



Unlocking Opportunities for a Sustainable Future

PETRONAS Technology Ventures Sdn Bhd

PETRONAS' Statement of Purpose

A progressive energy and solutions partner
enriching lives for a sustainable future.

Who We Are

PETRONAS Technology Ventures Sdn Bhd (PTVSB) is dedicated to bringing technology-based products from concept to market efficiently.

Our commitment to sustainability and technological advancement, coupled with our strategic focus on operational excellence and competitive edge, positions us as a leading force in driving the development and commercialisation of oil, gas, and energy technologies. In addition, we actively pursue strategic technology investments to further our goals and stay at the forefront of innovation.

PTVSB's Focus Areas



Green and low carbon



Convenience and mobility

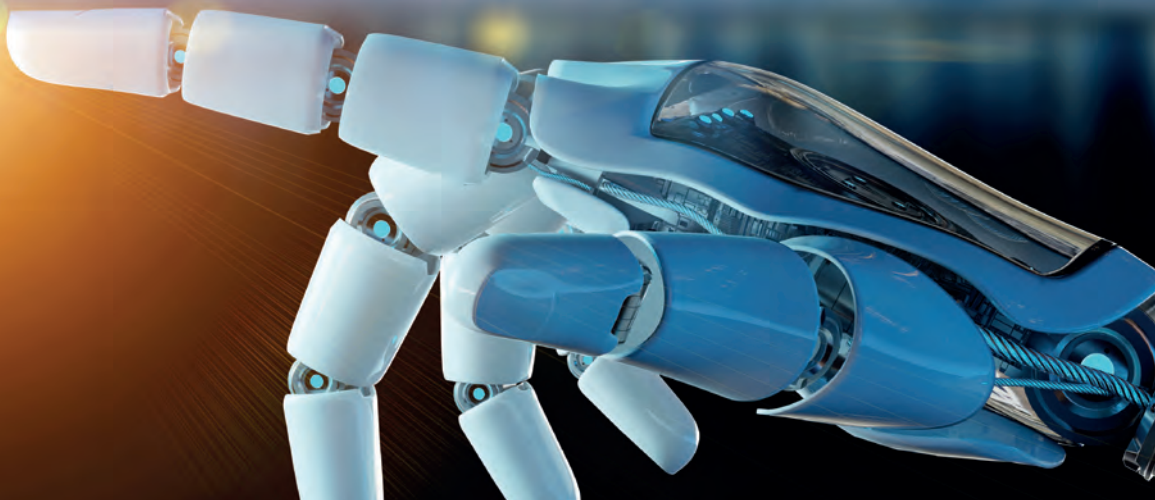
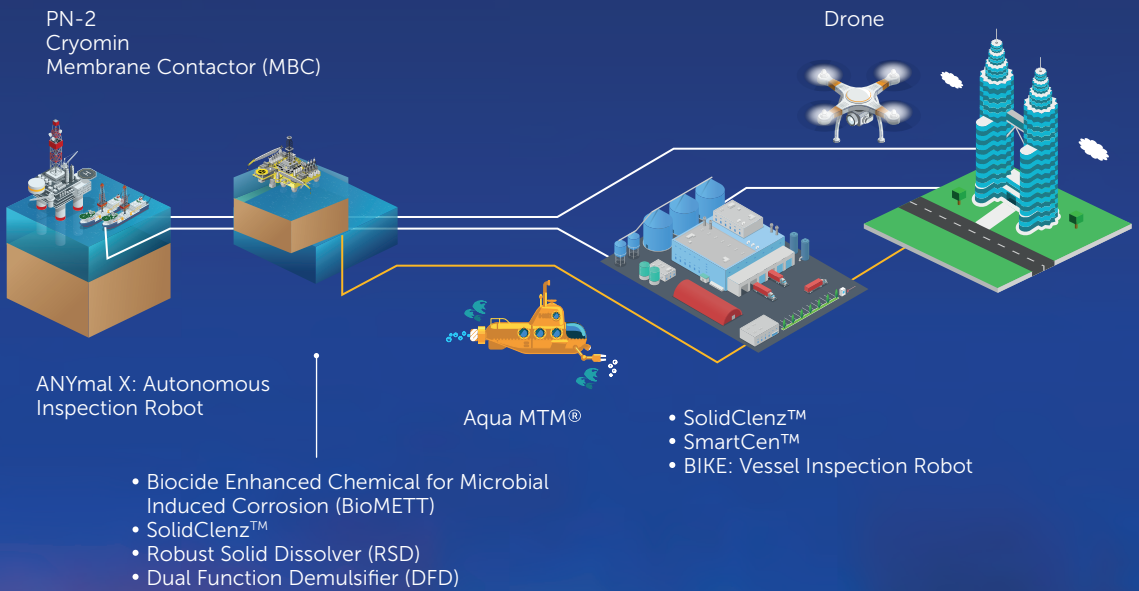


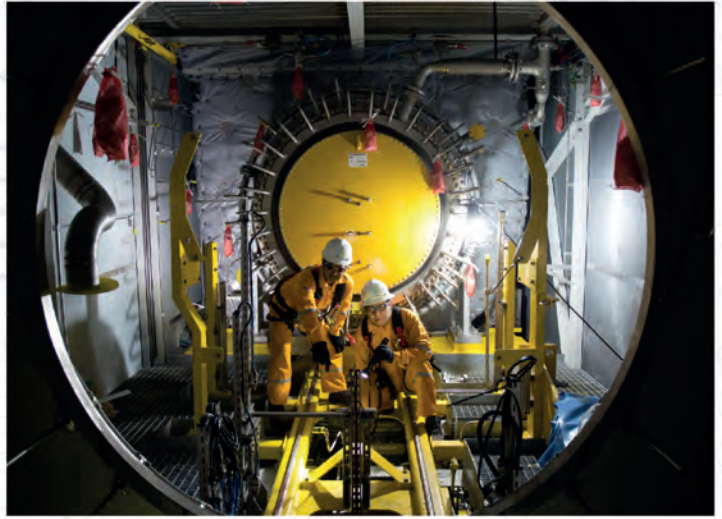
Repurposing hydrocarbons



What We Do

We provide end-to-end technology solutions across PETRONAS' integrated value chain.





Technology Solutions

Unlocking **possibilities** through **innovation**



Digital, Automation, and Robotics Technology

page **7**

- Safety and Productivity Online Tracker (SPOT)
- Artificial Intelligence in Safety and Compliance (AISC)
- BIKE: Vessel Inspection Robot
- ANYmal X: Autonomous Inspection Robot
- Drone Applications
- SmartCen™
- Hot Air Recirculation (HAR)
- VOLANT™



Specialised Chemicals

page **17**

- SolidClenz™
- Robust Solid Dissolver (RSD)
- Biocide Enhanced Chemical for Microbial Induced Corrosion (BioMETT)
- Dual Function Demulsifier (DFD)
- Grafted Bentonite (GB)
- CorroSolve+™



Production Enhancement Units

page **23**

- Sep-iSYS™: 3-Phase Integrated Separation Technology
- Sep-iSYS™: Integrated Separator Technology Under Low Pressure System
- Sep-iSYS™: Cyclonic Sand Removal Technology
- Sep-iSYS™: Low Pressure Production Unit (LPPU)
- Online Mercury Measurement System (OMMS™) 2.0
- Liquid Recovery System (LRS)



Pipeline Materials

page **31**

- ProAssure™ Wrap
- Non-Metallic Pipe (NMP)



Advanced Materials

page **35**

- ProShield+™
- ProCharge+™
- ProTough+™



Gas Processing Units

page **41**

- PN-1™
- PN-2
- CryoMin
- Membrane Contactor (MBC)



Hydrogen

page **47**

- Proton Exchange Membrane (H₂-PEM™)



Other Technologies

page **51**

- Intelligent Circulation while Drilling (iCWD™)
- TECHApps
- iCON®: Process Simulation Software
- M-FOSS Technology
- Geopolymer Cement
- Vibration Clamp™
- Aqua MTM®





Digital, Automation and Robotics Technology

Monitoring, high risk access and safety improvements through robotics, automation, drones and more.



SPOT

Safety and Productivity Online Tracker (SPOT) is a safety monitoring tool designed to detect workers in multiple locations, including hazardous areas.



This technology consists of three main components:

- Explosion-proof tag device
- Mobile application
- Dashboard for visualisation (data analytics)

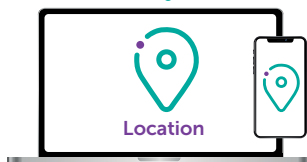
Deployed at:

- Delima Project (Melaka Refinery)
- PRSB (Bangi Research Centre)
- MMHE Fabrication Yard
- MRC SB (Turnaround)

How It Works



4G Connectivity



Applications

- Real-time location service of manpower
- Productivity monitoring

SPOT Analytics

Improved dashboard and visualisation to provide real-time personnel location, insights, and perform contact tracing. Based on machine learning localisation algorithm established on Received Signal Strength Indicator (RSSI).



Success Story

SPOT has tremendously helped to manage contractors' safety and productivity for big projects. It has led to the most successful turnaround activity ever achieved to date.



Managing Director
Malaysian Refining Company Sdn Bhd

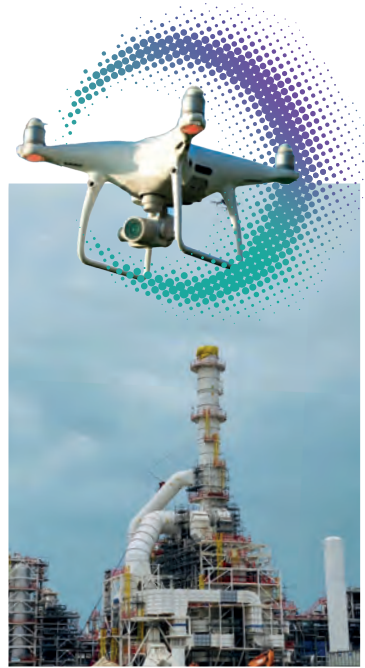


AISC

Artificial Intelligence in Safety and Compliance (AISC)

is a technology developed for safety monitoring, such as for unsafe acts and unsafe conditions, security surveillance, and timely intervention.

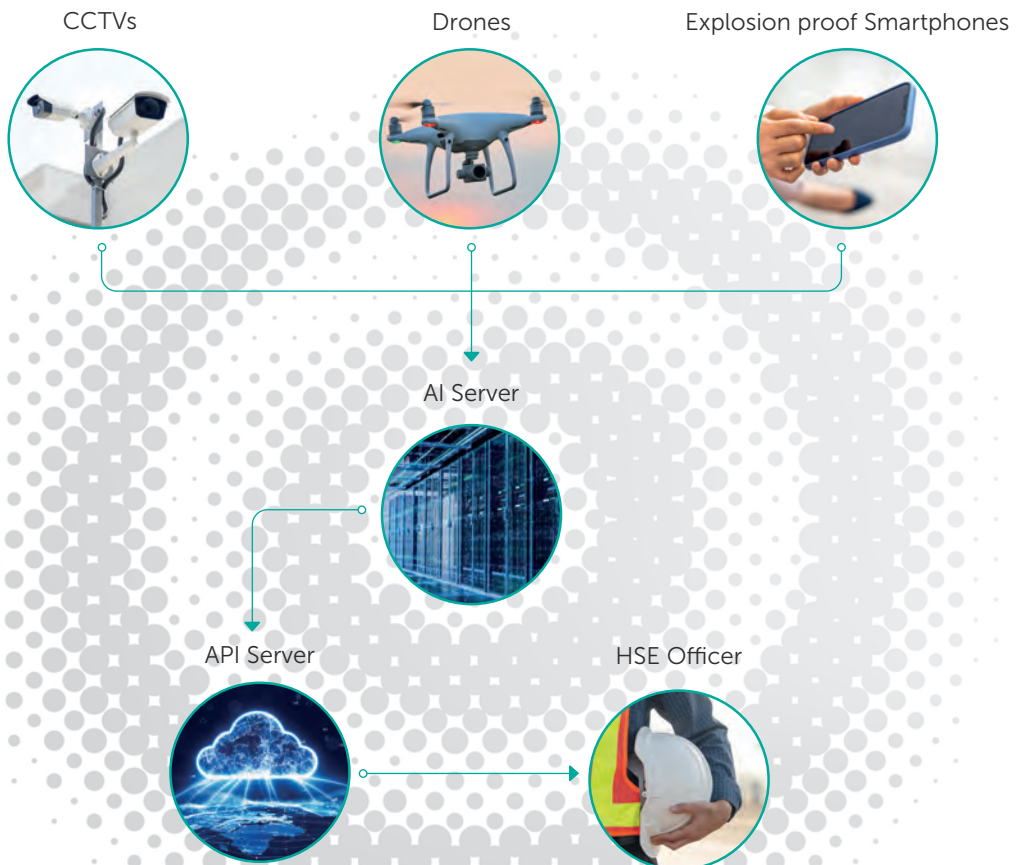
Video feeds from CCTVs and explosion-proof certified mobile cameras or drones are fed through the AI API on the server, which then flags non-compliance and alerts HSE supervisors through the app – greatly increasing their coverage.



Key Features

- Minimises incidents through artificial intelligence
- Increases HSE implementation efficiency through data analytics

How It Works





BIKE: Vessel Inspection Robot

BIKE is a remotely operated magnetic wheeled robot. The key functions i.e., power and communications are enabled through a tether cable. The inspection tools are interchangeable depending on the mission requirements e.g., HD camera, ultrasonic thickness gauge, and eddy current testing with locational awareness based on the 3D digital twin.

Key Features

- Minimises confined space entry - to improve and optimises HSE
- Eliminates the need for scaffolding manpower
- Improves data management workflow and repeatability of inspections
- Crack inspection, UT wall measurement, 3D localisation



How It Works

3D Localisation

Using the input from the sensors, the exact location of BIKE inside the digital twin can be determined and the locations of the inspection points can be tagged and saved for future reference. This ensures reliable and repeatable inspection results.



Physical asset



Digital twin creation



Inspection with 3D localisation



Data tagging and storage



ANYmal X: Autonomous Inspection Robot

ANYmal X is a 4-legged autonomous inspection robot designed for deployment in challenging environments to perform routine surface operations.

Its extreme mobility and advanced sensing allow autonomous checking, testing, and unmanned routine facilities inspection.

Key Features

- Explosion proof version for up to Zone 1 environments
- Waterproof and dustproof
- Customisable payload in addition to thermal, visual, gas, and audio inspection
- Integrates to existing IT and OT systems

How It Works

- Fully automated operation, obstacle avoidance and global replanning, after once being guided through the mission
- Manual and tele-operated control at any time
- Copes with tough and slippery terrain, including stair-climbing

Specifications

Weight: 55kg
Payload: 10 kg (max)
Operating size: 105 x 50 x 83 cm
Speed: 1.0 m/s (max)
Power: 300 W
Power autonomy: 2-4 hours
Charging time: 2 hours
Battery: Li-ion, 970Wh (44.4VDC, 21.8Ah)
PTZ camera:

- Resolution: 8 MP
- Video format: up to 4K
- Zoom: 20x

Audio: 20 Hz to 20 kHz
Thermal camera: -20 to 400 °C
Gas detector: LEL
Gauge reading: Analog & digital
Navigation: Remote & autonomous
Self-monitoring: Temp & current
Self-recovery: Stand & cooling





Drone Applications



Proven applications of drones in cargo delivery, painting and blasting, ultrasonic testing (UT), asset condition monitoring, as well as safety and security surveillance in operations.

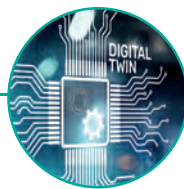
Key Features

- Proven application in energy industry with use cases applied in actual facilities
- Significant cost savings with enhanced efficiency
- Improved safety by minimising exposure to hazards, i.e., blasting, travelling, working at heights

UT measurement, painting, and blasting workflow



Physical Asset



Digital Twin Creation

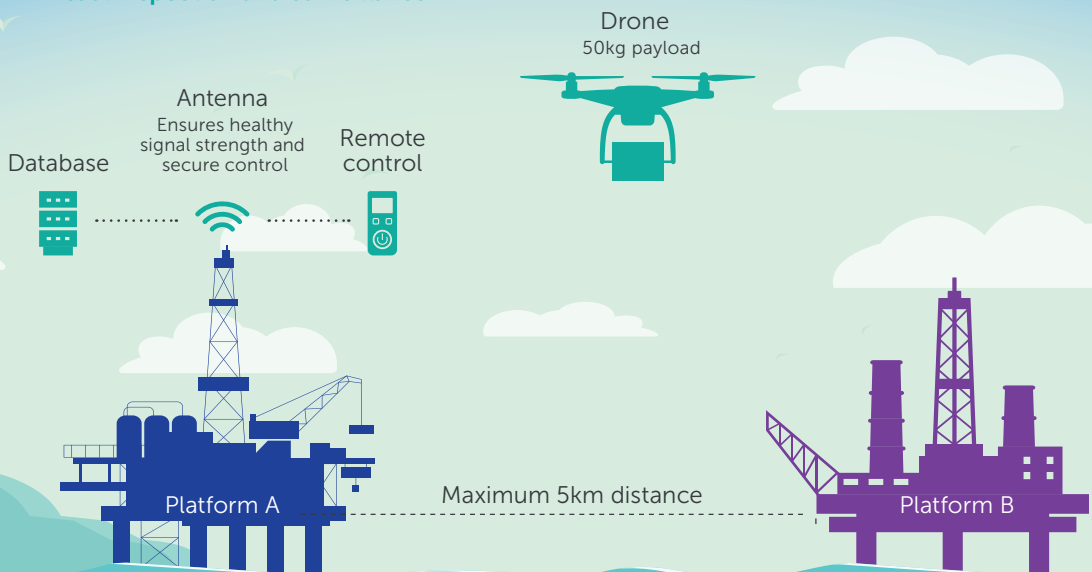


Inspection with 3D Localisation



Data Tagging and Storage

Visual Inspection and Surveillance





SmartCen™

SmartCen™ is a uniform and company-wide metering supervisory solution. The core of each SmartCen™ installation is our proven human-machine interface (HMI) software which is packaged with our partner's software that is tailored to the oil and gas industry.

Key Features

- Mis-measurement management, the Virtual Flow Computer, integrated validation and online uncertainty calculation
- Real-time verification of flow computation

How It Works

- Reduces human intervention during metering activities
- Enables proper analysis, trending, and diagnostic on field instrumentation and devices, including flow metres through centralised database
- Enables quick detection of abnormalities, with remote accessibility enabling quick response to metering issues



Success Story

SmartCen™ has clinched the 2015 Special Meritorious Awards for Engineering Innovation (SMEA) under Intelligent Systems and Components category.





Hot Air Recirculation (HAR)

HAR uses real-time weather data to predict power margin settings for gas turbines, ensuring stable plant operation and potential for increased LNG production.

Key Feature

- Enables prediction and mitigation of detrimental Hot Air Recirculation (HAR) phenomenon to LNG plant air coolers and gas turbines

How It Works

- Data is fed into Advanced Process Controls (APC) system on to the DCS (Distributed Control System) to automatically optimise power margin settings
- Dynamic model to optimise power margins in gas turbine operations to reduce downtime and increase LNG production
- Ease of implementation with the model feeding directly into the APC



Success Story

Successful deployment at MLNG Tiga, Train 8 with an expected revenue generation of RM 6 million from increased LNG production.



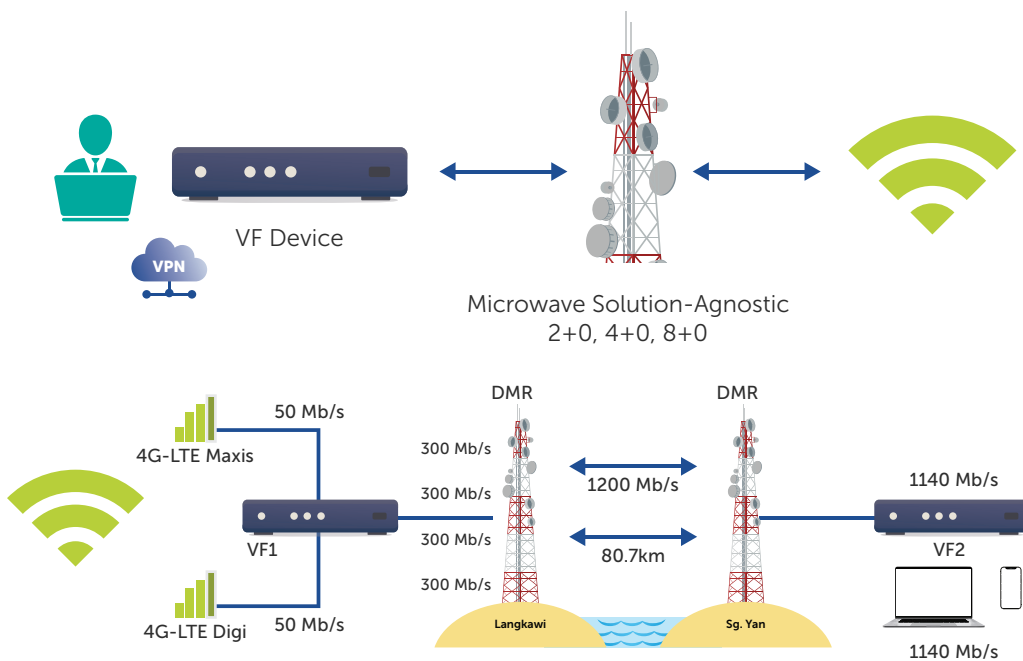


VOLANT™

Virtual Optics Long-haul Asynchronous Network Technology (VOLANT™) is a solution for long range Gigabit telecommunication for offshore facilities at a fraction of the cost of conventional fibre optic communication. This technology is compatible to all commercial IP-based communication network.

Key Features

- Long-haul high-speed broadband connectivity extension (> 50km)
- Fiber-optics network quality and experience for rural, remote, marine, and offshore areas
- Up to 90% cost saving against conventional fibre optics deployment
- Enabler for remote and autonomous operation (RAO)



Success Story

Successfully completed pilot between Gunung Raya, Langkawi to Sungai Yan, Kedah in open water test at a range of **80.7 km**.





Specialised Chemicals

Chemically and mechanically induced production improvements, such as maximising flow assurance and asset integrity in oil and gas applications worldwide.

SolidClenz™

SolidClenz™ is a unique and proven, custom designed technology used to remove organic (wax, asphaltene, naphthenate) and inorganic (CaCO_3 and BaSO_4 scales) solid deposits for wells and pipelines to increase well flow and enhance production. It can be customised according to the characteristics of the deposit formed and profile of each well.

Key Features

- High temperature flexibility range of 80 °C to 200 °C
- Modular technology and cost-effective yielding high return of investment (ROI)
- Restores rock wettability
- Long-term productivity improvement

How It Works

- Systems include Thermo-Chemical 2 pack system, 1 Pack Microemulsion acid system, 1 Pack Naphthenates Solvents system and Anti Foulant GP
- Uses aromatic naphtha as an organic dissolver to treat inorganic- and organic-mixed deposits which can cause formation damage



Success Story

Since 2011, SolidClenz™ has generated more than USD 100 million in value to clients from increased oil production.

This solution was shortlisted as the finalists for the Annual World Oil Awards 2014 and IChemE International Awards 2014.



Robust Solid Dissolver (RSD)

The development of the **Robust Solid Dissolver (RSD)** is to tackle a wide range of scale compositions. Piloted at Penara in 2019, this project considers the development of a multi-functional environmentally-friendly chemical, for reservoir stimulation and formation damage remediation.

Key Features

- Tremendous upside on use as stimulation chemicals including carbonate reservoirs
- Suitable for metal naphthenates treatment for enhanced oil recovery (EOR) application
- Formulations applicable to a wide range of mixed scales

How It Works

- RSD chemical dissolves mixed scales in a single treatment, unlike most commercial chemicals that require at least two separate treatments
- RSD offers lesser deferment duration on well treatment with minimal chemical handling and lower execution cost



BioMETT

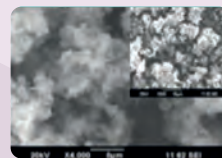
Biocide Enhanced Chemical for Microbial Induced Corrosion (BioMETT) is an enhanced formulation of biocide that provides better efficacy in managing Microbiological Induced Corrosion. A small volume of the enhancer, sourced from non-toxic substances, is added into the current biocide to boost its performance. Successfully piloted at Tukau and Semarang, BioMETT was tested to be compatible with other production and integrity chemicals.

Key Features

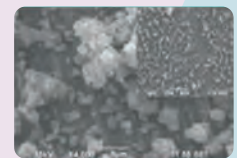
- Reduces pipeline integrity issues, less repair, and longer service life
- Enhance the effectiveness of current biocide Tetrakis Hydroxymethyl Phosphonium Sulfate (THPS)
- Reduces 30% of chemical amount which balances the price increase factor of other substances

How It Works

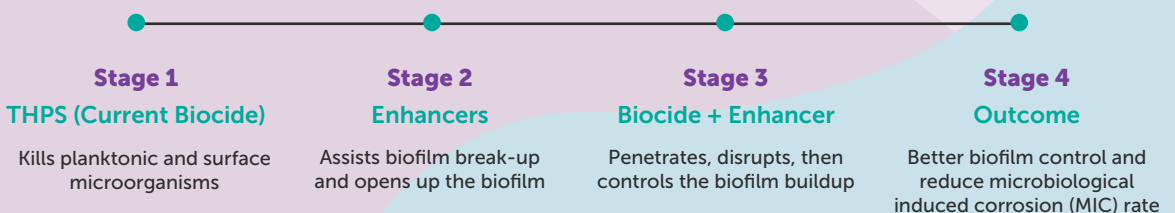
Scanning electron microscope (SEM) image showing the biofilm build up before and after treatment



Before



After





Dual Function Demulsifier (DFD)

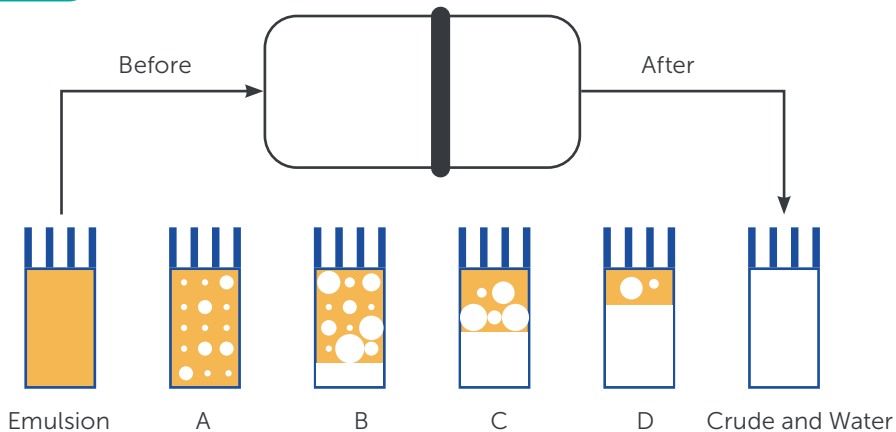
Dual Function Demulsifier (DFD) is a copolymer based demulsifier synthesised for demulsification of water-in-oil and oil-in-water emulsion. It is effective to dehydrate the oil at the separation point whilst improving water clarity. Piloted at Baronia, DFD functions as both demulsifier (primary) and de-oiler (secondary) in a single formulation.



Key Features

- Potential **value creation of RM 1 million per year** for one field compared to incumbent demulsifier and de-oiler
- Enhances primary demulsifier performance
- Acts as both a dropper and treater to coalesce water droplets and release free water
- Enhances the clarity and quality of separated water

How It Works



- Enhances primary demulsifier performance
- Flocculates the water droplets and facilitates coalescence
- Lowers the demulsifier viscosity for easy injectivity



Grafted Bentonite (GB)

Developed to reduce relative permeability to water, **Grafted Bentonite (GB)** is designed to impact all water producing zones, and is a water shut off chemical (not proven as conformance control chemical). This technology has been successfully piloted at Angsi well in December 2020.



Key Features

- Water cut **reduced from around 80% to 50%**
- Instantaneous oil gain about 219 stb/d from 171 stb/d to about **390 stb/d**
- Improved nano-clay performance in terms of adsorption, thermal stability, and residual resistance factor at actual reservoir condition

CorroSolve+™

CorroSolve+™ is a technology developed for oil and gas production to mitigate corrosion caused by the presence of acid gases such as CO₂, H₂S and organic acids or a combination of these species.

Key Features

- For gas transportation system in offshore and onshore installation
- High performance integrity chemical that is able to handle high CO₂ content up to 100 mol%

How It Works

- Enables wider use cases with carbon steel as material of choice
- Optimises the dosing required and chemical spending
- Ensures safe operation and environmental impact with less chemicals, reducing chances of loss of primary containment (LOPC)



Success Story

- ✓ Tested and proven at PETRONAS Dulang PL07 gaslift line, with an achieved target corrosion rate of ≤ 0.1 mm/year at the current dosage.







Production Enhancement Units

Suite of production enhancement units, ranging from separators to pressure boosters.



Sep-iSYS™: 3-Phase Integrated Separation Technology

Sep-iSYS™: 3-Phase Integrated Separation Technology is designed specifically for oil and water separation. The technology is made up of two sections which are slug and sand, and gas and liquid entrainment. It is suitable for both onshore and offshore applications.



Key Features

- Suitable for sub-zero degree celsius applications
- No complex pre-cooling system required
- Reduces greenhouse gas emissions

How It Works

- Protects downstream system from liquid carry-over due to high separation efficiency
- Capable of breaking down the emulsion before the liquid enters the separator
- Reduces the size of the slug handling component as liquid hold-up and degassing is undertaken in the downstream separator

WOW Facts!

Up to **50% CAPEX reduction** compared to conventional design

Up to **50% footprint and weight reduction** as less equipment and instrumentation is required



5 units were installed across PETRONAS facilities which includes the detailed design for PETRONAS' second floating LNG, PFLNG DUA





Sep-iSYS™: Integrated Separator Technology Under Low Pressure System

Sep-iSYS™ Integrated Separator Technology Under Low Pressure System is a system tailored for boosting the pressure of production fluids from low pressure wells. This technology is well suited for remote wellhead platforms where wells have insufficient pressure to deliver well fluids to production header.



Key Features

- Separates multiple phase (crude and gas) under low pressure
- Modular compression stage can be added for low pressure feed streams
- Suitable for sub-zero degree Celsius application
- No complex pre-cooling system required
- Applicable for onshore and offshore installation

How It Works

- Protects downstream system from liquid carry-over due to high separation efficiency
- Breaks down emulsion before the liquid enters the separator

Sep-iSYS™: Cyclonic Sand Removal Technology

Sep-iSYS™: Cyclonic Sand Removal Technology is a system of the Sep-iSYS™ technology, specially tailored for fields with sand problems.

Key Features

- High sand removal efficiency (down to 40 microns)
- Effective handling of coarse gas liquid separation, slug handling, and flow stabilisation
- Low fixed-pressure drop and high turn-down limit
- Suitable for green and brown facilities

How It Works

- Protects downstream system from liquid carry-over due to high separation efficiency
- Breaks down emulsion before the liquid enters the separator
- Modular system allows easy retrofit for existing cyclonic desanders

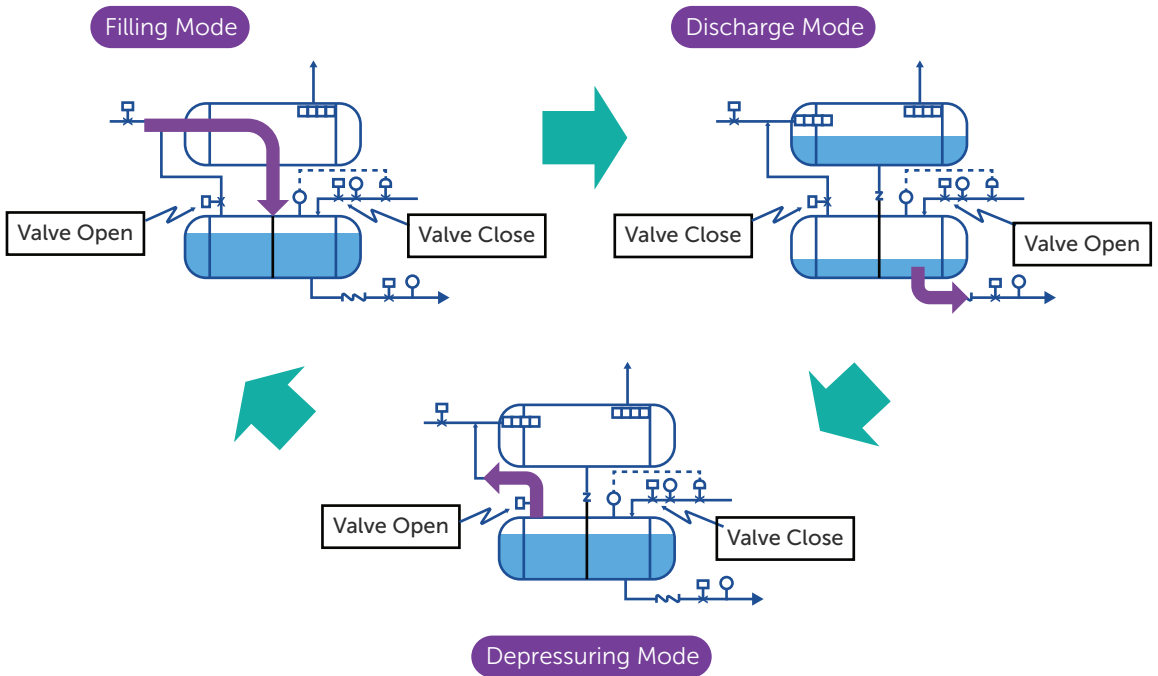


Sep-iSYS™: Low Pressure Production Unit (LPPU)

A system tailored for extracting production fluids from low-pressure wells. Ideally suited for remote wellhead platforms where wells have insufficient pressure to deliver well fluids to production header.

LPPU directly addresses pain points

- 1 **Compact and lightweight**, requiring only small footprint
- 2 Suitable for **brown and green fields**
- 3 **Self-contained system** with no external utilities required, except for high pressure gas source for motive gas
- 4 **No pumps** and **power generation** required
- 5 Low system complexity and controls, with **minimum or no manning required**





OMMS™

Online Mercury Measurement System (OMMS™) 2.0 is an automated online analyser used to monitor total mercury in high pressure liquid hydrocarbon streams (e.g., natural gas condensate). It can also be used to measure mercury in other hydrocarbon streams such as naphtha.

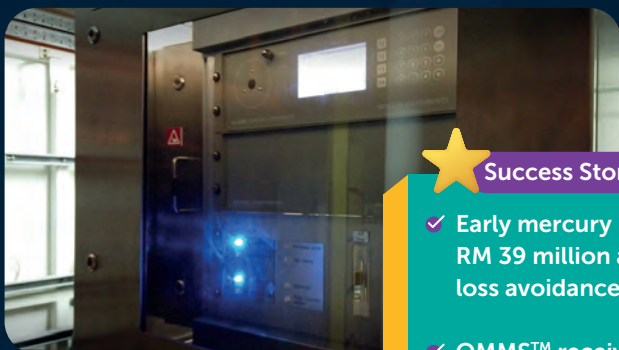


Key Features

- Meets condensate export specification
- Reduces sampling and analysis costs
- Faster results generation
- Enables early mercury management control
- Helps prevent production loss

How It Works

- Automated mercury measurement system replaces manual mercury sampling which is susceptible to HSE risk, and is costly and time consuming
- Eliminates personnel exposure to high-pressure conditions and unwanted exposure to mercury
- Capable of receiving up to six different sample inputs which are analysed sequentially and can be automatically calibrated for each analytical run



Success Story

- ✓ Early mercury management has contributed to RM 39 million and 20 MMcf/dmmscf in production loss avoidance
- ✓ OMMS™ received the Prime Minister Hibiscus Award (PMHA)'s Exceptional Achievement Award in 2011 and 2013 for its role in PETRONAS Carigali Sdn Bhd's Onshore Gas Terminal environmental initiatives



Liquid Recovery System (LRS)

Liquid Recovery System (LRS) is an enhanced condensate recovery technology to maximise the recovery of C₄+ hydrocarbons from the gases that are usually either being vented, flared, or re-injected back into the wells.

Key Features

- Optimisation of cooling duty by heat integration
- Minimisation of power requirement through coupling of Turbo-Expander with Booster Compressor
- Reduction of GHG and CO₂ emissions

How It Works

- Customised dewpointing control unit typically installed at gas separation plant to match site conditions
- Leverage high feed gas pressure to achieve sub-zero °C temperature via JT effect
- Condensate C₅+ fraction is separated from gas phase by utilising the cold temperature condition
- Leaned gas is routed back to gas export system









Pipeline Materials

Solutions in ensuring safety, reliability and compliance of asset integrity.

ProAssure™ Wrap

ProAssure™ Wrap is an overwrap pipeline repair system that is based on high strength composite materials. The composite is developed to afford quick in-situ repairs to be undertaken cost-effectively. It is highly flexible and hence, can overcome the issue of tight access and complex-shaped pipelines. Upon application, the wrap can harden through curing in ambient conditions.

The wrap can be used to repair and restore the functionality of corroded and leaking pipelines whilst providing protection against further corrosion attack.

Key Features

- Value creation through cost avoidance
- Effective and economical solution for extension of asset life, prevents loss of containment, and sustains asset integrity
- Composite repairs strengthen defective areas as well as provide asset corrosion protection

How It Works

- Repairs only affected portions of the pipe, allowing rehabilitation rather than replacement
- No shutdown, no hot work and requires minimal resources
- Highly flexible and can accommodate tight access, elbows, tees and complex geometrical shapes
- High chemical resistance and good insulating properties

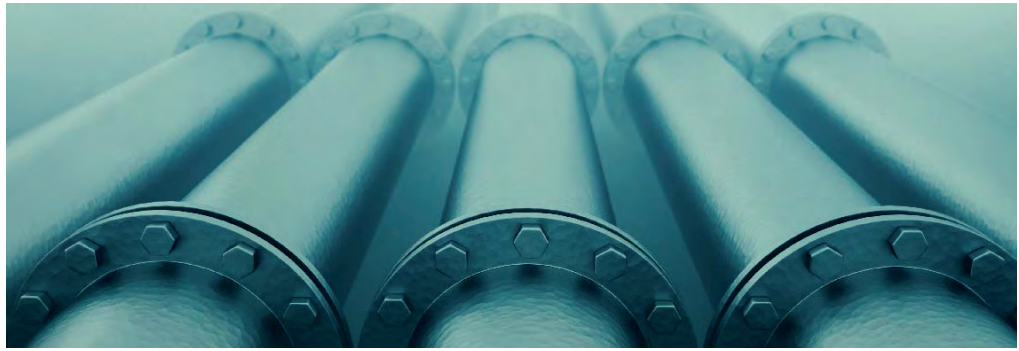
Success Story

- ✓ Qualified to **ISO/TS 24817** and **ASME PCC-2** by independent third-party laboratory and signed off by DNV GL
- ✓ More than **5,000 metres length** of ProAssure™ Wrap have been installed at **over 200 locations** between 2016 to 2020



Non-Metallic Pipe (NMP)

Non-Metallic Pipe (NMP) is a new or replacement of pipelines susceptible to Sulphate Reducing Bacteria (SRB) as a cost-effective alternative to carbon steel pipeline. The composite is developed to afford quick in-situ repairs to be undertaken, and consists of Thermoplastic Composite Pipe (TCP) and Reinforced Thermoplastic Pipe (RTP).

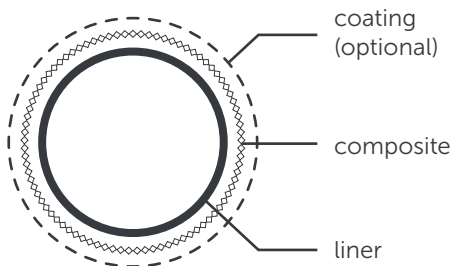


Key Features

- Maximum design temperature of 65°C
- Can be installed as standalone or pipe-in-pipe
- Corrosion resistance, especially for products containing wet CO₂ and H₂S

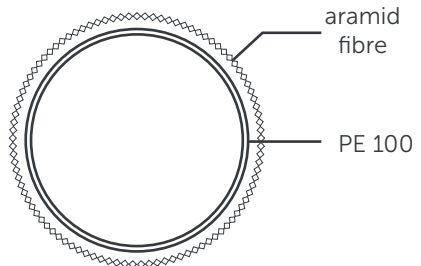
How It Works

Thermoplastic Composite Pipe (TCP)



- Thermoplastic liner (PA12/PE100)
- Melt-fused glass fiber-tapes impregnated in the same thermoplastic compound as structural (reinforcement) layer (Glass fiber)
- 6" PE

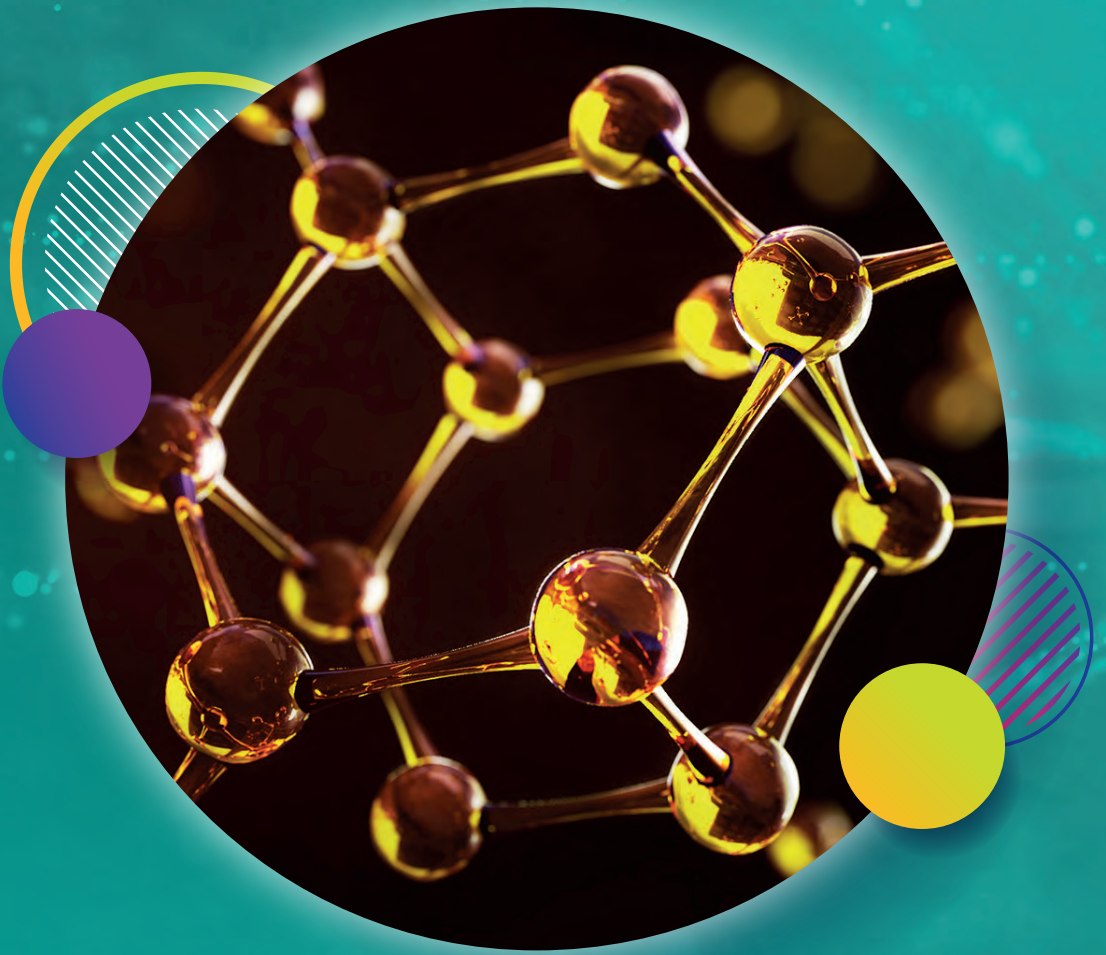
Reinforced Thermoplastic Pipe (RTP)



- Inner liner - Thermoplastic liner (PE100)
- Aramid fiber tape wrapped as structural (reinforcement) layer
- Outer jacket - Thermoplastic material (PE100)
- 6" and 12" ID

Success Story

Successfully installed at West Lutong (6" of 1.5 km length) and in operation since Dec 2017





Advanced Matererials

Improving asset life cycle using Advanced Materials products.

Advanced Materials

PETRONAS has studied materials specifically engineered to have new and enhanced properties for superior targeted performance. Among the materials explored, one that shows exciting potential is Graphene, a single layer of carbon atom, tiny in size (a million times thinner than the human hair) but exhibiting extreme strength (200 times stronger than steel).

The following products made with graphene are:

- ProShield+™
- ProCharge+™
- ProTough+™

ProShield+™

A specially formulated paint additive that offers lasting protection to your assets even in the harshest conditions for up to 16 years.

Withstands impact test for up to **18 Joules** without surface crack

Water barrier properties **3X** higher than neat epoxy paint

How It Works

- ProShield+™ does not require any changes to the existing blending process.
- ProShield+™ can be applied similarly as any other painting coats.

3X improvement in abrasion properties

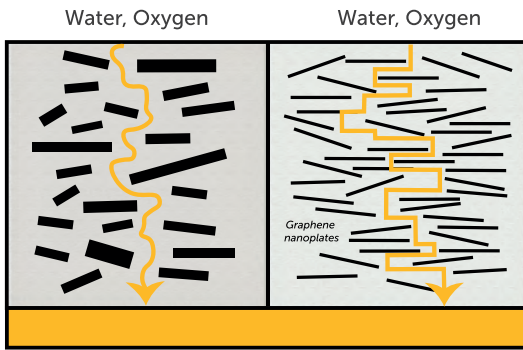
Improvement by **50%** in adhesion

Added Value

66% maintenance cost reduction per platform

0 Ensuring zero safety incidents caused by external corrosion throughout its warranty period

Passed SIRIM Short Term Tests (Adhesion, Abrasion, and Impact)

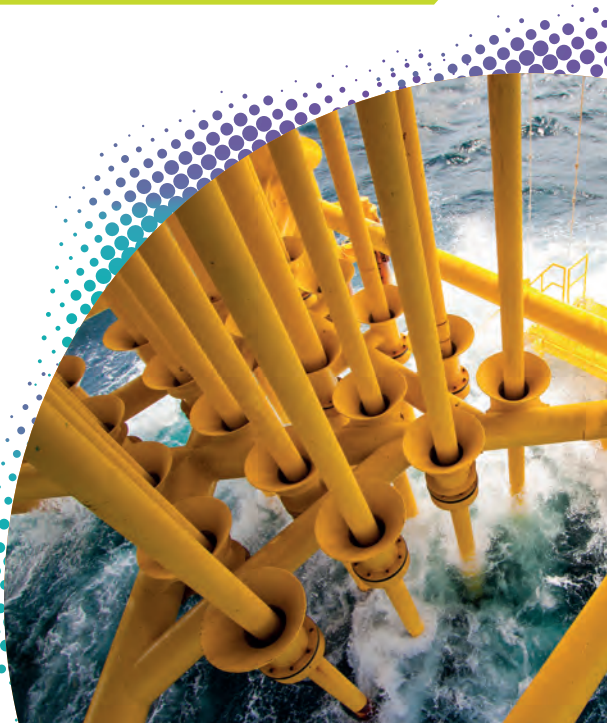


Conventional Epoxy Paint

Paint infused with ProShield+™

Application

- Port or jetty facilities
- Inspection and repair
- Offshore, onshore, and marine structures



Advanced Materials (cont.)

ProCharge+™

A conductive formulation for Lithium-ion (Li-ion) battery electrodes.



Batteries to Last



Enhanced Thermal Dissipation
 which is **1.5 times better** as Graphene has thermal conductivity of 4000W/(m.K) which is 10 times better than copper



Extends Battery Life Cycle
 by **50%** of its current state which results in lower cost of battery replacement



Sustainable
 reduced and cheaper waste management via extended design life by 1.5 times



Higher Energy Density
 improves overall surface area of the battery electrodes by at least 50%

WOW Facts!

More than **80%** reduced in volume resistance

More than **63%** reduced in volume resistivity compared to Carbon Nanotubes (CNT)

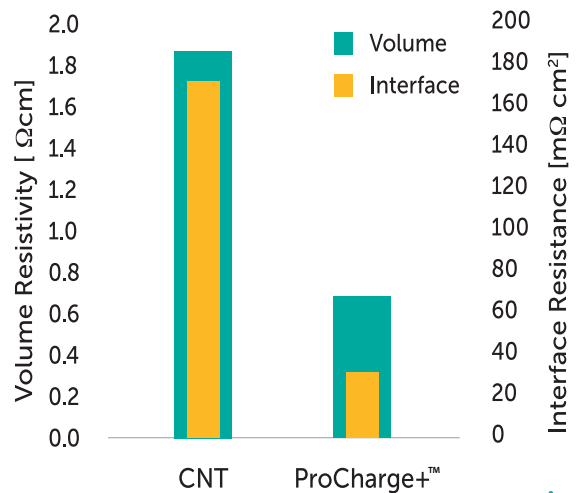
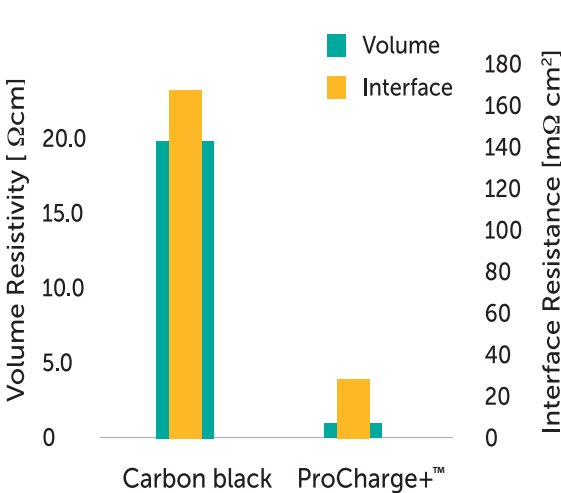
More than **81%** interface resistance



Application

- Electric Vehicles (EV)
- Robotics Technology
- Automated Guided Vehicle (AGV)

Note: Not limited to these applications only



Advanced Materials (cont.)

ProTough+™

Graphene-based additive that can be uniformly applied in both flat sheet and tubular structures of Carbon Fibre Composite materials to reduce material weight, reduce surface deformation and increase material lifespan.

GRCF directly addresses pain points

Increased Tensile Strength ▶▶▶▶ Reduce material usage allowing **weight reduction**

Improved Fatigue Life ▶▶▶▶ **Extend carbon fiber composite life span** under dynamic loading over time

Better Creep Reinforcement Efficiency ▶▶▶▶ **Reduce deformation** caused by resin shrinkage upon exposure of temperature over time



Added Value

12.5% improvement in tensile strength

17.5% improvement in creep reinforcement efficiency

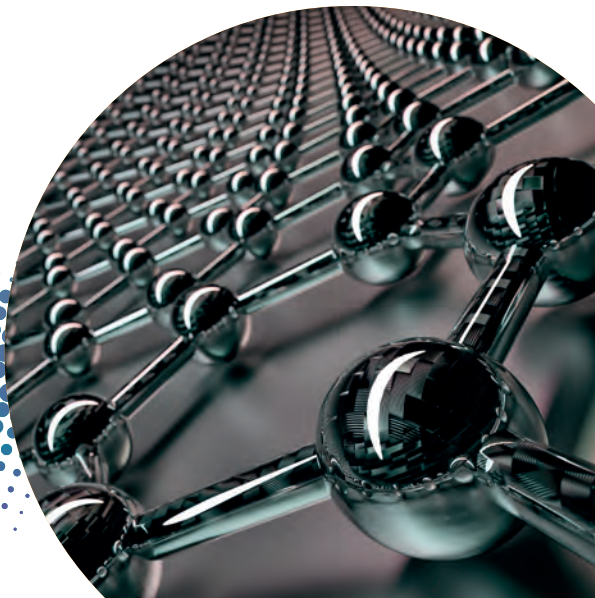
14 times more improvement in fatigue life



Application

- Automotive
- Hydrogen pressure vessel

Note: Not limited to these applications only



PETRONAS' refinery plant based in Melaka, as one of our sources of petroleum coke.







Gas Processing Units

Improving hydrocarbon processes through effective solutions.

PN-1™: Multifibre Membrane for CO₂ Removal

PN-1™ membrane is a multifibre membrane design, jointly developed by PETRONAS and its partner. This first in-house membrane utilises two or more different types of membrane fibres with different performance characteristics into a single membrane element. This technology is also capable of improving separation performance and maximising overall gas processing capacity.

Key Features

- PN-1™ is the largest membrane ever made, designed for 30" size to process high CO₂ gas content
- The first multi-layer membrane arrangement henceforth able to process a wide range of CO₂ content ultimately reducing weight

How It Works

- Creates 10% to 15% hydrocarbon losses
- Potentially reduces membrane skids total deck footprint by an estimation of 60% and membrane skids total weight by an estimation of 40%
- Creates a potential CAPEX reduction of up to 5%
- Reduces annual replacement cost by 7%



Success Story

- ✓ Tested onshore in SACROC, Texas, United States of America operated by Kinder-Morgan from 2010 to 2013 for CO₂ concentration
- ✓ Commercialised at Terengganu Gas Terminal (TGAST) in Kerteh, Terengganu

PN-2

PN-2 is the first PETRONAS owned membrane production prototype, designed to remove CO₂ from natural gas.

Key Features

- More surface area per membrane module in comparison to similar existing membrane
- Reduces hydrocarbon loss, requires less areas and footprint with cheaper membrane element cost

How It Works

- Reduces hydrocarbon loss between 5% to 15%
- Capable of handling high CO₂ content of up to 70 mol



Success Story

- ✓ Malaysia's first fabricated membrane housing
- ✓ Successfully installed and is currently operating at Tangga Barat in November 2013

CryoMin

CryoMin for bulk CO₂ removal from natural gas is the key technology for acid gas removal when space is premium, and weight is a limitation for offshore application.

This award-winning technology managed to reduce 50% of column height which translates to 30% reduction of CAPEX relative to conventional cryogenic distillation technology.

Key Features

- Additional power required for rotation of CryoMin is relatively minimal
- Uses rotating bed column to separate high CO₂ from natural gas
- CryoMin rotating packed column comes with adjustable speed (up to 1000 rpm)
- Proven for bulk CO₂ separation with targeted specification down to 20% mol at top product



🔍

Fact Sheet

Property	Value
Pressure	35-50 bar
Temperature	-55°C to 12°C
Rotation speed	100 to 1000 RPM
Feed gas	High CO ₂ natural gas
Water spec.	<1ppm

🏆

Accolades

- Highly commended in the IChemE Global Awards 2020 Innovative Product Category- CryoMin Technology for Bulk CO₂ Removal
- Finalist for the IChemE Malaysia Awards 2019 Oil & Gas Award-High Gravity Cryogenic Distillation (CryoMin)

Membrane Contactor Technology

Membrane Contactor Technology (MBC) is the first in the world that offers wider CO₂ removal range and selectively absorbs CO₂ and H₂S.

It utilises a proprietary hollow-fibre membrane and amine-based industrial solvent to significantly reduce CO₂ concentration to meet the plant processing requirement for liquefaction of natural gas. MBC appreciably reduces CAPEX for our floating LNG facilities with its significantly reduced size and weight, for feasible monetisation of stranded gas fields.

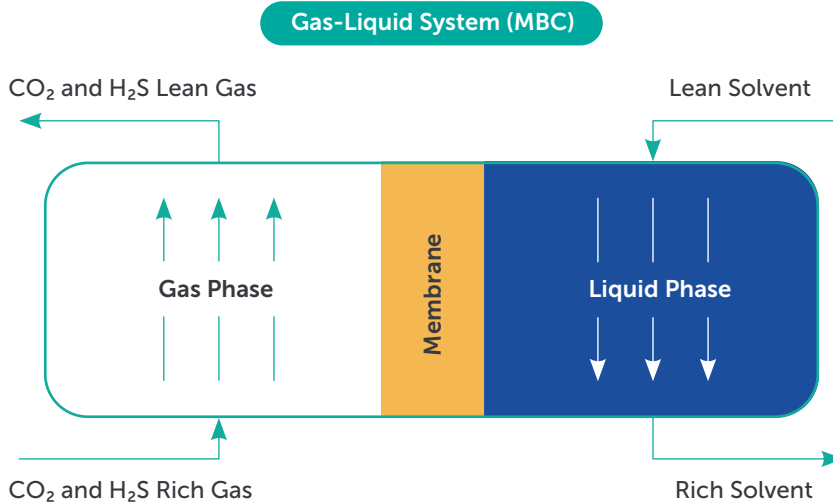
Key Features

- Low hydrocarbon loss at about 1%
- Able to remove CO₂ and H₂S down to <50 and 5ppm
- Estimated around 30% lower solvent circulation rate
- Capable of handling up to 25% of CO₂ and 5% H₂S content down to ppm level



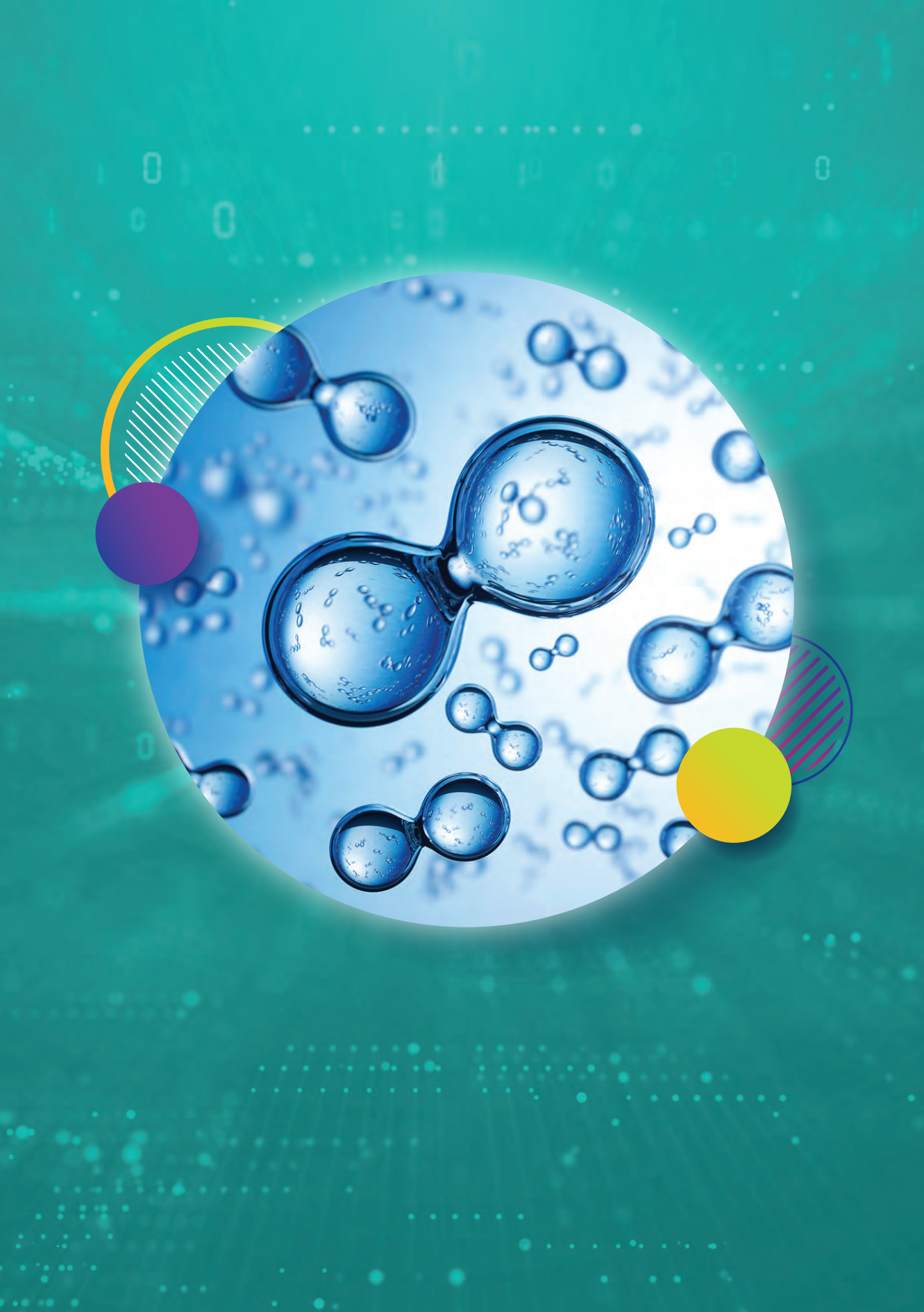
How It Works

- Mass transfer is based on diffusion on CO₂ and H₂S to the solvent-membrane boundary, where CO₂ and H₂S will be selectively absorbed due to solvent's selectivity



Success Story

Successfully installed and operated MBC pilot plant in GPK, Kerteh and demo plant in TGAST in operation since 2022





Hydrogen

Solution for a sustainable future

Hydrogen Proton Exchange Membrane (H₂-PEM™)

PETRONAS H₂-PEM™ is the latest proton exchange membrane electrolyser in the market. It was inspired to realise and achieve the company’s Net Zero Carbon Emissions by 2050 aspiration. The technology was designed and developed to meet the high demand for high efficiency electrolyser, enabling cheaper hydrogen production costs.

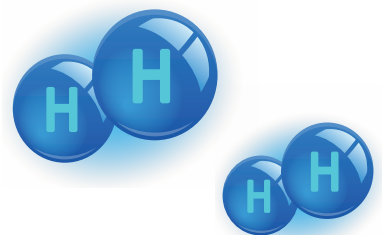
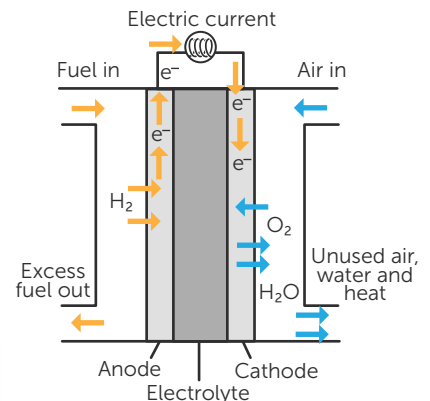
Key Features

- Unique balance of overall bipolar plate design and material of construction allows the development of a more efficient system
- Shown to meet the efficiency of 52kWh/kg of H₂ and CAPEX of USD800/kW

Parameters	Unit	Typical PEM	PETRONAS PEM
Efficiency	kW of electricity /kg of H ₂	58	52
Lifetime Stack	Years	5-7	6
CAPEX - total system cost	USD/kW	1350	800
OPEX	% of initial CAPEX years	2	2

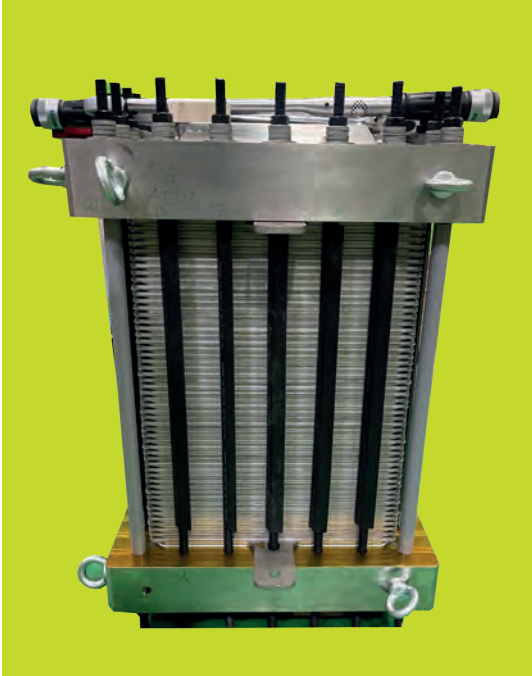
How It Works

- H₂-PEM™ is separated into its component elements, Hydrogen (H₂) and Oxygen (O₂), on either side of a solid polymer electrolyte membrane in PEM water electrolysis
- Water delivered to the anode (or oxygen electrode) in the electrolyser is oxidised into oxygen and protons, while electrons are liberated when a DC voltage is applied
- H⁺ ions, or protons, travel through the PEM to the cathode (also known as the hydrogen electrode), where they collide with electrons from the opposing side of the circuit and are converted to hydrogen gas





Hydrogen fuel pump at Petros multi-fuel station, Kuching, Sarawak using **450 kW** of H₂-PEM™







Other Technologies



Intelligent Circulation while Drilling (iCWD™)

iCWD™ is a circulation sub, placed as one of the bottom hole assemblies (BHA) for drilling. Its design is based on a remotely controlled three-way valve system, enabling the driller to command the tool in any of the special modes below:

- Normal drilling mode
- Bypass mode
- Hole cleaning mode
- Isolation mode

Key Features

- Quick and efficient lost circulation material (LCM) placement while protecting sensitive BHA tools against damage
- Hole cleaning helps remove cutting beds, which is a source of stuck pipe, particularly while pulling out of hole
- Provides significant cost savings for drilling operations in challenging drilling environments

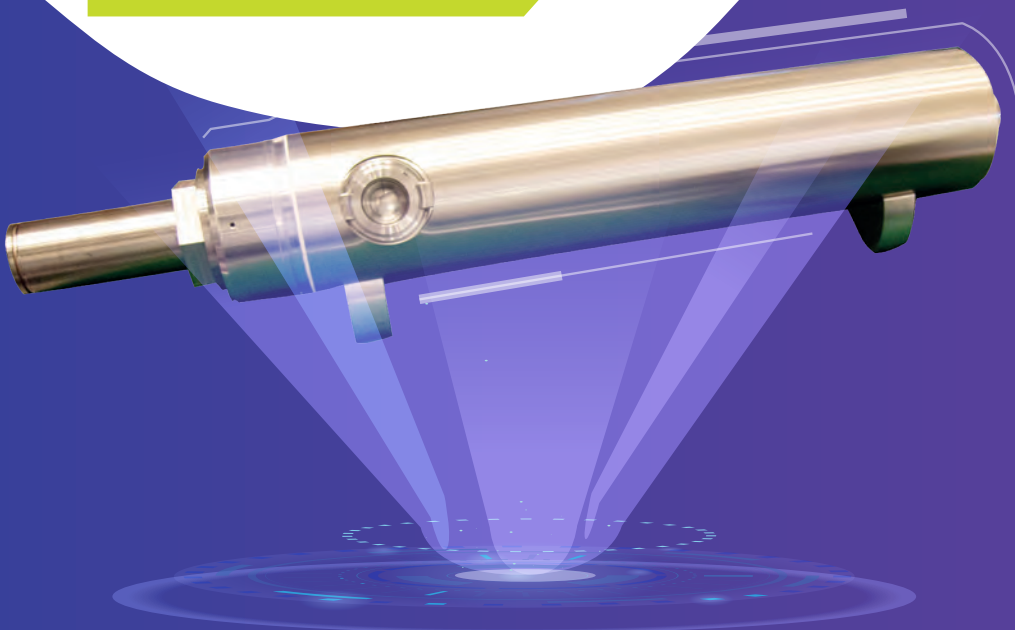
How It Works

- Smart electronics and sensors enable operator to run multiple tools required with each controlled and activated independently into any mode through Agile Activation command sent from surface
- Can be placed anywhere in the drilling string and does not require mechanical access or a drop ball to operate



Success Story

iCWD™ won the **'Spotlight on New Technology' Award** at OTC Asia 2016.





TECHApps

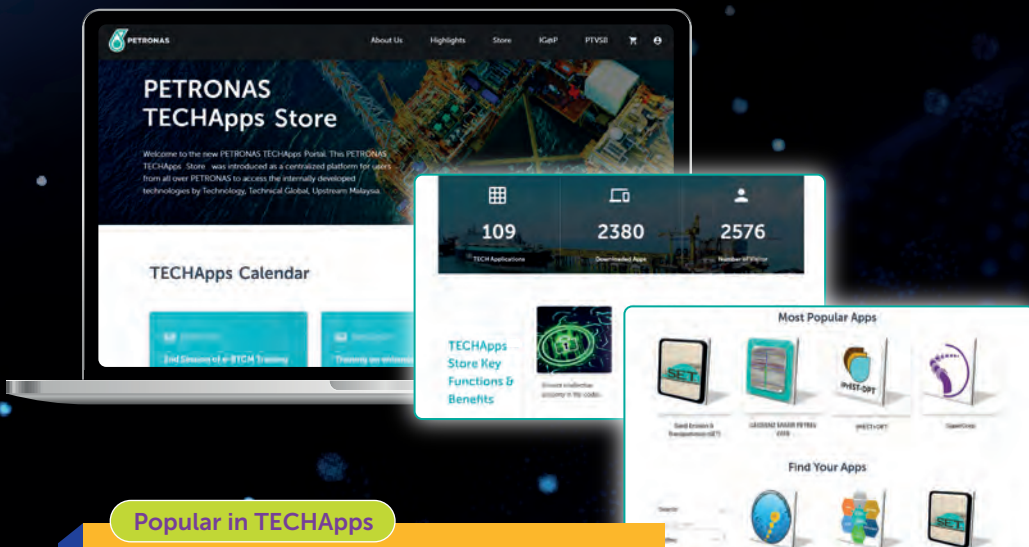
PETRONAS Proprietary Technical Applications (TECHApps) is a centralised digital distribution platform for users to access various proprietary technical solutions.

Key Features

- Technical support, bug fixing, feedback gathering, Application Lifecycle Management (ALM). A collaborative tool for users to provide feedback and input on the applications
- Delivered cost-saving solutions, saving almost RM 12.75 million in terms of existing licence subscriptions
- Provides IP protection via improved software securities and distribution platforms for in-house technical applications

How It Works

- Provides access to software documentation
- Automates access request and approval to download the applications
- Allows contact with Subject Matter Experts (SMEs)



Popular in TECHApps

- Sand Erosion & Transportation (SET)
- GEOSENZ ENSDR PETREL 2019
- iPrEST + DPT
- SuperCorp, and more.

All which can be subscribed on the TECHApps Store online.





iCON[®]: Process Simulation Software

iCON[®] is a steady state and dynamic process simulation software for the enhancement of plant performance, designs, operations, and process optimisation.

Key Features

- Offers multiple engineering solutions via built-in optimiser and regression tools
- Highly reliable thermodynamic engine due to wide range of component database and specialised thermodynamic property packages
- More than 300 licences worldwide, with a growing market share
- Start-up and shut down stability test for a smooth Floating LNG operation
- Standard application across all PETRONAS plants and facilities

How It Works

- Open architecture allows seamless integration with third party software and database
- GUI-based utility system modelling and optimisation for steam system, gas and steam turbines, boilers or high pressure steam generators, and furnaces



WOW Facts!

300 licences worldwide, with a growing market share

Its application in upstream optimisation has resulted to:

2% increment per yield of oil generated

30% reduced pigging frequency for upstream pipelines





M-FOSS Technology

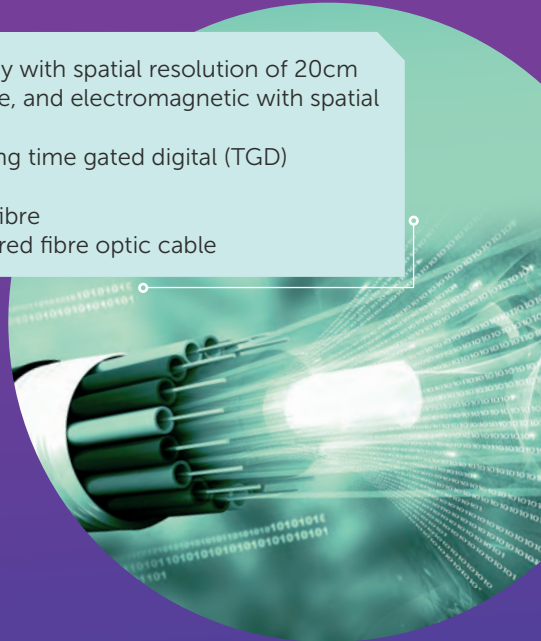
M-FOSS Technology is an integrated, multi-sensor fibre optic system deployable in downhole environment.

Key Features

- Interrogator Unit (IU): Novelty Multi Sensor IU technology with spatial resolution of 20cm
- IU PR7300: Multi-sensor (acoustic, temperature, pressure, and electromagnetic with spatial resolution of 20cm)
- IU PR3330: High resolution low noise DAS, designed using time gated digital (TGD) technology
- Fibre Optic Sensor: Patented multi-sensor single mode fibre
- Fibre Optic Cable: Patented novelty multi-sensor armoured fibre optic cable

How It Works

- Continuous well monitoring using M-FOSS in SDP or CCS programmes will reduce the need for surface seismic acquisition, enabling avoidance of surface seismic monitoring cost.



Geopolymer Cement

Geopolymer cement is a competitive edge technology, designed from a byproduct of burning pulverised coal in electric generation power plants. Unlike Ordinary Portland Cement (OPC), geopolymer cement does not undergo carbonation process in the presence of CO₂ and water, making it ideal for carbon capture utilisation and storage application.



Key Features

- Flexible and robust
- Reduce carbon footprint
- Offer up to 50% cost savings on CO₂ cement system
- Turn waste into green product

How It Works

- Geopolymer cement is made by reaction of alkaline activators with aluminosilicates, which produced geopolymerisation reaction, creating polymeric chain and rigid structure



Vibration Clamp™

Vibration Clamp™ is a robust, easy-to-install pipe support which has been carefully designed to suppress pipe vibrations in extreme conditions.

The Vibration Clamp™ consists of three parts: outer clamp, inner clamp, and anti-vibration pad. The anti-vibration pad is fixed between the inner and the outer clamp, where the inner clamp encircles the pipe, and the outer clamp encircles the inner clamp to provide support.

Key Features

- Holds vibration level up to 33Hz and above
- Proven to be safe, practical and easy to install, and maintenance free
- Designed for piping usage with temperature range of up to 300°C

How It Works

- The anti-vibration pad uses a damping layer to help suppress vibration loads from the pipe



Success Story

- ✓ The Vibration Clamp™ has been installed at PETRONAS facilities since August 2013 and piping vibration issues have been successfully resolved





Aqua MTM®

Aqua MTM® is a non-intrusive tool, based on Magnetic Tomography Method (MTM) used for subsea pipeline inspections. It evaluates defects in metal and weld joints, monitoring any development of corrosion and assessing the state of corrosion based on the relative change in local stress levels in the pipeline.

This has an advantage over subsea inspection of unpiggable pipelines done using a temporary launcher and auxiliary pumping to run an Inline Inspection (ILI) tool, which is often costly even for short distance pipelines.

Key Features

- No minimum or maximum operating pressure required
- Suitable for all pipeline sizes and all ferromagnetic pipelines including tight turns and various diameters
- Real-time pipeline inspection
- Lower cost and higher accuracy than conventional surveys

WOW Facts!

70% cost savings
compared to Inline
Inspection (ILI)
methods

500km of subsea
pipelines inspected
at PETRONAS facilities in Sabah
and Sarawak, and international
clients in Indonesia and Abu Dhabi







PETRONAS

2023 PETROLIAM NASIONAL BERHAD (PETRONAS)

All rights reserved. No part of this document may be reproduced, stored in a retrieval system or transmitted in any form or by any means (electronic, mechanical, photocopying, recording or otherwise) without the permission of the copyright owner. PETRONAS makes no representation or warranty. Whether expressed or implied, as to the accuracy or completeness of the facts presented. PETRONAS disclaims responsibility from any liability arising out of reliance on the contents of this publication.

www.petronas.com.my