Johnson Matthey

Methanol synthesis catalysts

Conventional and sustainable feedstocks

www.matthey.com

A partner you can depend on

The #1 methanol synthesis technology and catalyst supplier

Johnson Matthey (JM) has been at the forefront of methanol technology (through ICI heritage) since it developed the modern Low Pressure Methanol process in the 1960s and its **KATALCO**™ 51-series of methanol synthesis catalysts. All modern methanol plants are still based on this pioneering technology.

Today, JM is the #1 methanol synthesis technology and catalyst supplier and by combining our cutting-edge catalysts with our most efficient innovative technology offers a pathway for methanol producers to maximise plant performance and efficiency.

We are responsible for the biggest methanol synthesis loops in the world and have licensed more than 100 methanol plants contributing to more than 60 million tonnes per year of methanol production all over the globe.

Over the years, JM has enhanced its technology and catalysts, and is proud to offer the most efficient and reliable solutions in the market. As the leading methanol catalyst and technology supplier, our focus is to deliver world class plant performance driving profitability quickly and easily for our customers.

Our solution at a glance

Comprehensive solutions

From standard applications to specialised requirements our catalysts cover a broad spectrum of methanol synthesis needs.

Expert support

Backed by decades of deep industry experience in both catalyst development and cutting-edge technology our team of specialists provides comprehensive support and expertise, guiding you through every stage from selection to implementation and beyond. We are committed to helping you optimise your methanol processes to achieve best results.

Sustainability focus

We seek to improve the efficiency, effectiveness and sustainable impact of our methanol technology and product solutions, to enable our customers achieve high plant productivity by making more with less.

Boost methanol yields

Unlock peak plant performance with cutting edge methanol catalysts.

In an ever-evolving market, staying ahead requires integrating efficient methanol technology with cutting edge catalysts and absorbents. Our methanol solutions are designed to help you overcome the challenges of today's market while maximising your plants performance.

At Johnson Matthey we recognise the pressures our customers face in a rapidly changing methanol market and our comprehensive range of methanol synthesis catalysts delivers superior performance, reliability and efficiency across various applications and technology. Whether you require high stability, low shrinkage or optimised performance for CO_2 conversion, our catalysts are designed to meet your needs.

Since the early development of the first copper-zinc low pressure synthesis catalyst, **KATALCO** 51-1, Our state-of-the-art **KATALCO** catalysts and absorbents, have been continuously evolving and are now synonymous with enhanced process performance, reliability in service and long life.

Methanol synthesis development at Johnson Matthey

Long heritage and experience in methanol synthesis catalyst development.

1965
KATALCO 51-1
Original formulation for 50 bar plants

1966
ICI Low pressure methanol using Cuzn catalysts

1999
KATALCO 51-9
First low shrinkage methanol catalyst for radial converters

2004
KATALCO 51-9S
Improved strength and volumetric activity

2020
KATALCO 51-102
Higher methanol make for longer.

2023
eMERALD 201
First e-methanol catalyst, to enable sustainable methanol production.

Advantages of choosing **KATALCO** methanol synthesis catalysts

The **KATALCO** 51-series of catalysts is used for the synthesis of methanol from carbon monoxide, carbon dioxide and hydrogen. It has offered methanol producers excellent performance since its introduction in the late 1960s, and currently accounts for an annual methanol production of more than 20 million tonnes.

Long Life

All charges of **KATALCO** 51-series catalysts have been shown to provide very stable catalyst activity. This results in high carbon efficiency and high selectivity giving low by-product formation. Typical catalyst life is three to four years, but some of our latest generation products have operated for over seven years.

The use of unique promoters to improve the dispersion of the metal oxide crystallites throughout the catalyst micro-structure ensures long catalyst life and allows for high methanol production rates throughout the catalyst life.

By product formation

The high selectivity of the **KATALCO** 51-series minimises by-product formation and therefore again increases the methanol production of the plant. This reduces the loss of carbon oxides that are converted into by-products and thereby increases the methanol production from the plant. Furthermore, lower by-product levels also lead to improved recovery of methanol in the distillation section due to the reduced requirement for fusel oil purge. If the distillation section of the plant limits the plant rate during summer months, low by-product formation allows for increased plant rates during this time of year.

Long life

The **KATALCO** 51-series of catalysts have proven to offer excellent long lives in a wide range of converter types whilst maximizing methanol production.

High selectivity

The high, stable activity of **KATALCO** 51-series products allows for operating at low temperatures, which minimizes the formation of by-products such as higher alcohols.

Low shrinkage

KATALCO 51-91 has very low shrinkage on reduction. This low shrinkage makes it particularly well-suited to radial flow reactors.

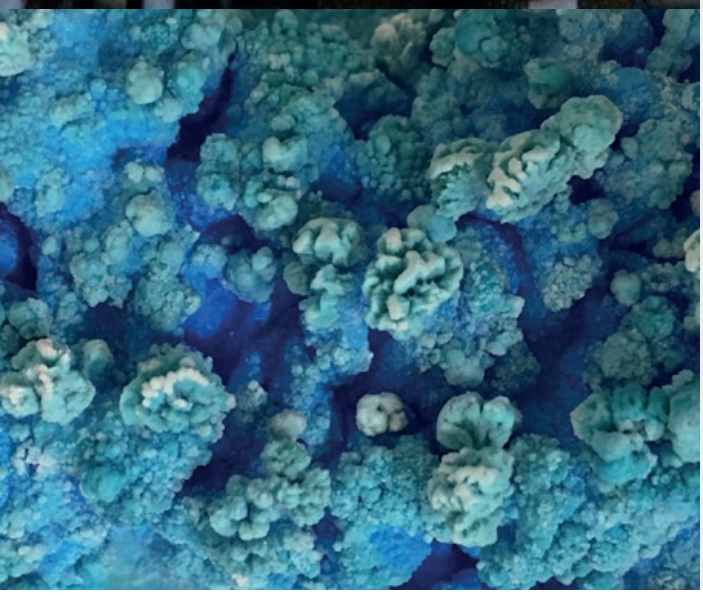
Proven in all converter designs

The **KATALCO** 51-series has been proven to offer excellent activity in the wide range of converter designs that are used on methanol plants.

Experience with CO_2 addition

The **KATALCO** 51-series has been used on a large number of plants where CO_2 is added either to the loop or the reformer. Johnson Matthey's series of methanol synthesis catalysts are all suitable for operation with high levels of CO_2 in the loop.

Methanol synthesis catalyst selector



Johnson Matthey currently offers a comprehensive range of methanol synthesis catalysts, from traditional, standard applications to specialised requirements, our catalysts cover a broad spectrum of methanol synthesis needs and are summarised below:

KATALCO 51-8, has a proven track record across a wide range of reactor designs and operating conditions, providing a robust and reliable solution for general methanol synthesis applications offering balanced and versatile performance characteristics.

For known strenuous converter duties or plants experiencing frequent shutdowns, then the exceptional strength coupled with high activity of **KATALCO** 51-102 is beneficial. **KATALCO** 51-102 is a ground-breaking product that offers advantages in terms of activity, in-service strength, selectivity and will offer benefits to all methanol plants. However, those benefits will be most appreciable in highly loaded designs where standard catalysts operate with short lives or with poor conversion levels.

Sustainable solutions

Providing different catalyst products, and not relying on a single 'universal' catalyst, better caters for the different methanol synthesis technologies that exist and allows choice of the optimum product for the specific duty.

Our methanol synthesis catalysts have been installed in some of the world's largest methanol plants to date, offering methanol producers excellent performance, stability and reliability and resulting in higher plant efficiency. Providing different catalyst products, and not relying on a single 'universal' catalyst, better caters for the different methanol synthesis technologies that exist and allows choice of the optimum product for the specific duty.

All catalyst options are suitable for the range of different synthesis gas compositions being used, with typical temperature ranges of operation from 200 -290°C (392-554°F) and at pressures between 30–110bar (435-1595 psi), allowing flexibility in flow sheet design and optimisation.

Our catalysts at a glance

Product name	Features	Converter design					
		ARC	TCC	rSRC	aSRC	Lurgi GCC	Linde Variobar
KATALCO 51-8	Standard catalyst for most duties	✓	✓	–	✓	✓	✓
KATALCO 51-91	Low shrinkage, higher single pass conversion, Improved heat transfer	✓	–	✓	–	–	–
KATALCO 51-102	Highest activity, high thermal stability, High mechanical strength, Low temperature operation	✓	✓	–	✓	✓	✓
SUSTAINABLE SOLUTIONS							
eMERALD 201	CO_2 to methanol, excellent hydrothermal stability, high mechanical strength	✓	✓	–	✓	✓	✓

KATALCO 51-102

Superior methanol synthesis catalyst

Extending and protecting catalyst's lifetime, to make methanol for longer

KATALCO 51-102, is JM's latest generation of methanol synthesis catalyst with improved catalyst stability, compared to prior generations.

The unique promoters in **KATALCO** 51-102, offer greater resistance to thermal sintering, the most common cause for catalyst deactivation and die-off. This improves methanol productivity and extends the life of the catalysts, enabling methanol producers to make more for longer.

The significantly improved stability of **KATALCO** 51-102 will allow the plant to be operated at lower temperatures for longer, which will reduce the formation of by-products throughout the lifetime of the catalyst and is the perfect partner for low circulation synthesis loops.

Maintaining high feedstock efficiency is key for methanol production, however low-circulation synthesis loops are often perceived to have a lower efficiency when compared to high-circulation loops due to high steam pressure requirements, which can have a detrimental impact on catalyst activity at start of run.

Johnson's Matthey's next generation of methanol synthesis catalysts have been engineered to stabilise finely dispersed copper and zinc particles by interspersing them with metal oxides, significantly enhancing longevity and enabling methanol producers to make more methanol for longer.

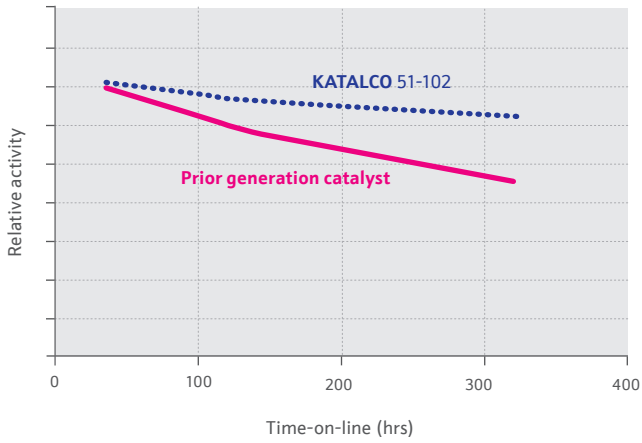


Figure 1: **KATALCO** 51-102 performance under accelerated ageing conditions vs previous generation methanol synthesis catalyst.

JM scientists observed that zinc oxide was losing surface area through crystallite growth even though the temperature was theoretically too low. It was concluded that the water vapour produced in the methanol synthesis reaction was creating a zinc hydroxide species which sintered at much lower temperatures, and could be attributed to hydrothermal sintering.

The unique composition of **KATALCO** 51-102 ensures that the copper and zinc particles remain finely dispersed, providing a more effective barrier preventing agglomeration and degradation over time.

Thanks to the enhanced stability of **KATALCO** 51-102 performance is better maintained over the catalyst life and the optimum loop efficiency can be achieved for longer, and when coupled with Johnson Matthey's **PRECISION METHANOL**™ flowsheet will enable you to unlock the value potential from your methanol plant and maximise plant operations.

Our methanol synthesis catalysts have been installed in some of the world's largest methanol plants to date, offering methanol producers excellent performance, stability and reliability and resulting in higher plant efficiency. The performance of **KATALCO** 51-102 synthesis catalyst has been proven in a range of converter and flowsheet designs, the enhanced stability has already enabled more methanol production for our customers around the world.

Simply stated our newest offering **KATALCO** 51-102 will make the most methanol with less feedstock, give longest life, with superior selectivity towards methanol formation and suppressing by-product formation.

Scan to learn more about our PRECISION METHANOL product

Significant value generation for customers

The improved performance of **KATALCO** 51-102 could deliver the following for a typical 3000 mtpd plant:

- **An additional 2.5% methanol make over 4 years, worth $9 million extra (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 benefits that can be achieved by any individual operator, however, will depend on the specific circumstances on their plant. JMs methanol team will be delighted to discuss and evaluate benefits on a case-by-case basis.

Maximising methanol production

KATALCO 51-91 – the unique low shrinkage highly active methanol synthesis catalyst

KATALCO 51-91 is a smaller low shrinkage variant of the well-established **KATALCO** 51-9 methanol synthesis catalyst and provides improved in-service strength and higher effective activity when compared to equivalent products of larger size pellet dimensions, particularly at temperatures where diffusion limits methanol formation.

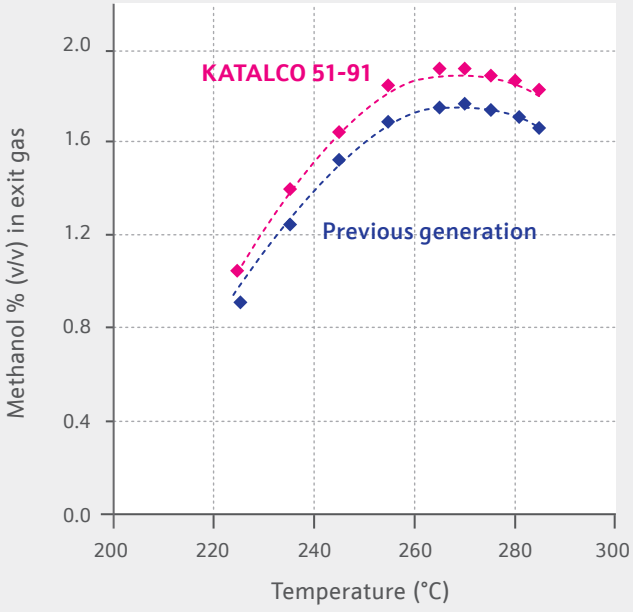


Figure 2: **KATALCO** 51-91 delivers higher methanol production per pass vs previous generation

KATALCO 51-91 vs previous low shrinkage variant

Smaller pellets also tend to have superior selectivity toward methanol formation since the concentration of methanol within the smaller pellets is decreased, preventing the methanol reacting further.

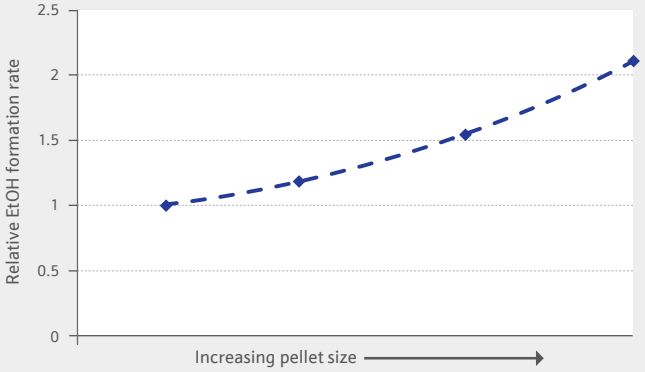


Figure 3: **KATALCO** 51-91 optimised for higher methanol selectivity and lower by-products

The increase in activity per unit volume of catalyst and decrease in by-product formation offered by **KATALCO** 51-91 has been achieved by optimisation of the pellet dimensions, with minimal impact on the pressure drop.

KATALCO 51-91 has also been designed to minimise the impact of pellet diffusion limitations allowing for high pellet effectiveness to maximise methanol production.

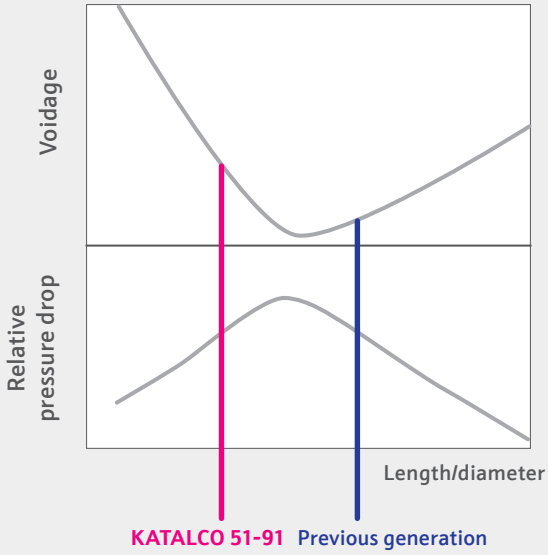


Figure 4: **KATALCO** 51-91 engineered for high methanol yield with low pressure drop.

The low shrinkage of **KATALCO** 51-91 is particularly well suited to radial flow converter designs, such as the JM Radial Steam Raising Converters (R-SRC), utilised in the **BALANCE METHANOL**™ and **SWITCH METHANOL**™ flowsheets ensuring maximum vessel utilisation and more uniform gas distribution after reduction.

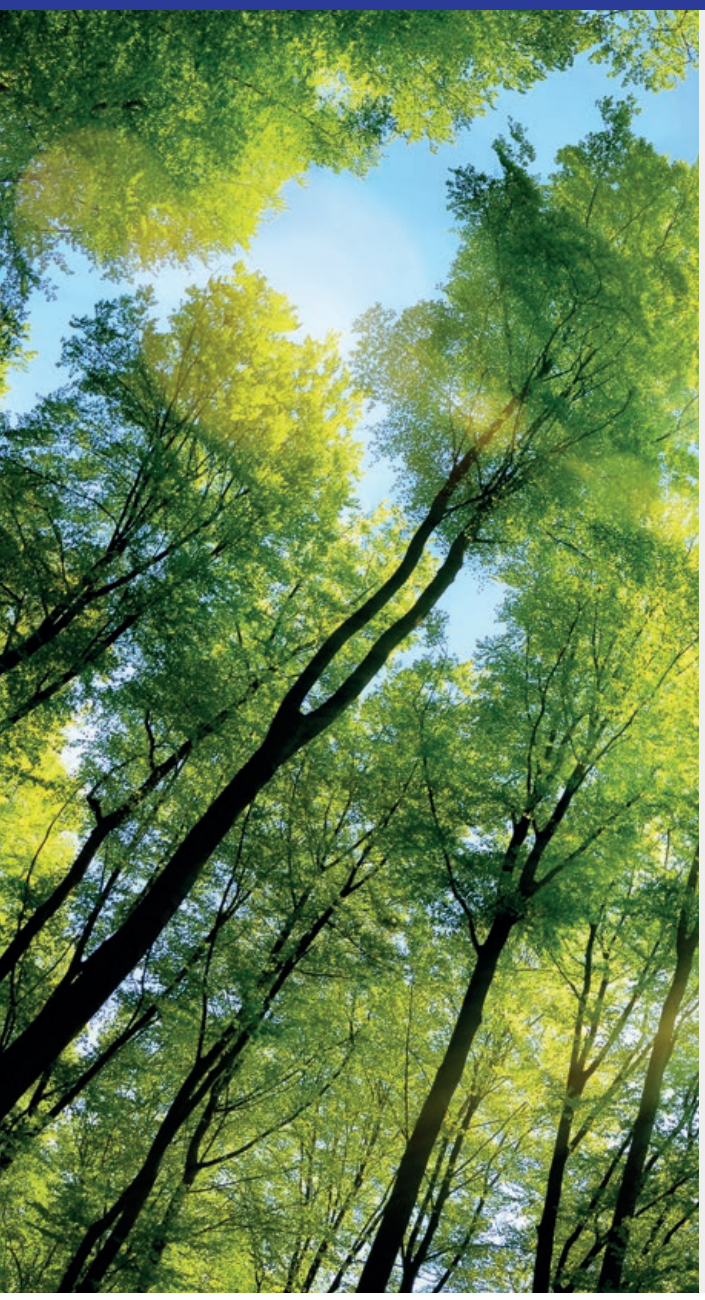
The benefits of **KATALCO** 51-91 have been realised by some of the worlds largest methanol plants enabled by JM R-SRC technology.

KATALCO 51-92 is the next generation product which employs JM's newest, patented promoter technology. This additionally achieves greatly improved resistance to deactivation by thermal sintering, further extending the useful operating life of the catalyst.

Key benefits

- Low shrinkage
- High conversion
- High reduced strength
- Improved heat transfer
- Improved gas distributuon
- Uniform temperature operation

Scaling for a sustainable future **eMERALD** 201



Integrated technology and catalyst solution

Building on long heritage of developing high performing methanol synthesis catalysts, **eMERALD**™ 201 methanol synthesis is the latest development specifically targeting CO_2 to Methanol plants.

eMERALD 201 has been uniquely engineered to complement our **eMERALD** methanol technology, creating a competitive solution for the conversion of CO_2 to methanol, ensuring high plant performance and efficiency for longer. Our **eMERALD** methanol flowsheet and **eMERALD** 201 catalyst are perfectly partners to help you produce methanol sustainably and efficiently now and into the future.

Superior stability

As the CO_2 to methanol reaction results in a much higher level of water formation compared to more traditional routes, it is crucial to use a highly stable catalyst that can withstand the high steam partial pressure to maintain high activity and throughput throughout the catalyst lifecycle.

eMERALD 201 utilises our latest combination of promoters that offer enhanced hydrothermal stability and greater resistance to thermal sintering, the primary cause of catalyst deactivation and die-off. The new promoters specifically target the components of the catalyst which are most susceptible to ageing in the high-water environment present in the CO_2 to methanol process, often called hydrothermal ageing, offering excellent stability in the most demanding operating environments.

High mechanical strength

The mechanical strength of methanol synthesis catalysts is one of the most important factors for reliable and efficient plant performance. Low mechanical strength can lead to a rapid increase in pressure drop, resulting in inefficient plant performance and even premature catalyst replacements.

The high mechanical strength of **eMERALD** 201 offers the robustness needed for the characteristically demanding operating conditions for direct CO_2 to methanol production, thereby ensuring high plant availability and reliability.

Scan to learn more about our eMERALD product

Scan to learn more about our Sustainable solutions

Key benefits

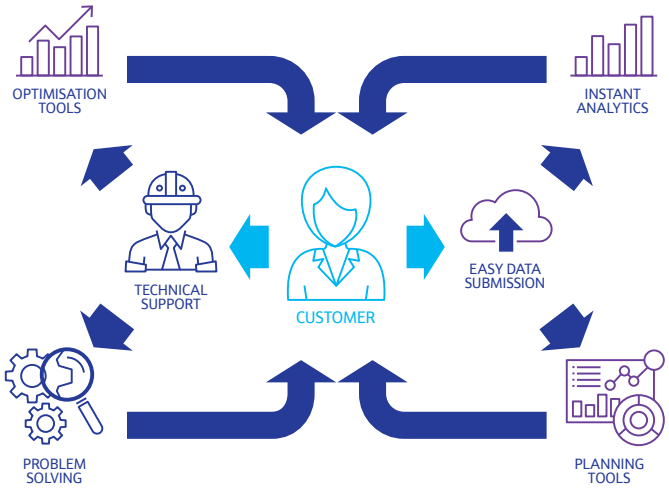
- Patented technology
- Low carbon intensity methanol
- Excellent hydrothermal stability
- High mechanical strength
- Resilient to operational swings
- Low temperature operation

Sustained high plant performance and monitoring

Johnson Matthey, through a thorough understanding of the design, operation and troubleshooting problems on methanol plants, has a breadth and depth of theoretical and practical knowledge that is unsurpassed and have been providing a range of supporting analytics, reporting and insight services to methanol producers since the very first low pressure methanol plants in the 1960s with the goal of helping to maximise the performance of their site or plant.

Today is no different and methanol still an essential building block in our everyday lives, for use in paints, plastics and fuels and as the world pushes towards a net zero future, it's important that we continue to provide our customers with more efficient, digital solutions, so that chemicals can be produced more sustainably.

The **JM-LEVO**™ Methanol digital platform delivers insightful analytics based on JM expertise and advanced data modelling.



The Portal was built after listening to methanol producers and understanding the key challenges they face

- Improve your understanding of your plant operation
- Achieve your targets such as increased production or improved efficiency
- Spend less time gathering and manipulating data
- Have more time with JM experts on focused, technical conversations
- Increase safety standards through early identification of developing issues
- Improve turnaround planning from better catalyst modelling

Optimise Methanol production with JM-LEVO

The **JM-LEVO** Methanol Portal provides you with the tools to efficiently monitor, adapt and optimise your processes in line with changing priorities and business requirements. The portal brings nearly 60 years of experience of the methanol industry into a new digital solution, giving you direct access to the latest analysis and recommendations.

With performance front of mind, we focus on issues and challenges, offer guidance to mitigate any operational risks and facilitate key decisions to achieve new level of plant performance.

A commitment to excellence

Our technical services enable the best performance from your plant. The overall impact of Johnson Matthey catalysts and technology can improve methanol plant costs by millions of dollars every year.

Contact us for further information on our products and services for methanol production

This document is printed on Essential silk paper, which contains material sourced from responsibly managed forests and is Elementary Chlorine Free (ECF). We are helping The Woodland Trust and The Woodland Carbon scheme, which aims to improve the landscape of Britain by planting more trees and protecting our national heritage of precious ancient woodland.

Designed and produced by www.houseoftype.co.uk

Billingham, UK
Tel +44 (0) 1642 553601
www.matthey.com

Johnson Matthey

1968JM/0325/0/CT