



Johnson Matthey  
Inspiring science, enhancing life

An update on **KATALCO** 51-102 synthesis catalyst and developments for CO<sub>2</sub> to methanol

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June 2021





# Outline

## Methanol synthesis catalysts

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- The chemistry behind **KATALCO™** 51-series

## KATALCO 51-102

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- Lab evaluations
- Pilot scale evaluations
- References

## CO<sub>2</sub> hydrogenation to methanol

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# Methanol synthesis catalysts

>55 years of continuous innovation for KATALCO 51-series



**From KATALCO 51-1 ... to KATALCO 51-102**

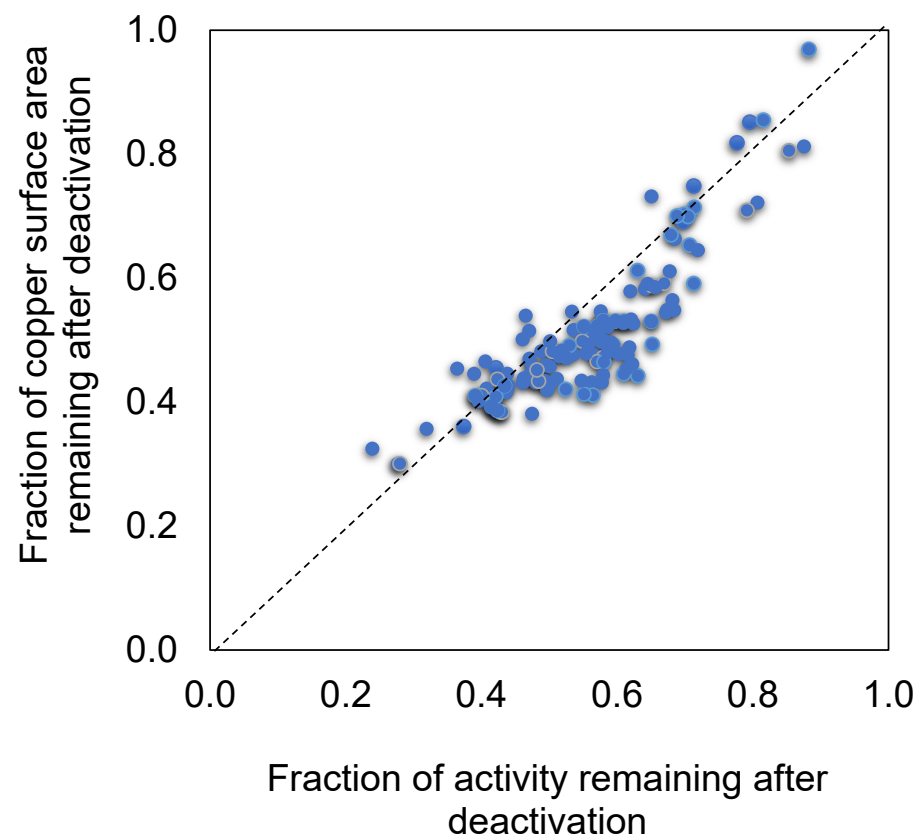


# Methanol synthesis catalysts

## The chemistry behind KATALCO 51-series



CuO	64 wt%
ZnO	24 wt%
Al <sub>2</sub> O <sub>3</sub>	10 wt%
MgO	2 wt%

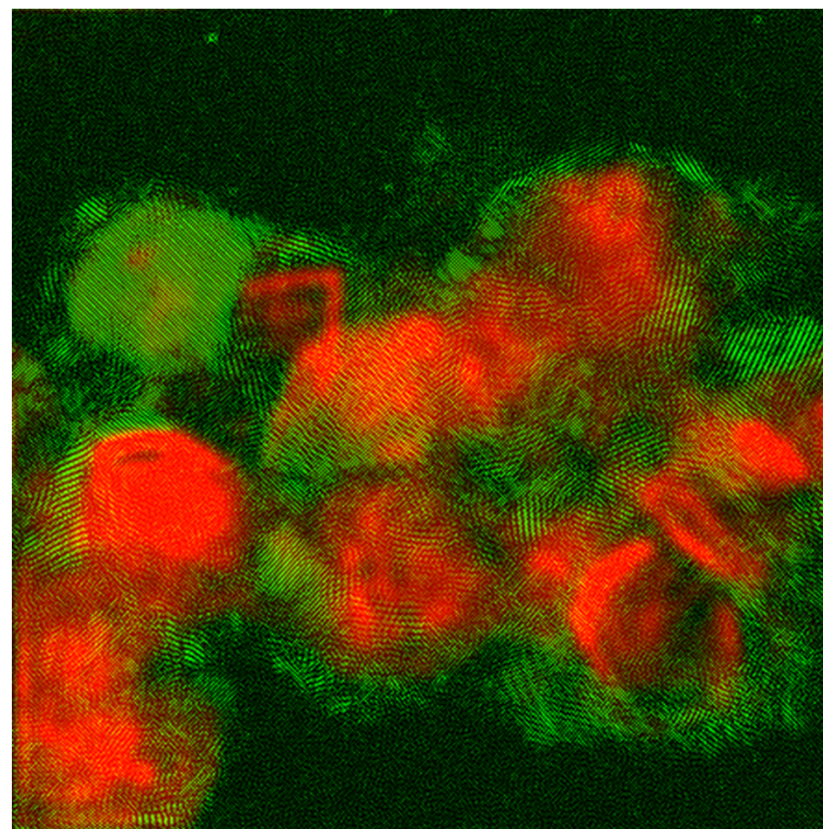


# Methanol synthesis catalysts

## The chemistry behind KATALCO 51-series



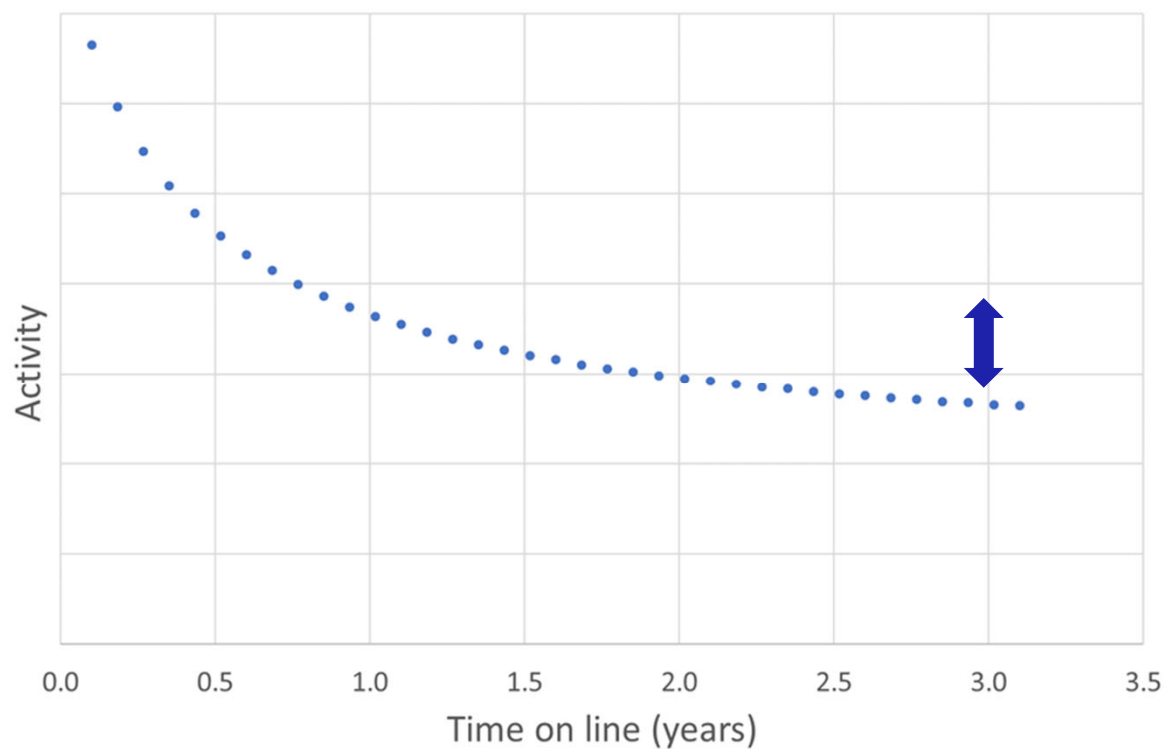
CuO	64 wt%
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Al <sub>2</sub> O <sub>3</sub>	10 wt%
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# Methanol synthesis catalysts

## Deactivation

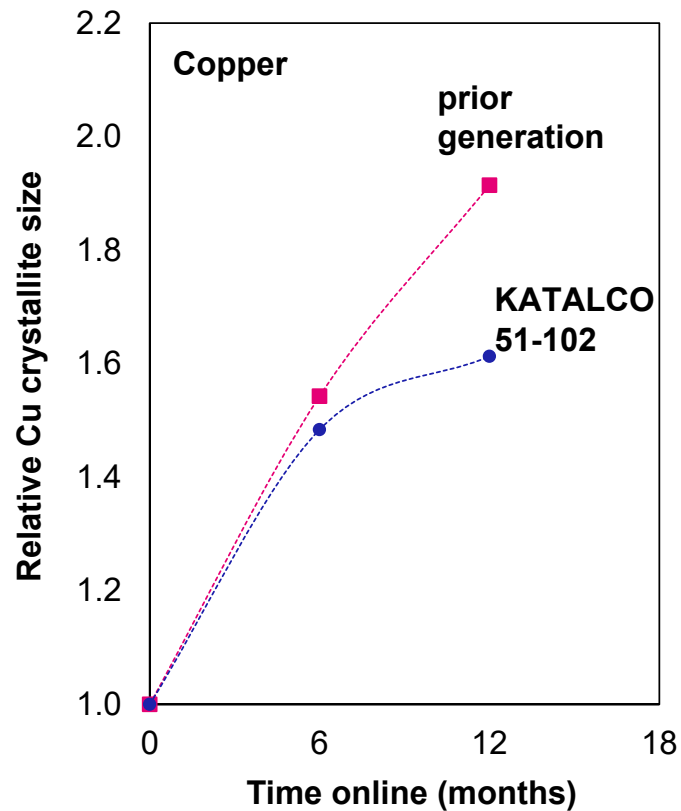
Deactivation dominated by sintering of the copper component





# KATALCO 51-102

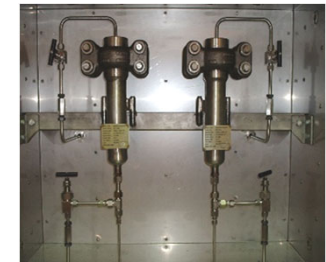
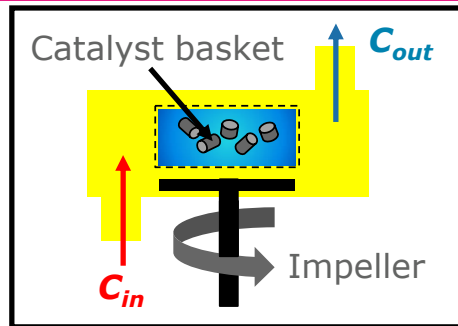
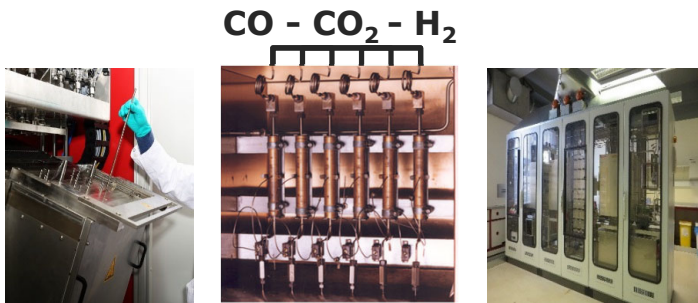
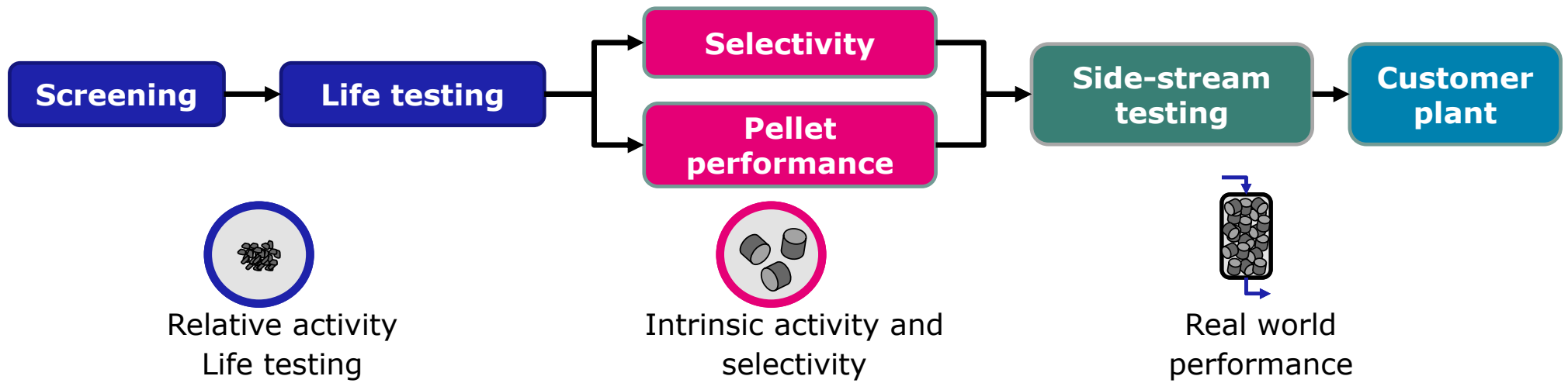
Improved long-term stability given by the addition of Si to the formulation



Slows down the sintering of copper that reduces activity over time

Hence reduces the rate of catalyst deactivation and makes more methanol for longer

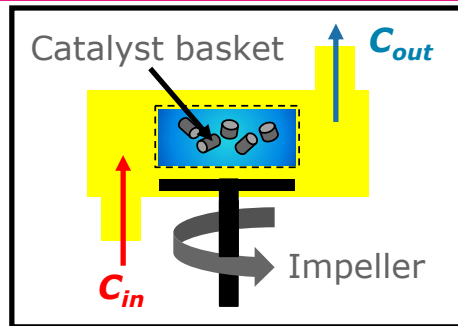
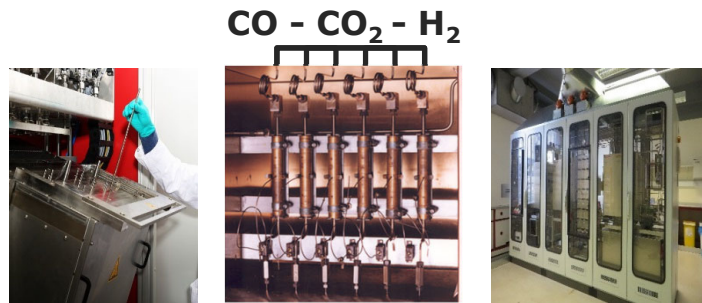
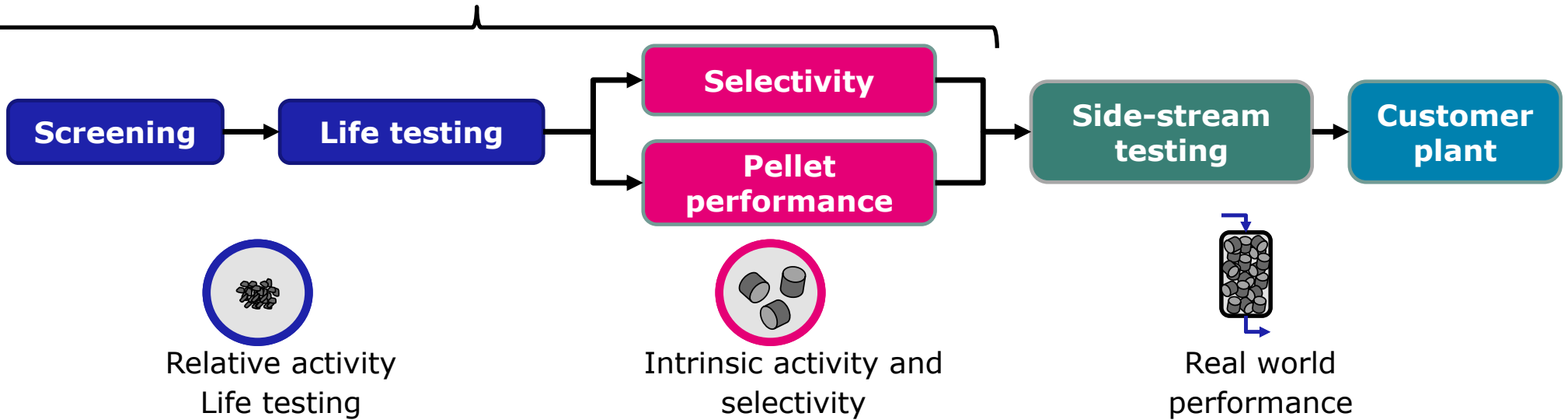
# Evaluation of KATALCO 51-102





# Evaluation of **KATALCO 51-102**

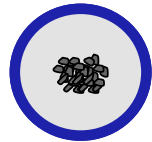
Fully assessed in our lab testing units



# Evaluation of **KATALCO 51-102**

Fully assessed in our lab testing units

Evaluated at pilot scale testing



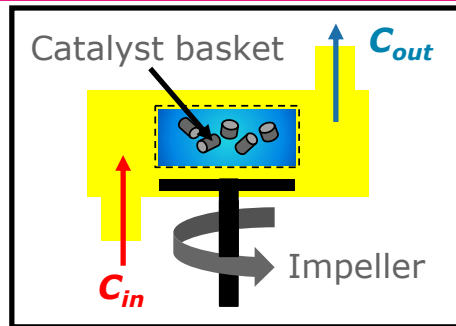
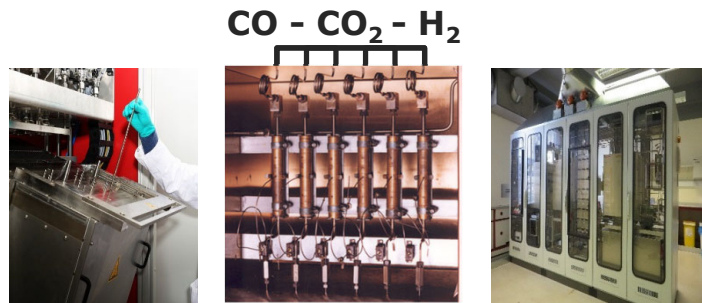
Relative activity  
Life testing



Intrinsic activity and  
selectivity



Real world  
performance

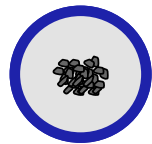


# Evaluation of KATALCO 51-102

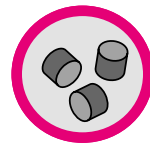
Fully assessed in our lab testing units

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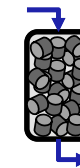
3 references



Relative activity  
Life testing

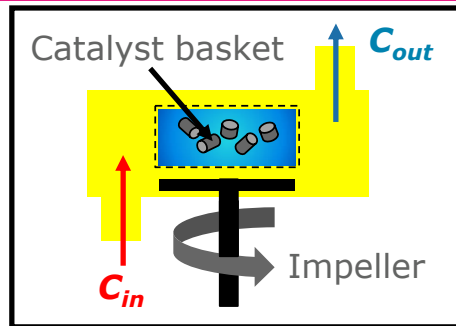
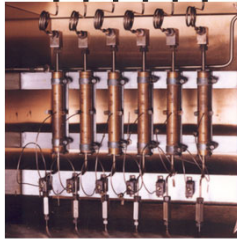


Intrinsic activity and  
selectivity



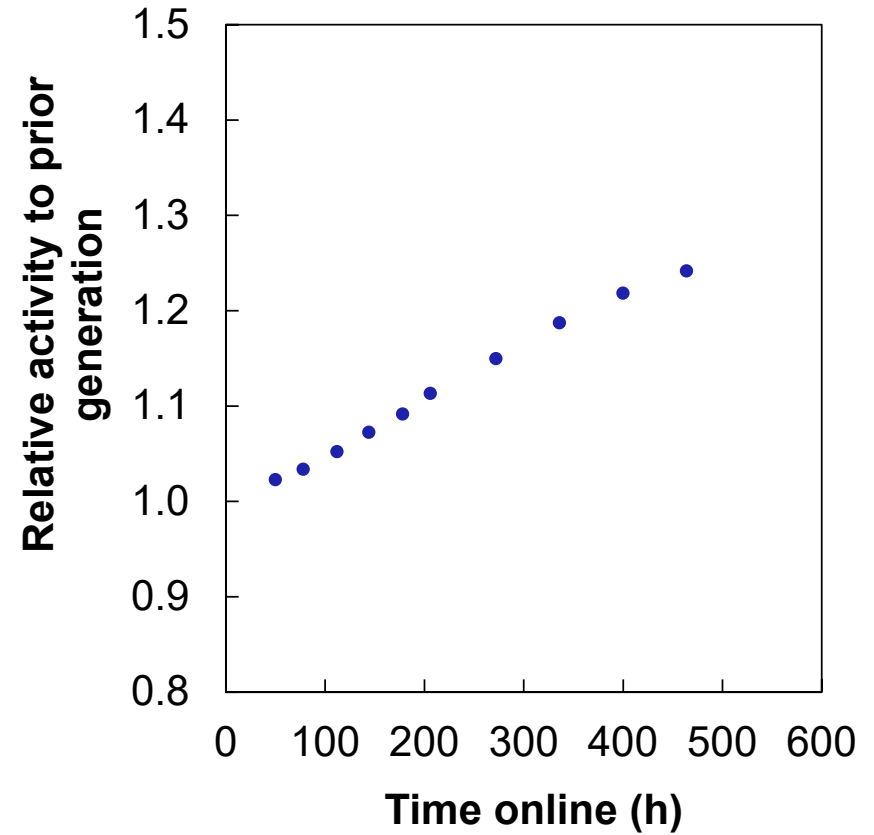
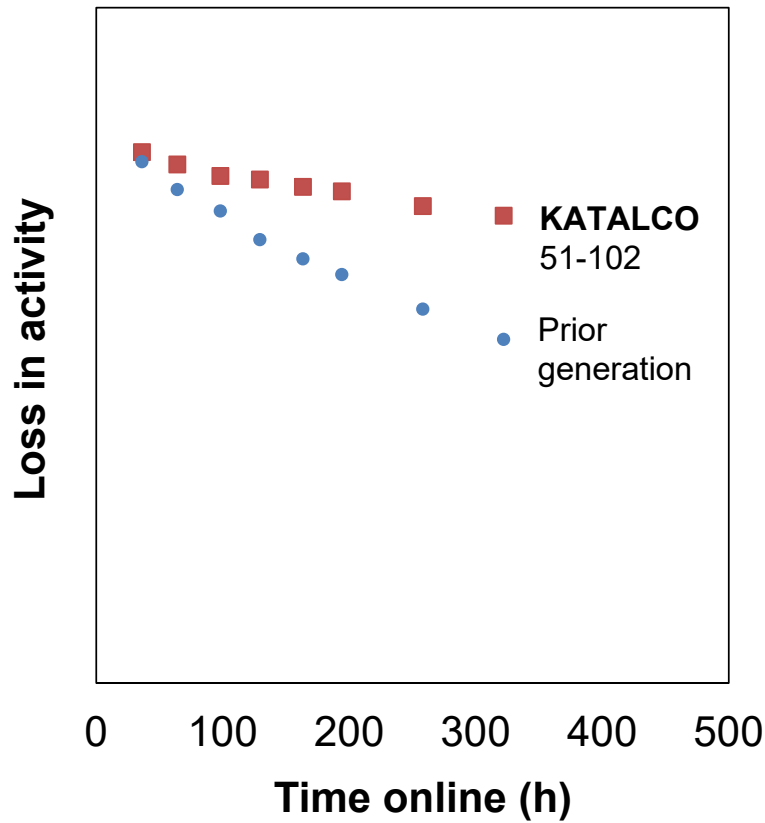
Real world  
performance

CO - CO<sub>2</sub> - H<sub>2</sub>



# Lab assessment of **KATALCO 51-102**

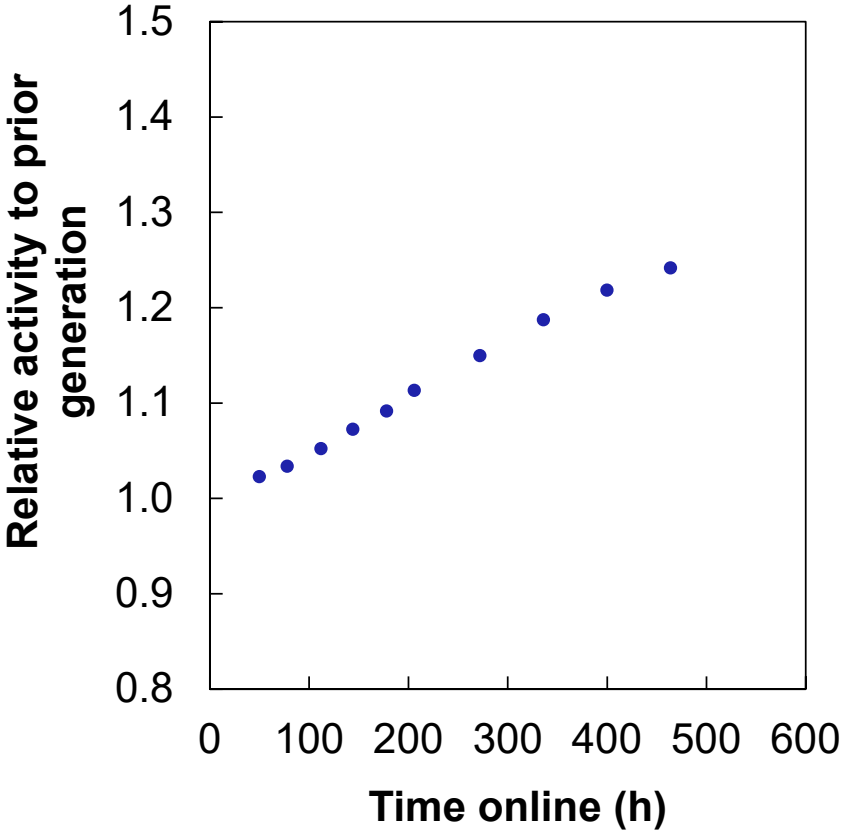
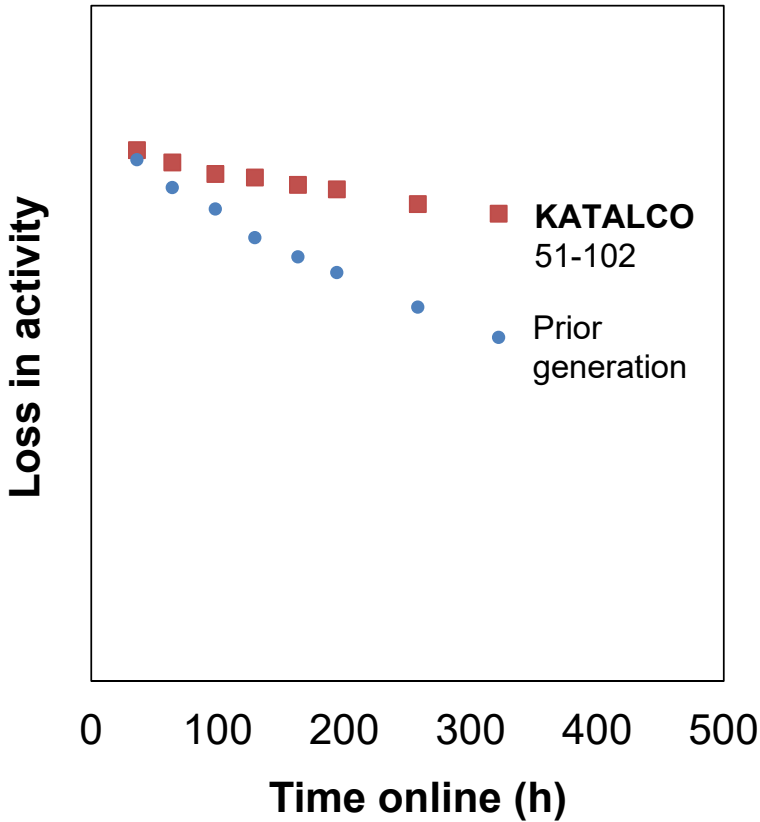
Relative activity to reference material over time – accelerated deactivation tests





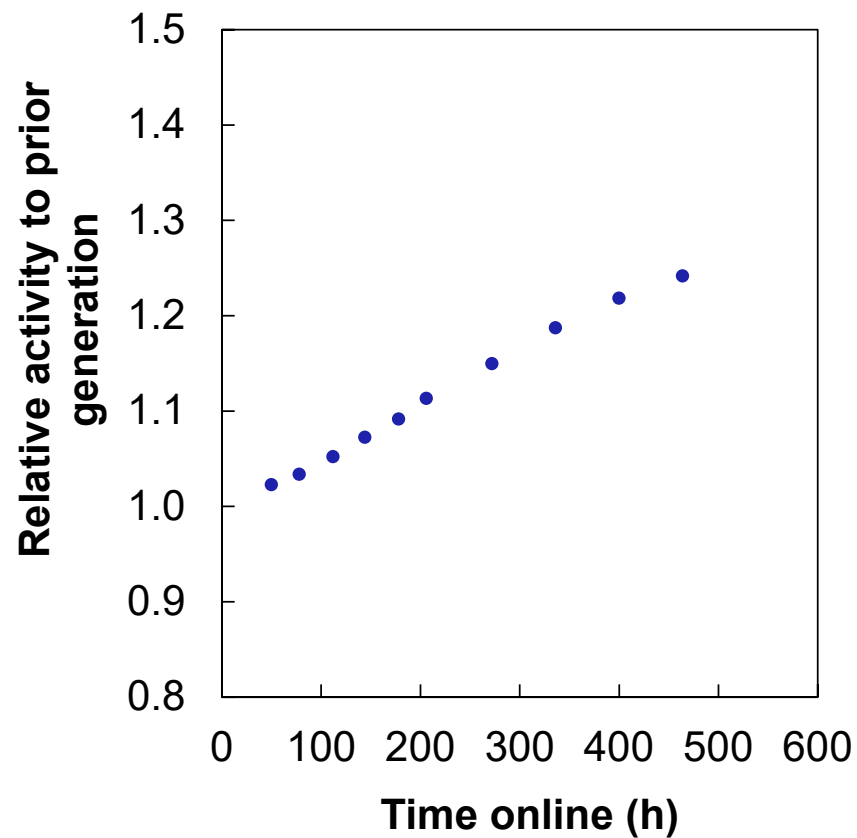
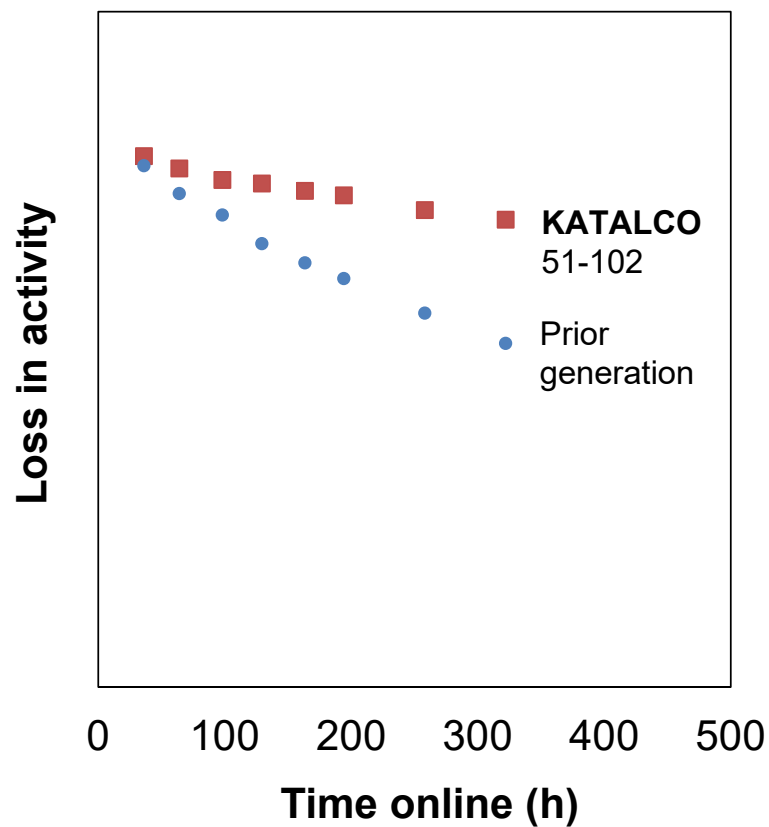
# Lab assessment of **KATALCO 51-102**

## Relative activity to reference material over time – accelerated deactivation tests



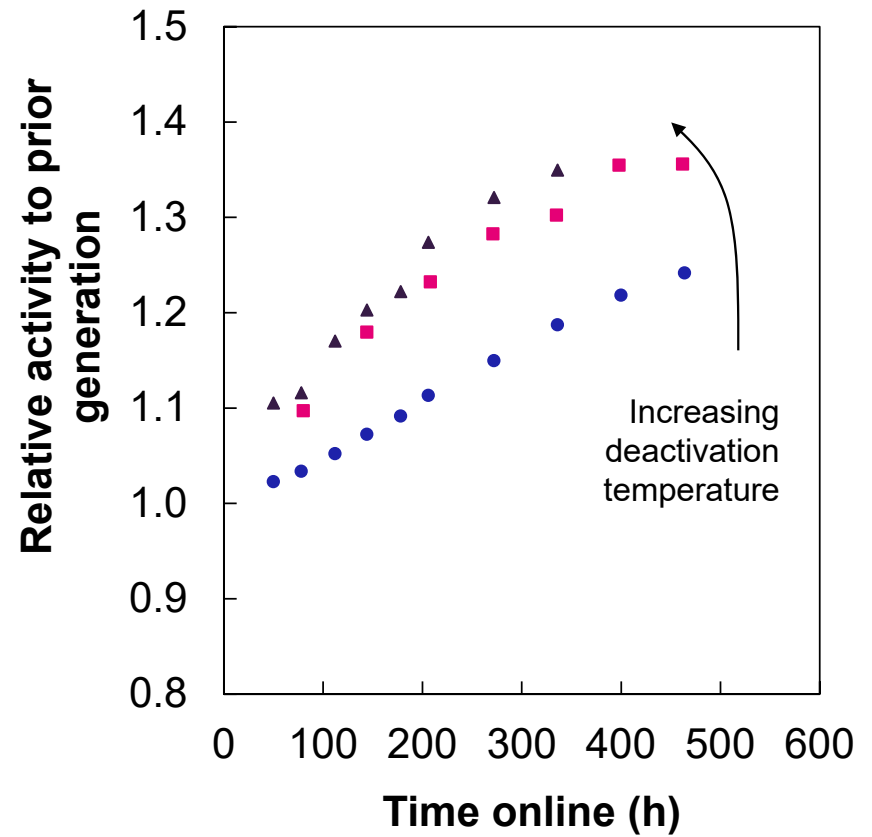
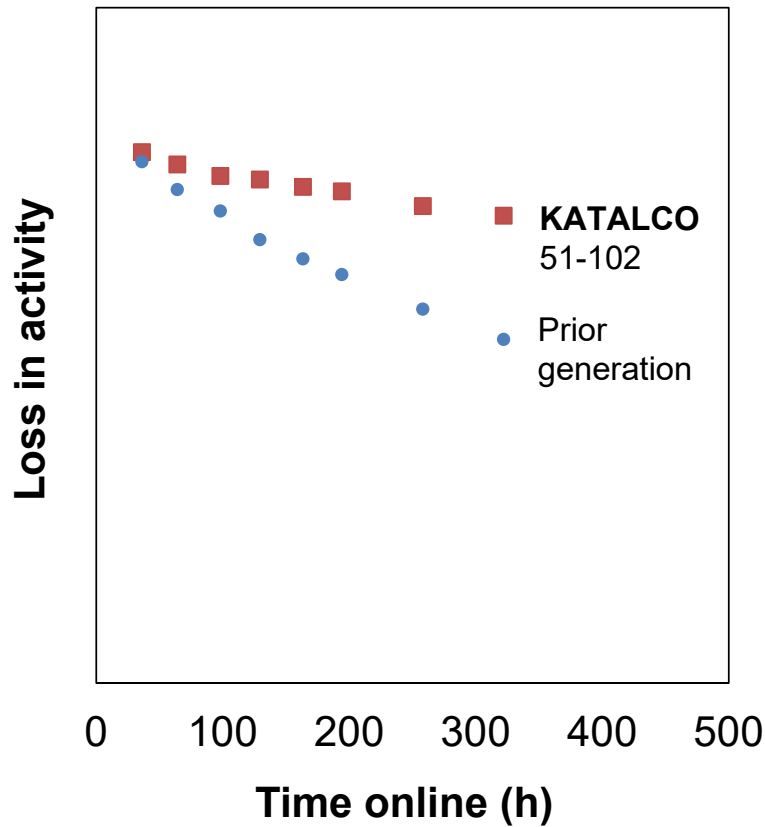
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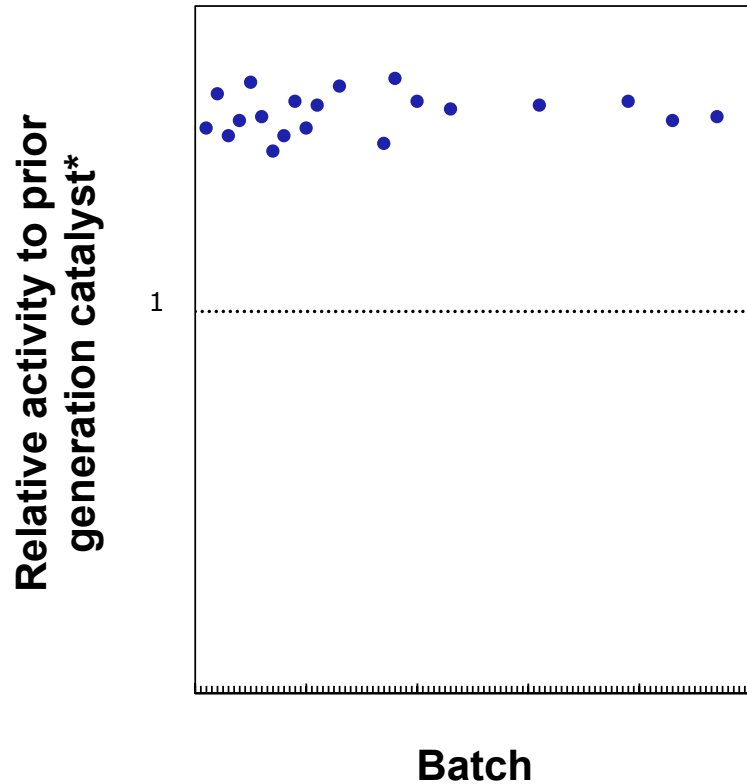
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## Relative activity to reference material over time – accelerated deactivation tests



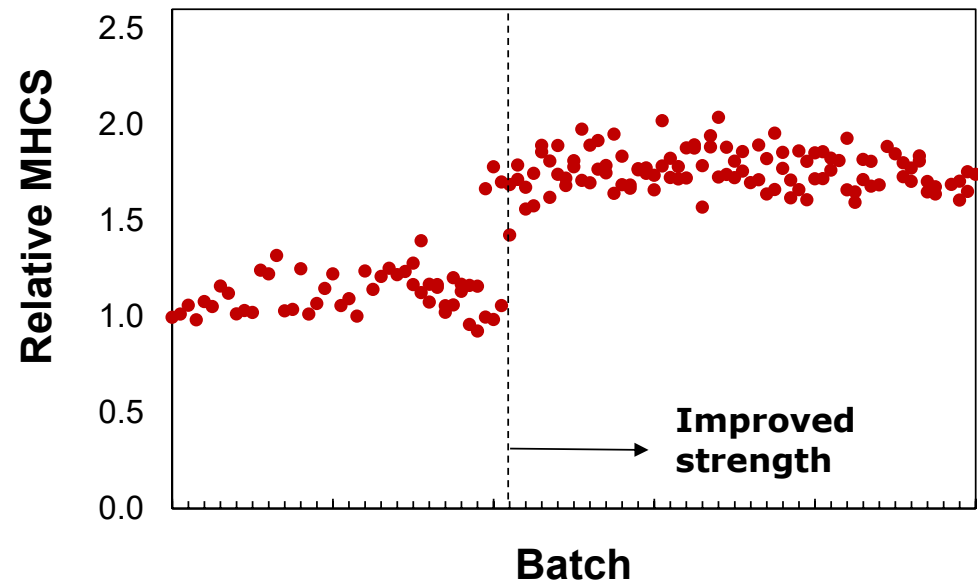
# Lab assessment of **KATALCO 51-102**

Quality control - >100 batches have been consistently manufactured since launch



\* After a period of accelerated deactivation

Strength, attrition resistance, shrinkage on reduction, mass loss on reduction, copper loading and zinc loading for **KATALCO 51-102** are comparable to the prior generation of catalysts from the **KATALCO 51-series**

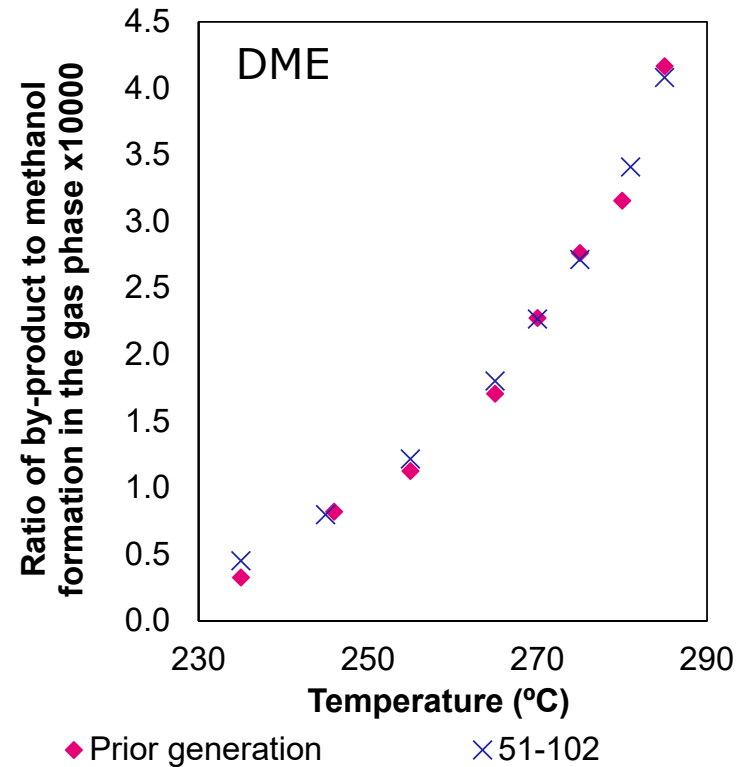
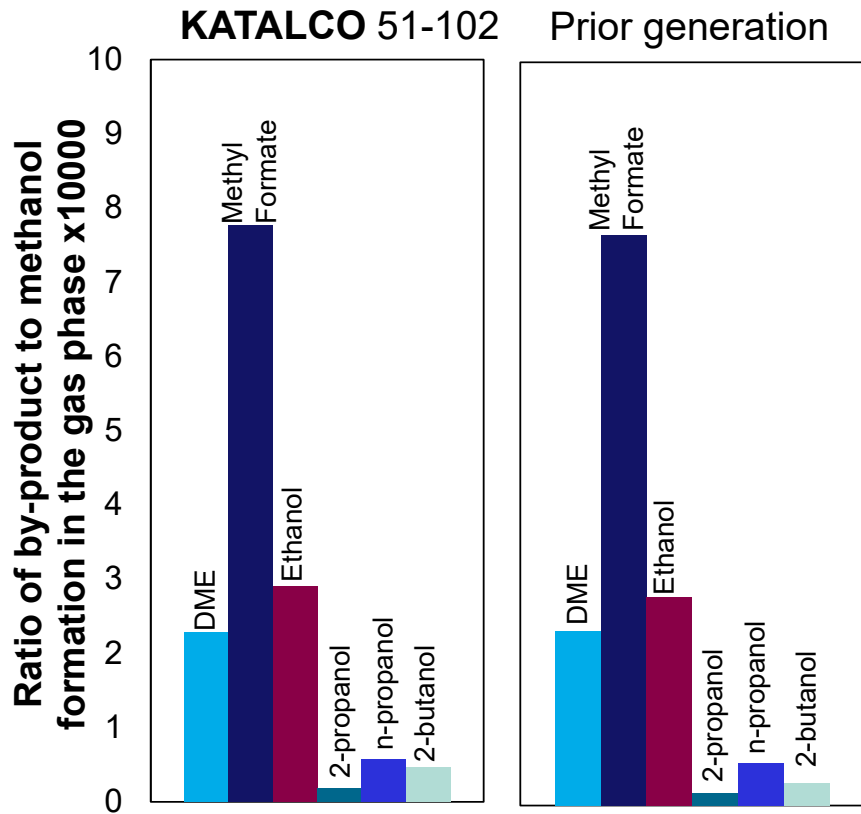


MHCS: mean horizontal crush strength



# Lab assessment of KATALCO 51-102

## By-product formation



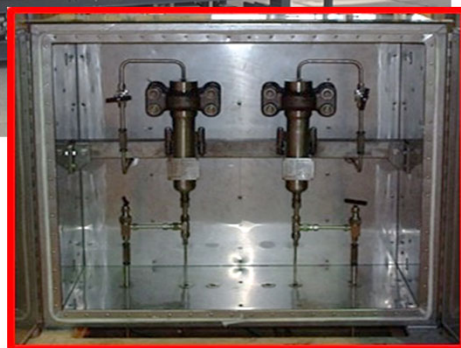
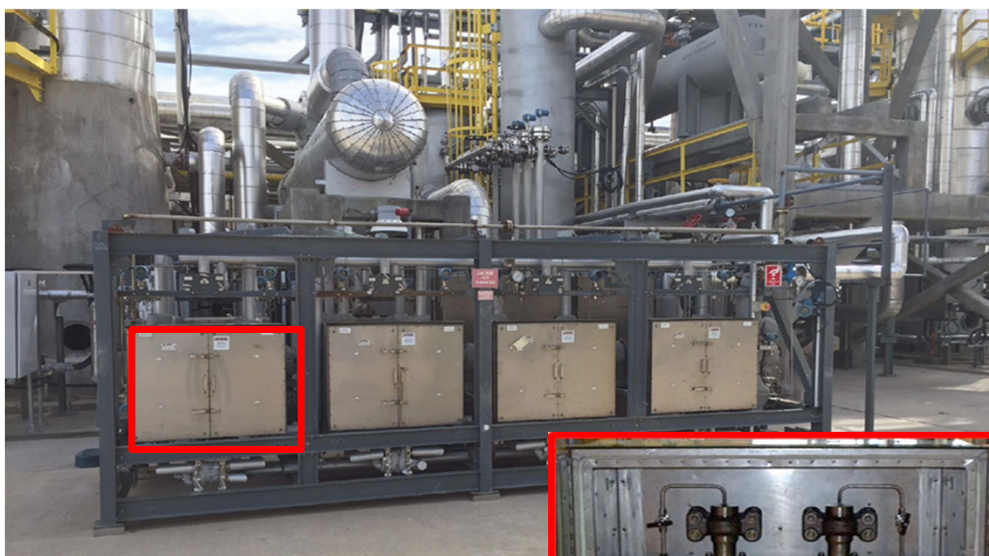
Broadly comparable to prior generation catalysts

By-products are mainly kinetically (temperature) dependent

Likely to be lower over life, due to slower aging hence slower ramp-up of temperature

# Pilot scale assessment of **KATALCO 51-102**

## Methanol side-stream unit

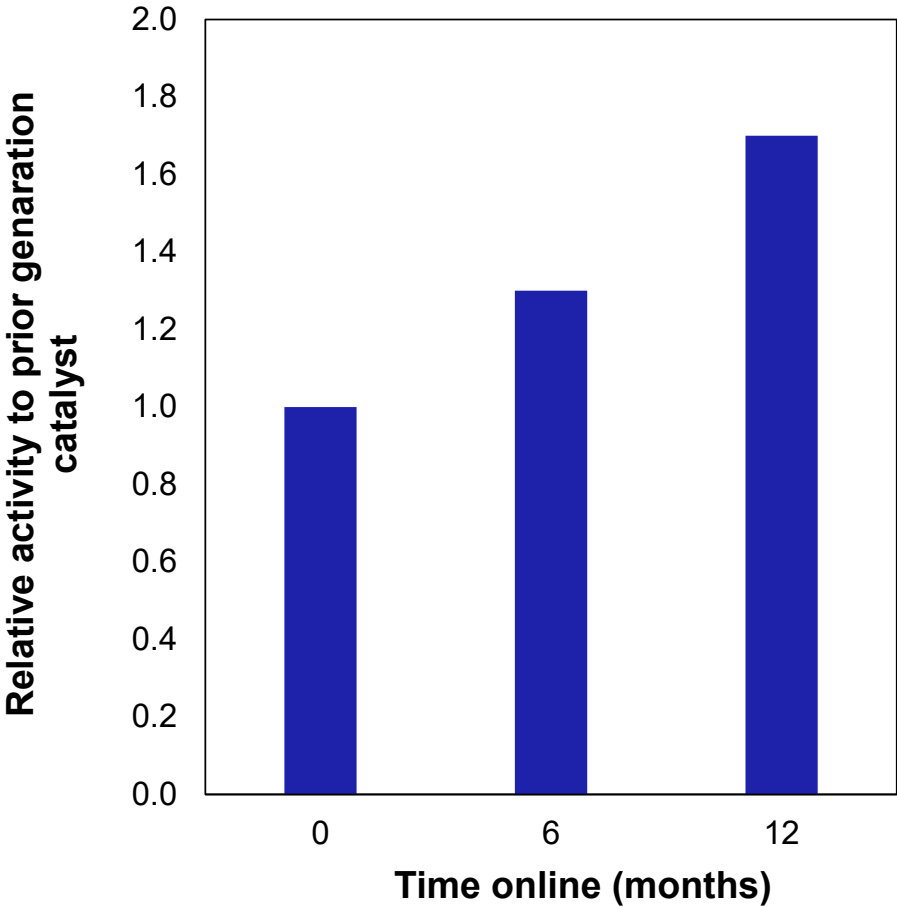
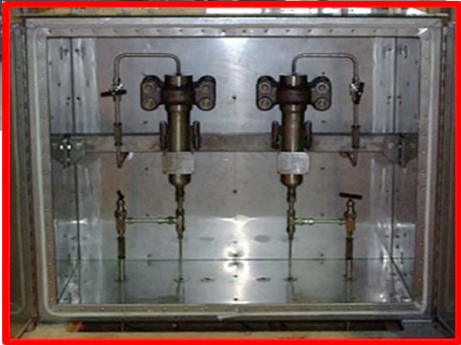
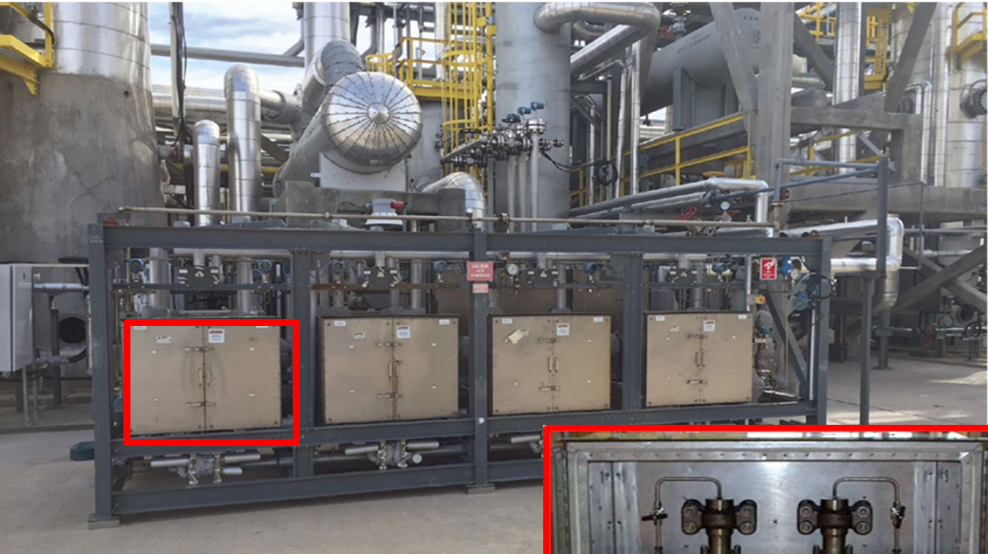


- Attached to a real plant. Currently located at Proman USA, Pampa Plant
- 12 reactors configured as six pairs
- Expose catalyst to actual plant conditions (temperature, pressure, feed composition)
- 1 reactor in each pair loaded with reference catalyst
- Reactors can be boxed up and shipped under nitrogen to prevent re-oxidation of the catalyst prior to testing



# Pilot scale assessment of **KATALCO 51-102**

## Methanol side-stream unit



# Enhanced longer term activity of **KATALCO 51-102**

## Industrial references

- 16.5 m<sup>3</sup> charge installed at Proman USA (Pampa) in Nov 2018
- Operation on average at 120% of design rate

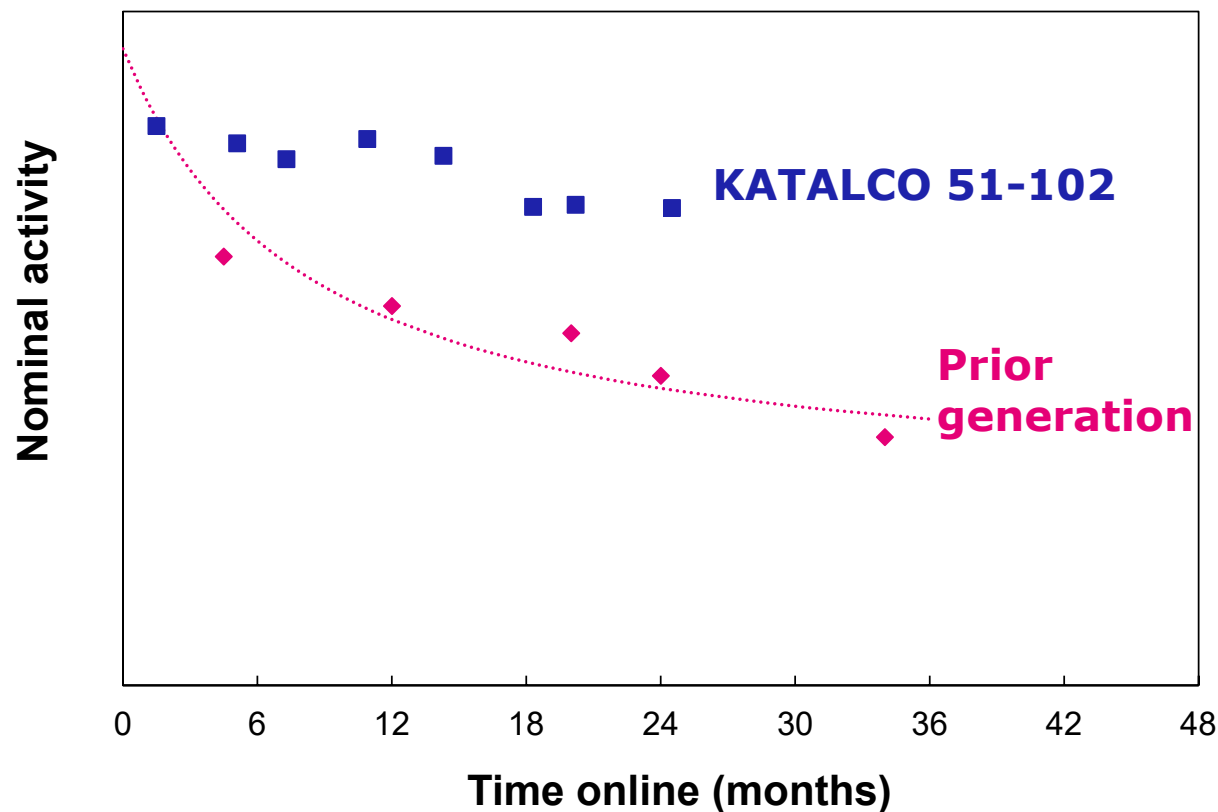




# Enhanced longer term activity of **KATALCO 51-102**

## Industrial references

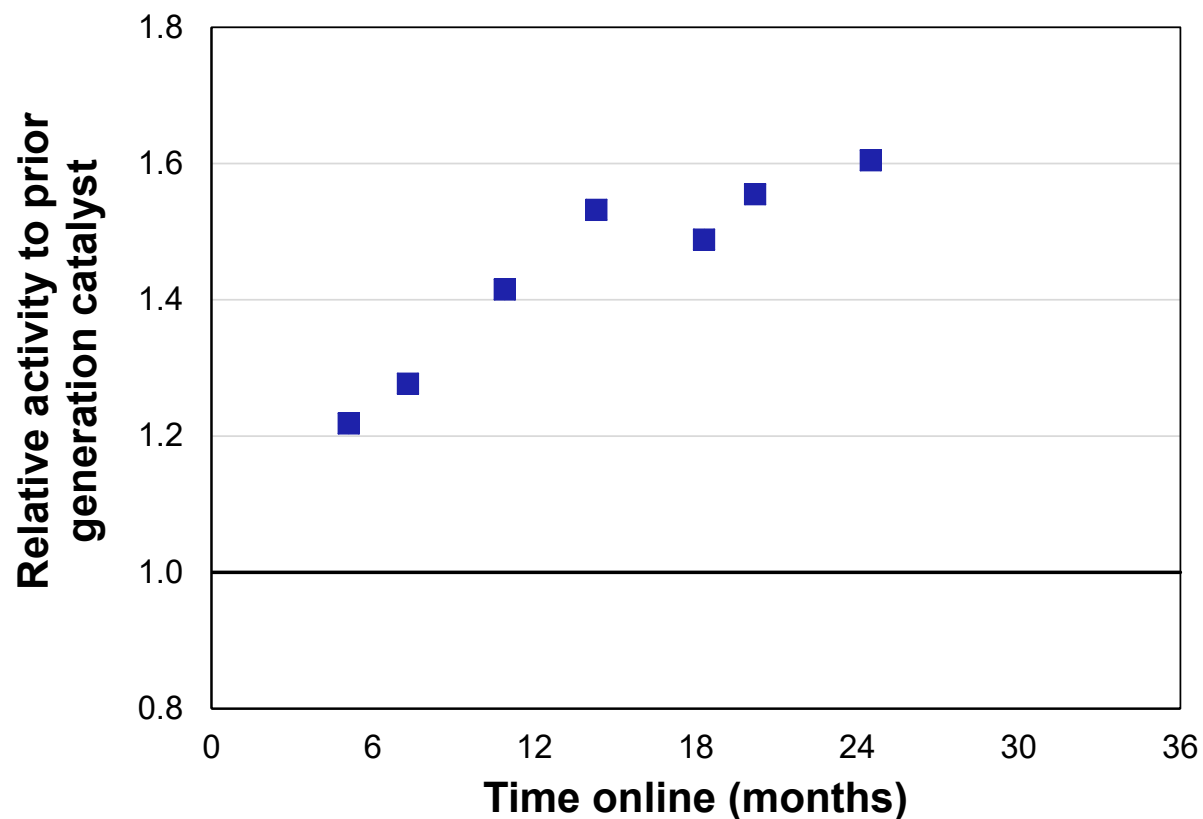
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- Performance to date in line with expectations



# Enhanced longer term activity of **KATALCO 51-102**

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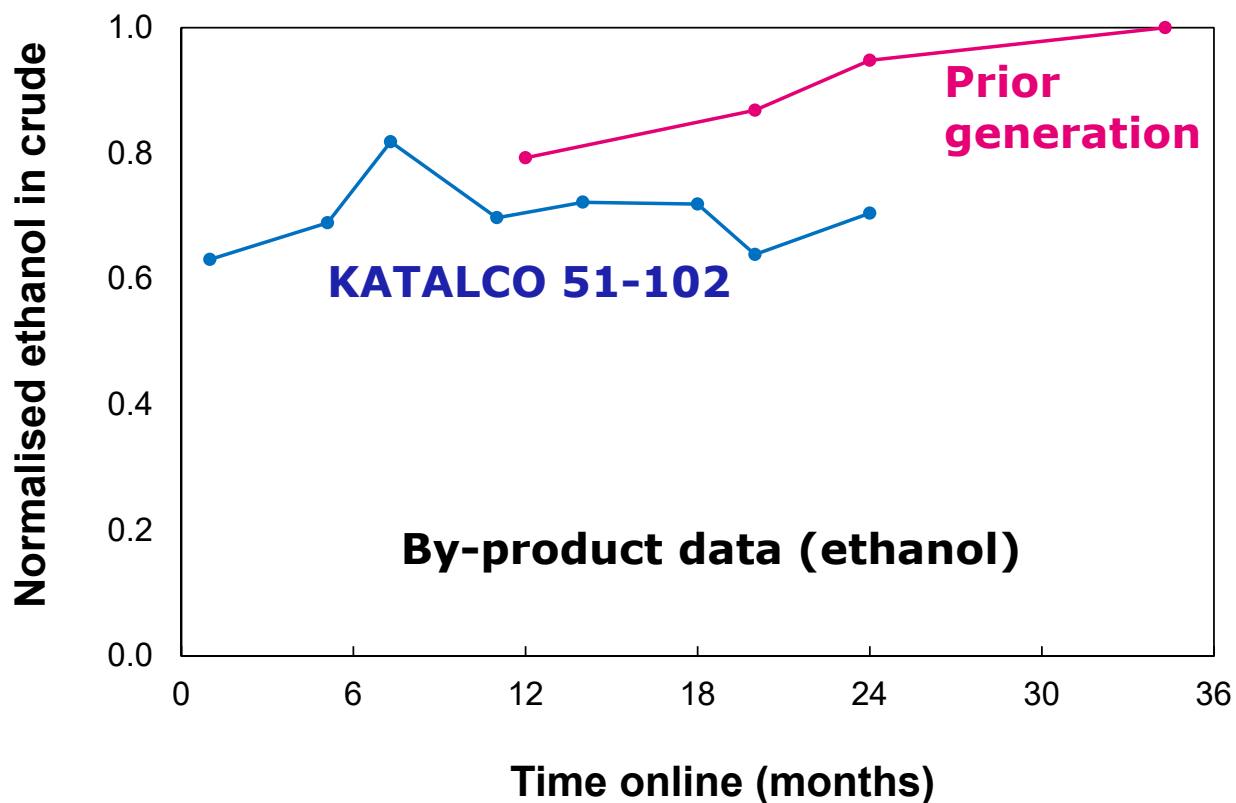
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# Enhanced longer term activity of **KATALCO 51-102**

## Industrial references

- 16.5 m<sup>3</sup> charge installed at Proman USA (Pampa) in Nov 2018
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- **Same or even lower by-product make**



# Enhanced longer term activity of **KATALCO 51-102**

## Industrial references

### Reference 1

- 16.5 m<sup>3</sup> charge installed at Proman USA (Pampa) in Nov 2018
- Operation on average at 120% of design rate
- Performance to date in line with expectations
- Same or even lower by-product make

### Reference 2

- The second charge of **KATALCO 51-102** has been loaded in a quench-cooled converter operating at over 1,800 mtpd
- 6 months online
- Performance is in line with the expectations at start of life

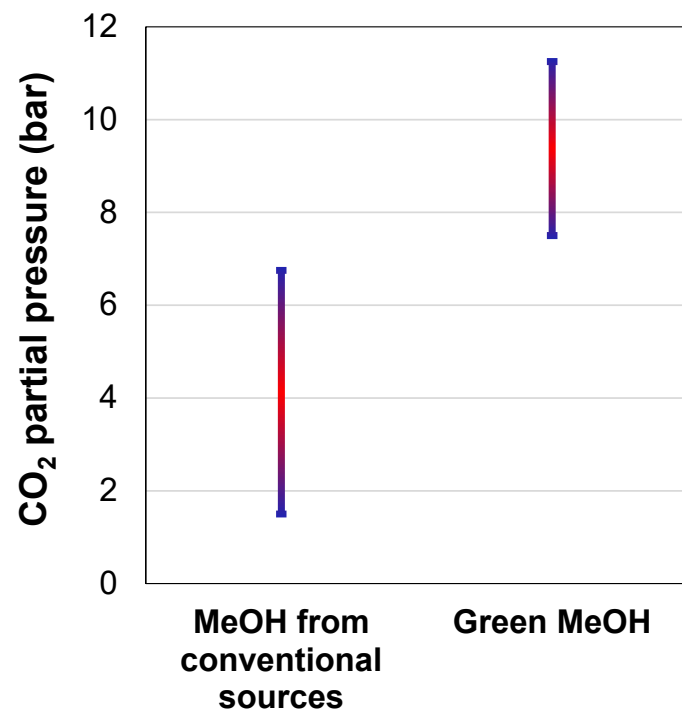
### Reference 3

- The third charge will be installed in a methanol plant with a capacity of over 1,600 mtpd.

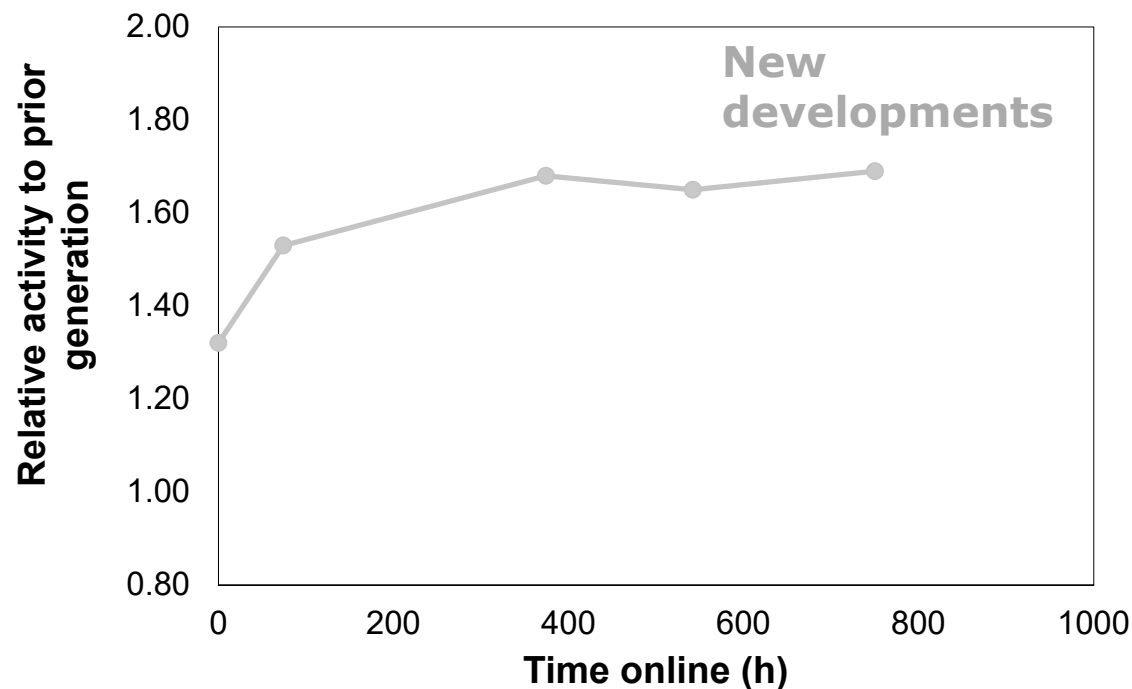
# CO<sub>2</sub> hydrogenation to methanol

## Moving toward net zero emissions

Catalysts from **KATALCO** 51-series are already being used successfully in these applications...



... and we can benefit from an even more hydrothermally stable catalyst using Si as a stability promoter and future developments building from the same principles



Accelerated deactivation test

# KATALCO 51-102

More methanol, for longer



**KATALCO 51-102** offers significant value generation for customers. A typical 3000 mtpd plant switching to **KATALCO 51-102** could make an additional 2.5% methanol over 4 years, worth \$9 million in extra margin (assuming \$100/mt margin). An extra year on the change-out cycle would be worth a further \$0.8 million per year. A more stressed or revamped plant could generate even more value.

The technical developments that are intrinsic to **KATALCO 51-102** will also yield major benefits for 'green' methanol plants utilising CO<sub>2</sub> as a feedstock.



# Johnson Matthey ProcessWise Webinars

An update on KATALCO 51-102 synthesis catalyst



## Questions and Answers

Please submit your questions, feedback and suggestions for future webinar topics through the Team Live Events Q&A panel on the right of your screen

