Meeting future SO_2 emission challenges with Topsøe's new VK-701 LEAP**5**™

RESEARCH | TECHNOLOGY | CATALYSTS

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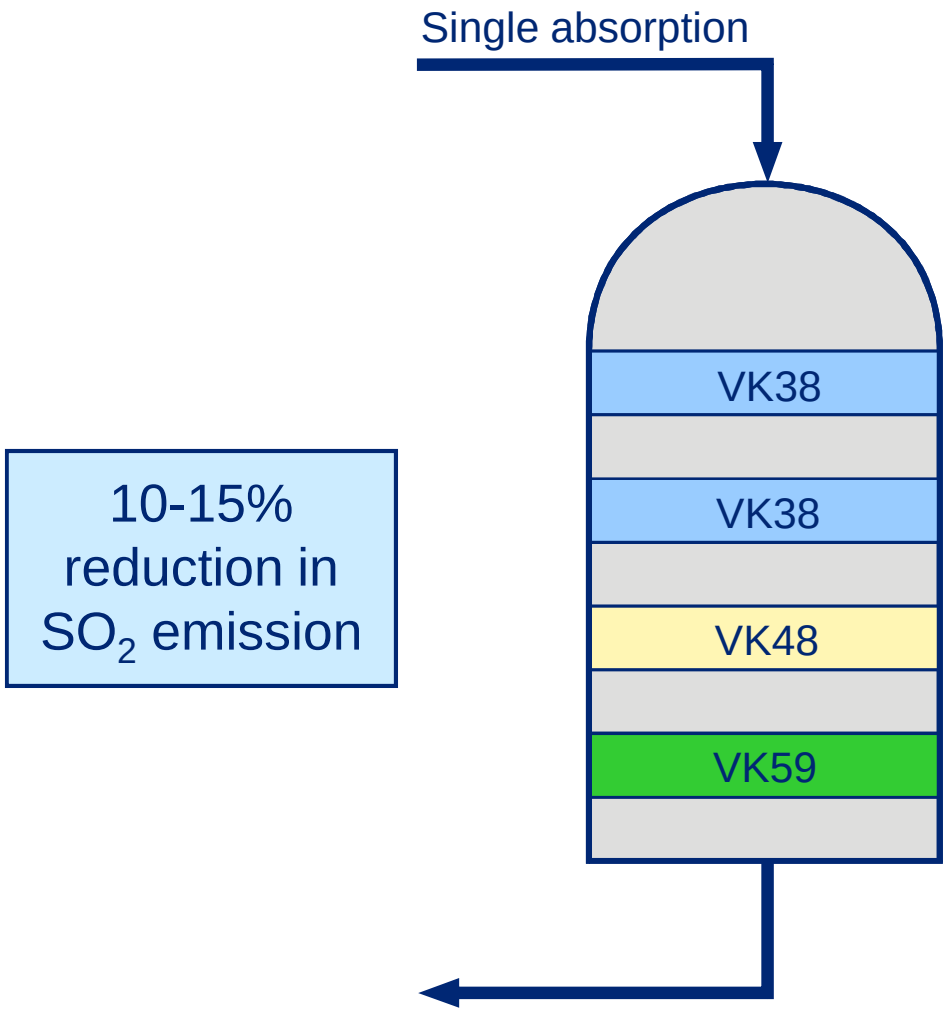
Achieve the Unachievable
VK-701 LEAP**5**™

Meeting SO_2 emission challenges

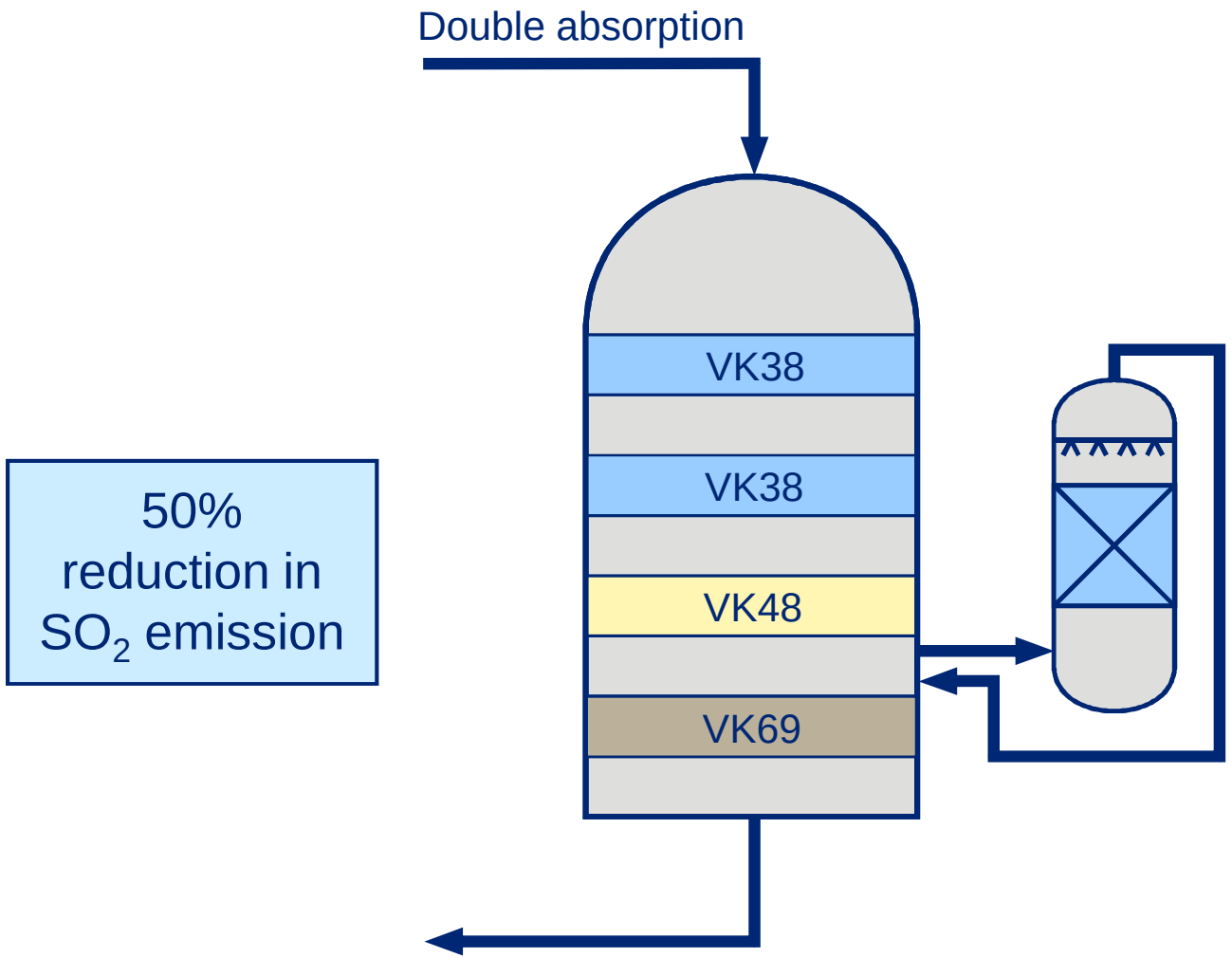
Today's options for reduction of SO_2 emissions

- Better low-temperature catalysts
- Additional catalyst beds
- Revamp to double- or triple-absorption
- Tail gas scrubbing

Low temperature catalyst options



Low temperature catalyst options



The new VK-701 LEAP**5**™ from Topsøe

- Lower passes in single-absorption plants
- 3rd pass in 3+1 or 3+2 double-absorption plants

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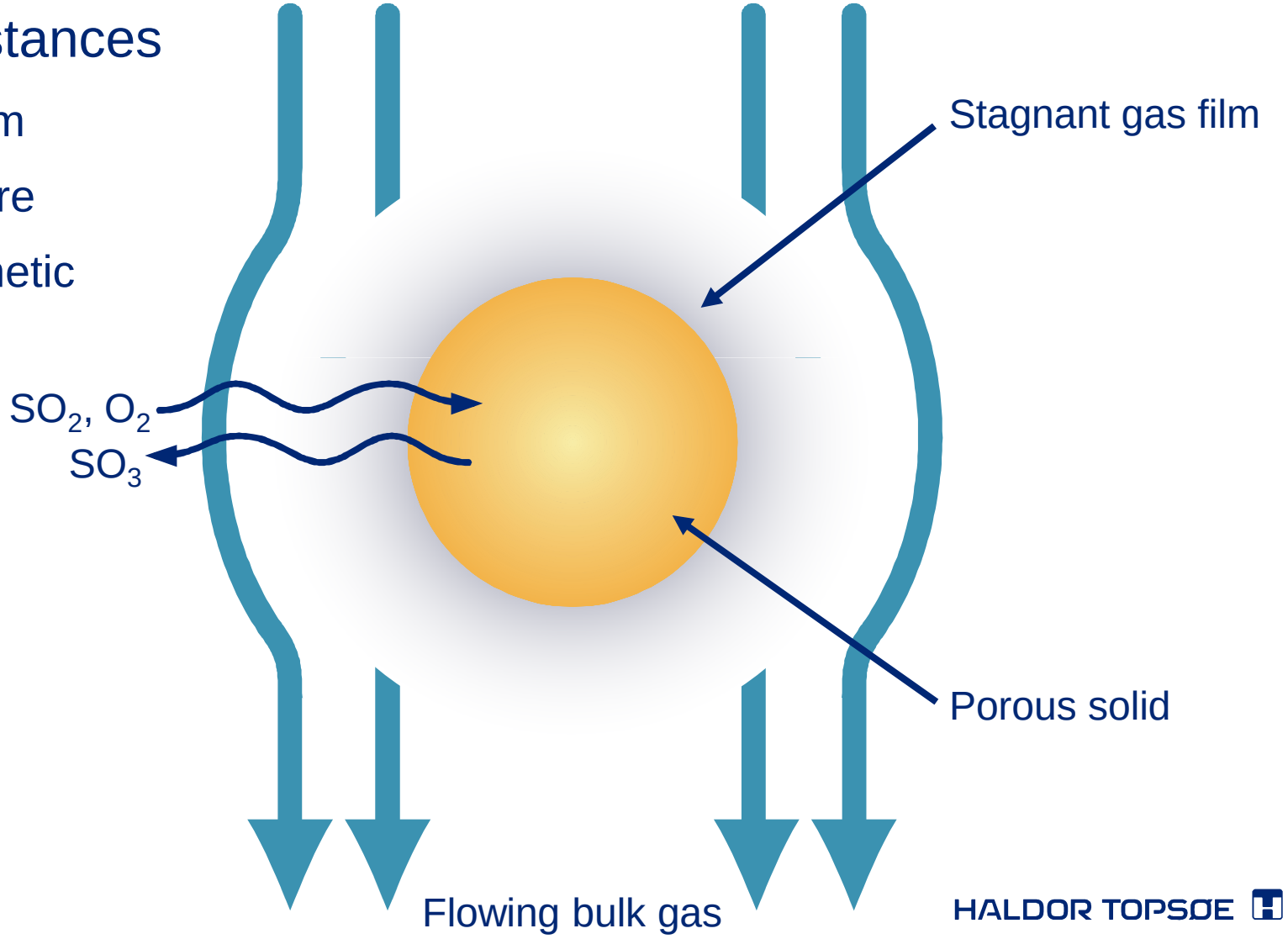
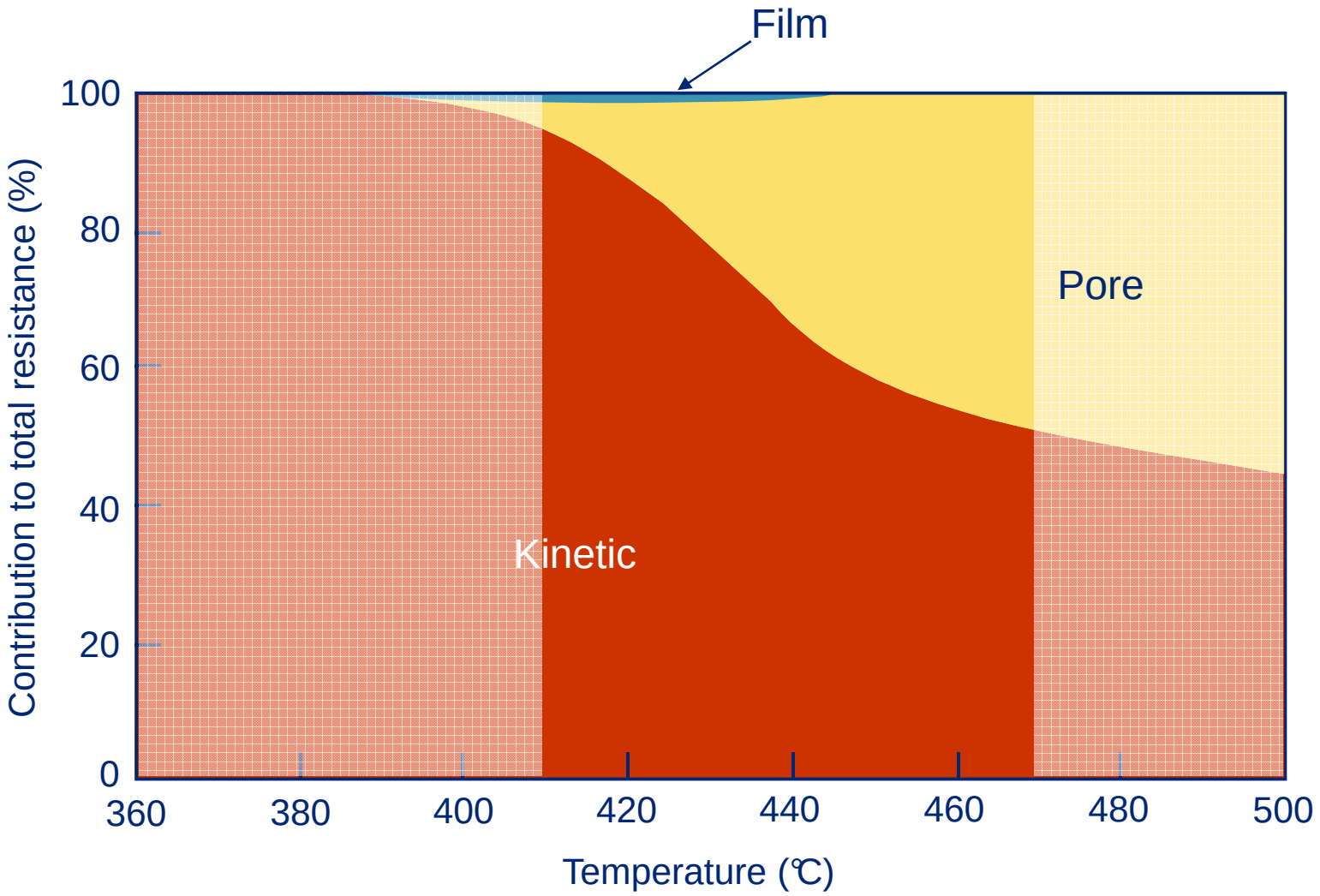
Catalyst mass and heat transfer

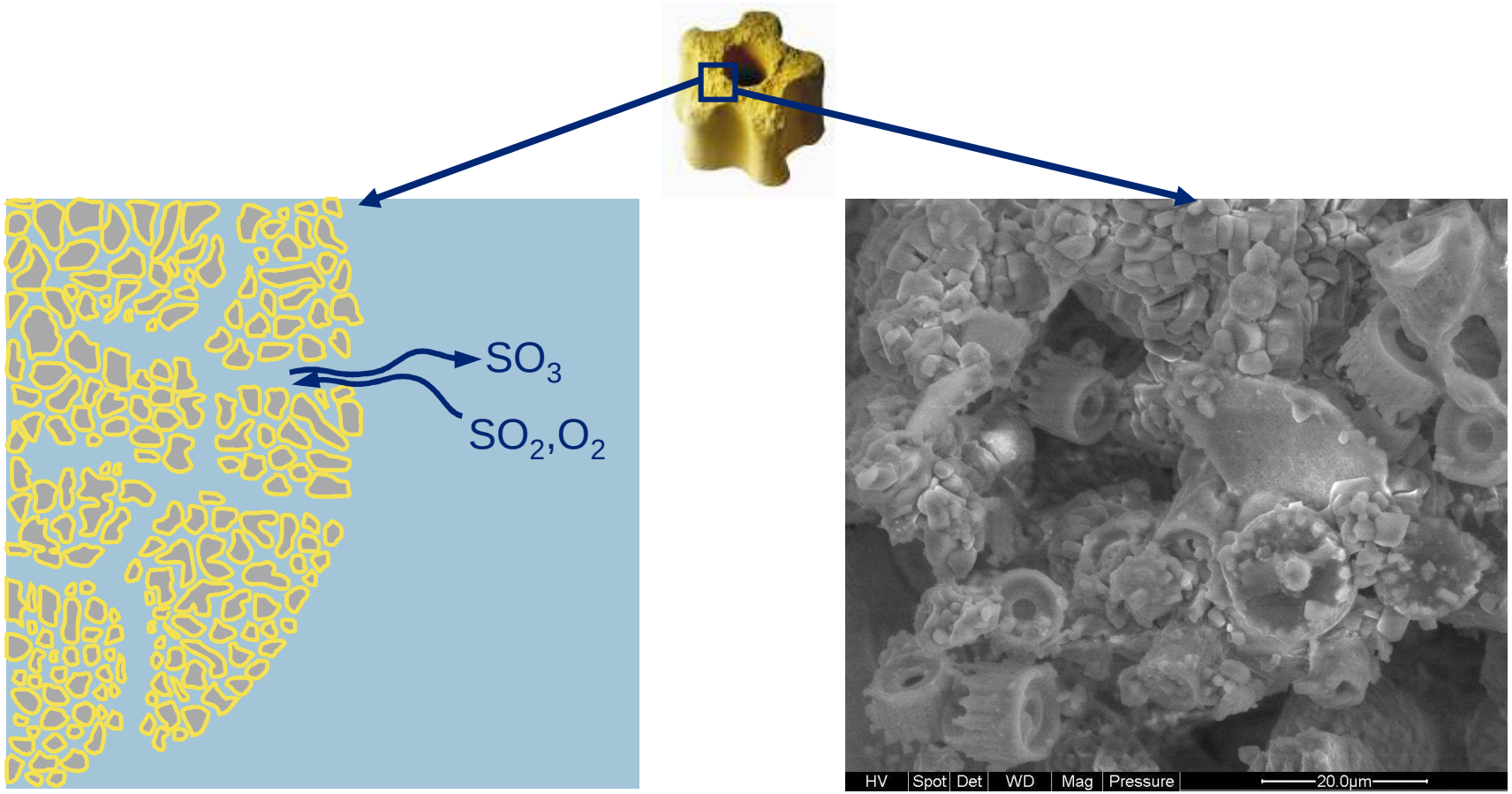
- Resistances
  - Film
  - Pore
  - Kinetic



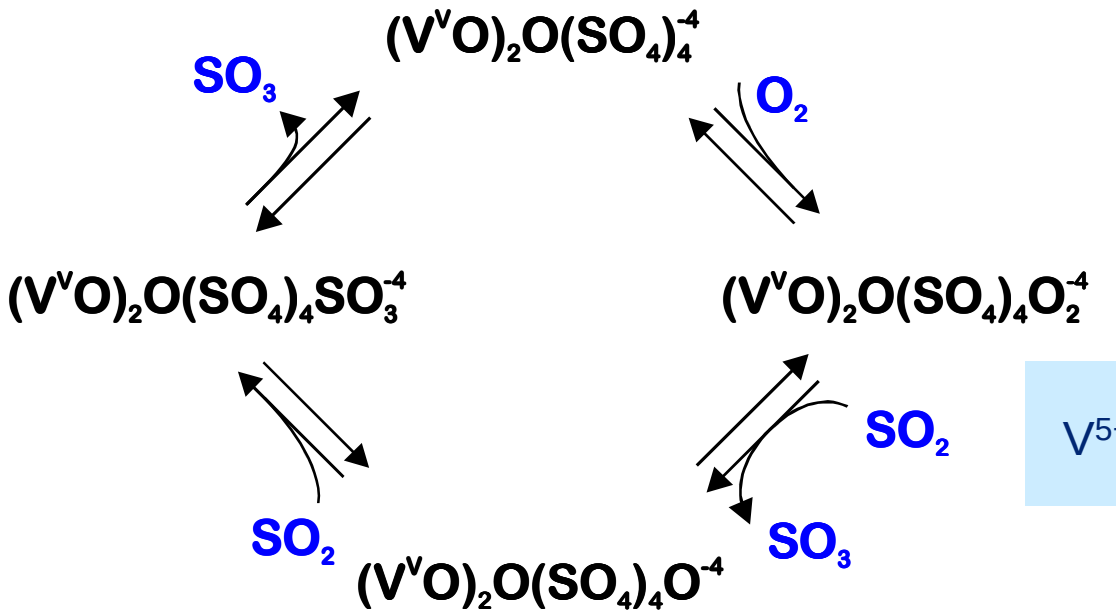
Reaction resistances in converted strong gas



Intrinsic morphology of a commercial sulphuric acid catalyst



Mechanism of catalytic SO_2 oxidation



V^{5+} is the active oxidation state

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

VK-701 LEAP**5**™

- Changed intrinsic morphology and surface properties of the carrier
- Optimised active phase for high SO_3 concentration
- Less transport restrictions in the active molten phase
- Installation and optimisation of a new unique production technology

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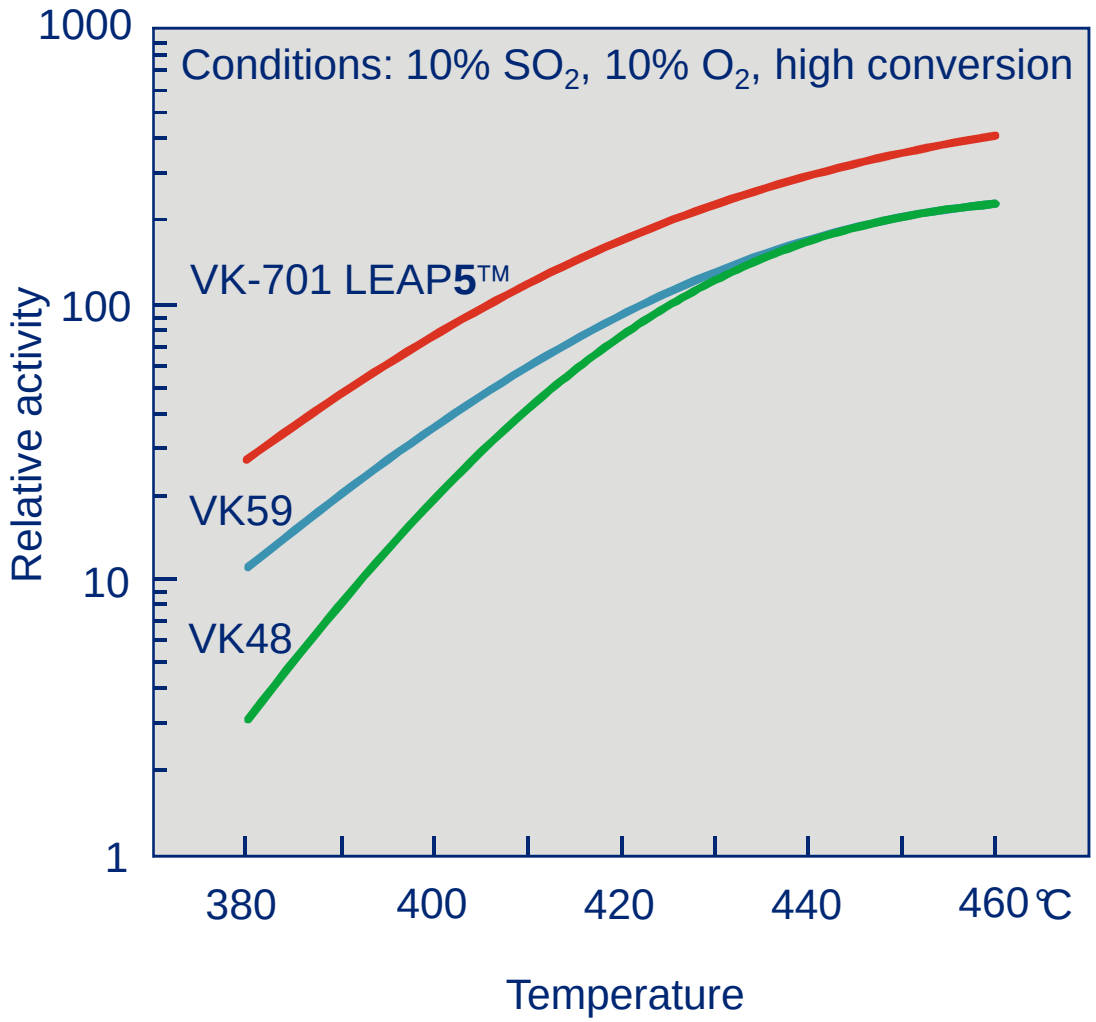
VK-701 LEAP**5**™ facts and figures

Catalyst	VK-701 LEAP**5**™
Size and shape	Daisy 12 mm
V_2O_5 content	~8%
Typical operating temperature	420-500℃
Thermo stability	650℃

Superior activity of VK-701 LEAP**5**™



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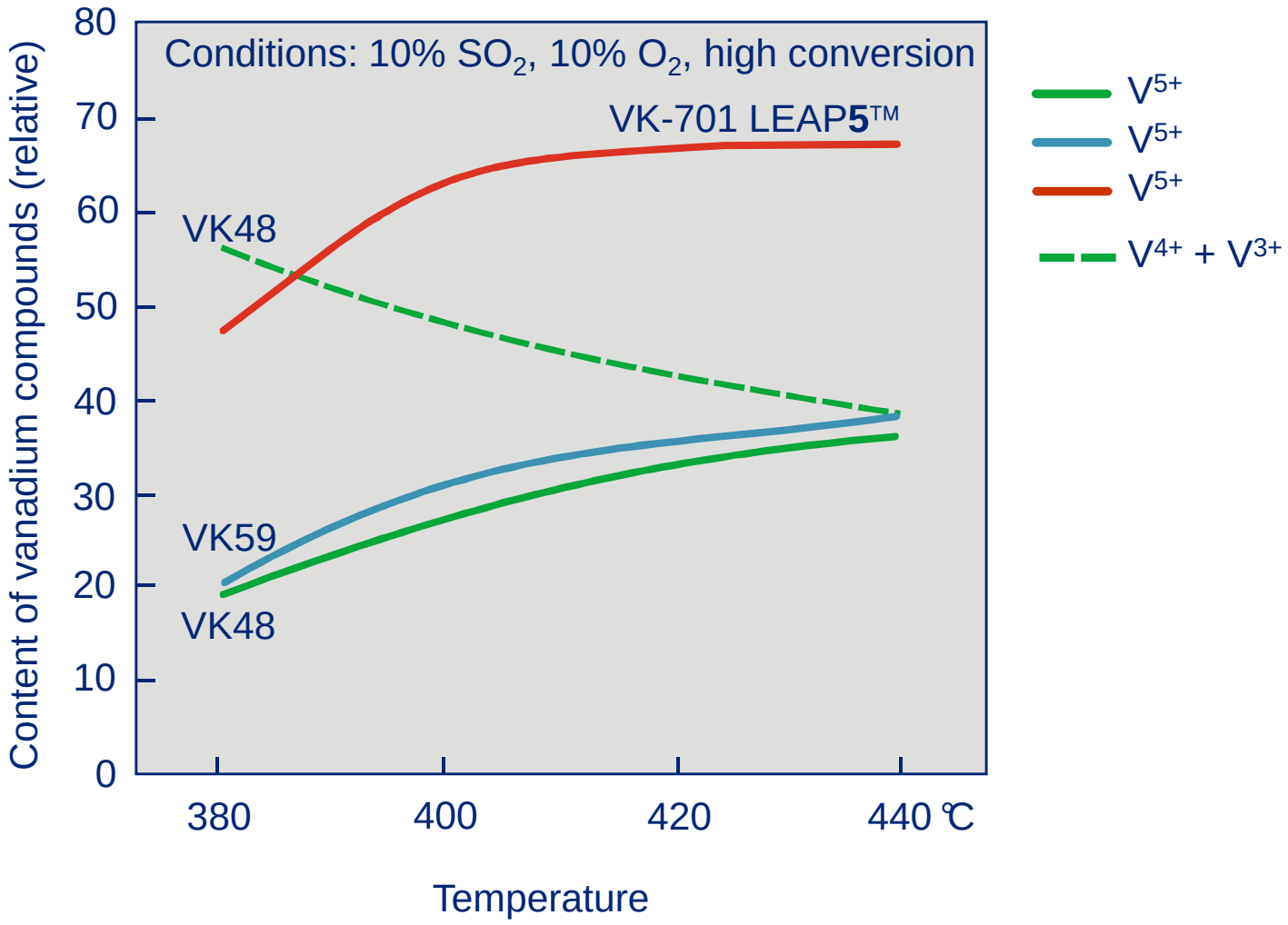
Vanadium oxidation states in VK-701 LEAP**5**™



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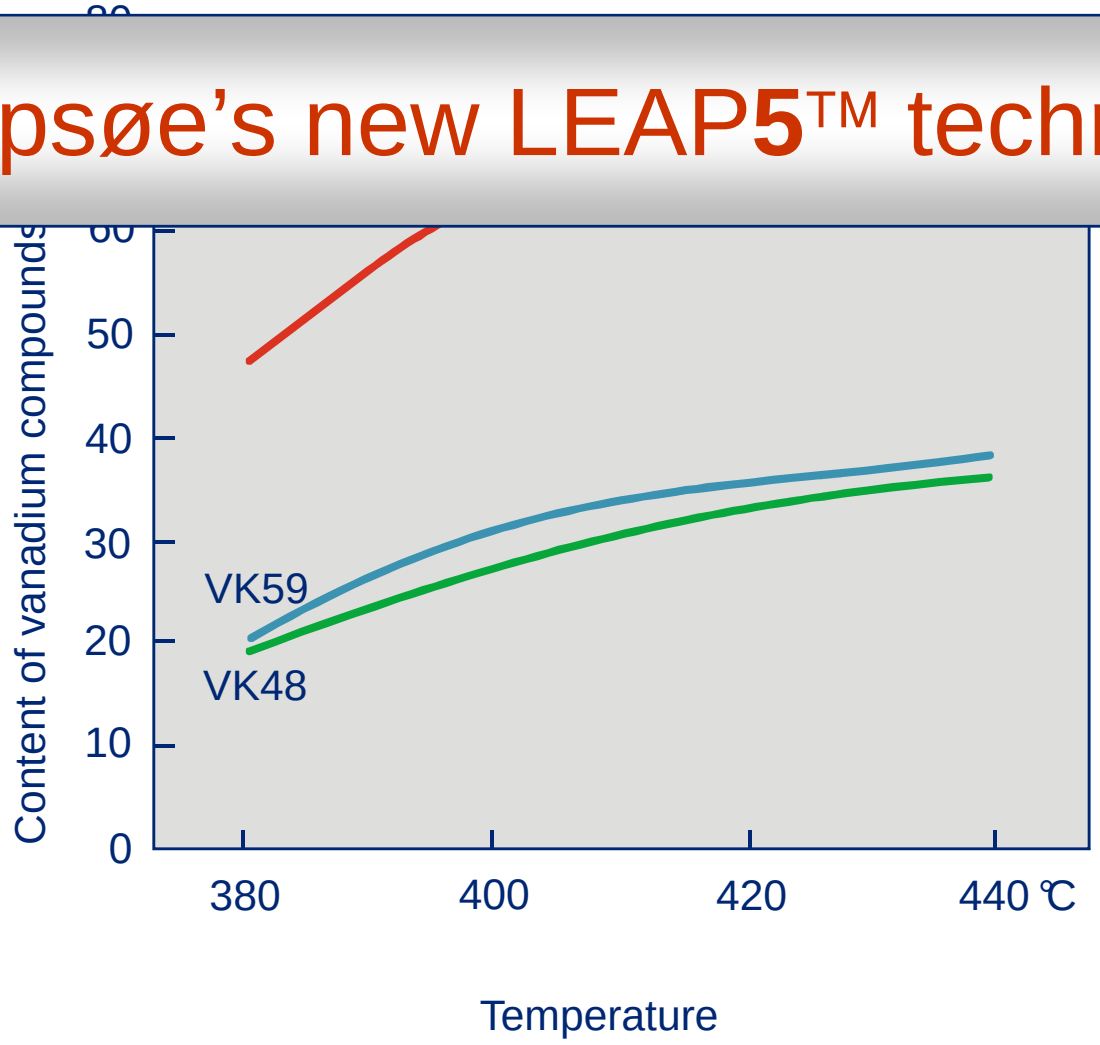
Vanadium oxidation states in VK-701 LEAP**5**™

Topsøe's new LEAP5™ technology



Example 1
D.A. plant operating with 99.7% conversion

Layout : 3+1 double-absorption plant

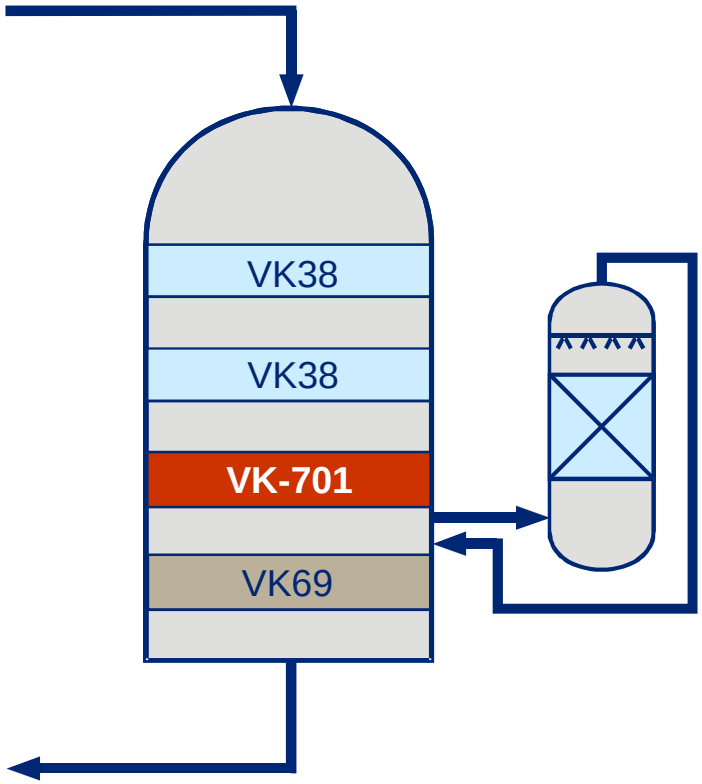
SO_2 source : S-burning

Feed gas : 11.5% SO_2, 9.5% O_2

Total initial conversion : 99.7%

Catalysts in beds 1/2 : VK38 / VK38

Conversion outlet bed 2 : 86.6%



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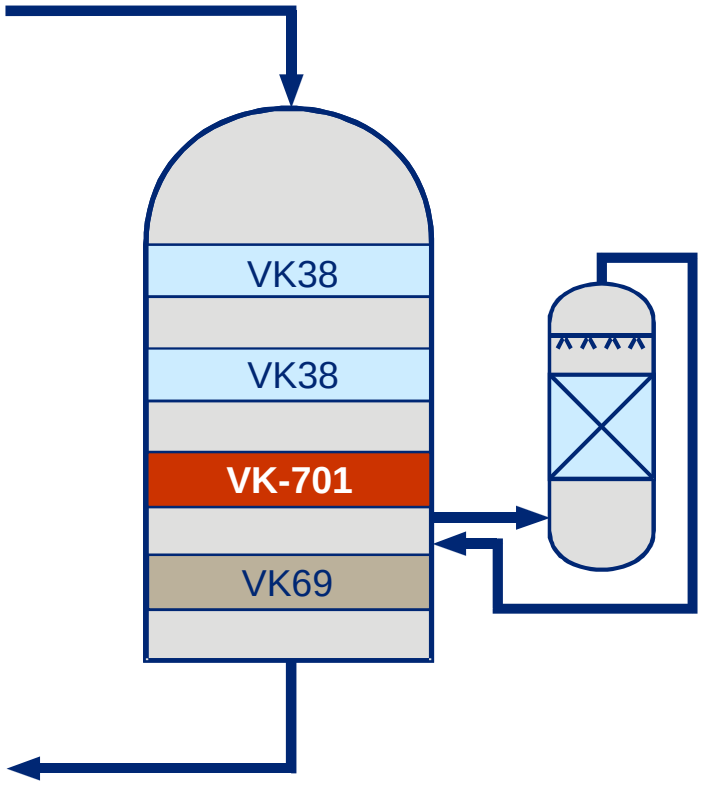
Example 1
D.A. plant operating with 99.7% conversion

24% SO_2 reduction compared to VK48/VK69
62% SO_2 reduction compared to VK48/VK38

Catalyst in bed 3	**VK48**	**VK48**	**VK-701 LEAP5™**
Inlet temperature, ℃	445		
Conversion outlet bed 3, %	93.92		
Catalyst in bed 4	**VK38**	**VK69**	**VK69**
Intlet temperature, ℃	425		
Overall conversion, %	99.70		
SO_2 in the stack, ppm	420		
Relative SO_2 emission	100		

Example 2
D.A. plant operating with 99.85% conversion

Layout	: 3+1 double-absorption plant
SO_2 source	: S-burning
Feed gas	: 11.5% SO_2, 9.5% O_2
Total initial conversion	: 99.85%
Catalysts in beds 1/2	: VK38 / VK38
Conversion outlet bed 2	: 86.6%



Example 2
D.A. plant operating with 99.85% conversion

30% SO_2 reduction compared to VK48/VK69
62% SO_2 reduction compared to VK48/VK38

Catalyst in bed 3	**VK48**	**VK48**	**VK-701 LEAP5™**
Inlet temperature, ℃	440		
Conversion outlet bed 3, %	94.7		
Catalyst in bed 4	**VK38**	**VK69**	**VK69**
Intlet temperature, ℃	415		
Overall conversion, %	99.85		
SO_2 in the stack, ppm	210		
Relative SO_2 emission	100		

Industrial operating experience

Layout : 5-pass single-absorption

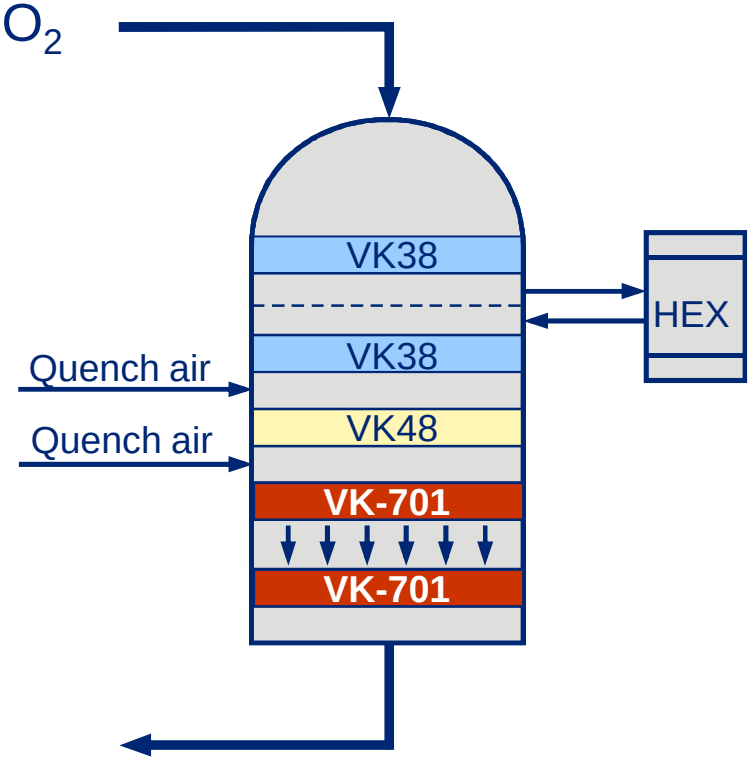
SO_2 source : S-burning

Capacity : 245 MTPD

Feed gas : 8.8% SO_2, 12% O_2

Goal

- Reduce SO_2 emissions
- Increase capacity



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Industrial operating experience

SO_2 emission reduced by **20%** at 9% higher production capacity

	Before installation of VK-701 LEAP**5**™	After installation of VK-701 LEAP**5**™
Catalyst loading in beds 4 and 5	12.0 m^3 VK59 13.2 m^3 VK48	
Production rate, MTPD	245	
Inlet temperature, bed 4, ℃	420	
Overall conversion, %	98.77	
SO_2 in the stack, ppm	1005	

Conclusions

- Single-absorption
  - Reduce SO_2 emissions by up to 40% with VK-701 LEAP**5**™ in the final pass
- Double-absorption
  - Cut SO_2 emissions by 40% in 3+1 plants operating with VK69 by replacing the 3rd pass with VK-701 LEAP**5**™
  - Achieve 50 ppm SO_2 emission from existing 3+1 plants
  - Design new plants with as little as 20-50 ppm SO_2
  - Avoid tail-gas scrubbing
- VK-701 LEAP**5**™ performance confirmed industrially