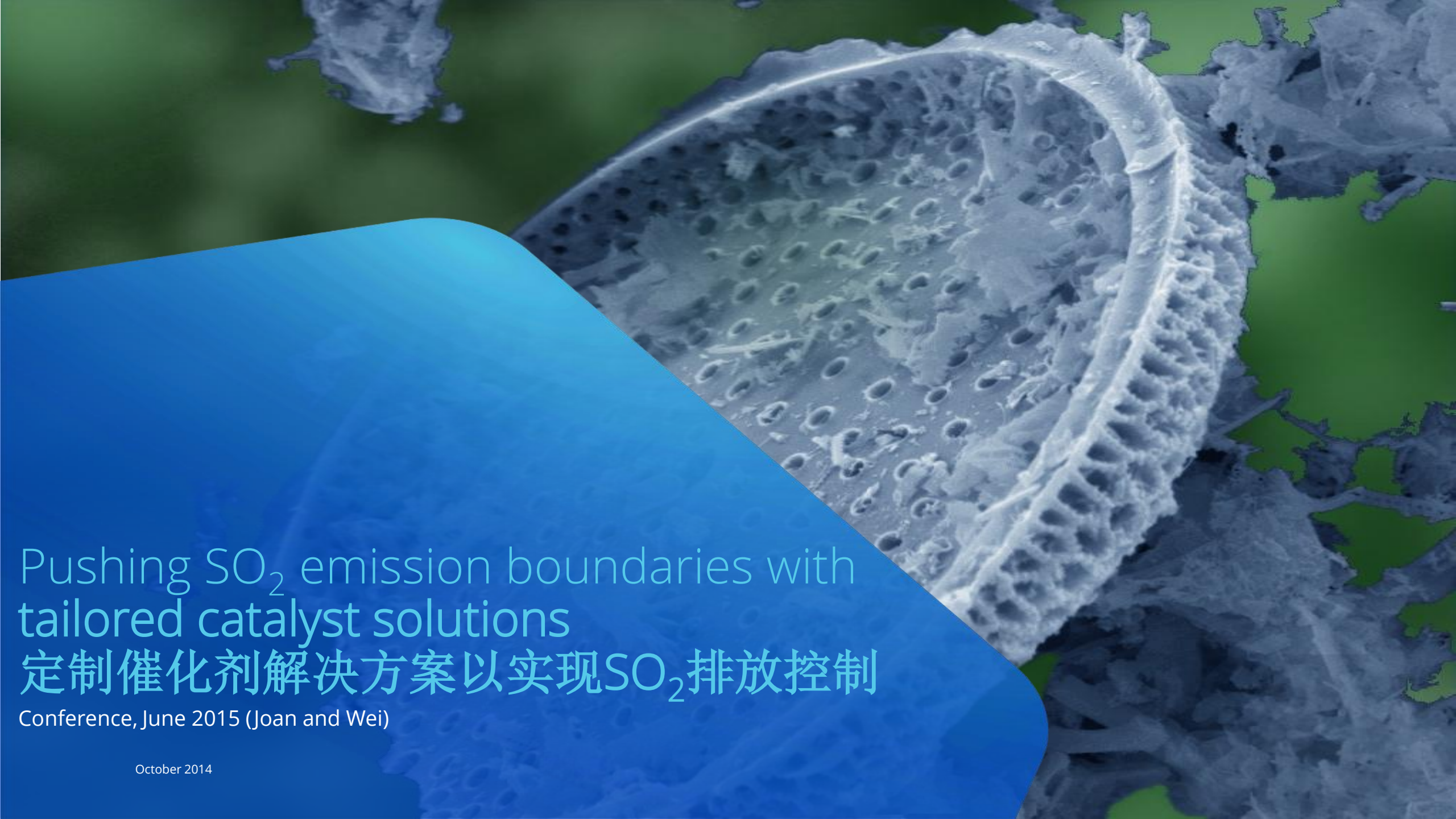


Pushing SO_2 emission boundaries with tailored catalyst solutions

定制催化剂解决方案以实现SO_2排放控制

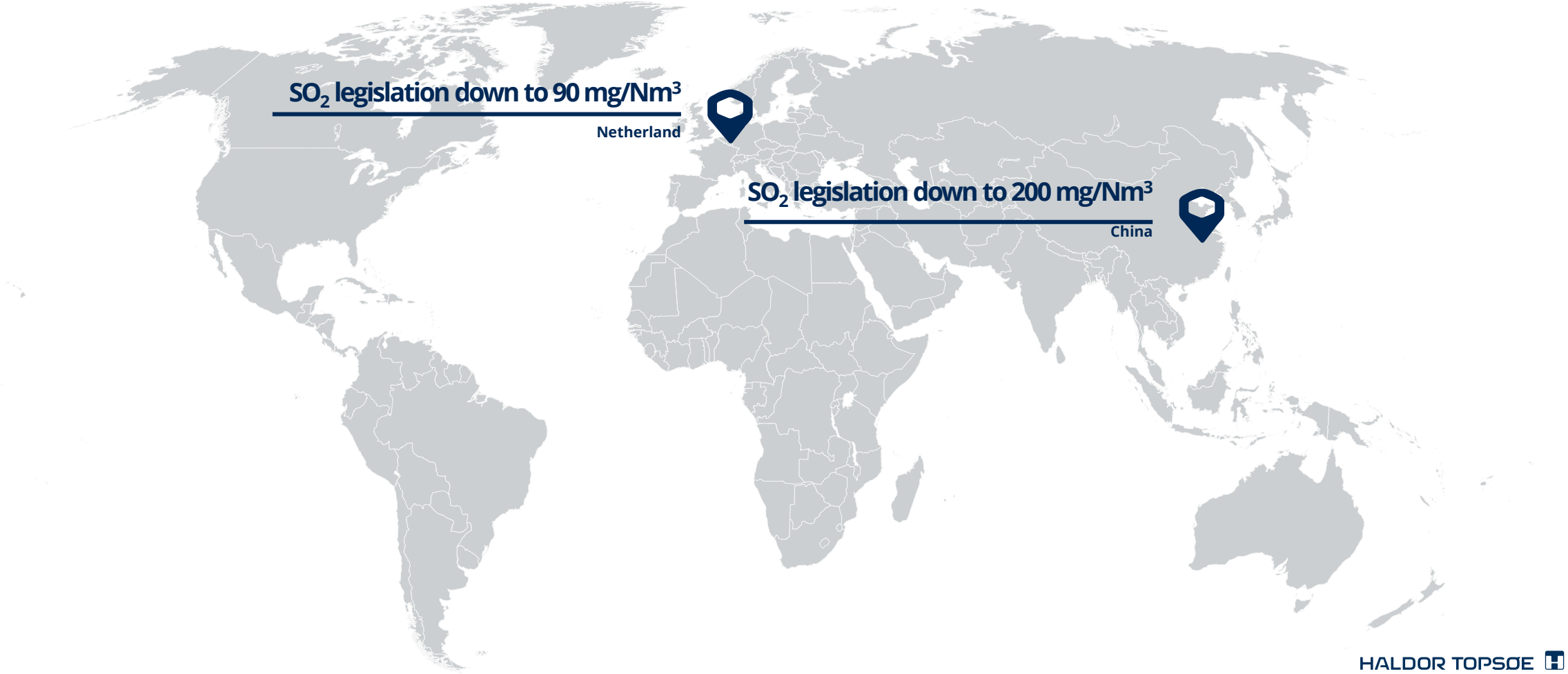
Conference, June 2015 (Joan and Wei)

October 2014

SO_2 emission boundariesSO2排放上限

China is one of the countries with the lowest emission

中国是世界上排放控制最严格的国家之一



Our founder Dr. Haldor Topsøe我们的创始人—哈德尔·托普索博士

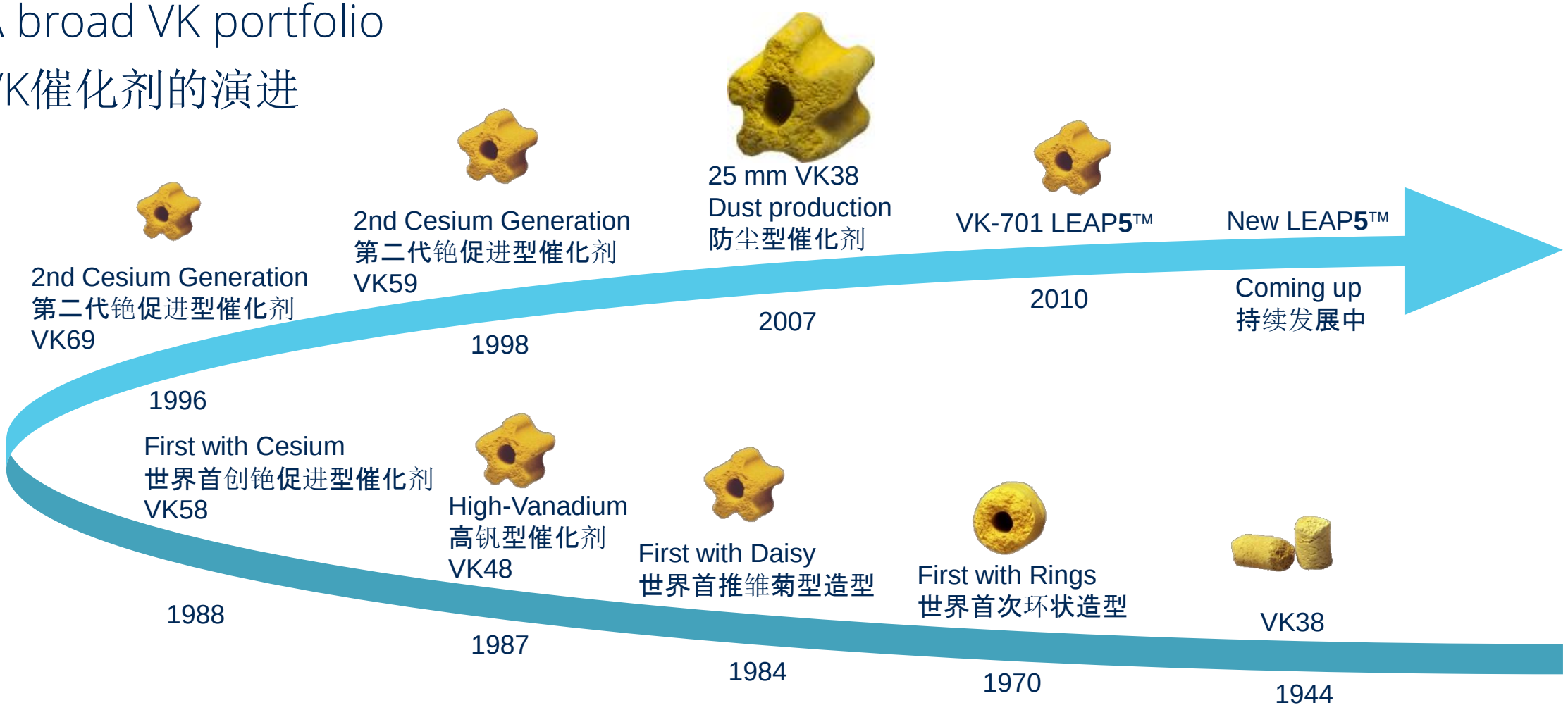
More than 70 years of experience within sulfuric acid

在硫酸领域拥有超过70年的实践经验

Haldor Topsoe

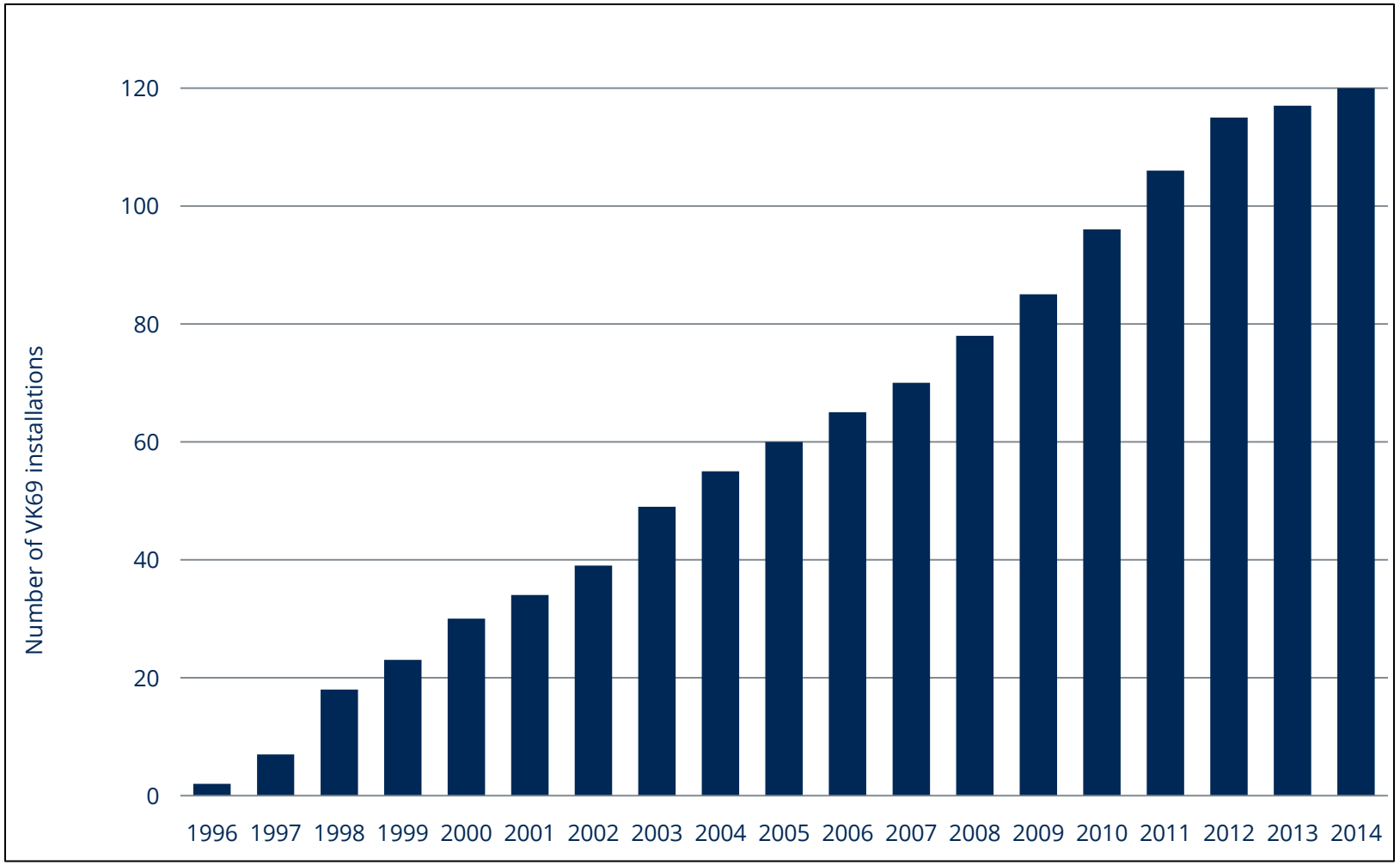
A broad VK portfolio

VK催化剂的演进



VK69 references VK69催化剂全球业绩

More than 120 references today 目前已超过120套装置采用



HALDOR TOPSOE

LEAP5™ catalysts

Magnifying performance with high SO_3 concentration

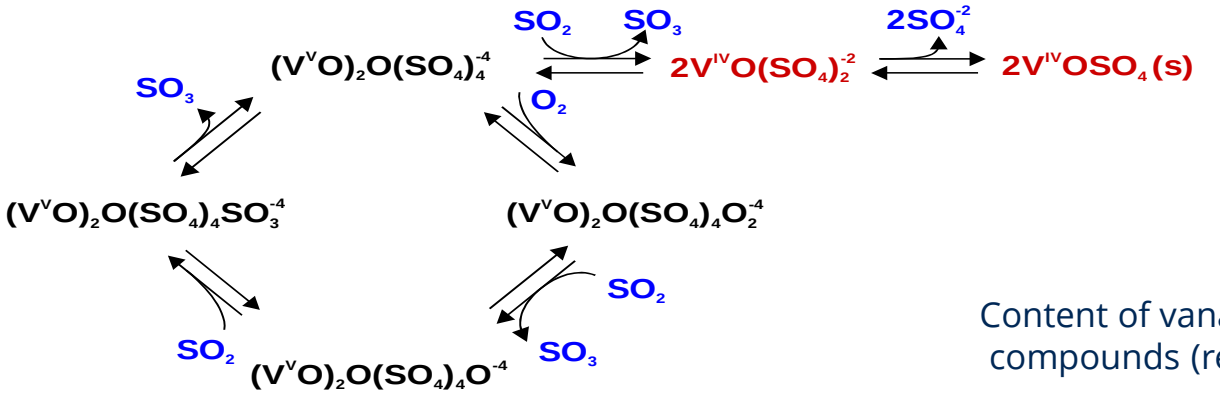
高SO_3浓度条件下的卓越性能

- Designed for high SO_3 environments
  专门设计应用于高SO_3环境
- More active across entire temperature range
  在全部温度范围内，活性均有提升
- Allows bed 3 to be operated at a lower inlet temperature
  允许三床在较低进口温度下操作
- Additional conversion in bed 3 shifts the equilibrium curve for bed 4
  提高三床转化率，以提升四床的平衡曲线

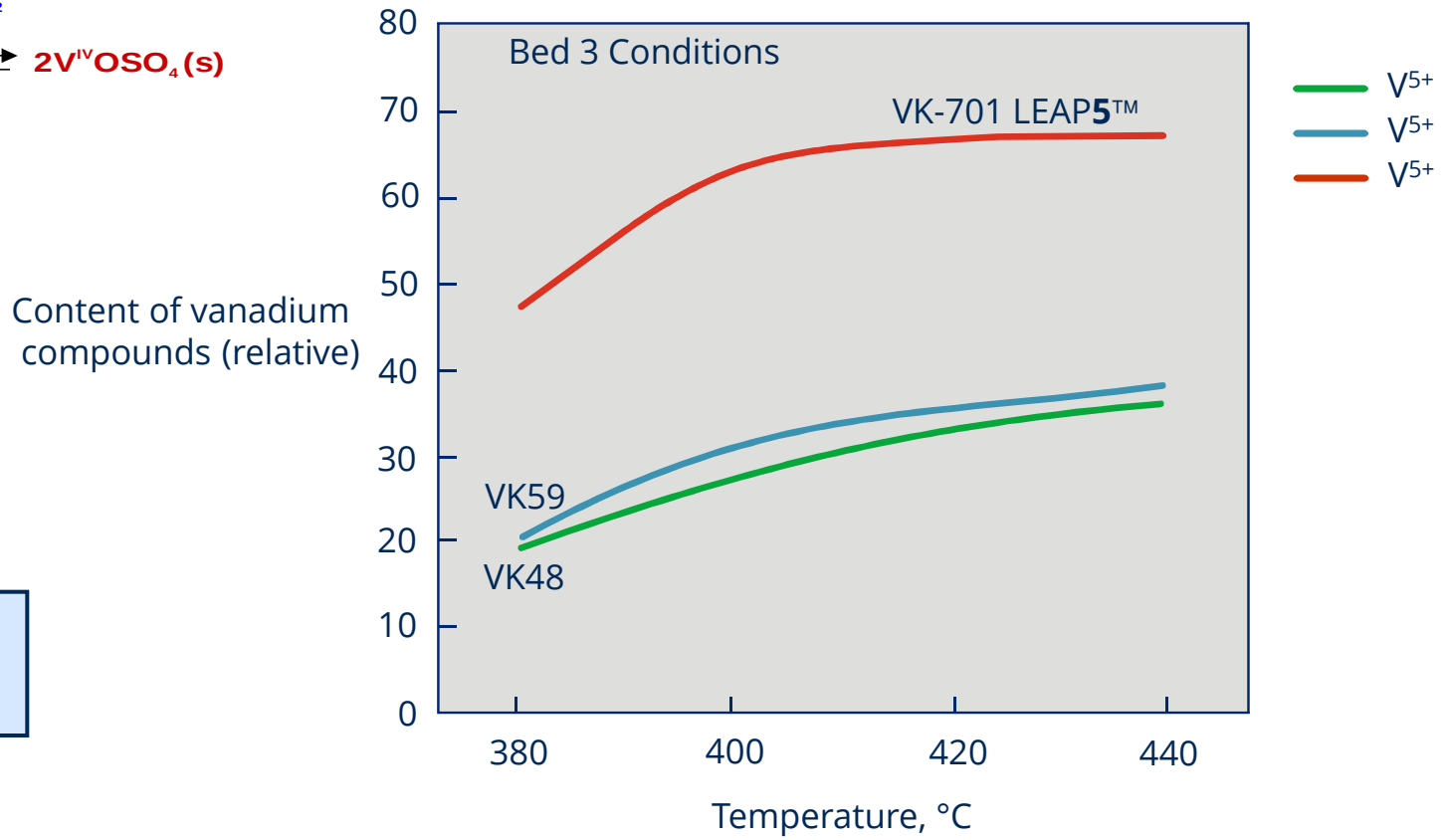
Mechanism of catalytic SO2 oxidation SO_2氧化反应机理

VK-701 LEAP5™ operates with a higher content of Vanadium +5

VK-701 LEAP5™在高V^{+5}含量状态下工作

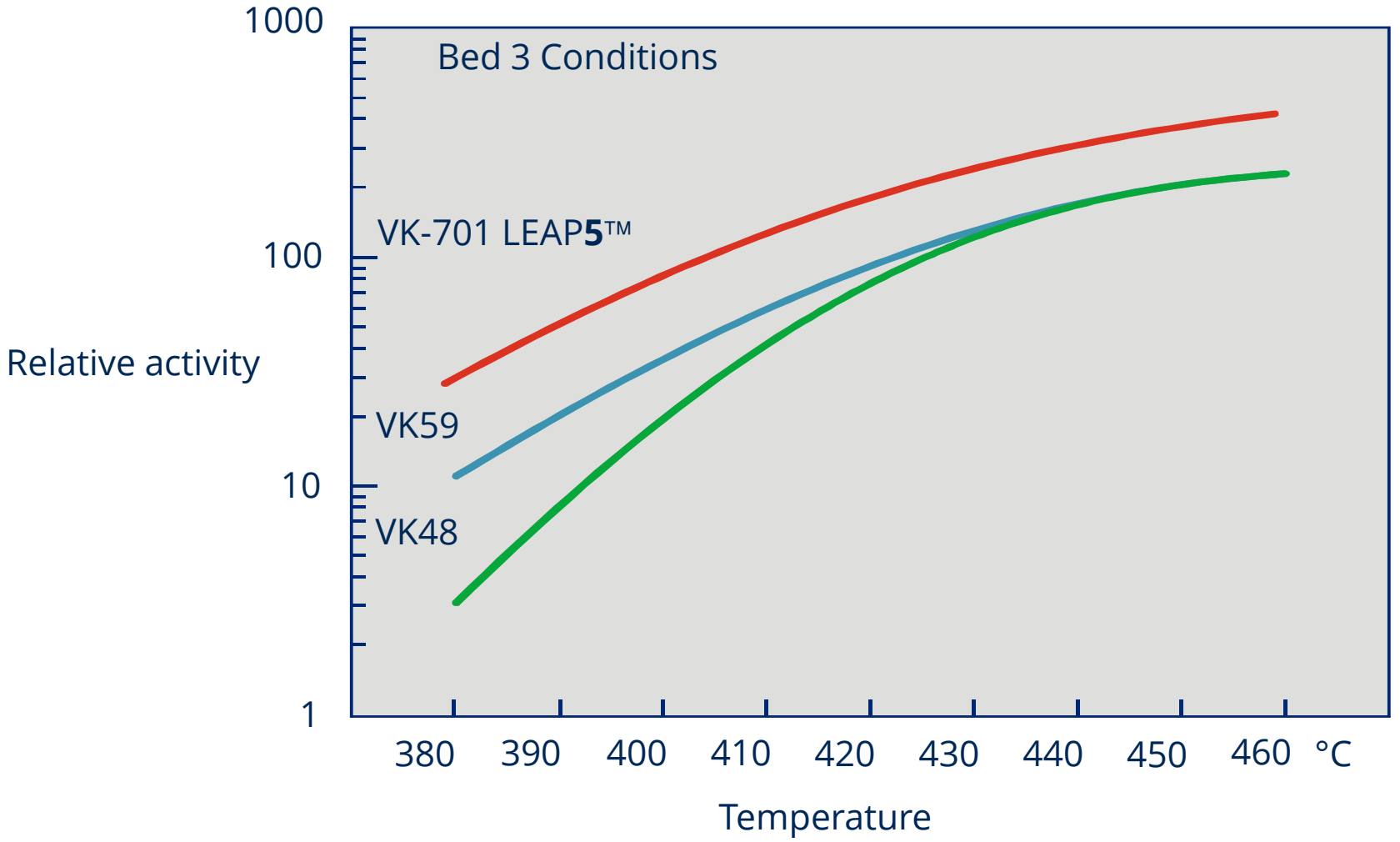


Source: O.B. Lapina et al (1999). Catalysis Today, 469-479.

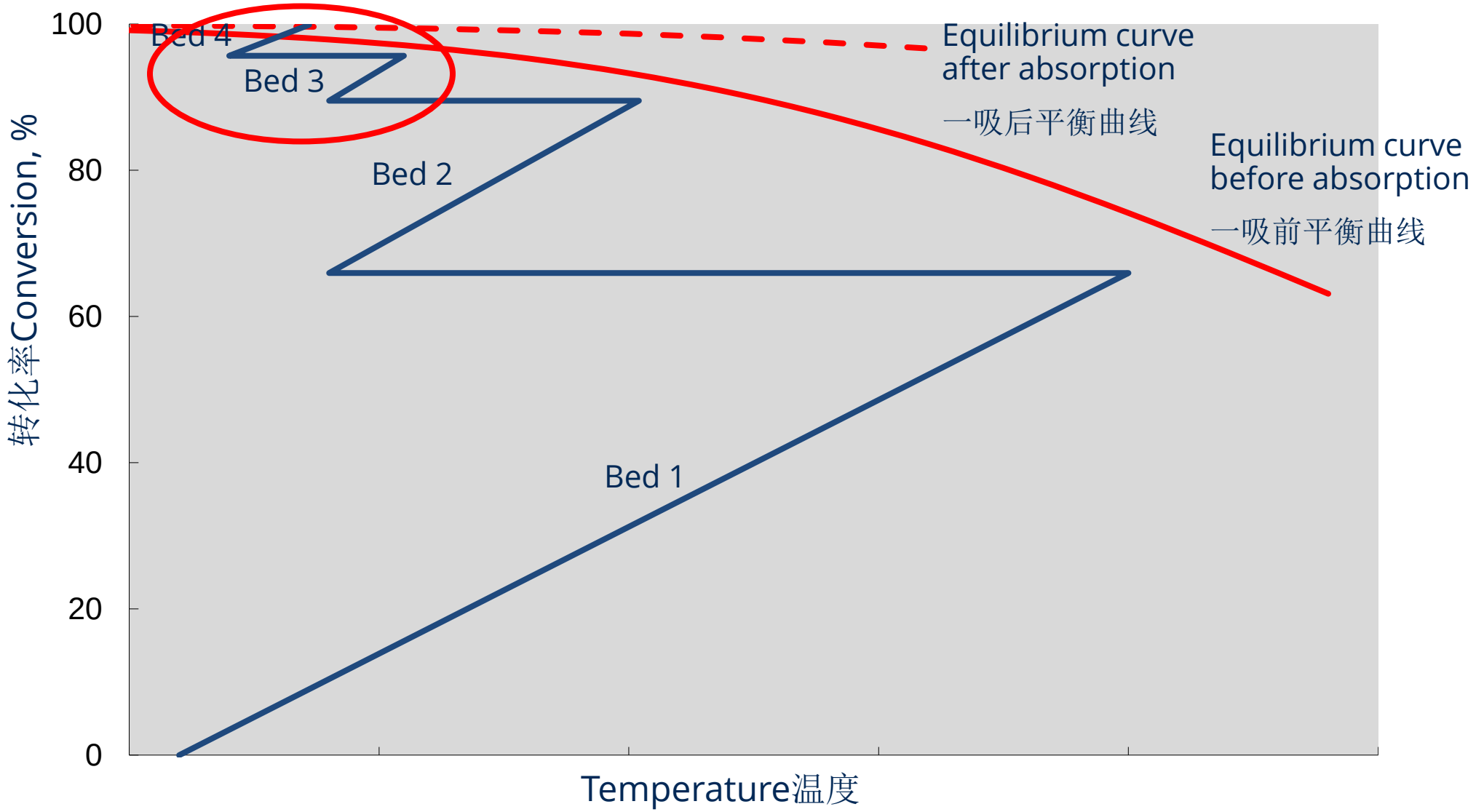


V5+ is the active oxidation state
五价钒是氧化活性态

Superior activity of VK-701 LEAP5™ with high SO_3 concentrations
VK-701 LEAP5™在高SO_3浓度条件下具有超高反应活性



Typical 3+1 double absorption operating curve
3+1两转两吸装置操作曲线



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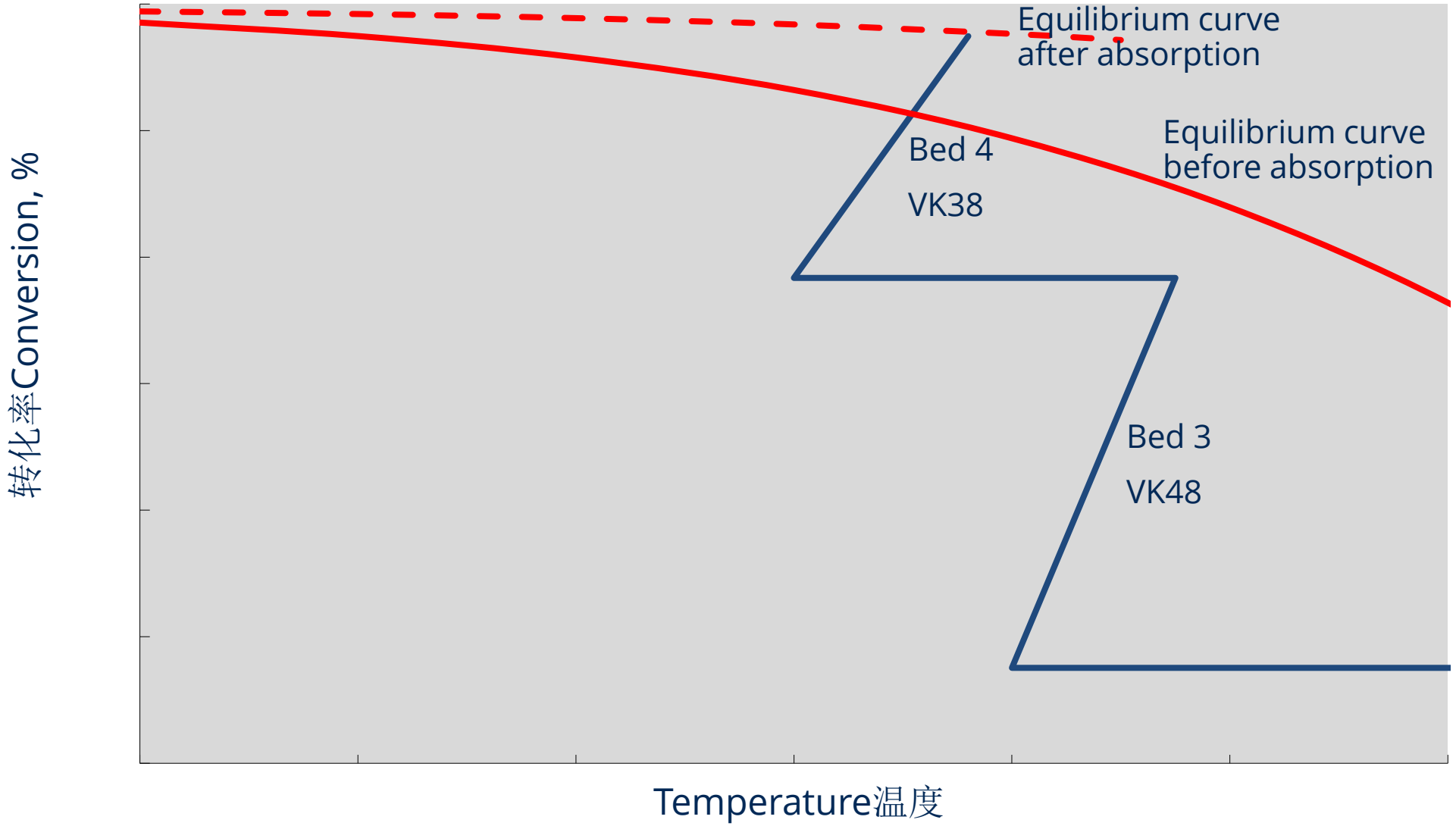
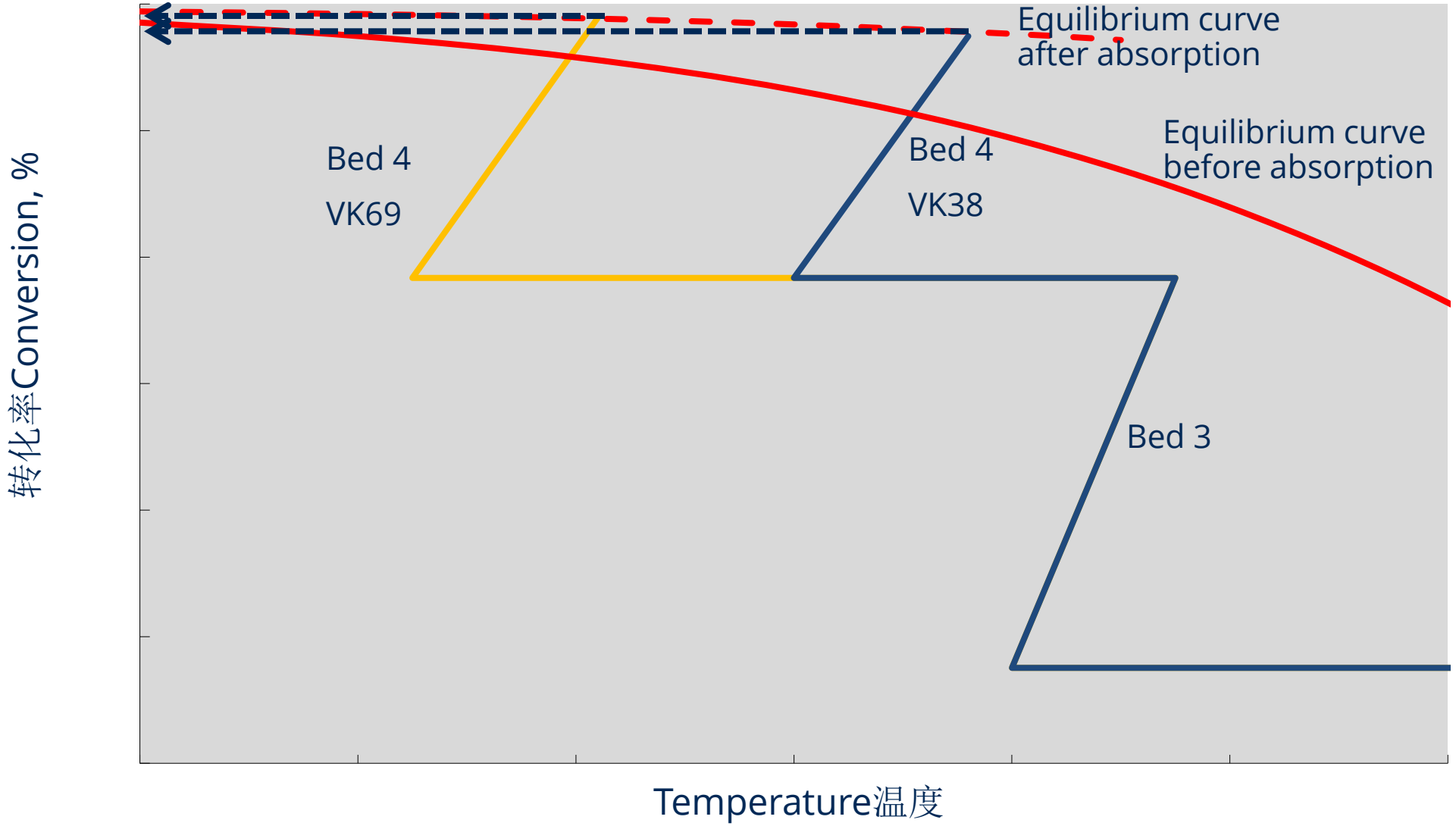
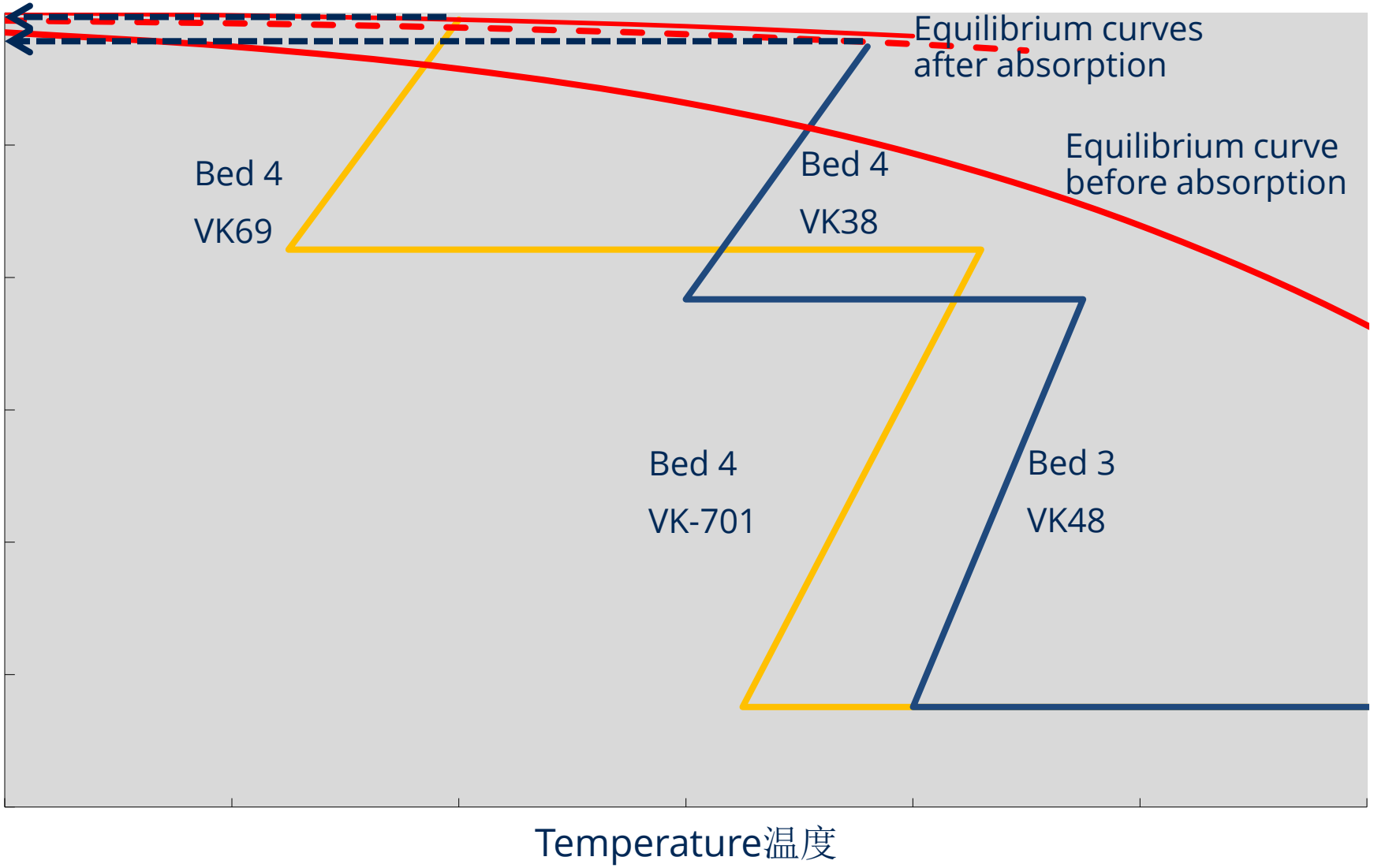
Operating curve for beds 3 & 4



Operating curve for beds 3 & 4



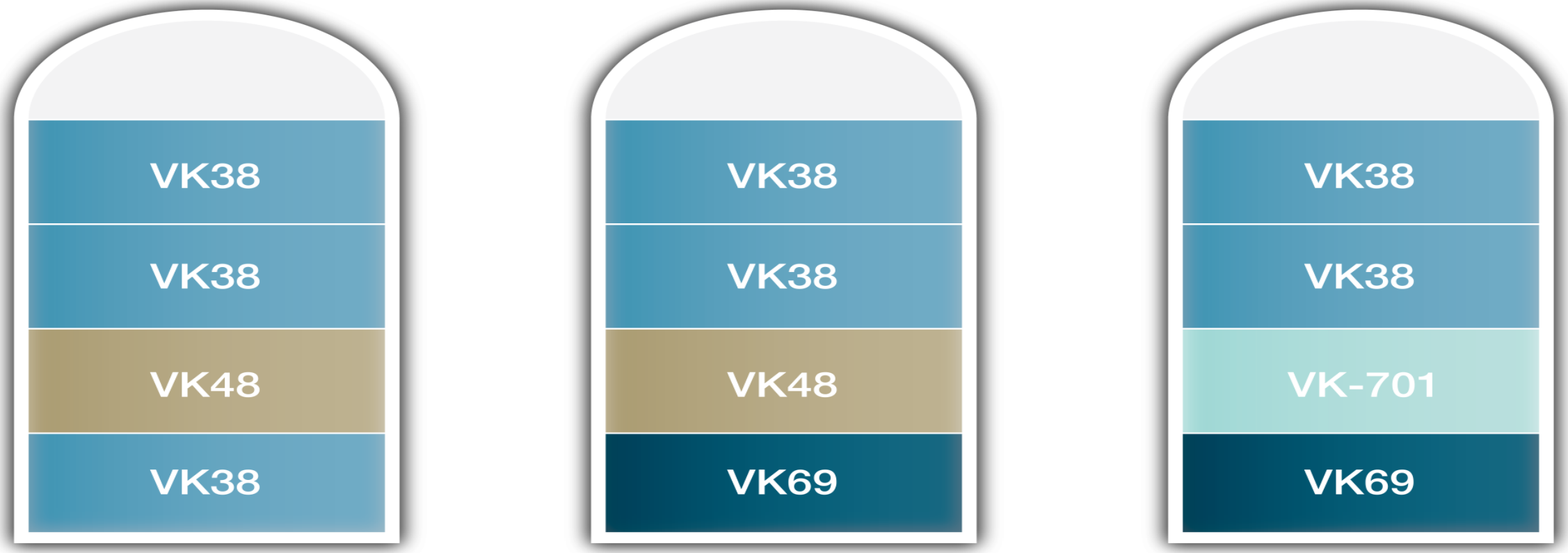
Operating curve for beds 3 & 4



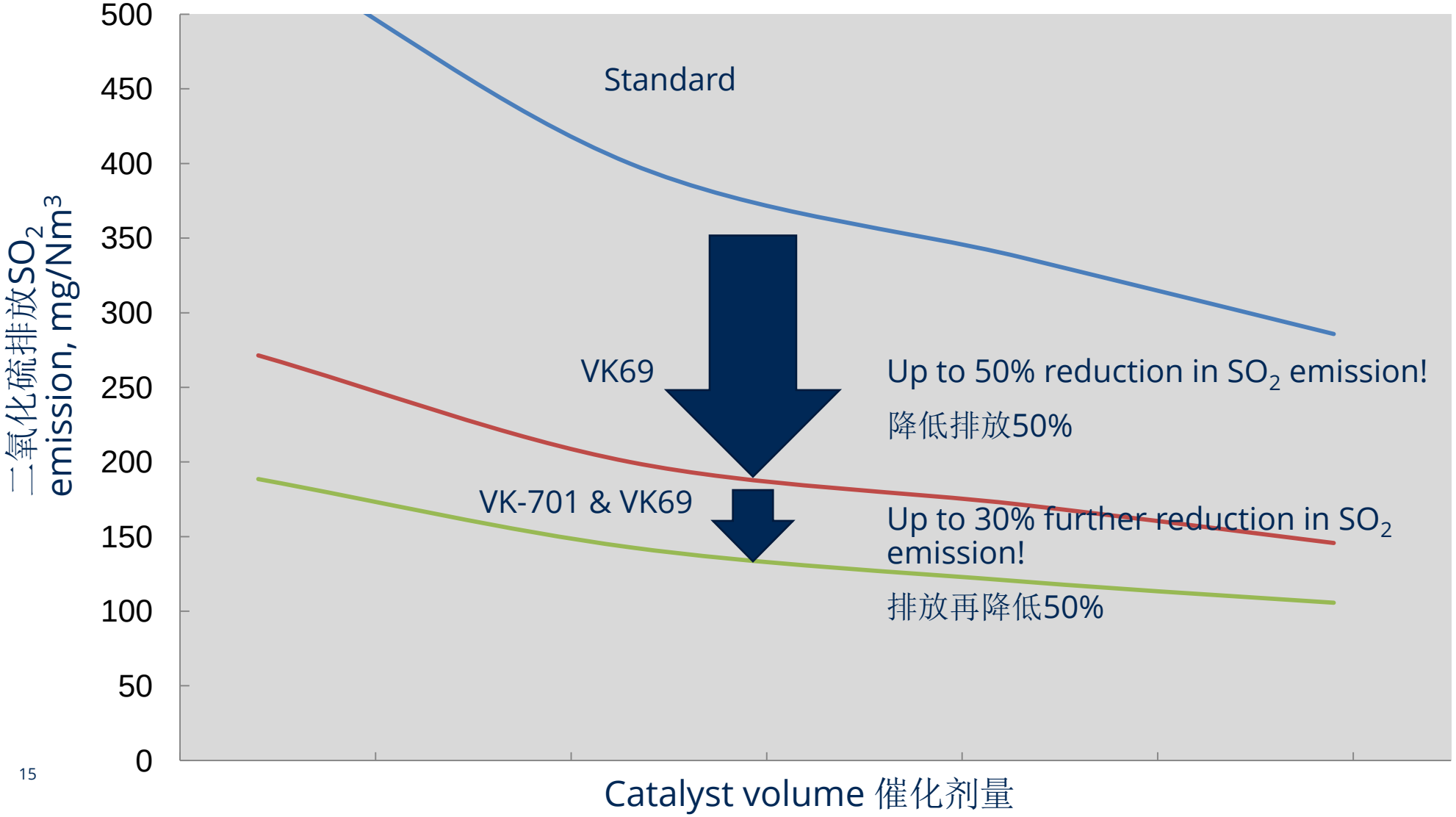
Basis for all Simulations
模拟案例

- 1000 MTPD 酸产量—1000吨/天（折百）
- Sulfur burning 硫磺制酸装置
- 11% SO_2, 10% O_2 inlet to bed 1 进气条件—11% SO_2，10% O_2
- 3+1DA 3+1两转两吸
- Operating at sea level 装置位于海平面上

Catalyst loadings for 3+1 converters
3+1装置催化剂装填方案



SO_2 emissions in a 3+1DA sulfur burner with 11 % SO_2
硫磺制酸装置，进气气浓为11%情况下，各装填方案对应SO2排放情况



Conclusions
结论

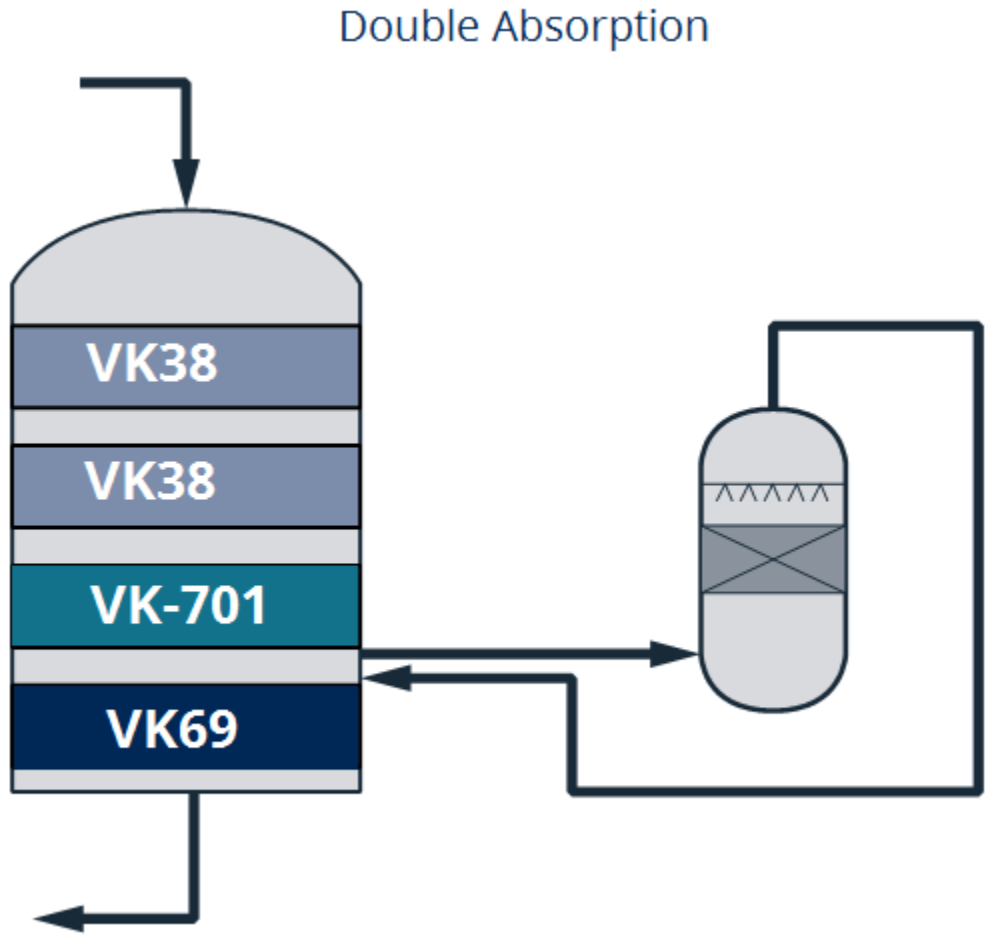
- Easy to obtain 400 mg/Nm^3 with standard VK38 & VK48
- 通过VK38、VK48标准催化剂可以很容易的实现400mg/m^{3}排放标准
- **Up to 50% reduction** of emission can be obtained with VK69 installed in bed 4
- 通过在四床装填VK69催化剂，可以在上述基础上减排50%
- **Further 30% reduction** of emission can be obtained by installing VK-701 in bed 3
- 通过在三床装填VK701催化剂，可以继续再减排30%

CASE STORY 1 – reducing emission with VK69 & VK-701 LEAP5™
案例一—通过装填VK69 & VK-701 LEAP5™催化剂实现减排
Example from North America 北美洲真实案例

- Emission had to be reduced in the 3+1 plant from 350 ppm to 160 ppm.
- 需要将某3+1装置的SO_2排放从350ppm降低到160ppm
- Solution: to revamp and install VK69 and VK-701 LEAP**5™**
- 解决方案：装填VK69 & VK-701 LEAP5™催化剂

Design specification设计基础啊:

- 3+1 double absorption 3+1两转两吸
- 2000 MTPD
- **150 L cat/MTPD**
- 11.7% SO_2
- 9.3% O_2



CASE STORY 1 – VK-701 LEAP5™

- Start up June 2012

	Prior to loading (TOPGUN)	Predicted	SOR (TOPGUN)	1 year* (TOPGUN)	2 years (TOPGUN)
Production	2085 MTPD	2085 MTPD	2085 MTPD	2065 MTPD	2060 MTPD
SO_2	11.50%	11.7%	11.80%	11.78%	11.95%
Conversion	99.75%	99.89%	99.92%	99.89%	99.89%
Emission	350 ppm	160 ppm	**118 ppm**	**159 ppm**	**160 ppm**

* During this TOPGUN a leak was detected in one of the re-heat exchangers

- After two years the activity of VK-701 LEAP**5™** is similar to fresh

Thank You