填埋气体提纯制作天然气技术应用案例

Application Case of Landfill Gas Conversion to CNG

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内容
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- 1、LFG的产生及危害
  Landfill gas generation and its hazards
- 2、LFG的资源价值及利用途径
  Resource value and its utilization approaches
- 3、LFG提纯分离技术
  Purifying and separation of LFG
- 4、应用案例
  Application case

LFG的产生
LFG Generation

- 填埋气体(LFG, Landfill Gas)是生活垃圾填埋场中产生的气体污染物

  Landfill gas is a pollutant generated in MSW landfill site
- 卫生填埋是中国生活垃圾处理处置的主要技术手段，占垃圾无害化处理总量的80%。

  Landfill is the most important way for MSW disposal in China, accounting for about 80% of the total volume
- 填埋气体的主要成分为CH_4和CO_2

  The major compositions are CH_4 and CO_2

LFG的典型组成
Typical Composition of Landfill Gas

组　分	Component	体积百分比（%） Volume percent
甲烷	Methane	45 ~ 60
二氧化碳	Carbon Dioxide	40 ~ 60
氮	Nitrogen	2.0 ~ 5.0
氧	Oxygen	0.1 ~ 1.0
硫化物	Sulfur compounds	0.0 ~ 1.0
氨	Ammonia	0.1 ~ 1.0
氢	Hydrogen	0.0 ~ 0.2
一氧化碳	Carbon monoxide	0.0 ~ 0.2
微量化合物	Trace compounds	0.01 ~ 0.6

LFG的危害性
Hazards of LFG

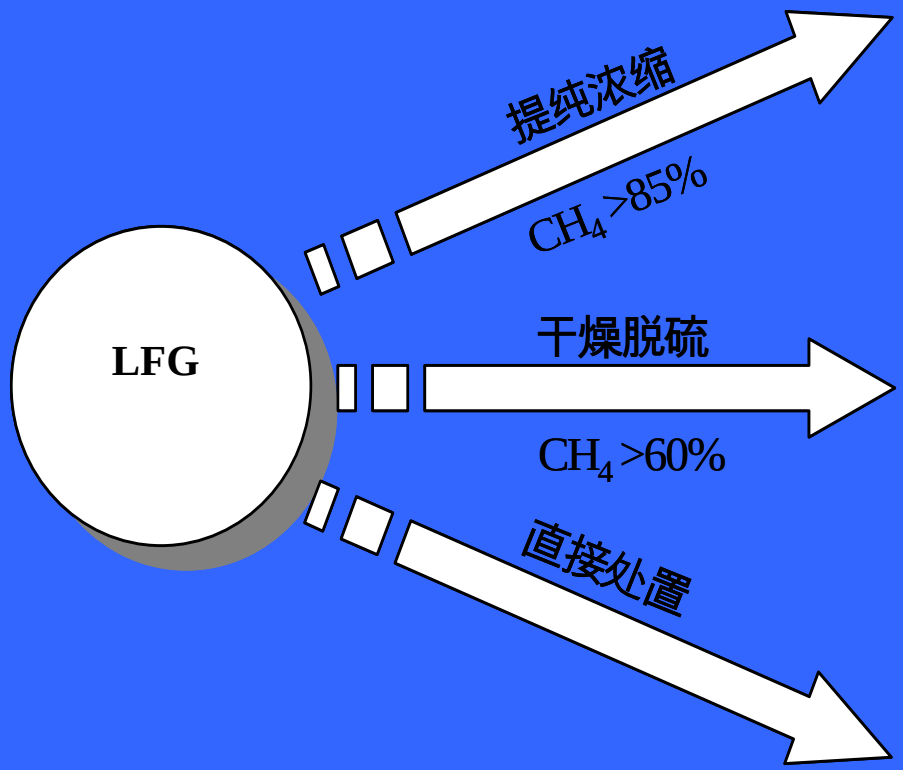
- 局部自燃、火灾、爆炸；
  Spontaneous combustion, fire, explosion
- 危害动植物、人类健康；
  Health damage to plant, animal and human
- 产生臭味；
  Source of odor
- 温室效应
  Greenhouse effect

LFG的资源价值
Resource Value of LFG

燃料种类	纯甲烷	填埋气	汽油	柴油
fuel	Methane	LFG	Gasoline	Diesel
发热量 Caloric value （kJ/m3）	8580	4633.2	7300	9500

- 1m^{3}LFG相当于0.45L柴油或0.6L汽油
- The caloric value of 1m^3 LFG is equivalent to 0.45L diesel or 0.6L gasoline

LFG的利用途径
Utilization Approaches of LFG



用作汽车燃料、化工原料、燃料电池燃料等，能量转化率40～60%
CNG, raw material of chemical products and fuel cells

用作气体发电、城市燃气等，能量转化率20～40%
Electricity generation and municipal gas

火炬燃烧排放
Flaring

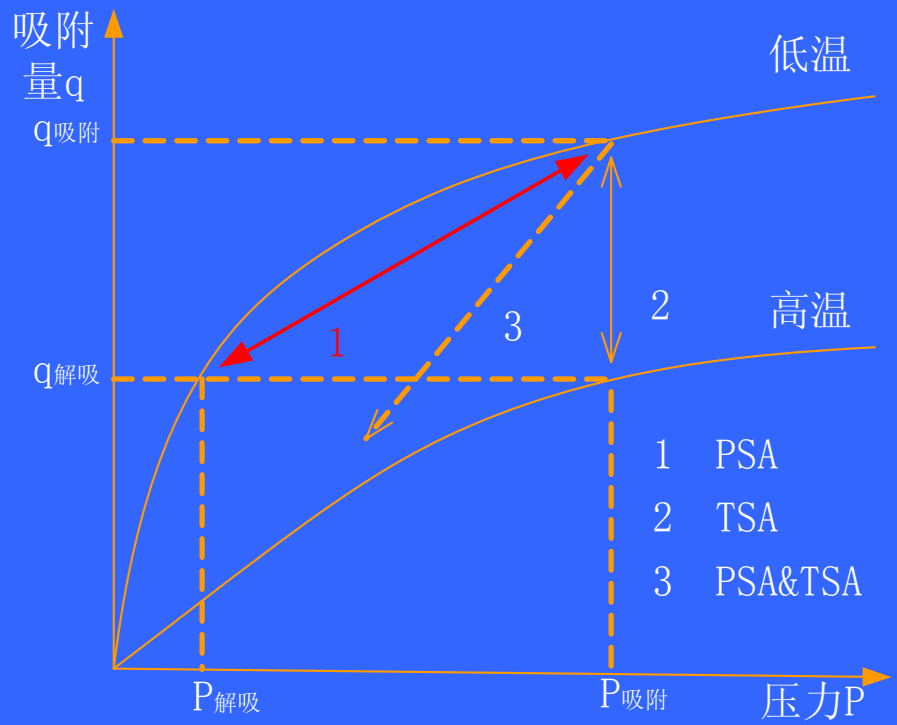
LFG制取CNG的意义
Significance of LFG Conversion to CNG

- 消除填埋气体危害
  To avoid harmful effect of LFG
- 满足日益紧缺的汽车燃料市场
  To meet the increasing vehicle fuel requirement
- 减少汽车尾气污染
  To reduce vehicle exhaust pollution
- 调压后供给小区居民
  To supply for residents after pressure regulation

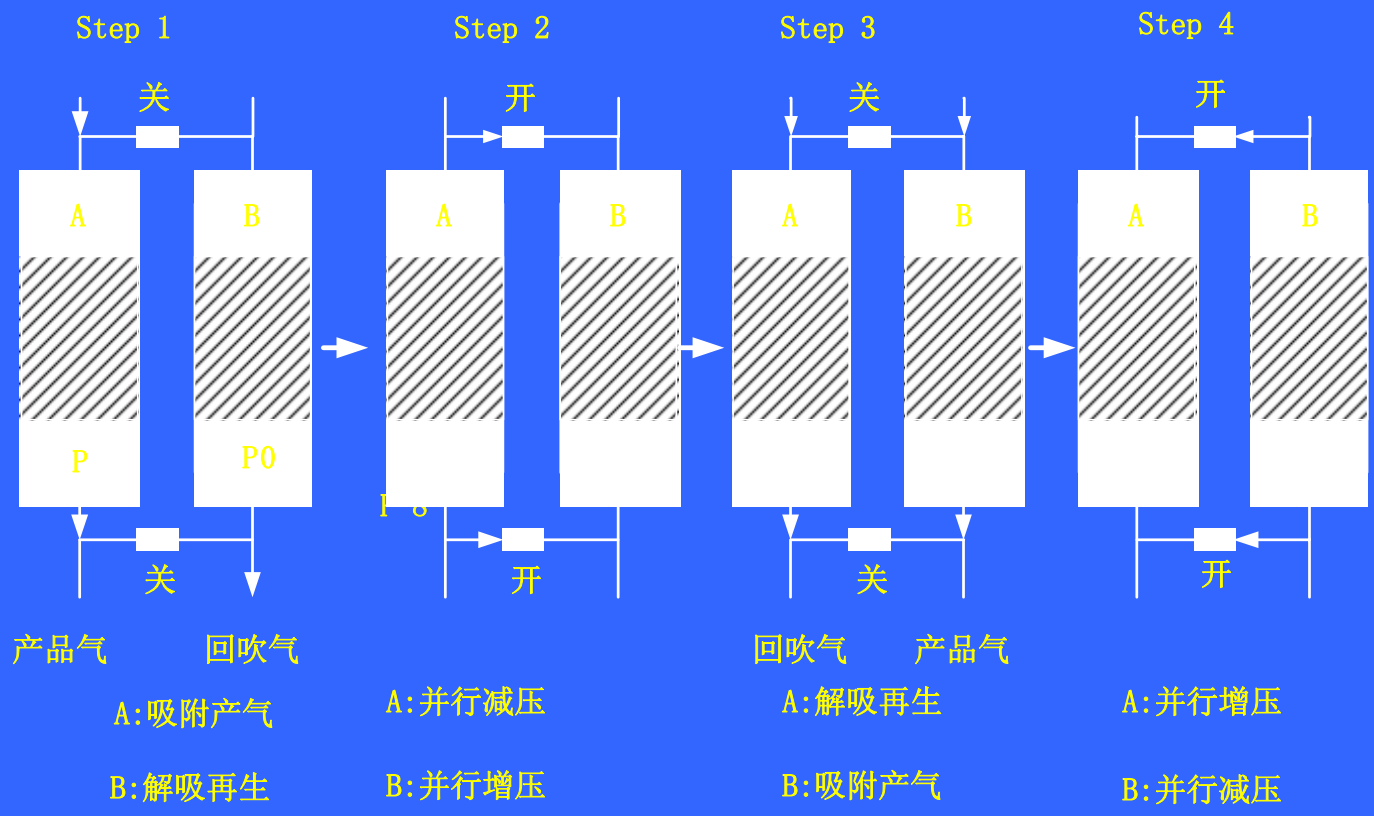
LFG分离提纯技术
Purifying and Separation of LFG

- 吸附分离
  Adsorption
- 吸收分离
  Absorption
- 膜分离
  Membrane separation

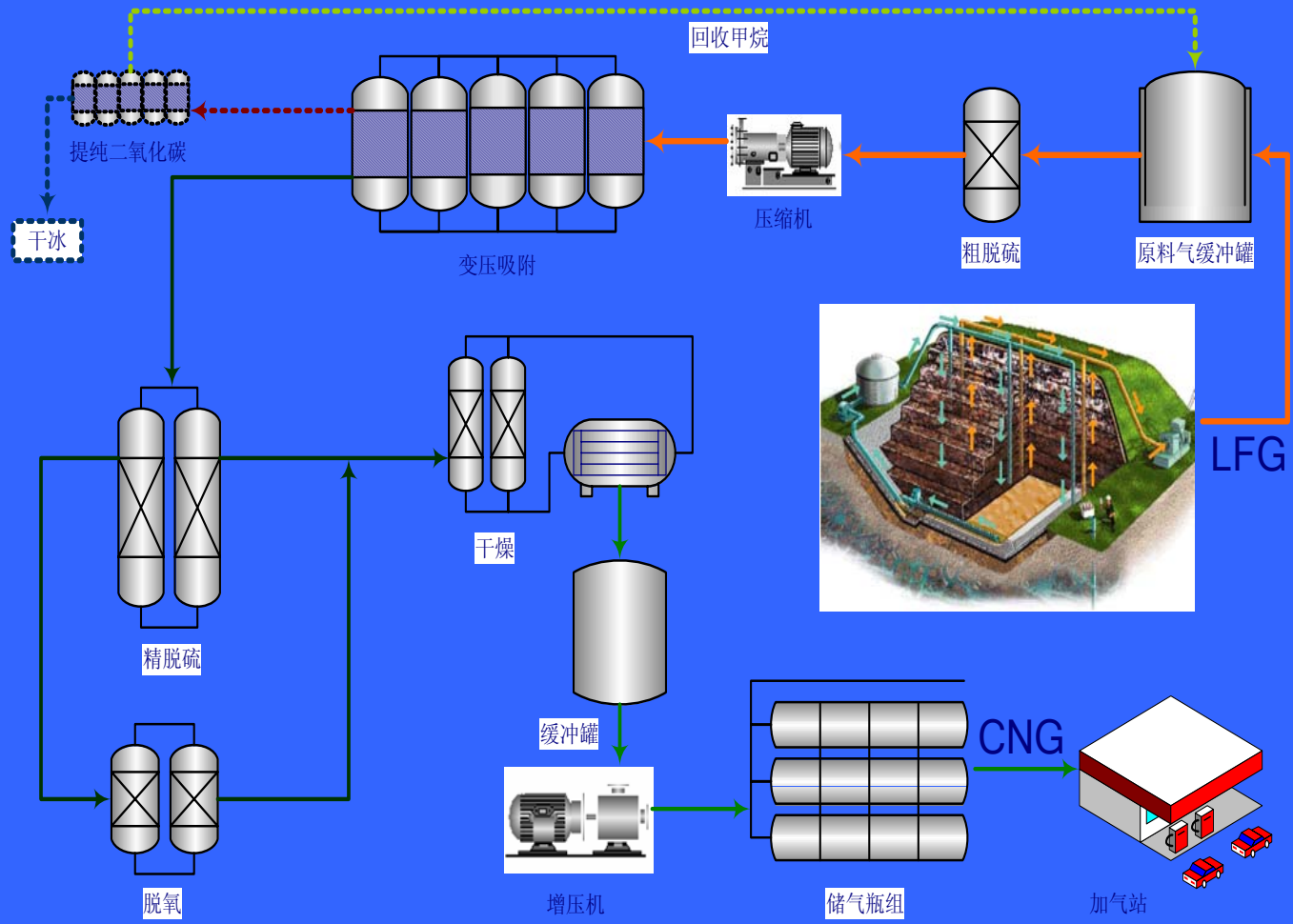
变压吸附原理
Principle of pressure swing adsorption

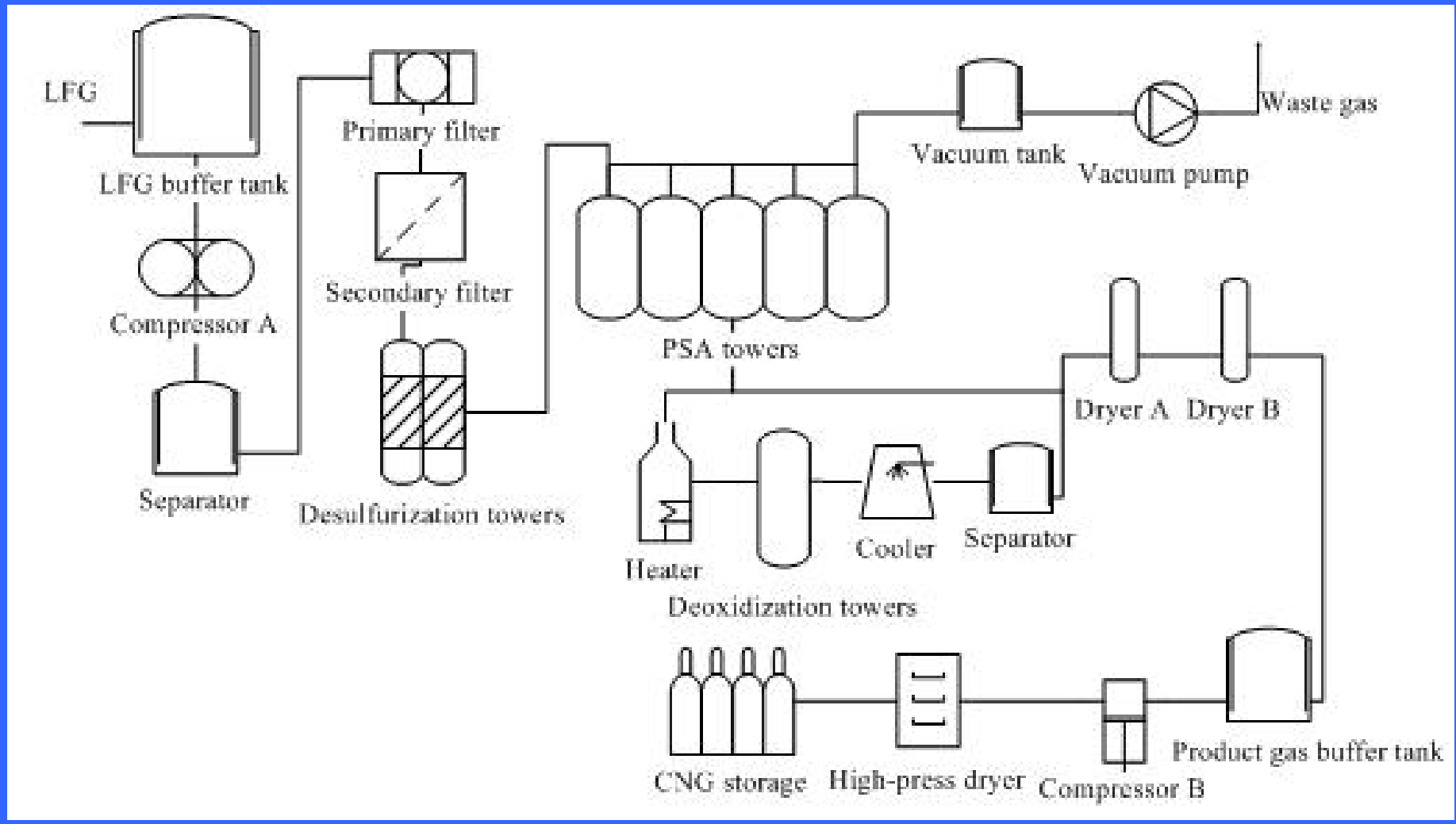


变压吸附循环
Press Swing Adsorption Circle

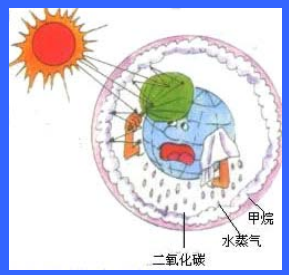


填埋气体提纯系统工艺流程图
LFG Purifying Process Diagram

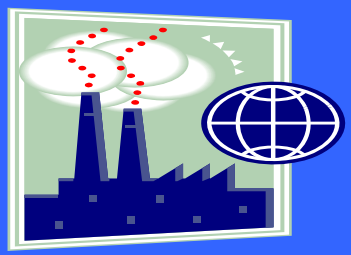



LFG
LFG buffer tank
Compressor A
Separator
Primary filter
Secondary filter
Desulfurization towers
PSA towers
Vacuum tank
Vacuum pump
Waste gas
Dryer A
Dryer B
Heater
Deoxidization towers
Cooler
Separator
CNG storage
High-press dryer
Compressor B
Product gas buffer tank

填埋气体提纯利用实现“零排放”
Zero Emission of LFG Purifying System



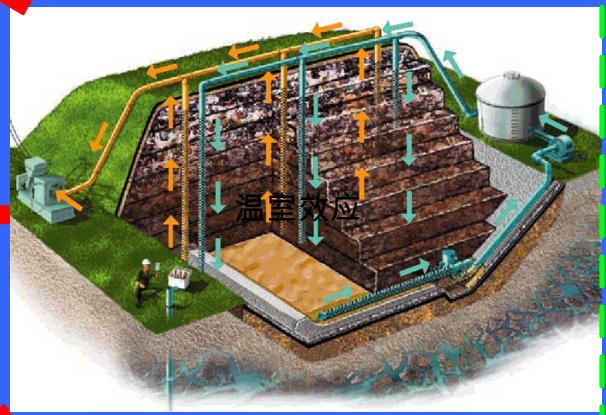
温室效应



大气污染

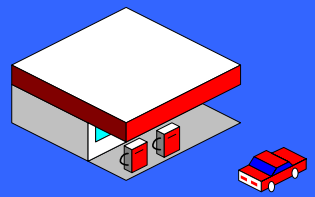
火灾爆炸

自然排放



填埋气体产生

提纯净化



清洁燃料

干冰

零排放

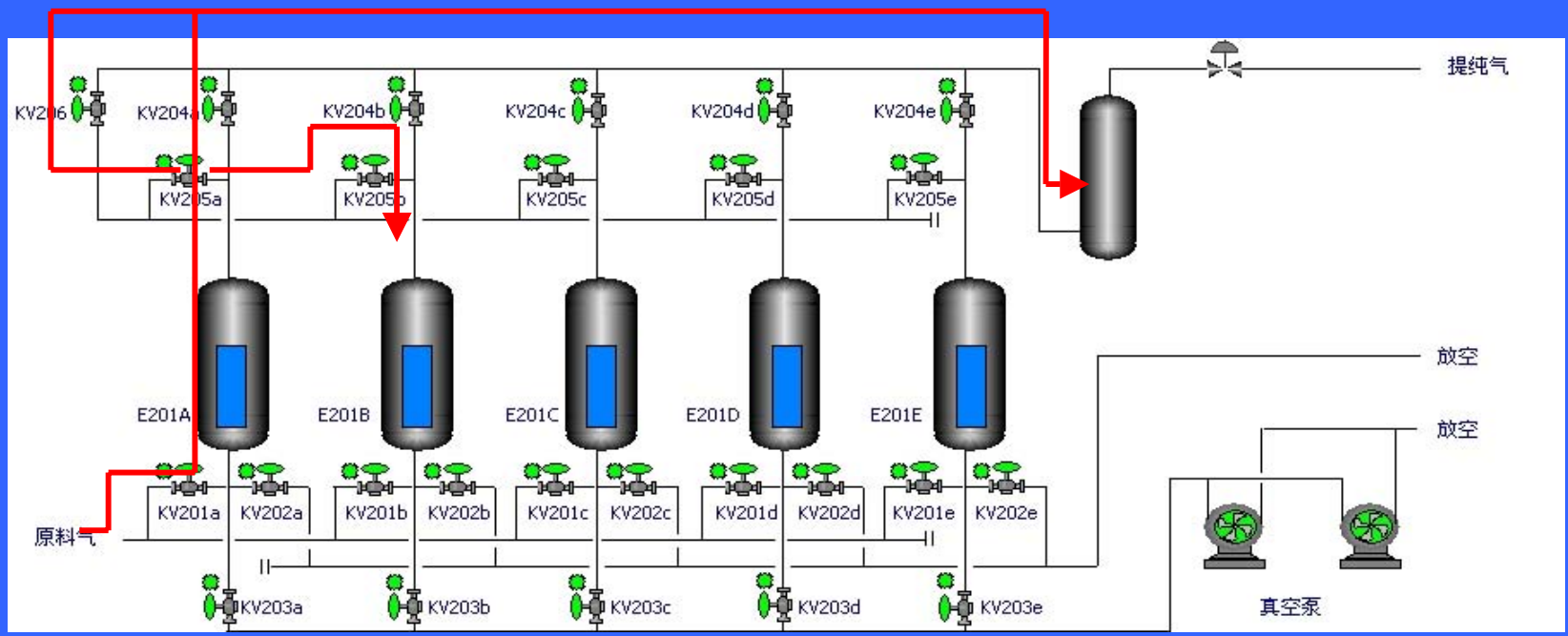
应用案例
Application Case

深圳下坪填埋气体提纯示范工程

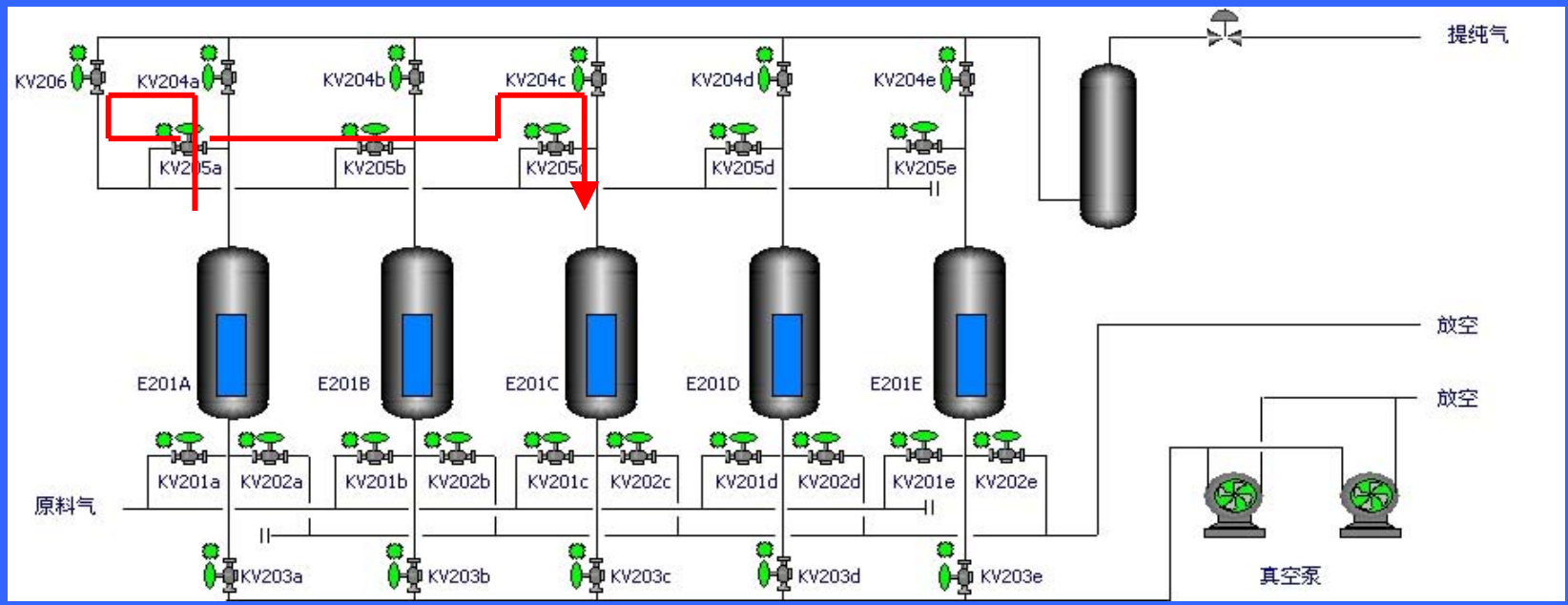
LFG Purifying Demonstration Project in Xiaping, Shenzhen City


CAT

吸附
Adsorption

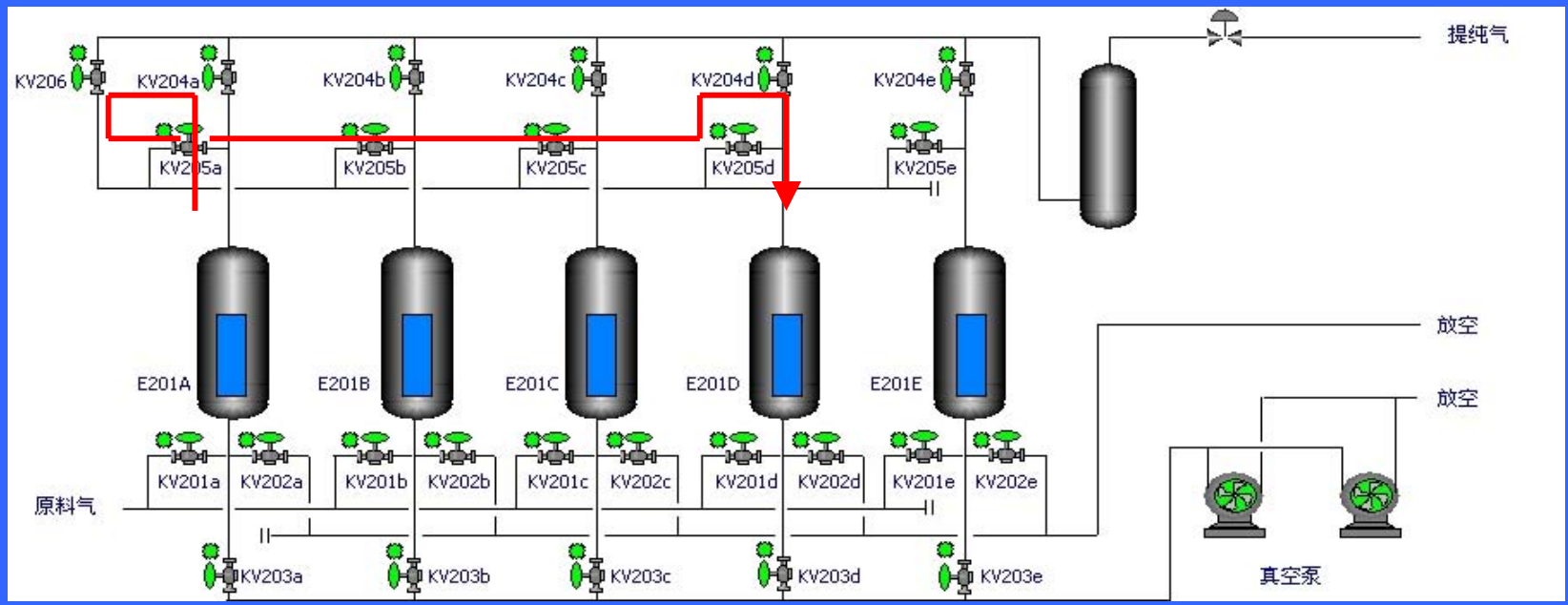


一均降
First pressure decrease

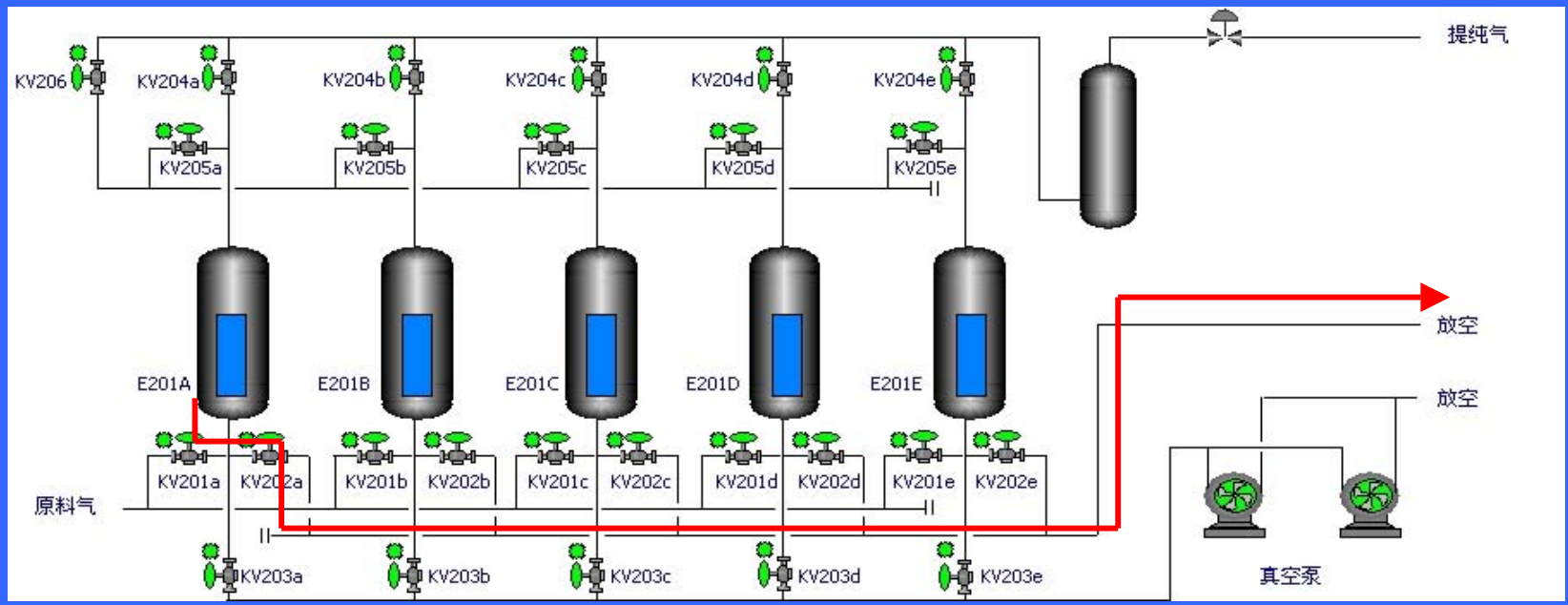


二均降

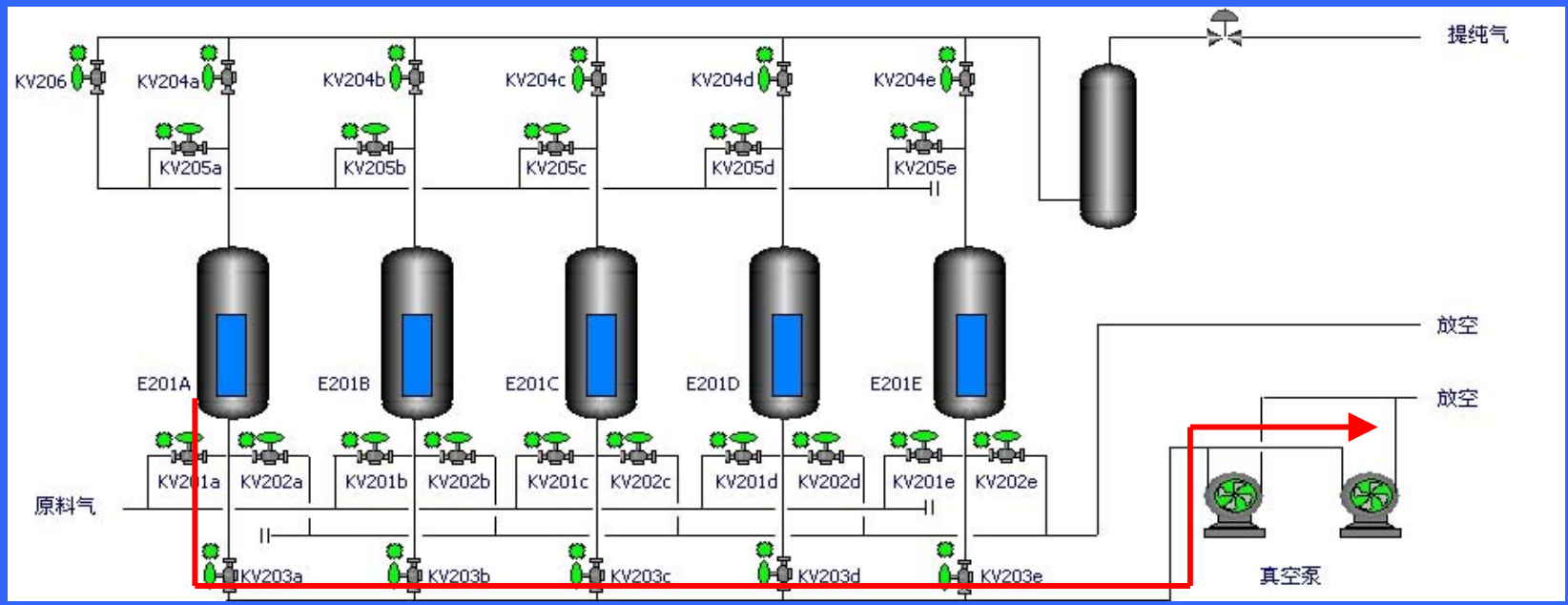
Secondary pressure decrease



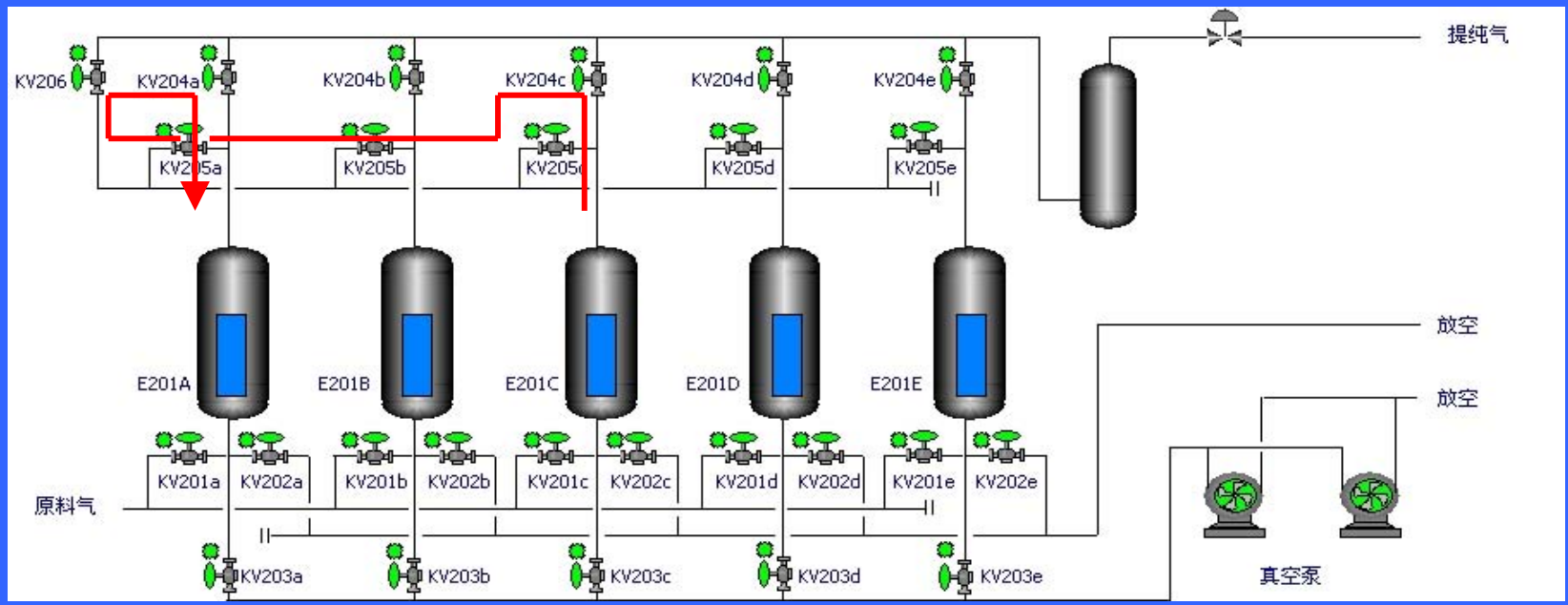
逆放
Final pressure decrease



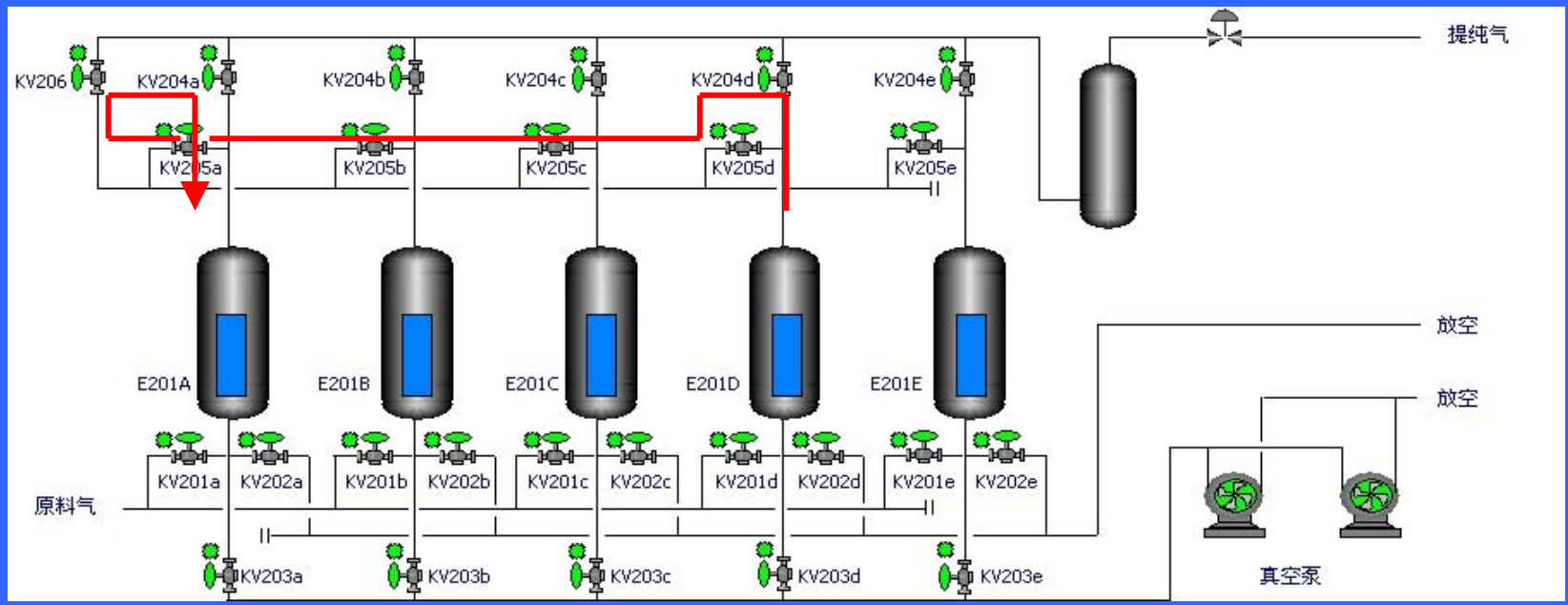
抽真空
Vacuum


提纯气
KV206
KV204a
KV204b
KV204c
KV204d
KV204e
KV205a
KV205b
KV205c
KV205d
KV205e
E201A
E201B
E201C
E201D
E201E
放空
放空
KV201a
KV202a
KV201b
KV202b
KV201c
KV202c
KV201d
KV202d
KV201e
KV202e
原料气
KV203a
KV203b
KV203c
KV203d
KV203e
真空泵

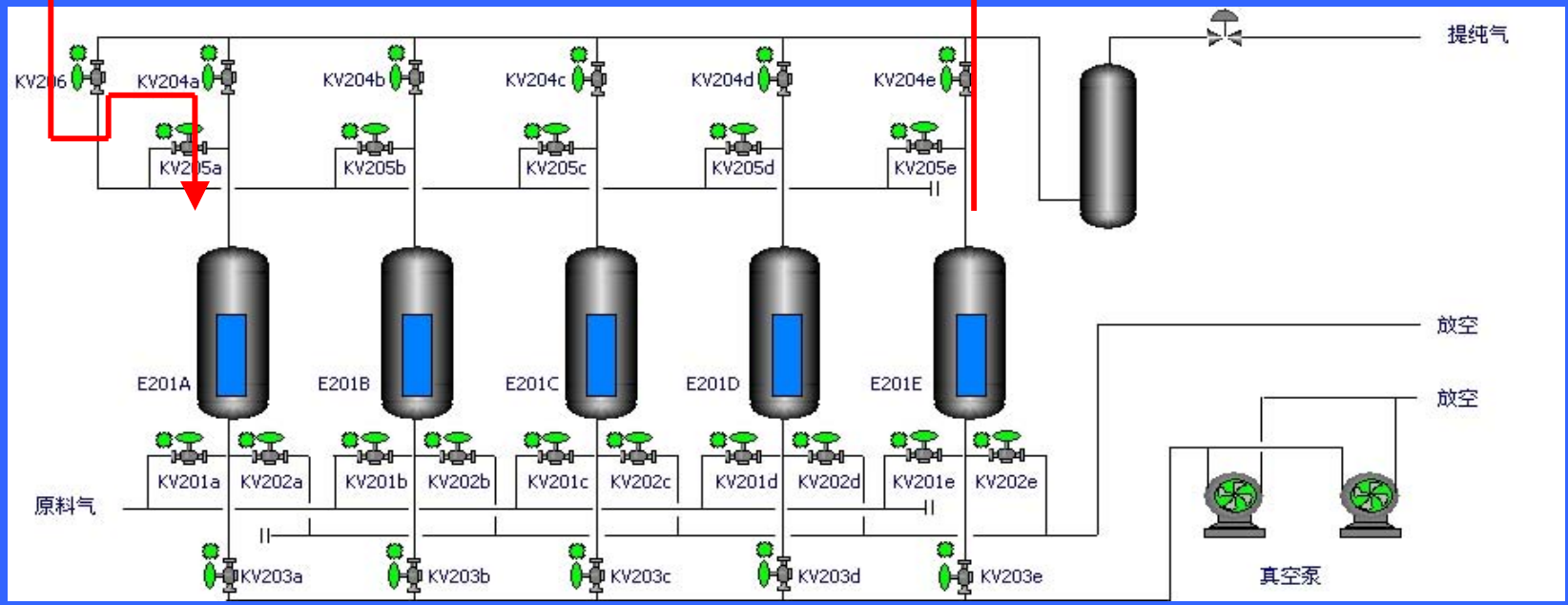
二均升
Secondary pressure raise



一均升
First pressure raise



终充
Final pressure raise

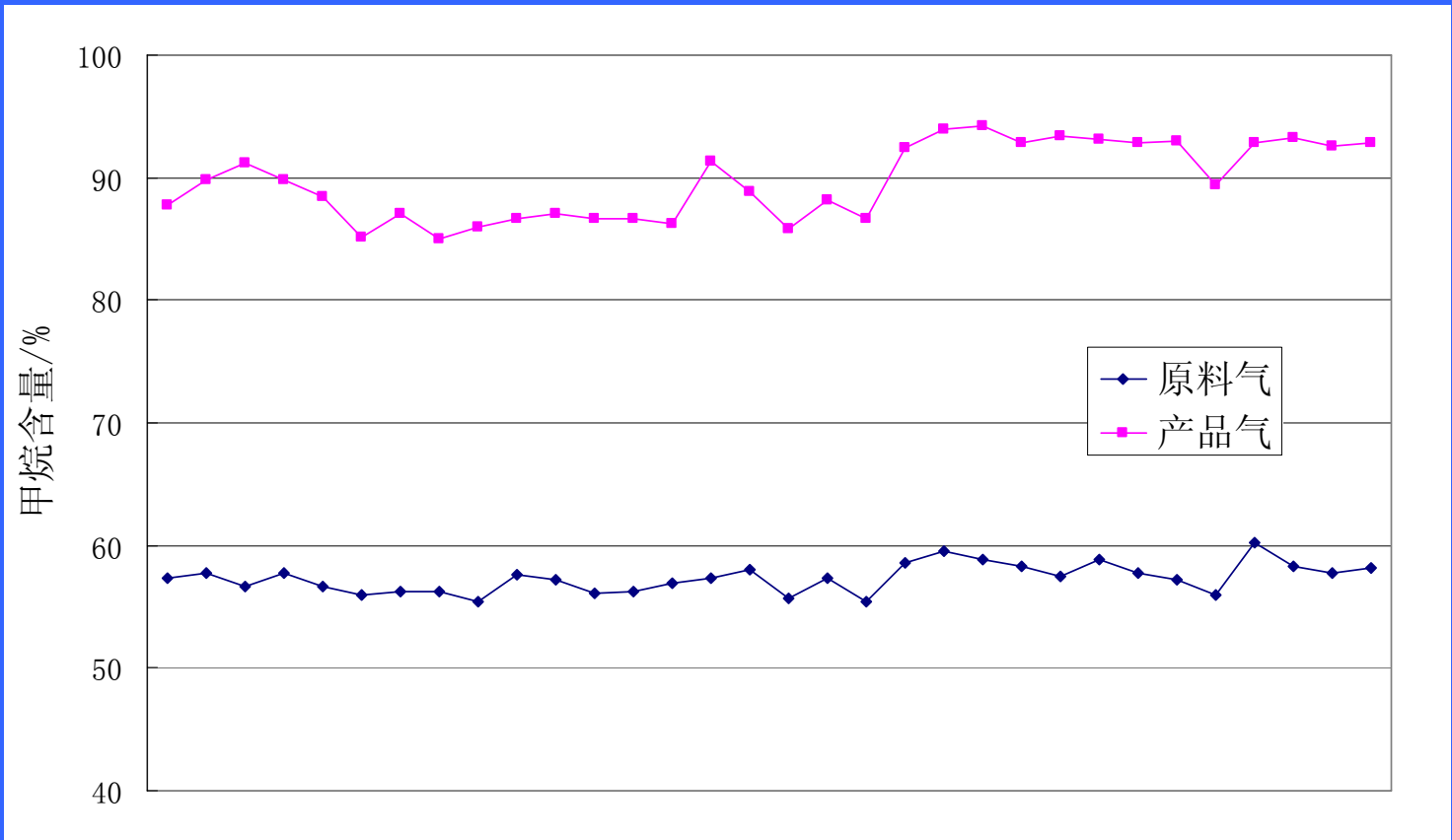


项目简介
Project Introduction

- 建成时间：2006年　　Year: 2006
- 地点：广东深圳
- Place: Shenzhen, Guangdong
- 一期规模：500立方米填埋气/小时
- Scale of Phase I: 500 Nm^3 LFG/h

提纯前后甲烷含量

CH_4 Concentration Before and After Purifying



原料气和产品气主要指标对比
Index Comparation of Raw and Product Gas

指标	Index	原料气（填埋气）Raw Gas (LFG)	提纯后产品气 Product Gas
高位发热量，MJ/m^3	High Heat Value	> 15	> 31.4
总硫（以硫计），mg/m^3	Total Sufur	未检出	≤200
硫化氢，mg/m^3	Sulfureted Hydrogen	≤200	≤15
二氧化碳，%	Carbon Dioxide	20-40	≤3.0
氧气，%	Oxygen	≤5	≤0.5
水露点，℃	Dew Point	常温, normal temperatute	- 22℃

深圳下坪填埋气提纯项目产品检测报告
Survey Report of Product Gas

Report Number# gas report 061129-001A

Components	Run#1 Mol%	Run#2 Mol%	RESULTS AVERAG	Max Error	ASTM1945 REPEAT RUN IN	STD MOL%
Nitrogen	10.4958	10.5174	10.51	0.0216	Y	2.4800
Methane	88.4745	88.4448	88.46	0.0297	Y	88.6890
Ethane	0.0000	0.0000	0.00	0.0000	Y	5.0000
Propane	0.0000	0.0000	0.00	0.0000	Y	0.9970
i-Butane	0.0000	0.0000	0.00	0.0000	Y	0.3000
n-Butane	0.0000	0.0000	0.00	0.0000	Y	0.3000
i-Pentane	0.0000	0.0000	0.00	0.0000	Y	0.1000
n-Pentane	0.0000	0.0000	0.00	0.0000	Y	0.1000
C6+	0.0000	0.0000	0.00	0.0000	Y	0.0300
Oxygen	0.8514	0.8531	0.85	0.0017	Y	0.0998
CO2	0.1783	0.1846	0.18	0.0063	Y	1.0030
Total	100.000	100.000	100.00			
Total unnormalized	99.322	99.363				

H2S	0.00	ISO19739/04	10ppm
Total Sulphur(A+b)	0.00	ISO19739/04	10ppm
CARBONYL SULFIED(A)	0.00	ISO19739/04	5ppm
METHYL+ETHYL MERCAPTANE(B)	0.00	ISO19739/04	5ppm

Gross Heating ValueGPA 15℃,101.325Kpa)	33.41	MJ/m3	
iso-Gross Heating Value(20℃/20℃) 101.325Kpa	32.82	MJ/m3	
MON	125		
Real Gas Relation DensityGPA 2145	0.6238	kg/m3	
Real Gas Relation Density ISO6976	0.71	kg/m3	
Wobble Index	42.31	MJ/m3	

GUANG DONG DAPENG LNG COMPANY LIMITED 广东大鹏液化天然气有限公司

Analyst: Lei Lei

Approved Signed: Lakowe

改造后使用CNG的洒水车
CNG Refitting Watering Cart

Diesel substitution ratio: 55.3%

CNG : Diesel = 0.84 : 1

改造后使用CNG的推土机
CNG Refitting Buldozer

Diesel substitution ratio: 48.77%　　CNG : Diesel = 1.04 : 1

改造后的油气双燃料车
CNG-Gasoline Dual-Fuel Refitting Vehicle

结束语
Conclusion

- 工艺系统及相关设备、装备已相对成熟，完全满足工程应用的要求。
- The technology and equipment is relatively practical, which can meet requirements of project application.
- 该技术的全面推广，有望改变LFG无序排放、潜在能源被浪费的现状，提高垃圾填埋行业生物质能利用水平，同时有利于填埋场污染控制，推进填埋场生态化建设。
- Adopting generally the technology can be expected to change the current status of fugitive LFG emission and energy waste, improve biomass energy utilization and promote ecological construction of landfill site.

谢谢！

Thank you!