6	8351,6	3425,1
Mass Flow	*kg/h*	18053,9	15153,2	2900,8
Mole Frac (Nitrogen)		0,0040	0,0000	0,0137
Mole Frac (CO2)		0,7120	0,9496	0,1327
Mole Frac (Methane)		0,2680	0,0309	0,8462
Mole Frac (Ethane)		0,0110	0,0128	0,0066
Mole Frac (H2S)		0,0050	0,0067	0,0008

Example 2

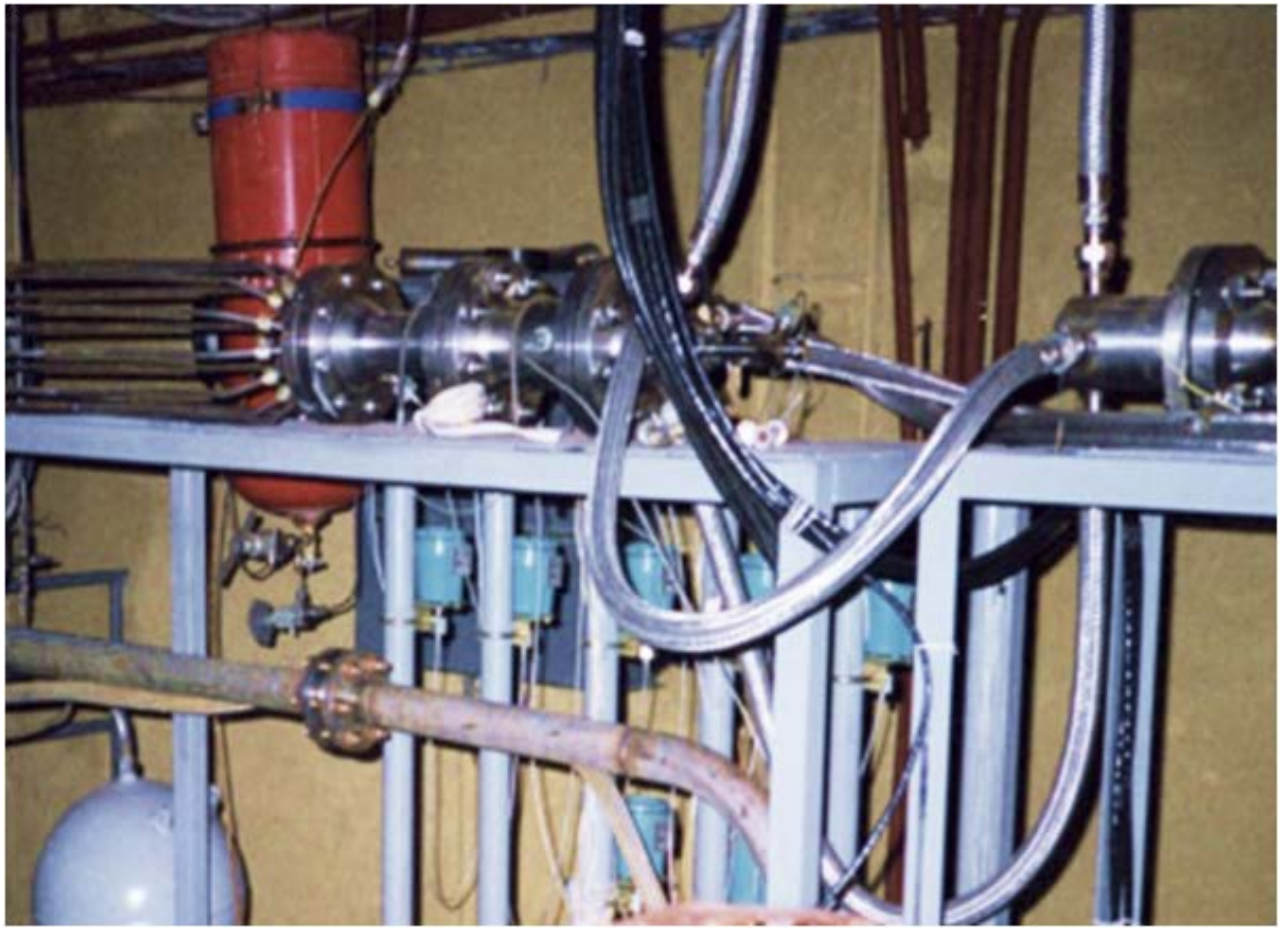
	Unit	Feed Gas	CO2	Outlet Gas
Temperature	C	40,0	15,6	30,0
Pressure	MPa	6,0	0,5	2,5
Molar Flow	m3/h	9722,0	7006,7	2715,2
Mass Flow	kg/h	14528,3	12575,6	1952,7
Mole Frac (CO2)		0,5601	0,8452	0,0280
Mole Frac (Methane)		0,3596	0,0459	0,9625
Mole Frac (Ethane)		0,0377	0,0498	0,0094
Mole Frac (Propane)		0,0238	0,0330	0,0001
Mole Frac (i-Butane)		0,0038	0,0053	0,0000
Mole Frac (n-Butane)		0,0081	0,0113	0,0000
Mole Frac (i-Pentane)		0,0018	0,0026	0,0000
Mole Frac (n-Pentane)		0,0047	0,0065	0,0000
Mole Frac (n-Hexane)		0,0003	0,0005	0,0000

Example 3

	Unit	Feed Gas	C3+	CO2	Outlet Gas
Temperature	C	40,0	97	11,1	25,0
Pressure	MPa	8,0	2,2	0,2	2,1
Molar Flow	m3/h	9722,0	265,5	6411,5	3045,0
Mass Flow	kg/h	14528,3	687,1	11646,6	2195,2
Mole Frac (CO2)		0,5601	0,0319	0,8851	0,0291
Mole Frac (Methane)		0,3596	0,0000	0,0234	0,9564
Mole Frac (Ethane)		0,0377	0,0032	0,0637	0,0070
Mole Frac (Propane)		0,0238	0,2857	0,0241	0,0001
Mole Frac (i-Butane)		0,0038	0,1094	0,0013	0,0000
Mole Frac (n-Butane)		0,0081	0,2522	0,0019	0,0000
Mole Frac (i-Pentane)		0,0018	0,0630	0,0002	0,0000
Mole Frac (n-Pentane)		0,0047	0,1630	0,0004	0,0000
Mole Frac (n-Hexane)		0,0003	0,0000	0,0000	0,0000

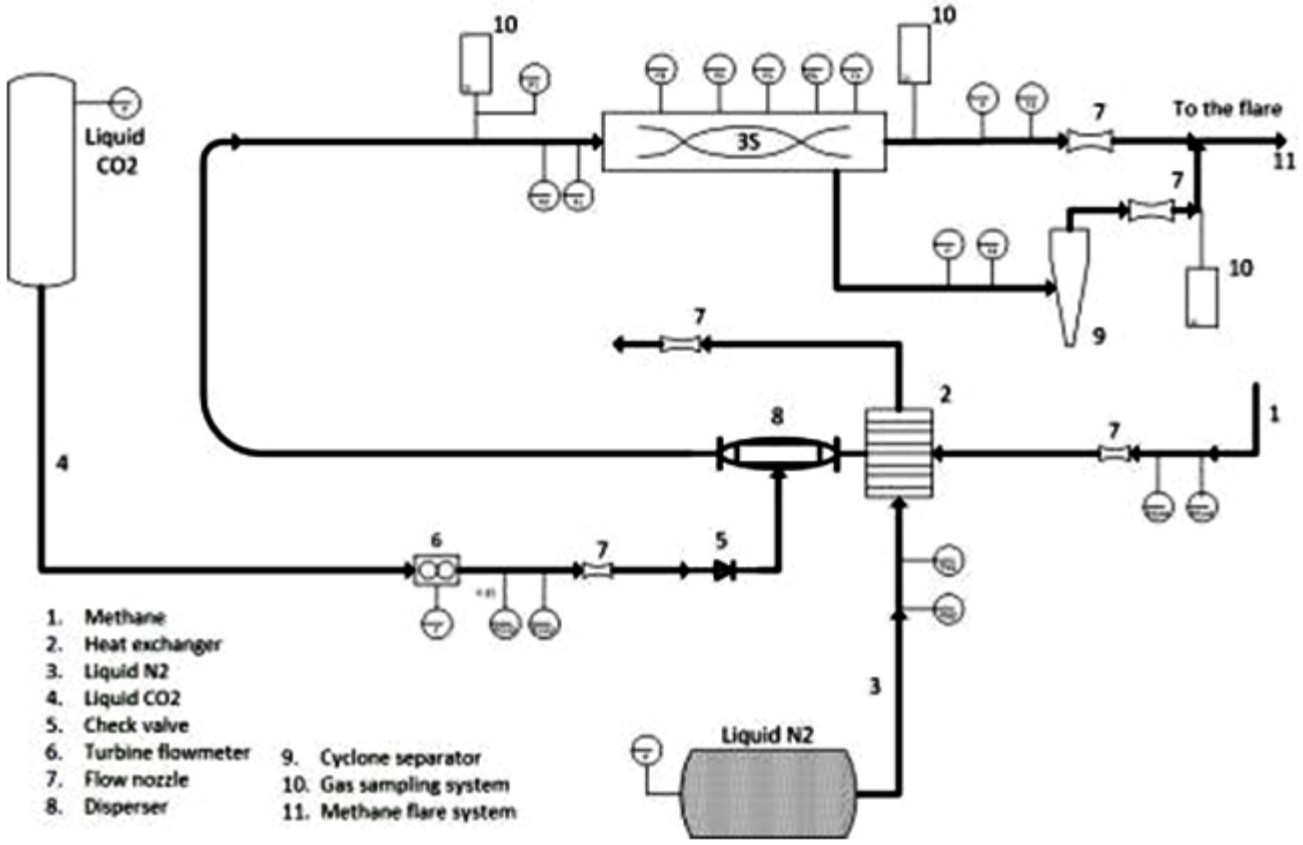
Experimental 3S-unit for CO2 recovery

3S-separator of the experimental unit



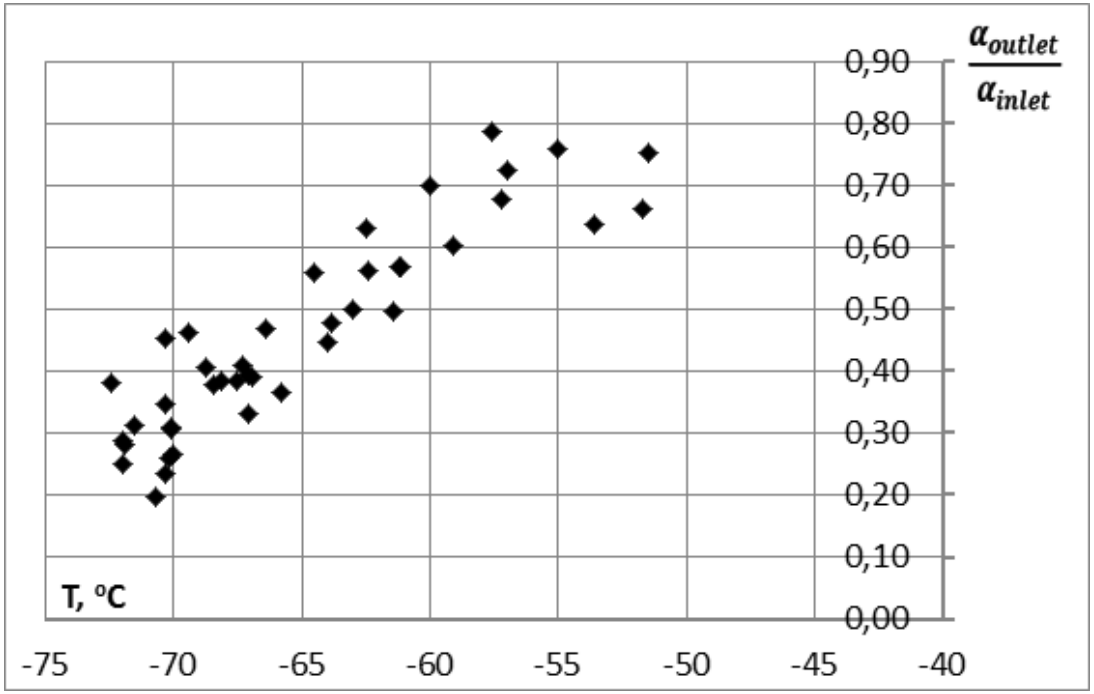
Experimental 3S-unit for CO2 recovery

Basic scheme of the experimental 3S-unit for CO2 recovery from natural gases



Test results of 3S-separator with mixtures of Methane and CO2

Dependence of 3S-separators operating efficiency



α_{outlet} - concentration of CO_2 (mol.) at the 3S outlet,
α_{inlet}- - concentration of CO_2 (mol.) at the 3S inlet,
T – gas temperature at the 3S inlet

Conclusions

- ✓ 3S-technology of supersonic separation is most effective for natural gas with high CO_2 content, especially when it is difficult to use conventional technologies.
- ✓ Proposed 3S-separation units provide CO_2 concentration in the outlet of the unit less than 2 % mol. (at any CO_2 content in the inlet gas).
- ✓ Tests of 3S-separators, conducted on hydrocarbon mixtures, containing CO_2, have shown that the developed 3S-separator provides the desired efficiency of CO_2 separation from natural gases.